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# ScienceSpark

## Book 7



**Authors**

Anita Paul • Karuni Subrahmanyam
Deepika Parashari • Seema Sinha

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# Contents

# 1 Basic Chemistry

**You will learn about**

- Chemical symbols
- Valency
- Formula

Chemistry is the study of science where we study the properties, composition, and characteristics of matter. Matter is made up of one or more of the several naturally occurring elements in the universe. Do you know what an element is? An *element* is a substance that cannot be broken down into simpler substances by any ordinary reaction. Examples of elements are sodium, potassium, etc. We represent the element by a symbol.

A *symbol* is the short form of the name of an element. It is the first letter of the English name, the first letter along with one more letter of the English name, or one or two letters of the Latin name of an element.

The symbol of hydrogen is H derived from its English name and the symbol of sodium is Na derived from its Latin name.

Some elements represented by their symbols are represented below.

| Element (English name) | Symbol | Element—Latin name | Symbol |
|---|---|---|---|
| Hydrogen | H | Sodium—*natrium* | Na |
| Oxygen | O | Potassium—*kalium* | K |
| Aluminium | Al | Iron—*ferrum* | Fe |
| Calcium | Ca | Copper—*cuprum* | Cu |

An element is made up of atoms. *Atoms* are the basic unit of chemistry. Atoms combine to form *molecules*. A molecule can exist independently, for example, two atoms of hydrogen form a hydrogen molecule which can exist independently, but an atom of hydrogen cannot.

The *valency* of an element is its ability to combine with another element. It is measured by the number of hydrogen (H) or chlorine (Cl) atoms that the atom of the element can combine with. H and Cl are *univalent*, *i.e.*, their valency is 1. Elements which do not combine with hydrogen combine with chlorine. Elements with valencies 1, 2, 3, and 4 are mono-, bi-, tri-, and tetravalent, respectively, and the naming continues according to the valency. Some elements have variable valencies. Examples are iron (having valencies 2 and 3), copper (having valencies 1 and 2), etc.

Some common elements are tabled below according to their valencies.

| Monovalent | Bivalent/ divalent | Trivalent |
|---|---|---|
| Hydrogen | Oxygen | Nitrogen |
| Chlorine | Magnesium | Aluminium |
| Potassium | Manganese | |
| Sodium | Calcium | |

A *formula* represents the number of atoms of the elements in a molecule. For example, we know that two atoms of the element hydrogen form a molecule of hydrogen. The formula will be $H_2$, where 2 is a subscript representing the number of atoms. A molecule having two atoms of the same element is said to be *diatomic* as in hydrogen. An example of a *triatomic* gas is ozone ($O_3$). Noble gases are highly inactive gases present in minute quantities in the air. They have one atom in their molecule and are therefore *monoatomic*.

When atoms of two or more elements combine, a molecule of a *compound* is formed. The chemical formula of a compound made of two elements is obtained by the exchange or transposition of their valencies.

For example:

- The valency of hydrogen is 1 and oxygen is 2. Therefore, if their valencies are exchanged or transposed, the formula of water is $H_2O$.
- A variation from this example is the formula of carbon dioxide ($CO_2$) where the valency of carbon is 4 and oxygen is 2, but the formula is not $C_2O_4$. Here the subscripts are divisible by a common factor, *i.e.*, 2. Hence the formula is $CO_2$.

Elements which have more than one valency are said to have variable valencies, *e.g.*, iron. Iron oxides with two formulae (plural for 'formula') can be found, *i.e.*, FeO and $Fe_2O_3$ where iron (Fe) has valencies of 2 and 3, respectively.

*Chemical changes* will occur when elements or compounds react among themselves and they are represented by chemical reactions. We will study about chemical reactions in Chapter 6.


**Element:** a substance that cannot be broken down into simpler substances

**Symbol:** the short form of the name of an element

**Molecule:** atoms combine to form molecules

**Valency:** the ability of an element to combine with another element

**Variable valency:** when an element has more than one valency

**Compound:** formed when atoms of two or more elements combine

**Formula(ae):** represents the number of atoms of the elements in a molecule; in case of a compound, it is an exchange or transposition of the valencies of the elements

**Chemical changes:** changes that occur when elements or compounds react among themselves and are represented by chemical reactions


- Matter is made up of one or more of the several naturally occurring elements in the universe.
- An element is a substance that cannot be broken down into simpler substances by any ordinary reaction.
- An element is made up of atoms. Atoms are the basic unit of chemistry. Atoms combine to form molecules.

- The valency of an element is its ability to combine with another element. It is measured by the number of H or Cl atoms that the atom of the element can combine with.
- When atoms of two or more elements combine, a molecule of a compound is formed.
- The chemical formula of a compound made of two elements is obtained by the exchange or transposition of their valencies.
- Elements which have more than one valency are said to have variable valencies.
- A formula represents the number of atoms of the elements in a molecule.
- Chemical changes will occur when elements or compounds react among themselves and they are represented by chemical reactions.

## Put on your THINKING CAP!

***1. Choose the correct option.***

a) The short form of the name of an element is

i) atom ii) molecule

iii) symbol iv) none of these

b) The valencies of two elements in a compound are _____ to obtain the formula.

i) subtracted ii) added

iii) retained iv) exchanged

c) Ozone is a _____ gas.

i) monoatomic ii) diatomic

iii) triatomic iv) none of these

d) What is the valency of Cl in $CaCl_2$?

i) 1 ii) 2

iii) 3 iv) 4

***2. Write T for true and F for false and correct the false statements.***

a) Nitrogen is bivalent. ☐

b) The symbol of iron is I. ☐

c) The valency of oxygen is 2. ☐

d) Atoms of an element form a compound. ☐

***3. Write short answers.***

a) What is meant by variable valency? Give two examples of elements which have variable valency.

b) Chemical formula of a compound made of two elements is obtained by the exchange or transposition of their valencies. Explain with an example.

c) If the symbol for hydrogen is 'H', why is the symbol for potassium 'K' instead of 'P'?

# 2 Nutrition in Plants

**You will learn about**

- Modes of nutrition
- Autotrophic nutrition in plants
- Heterotrophic nutrition in plants
- Symbiosis

All living organisms need food to survive. Food provides the essential nutrients (carbohydrates, fats, proteins, vitamins, and minerals) that are required by the body of the organisms to perform various life activities.

Organisms like plants can make their own food, but animals, including humans, cannot make their own food. Animals get their food from plants or other animals that eat plants. Thus, all animals are directly or indirectly dependent on plants to fulfil their food requirements.

**Infobit**

*Nutrition* is derived from the Latin word *nutrire*, which means to feed, nurse, support, and preserve. Essentially, nutrition refers to the variety of ways in which the body makes use of food.

## Modes of nutrition

The food eaten by the animals is broken down into simple substances to get energy. The process of taking in food and utilizing it for various life processes is called *nutrition*.

There are two modes of nutrition: autotrophic and heterotrophic.

Organisms that can synthesize or make their own food with the help of simple inorganic substances like carbon dioxide and water are called *autotrophs* (auto: self; troph: nutrition). This mode of nutrition is called *autotrophic nutrition*. All green plants belong to this group.

Organisms which obtain their energy by breaking down food obtained from other organisms are called *heterotrophs* (hetero: other; troph: nutrition). They get their food either from plants or from animals that eat plants. This mode of nutrition is called *heterotrophic nutrition*.

## Autotrophic nutrition in plants

Here, we will learn about how green plants prepare their food and how this food is transported to various parts of the plants. Green

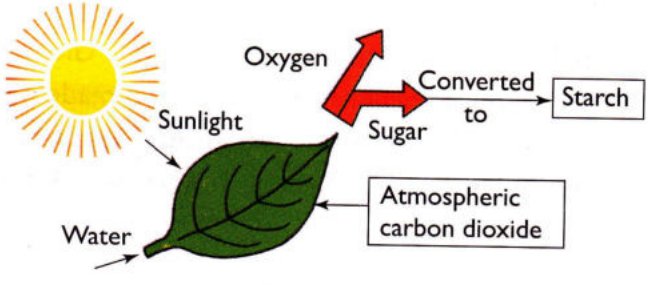



*Fig 2.1 Photosynthesis*

plants prepare their food by the process of photosynthesis.

## Photosynthesis

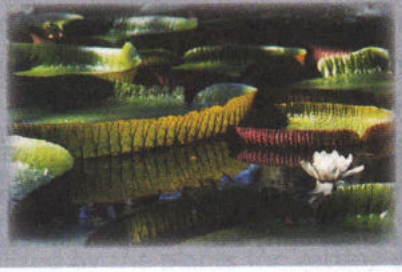
In green plants, the food is prepared by the leaves. The leaves of these plants contain a green pigment called *chlorophyll* that gives them the green colour. Chlorophyll absorbs sunlight. Energy of the sunlight is then used by the leaves to synthesize (prepare) food from carbon dioxide and water. This process of synthesis of food by the leaves in the presence of sunlight is called *photosynthesis* (photo: light; synthesis: to make). Thus, leaves are considered as food factories or kitchens of the plants.

The food thus prepared by the leaves is stored in the form of starch. By checking the presence of starch in a leaf, one can find out whether a leaf has undergone photosynthesis or not. Perform Activity 1 to demonstrate this.

Let us now study about each component required for photosynthesis.

***Carbon dioxide*** Carbon dioxide present in the air enters the leaf through small openings on its surface. These openings are called *stomata* (singular: *stoma*). Each stoma is surrounded by two guard cells and several epidermal cells. The guard cells regulate the opening and closing of the stomata.

**Infobit** The largest leaves grow on the Amazon water lily plant. In a year, the plant produces leaves more than 2 m (6.6 ft) wide.



**ACTIVITY 1**

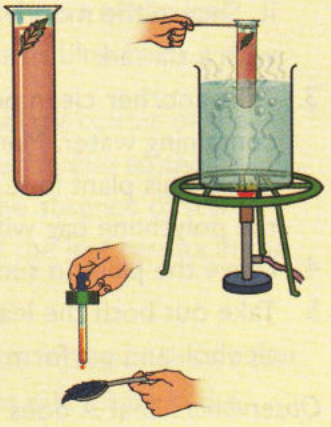
**To demonstrate the occurrence of photosynthesis in a healthy leaf**

*(To be demonstrated by the teacher)*

*Things required:* A green leaf, alcohol, burner, test tube, beaker, forceps, water, iodine solution

*Method:*

1. Take a leaf from a healthy plant and put it in a test tube containing alcohol.
2. Place the test tube with the leaf in the beaker filled with water.
3. Keep the complete setup over the burner and let it boil till all the chlorophyll is removed from the leaf, *i.e.*, the green colour of the leaf disappears.
   [**Caution**: Do not heat the test tube containing alcohol directly on the burner as it is inflammable.]
4. Using forceps carefully take the leaf out and wash it in water. Put a few drops of iodine solution on the leaf.



*Observation:* You will see the leaf turning blue-black in colour.

*Explanation:* When iodine is added to starch, its colour changes to blue-black. Thus, change in colour of the leaf to blue-black on adding a few drops of iodine solution indicates the presence of starch.

*Conclusion:* The presence of starch confirms that the process of photosynthesis was carried out in the leaf.

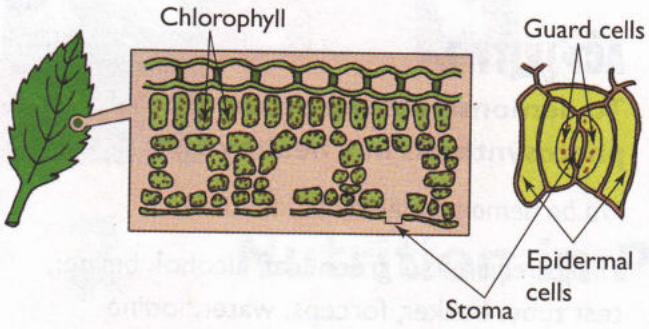



*Fig 2.2 Stoma*

## ACTIVITY 2

*(To be demonstrated by the teacher)*

*Things required:* A green leaf, alcohol, burner, test tube, beaker, forceps, water, iodine solution, two polythene bags

*Method:*

1. Place a plant in the dark for at least 24 hours to de-starch its leaves.
2. Take a clean polythene bag containing soda lime. Mark it A. Dip a leaf of this plant in it. Secure the mouth of the polythene bag with a thread.
3. Take another clean polythene bag containing water. Mark it B. Dip another leaf of this plant in it. Secure the mouth of the polythene bag with a thread.
4. Leave the plant in sunlight for six hours.
5. Take out both the leaves, boil them in alcohol, and perform the iodine test.

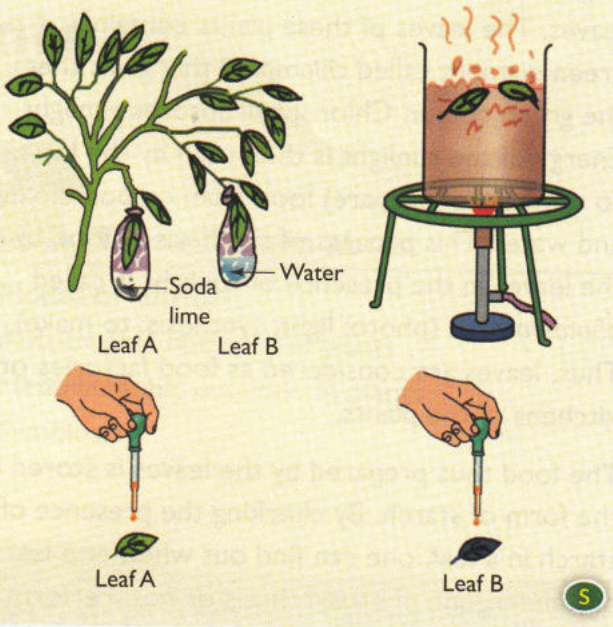
*Observation:* Leaf A does not turn blue-black in colour when the iodine test is performed whereas leaf B does.

*Explanation:*

**Leaf A:** As the soda lime absorbs all the $CO_2$ in the plastic bag, no carbon dioxide was available for the leaf to carry out photosynthesis and thus no starch was synthesized. This led to the negative iodine test, *i.e.*, the leaf did not turn blue-black.

**Leaf B:** Carbon dioxide was available to the leaf to carry out photosynthesis. Thus, starch was present which led to a positive iodine test, *i.e.*, the leaf turned blue-black.

*Conclusion:* Carbon dioxide is necessary for photosynthesis.




***Water*** Another raw material required for photosynthesis is water. Water and minerals present between the soil particles are absorbed by the roots and transported to the leaves. The transportation of water takes place through the pipe-like vessels present in the stem called xylem.

***Chlorophyll*** Photosynthesis takes place in leaves that contain a green pigment called chlorophyll. Let us conduct Activity 3 to prove that chlorophyll is essential for photosynthesis to occur.

If plants require chlorophyll for carrying out photosynthesis, then why are some leaves variegated or coloured?

Leaves contain substances called *pigments* that give them their colour. The abundance of the green pigment called chlorophyll in green plants gives them the green colour. The plants which have an abundance of non-green pigments show a different colour. But they too have some amount of chlorophyll that helps them to make their food.

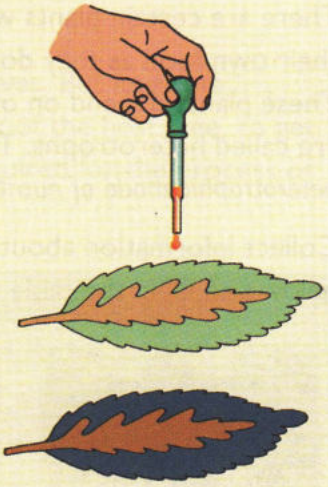
## ACTIVITY 3

*(To be demonstrated by the teacher)*

*Things required:* A variegated leaf (a leaf with different colours), alcohol, burner, test tube, beaker, forceps, water, iodine solution

*Method:*

1. Take a fallen variegated leaf from a Croton or Coleus plant.
2. Do the iodine test for the presence of starch as you did in Activity 1.



*Observation:* The parts of the leaf which were green turned blue-black whereas the other parts coloured differently did not.

*Explanation:* The green parts of the leaf contained the pigment chlorophyll, synthesized starch, and thus turned blue black with the addition of iodine solution.

*Conclusion:* Chlorophyll is necessary for a leaf to synthesize starch during photosynthesis.

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**Sunlight** Photosynthesis is the process that takes place in the presence of sunlight. During photosynthesis, the solar energy is converted into chemical energy which is stored in the form of sugar.

Let us now conduct an activity to prove it.

### Products of photosynthesis

Plants synthesize food in the form of carbohydrates during photosynthesis. Glucose is the immediate product of photosynthesis. This is utilized by the plants for getting energy.

## ACTIVITY 4

**To demonstrate that sunlight is necessary for photosynthesis**

*(To be demonstrated by the teacher)*

*Things required:* A potted plant with green leaves, thick black paper, spirit, burner, test tube, beaker, forceps, iodine solution, alcohol

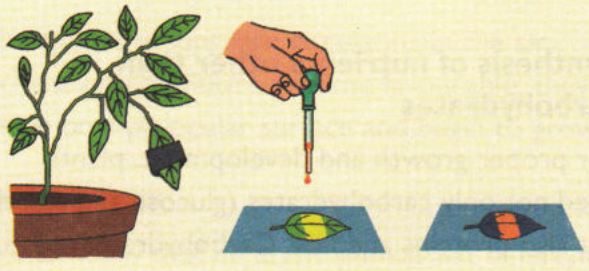
*Method:*

1. Keep the potted plant in dark for two days.
2. Cover the middle part of a leaf of this plant with black paper so that it does not get any sunlight.
3. Keep the plant in sunlight for a day.
4. Perform the iodine test on the leaf (as demonstrated in Activity 1).

*Observation:* You will notice that the part of the leaf that was deprived of sunlight turns yellow-brown while the part of the leaf exposed to sunlight turns blue-black.

*Explanation:* The blue-black colour of the exposed part of the leaf is due to the presence of starch. The absence of starch in the covered part of the leaf results in the yellow-brown colour.

*Conclusion:* The absence of starch shows that photosynthesis did not take place in the part of leaf that was deprived of sunlight. This shows that sunlight is necessary for photosynthesis.



S

The extra glucose is converted into starch and stored in different parts of the plant like stems, roots, and fruits. Oxygen is also released as a by-product of photosynthesis. This oxygen is essential for the survival of all living organisms.

The overall process of photosynthesis can be represented in the form of the following equation:

$$\text{Carbon dioxide} + \text{water} \xrightarrow[\text{chlorophyll}]{\text{light energy}} \text{carbohydrates} + \text{oxygen}$$

Or

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light energy}} C_6H_{12}O_6 + 6O_2$$

**Infobit** Vast forests in many tropical areas of the world are often called the 'lungs of the world' because they produce a large amount of oxygen.

### Algae

You might have seen green patches on the surface of ponds or lakes. These are *algae*. Algae are mostly found in sea, freshwater, and in wastewater. They contain chlorophyll and manufacture their own food through photosynthesis.

*Fig 2.3 Green algae*

### Synthesis of nutrients other than carbohydrates

For proper growth and development, plants need not only carbohydrates (glucose and starch) but also proteins and fats. Carbohydrates are composed of the elements carbon, oxygen, and hydrogen (carb: carbon; o: oxygen; hydrates: hydrogen). These elements are used for the synthesis of fats and proteins. However, synthesis of proteins also requires nitrogen. Although nitrogen is present in abundance in the atmosphere, plants cannot use this free nitrogen. Some nitrogen-fixing bacteria present in the soil fix this nitrogen into a soluble form which is then absorbed by the plants through the roots. Sometimes farmers add nitrogenous fertilizers to the soil to be used by plants.

## Heterotrophic nutrition in plants

There are certain plants which cannot synthesize their own food as they do not have chlorophyll. These plants depend on other plants for food and are called heterotrophs. They, therefore, exhibit *heterotrophic mode of nutrition.*

Collect information about the plants shown below and fill in the table that follows.

*(a) Cuscuta*

*(b) Mushroom*

*(c) Mistletoe*

*Fig 2.4 Heterotrophic plants*

| Name of the plant | Presence/ absence of leaves | Autotroph/ heterotroph |
|---|---|---|
| *Cuscuta* | | |
| Mushroom | | |
| Mistletoe | | |

Heterotrophic plants are further divided into the following categories:

- Parasitic plants or parasites

- Saprophytic plants or saprophytes
- Insectivorous plants or insectivores
- Symbiotic plants

## Parasites

A *parasite* is an organism that lives in or on another organism and derives nutrients from it. The organism from which a parasite derives its nutrients is called the *host*.

For example, *Cuscuta* (*amarbel*) is a leafless and rootless plant. It entangles itself around the host plant and derives food from it. It is often called the devil's hair.

Mistletoe has green leaves. But its roots penetrate into the bark of the host tree, to get water and minerals required for the process of photosynthesis.

**Infobit**

- Have you ever been bitten by a bed bug or head lice? These are animal parasites which derive their nutrients from humans. There are some parasites like hookworms and tapeworms which attack animals too.
- Our body is a walking colony of microscopic monsters—parasites. We cannot always see parasites but 75 per cent of the world's creatures belong to this group.

## Saprophytes

Take a moist piece of bread. Keep it in a dark and damp place for a few days.

You will observe the growth of white thread-like structures on the surface of the bread. This growth is a fungus called *bread mould*. It is a saprophyte.

Saprophytes are those organisms which cannot make their own food and obtain their nutrition from dead and decaying plant or animal matter. These organisms release digestive juices onto the

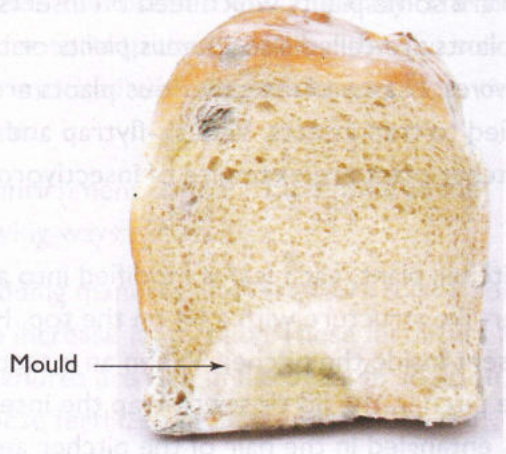



*Fig 2.5 Bread mould*

dead or decaying matter and convert it into a liquid form. They then absorb nutrients from it.

You might have observed small umbrella-like light brown structures growing on the logs of wood during the rainy season. These are called *mushrooms*.

*Fig 2.6 Mushroom*

A mushroom is also a fungi. Its mode of nutrition is saprotrophic. A mushroom is an edible fungi. However, not all varieties of mushroom are edible. Some varieties of mushroom are poisonous.

During the rainy reason, you may see white patches developing over leather items such as shoes and leather bags. These white patches are also fungi.

Where do the fungi in bread, wood, and leather come from?

The spores of fungi are circulating in the air. Whenever conditions become favourable, they settle on a particular surface and begin to grow.

## Insectivores

We all know that different animals eat different organisms. But have you ever seen or heard of plants eating animals?

There are some plants which feed on insects. Such plants are called *insectivorous plants* or *insectivores*. Leaves of insectivorous plants are modified to trap insects. Venus's-flytrap and the pitcher plant are examples of insectivorous plants.

In a pitcher plant, each leaf is modified into a pitcher-like structure with a lid on the top. Hair is present inside the pitcher. When an insect sits on the pitcher, the lid closes to trap the insect. It gets entangled in the hair of the pitcher and is killed by the digestive juices secreted inside the pitcher.

In a Venus's-flytrap, each leaf consists of two lobes. The inner surface has short stiff hair and is reddish in colour to attract insects. The moment an insect touches the hair, the lobes mesh up together to trap it.

Observe the pictures of the pitcher plant and Venus's-flytrap. What is the colour of their leaves?

*(a) Pitcher plant*

*(b) Venus's-flytrap*

*Fig 2.7 Insectivores*

Does this indicate that these plants also perform photosynthesis? The soil in which these plants grow is deficient in certain nutrients. These plants eat insects to fulfil their nutrient requirements.

**Let's Talk** Are pitcher plants and Venus's-flytraps also parasites? Why or why not? Discuss with your teacher.

The giant pitcher plant, which is believed to be the world's largest meat-eating shrub, attracts rodents and frogs into its slipper-shaped mouth and dissolves them with acid-like enzymes.

## Symbiosis

Study the following table that contains the names of a few organisms that live in association with each other.

| Organisms | Who gains | Who loses |
|---|---|---|
| *Cuscuta* and host tree | *Cuscuta* | Host tree |
| Oxpecker and rhinoceros | Both gain—oxpecker gets food and rhinoceros gets rid of parasites | |

In the first relationship, the *Cuscuta* plant gains nutrients whereas the host tree loses essential nutrients. It is, therefore, a *parasitic relationship* where only one organism gains.

In the second relationship, the oxpecker eats ticks and other parasites that live on the skin of the rhinoceros. The rhinoceros, on the other hand, gets rid of the parasites. Both organisms are thus mutually benefitted from each other. Such relationships where two organisms benefit from each other by sharing their resources and shelter are known as *symbiotic relationships*.

*Lichen* is an example of a symbiotic relationship between an alga and a fungus. Recall that alga is an autotroph and fungus is a saprotroph. Fungus provides shelter, water, and minerals from the soil to the alga. The alga, in return, prepares food for the fungus by photosynthesis.

*Fig 2.8 Lichen*

**ACTIVITY 5**

The human body is another example of a symbiotic relationship. Human beings depend on bacteria to produce a certain vitamin. Do you know which vitamin this is?

**Hint:** This vitamin can also be obtained from green leafy vegetables like lettuce and spinach. It is required for the proper clotting of blood.

## Enriching the nutrients in the soil

Plants constantly need nutrients for their growth. They absorb these nutrients from the soil. However, continually growing crops on the same field makes it deficient in vital nutrients like nitrogen. The soil does not get enough time to replenish the lost nutrients naturally. Therefore, in order to keep the plants healthy, the soil needs to be enriched with these nutrients from time to time.

The enrichment of soil can be done in the following ways:

1. Adding manures and fertilizers to the soil to increase its fertility. These fertilizers and manures are rich in nitrogen. In addition, these fertilizers contain potassium and phosphorus.
2. By growing leguminous plants like gram and peas in the field. The roots of leguminous plants contain *Rhizobium* bacteria which can fix atmospheric nitrogen into a soluble form in the soil.

Leguminous plants and *Rhizobium* share a symbiotic relationship with each other. *Rhizobium* cannot make its own food and therefore gets food and shelter from these plants. The bacteria in return provide the plants with nitrogen.

**Infobit**

- Lichens serve as a major food source for many types of animals including reindeer. Therefore, lichen is often called *reindeer moss*.
- Lichens are also brewed as tea in some places. They are also used as dyes to colour the textiles.


**Autotrophs:** organisms that can synthesize their own food with the help of simple inorganic substances like carbon dioxide and water

**Heterotrophs:** organisms that obtain their energy by breaking down food obtained from other organisms

**Photosynthesis:** the process by which green plants synthesize their food using carbon dioxide and water in the presence of sunlight and chlorophyll

**Symbiotic relationship:** relationships where two organisms benefit from each other by sharing their resources and shelter


- Nutrition is the process of taking in food and utilizing it for various life processes.
- Parasitic organisms derive their food from living organisms.
- Saprotrophic organisms derive their food from dead and decayed matter.
- Some plants are *insectivorous* in nature and thus their leaves are modified to trap insects.

## Put on your THINKING CAP!

***1. Select the correct option.***

a) The nutrients required by plants to make proteins are
   i) carbon, hydrogen, potassium, oxygen
   ii) carbon, nitrogen, potassium, oxygen
   iii) carbon, hydrogen, nitrogen, oxygen
   iv) phosphorus, hydrogen, potassium

b) Iodine shows blue-black colour with
   i) glucose
   ii) protein
   iii) starch
   iv) fat

c) Photosynthesis converts
   i) solar energy to mechanical energy
   ii) mechanical energy to solar energy
   iii) solar energy to chemical energy
   iv) chemical energy to solar energy

d) Mode of nutrition in fungi is
   i) autotrophic
   ii) parasitic
   iii) saprophytic
   iv) insectivores

e) Lichen is an example of
   i) autotrophic plant
   ii) heterotrophic plant
   iii) symbiotic relationship
   iv) none of these

f) Organisms that can synthesise their own food with the help of simple inorganic substances are called
   i) autotrophs
   ii) saprophytes
   iii) parasites
   iv) carnivores

g) Mushroom is an edible
   i) alga
   ii) fungus
   iii) parasite
   iv) bacterium

h) _____ is an insectivorous plant.
   i) *Cuscuta*
   ii) mistletoe
   iii) Venus's-flytrap
   iv) neem

***2. Fill in the blanks.***

a) _____ is the immediate product of photosynthesis.

b) The ultimate source of energy on Earth is _____.

c) *Rhizobium* fix _____ to _____.

d) The small openings on the leaf which allow gaseous exchange are called _____.

e) In a _____ relationship both organisms benefit from each other.

f) The process of taking in food and utilizing it for various life processes is called _____.

g) _____ are organisms that can synthesize their own food with the help of simple inorganic substances like carbon dioxide and water.

h) The organisms which obtain their energy by breaking down food obtained from other organisms are called _____.

i) The plants which feed on insects are called _____.

j) _____, sunlight, carbon dioxide, and water are essential components for the process of photosynthesis.

**3. *Match the following:***

| | |
|---|---|
| a) chlorophyll | i) *Rhizobium* |
| b) symbiosis | ii) pitcher plant |
| c) parasite | iii) starch |
| d) nitrogen fixing | iv) lichen |
| e) insectivorous plant | v) mistletoe |

**4. *Write short answers.***

a) Write down the complete equation of photosynthesis.

b) What is the mode of nutrition of algae?

c) Write the similarity between the following pairs.

i) Bread mould and mushroom

ii) Venus's-flytrap and pitcher plant

iii) Mistletoe and *Cuscuta*

iv) *Rhizobium* in leguminous plants and lichen



**5. *Answer in details.***

a) How is water transported to the leaves for photosynthesis?

b) Draw the structure of stomata in the leaves.

c) Plants can synthesize only carbohydrates. Then, how is the requirement of other nutrients met in plants?

d) Are all plants autotrophs? Support your answer with suitable examples.

e) Write the role of the following:

i) Stomata ii) Chlorophyll iii) Guard cells

f) How are the leaves of pitcher plant modified to catch insects?

g) How do fungi and algae benefit from each other? What is this relationship called?

h) Give reasons for the following:

i) The Venus's-flytrap and pitcher plant perform photosynthesis, yet they trap insects.

ii) In the absence of photosynthesis, life is not possible on Earth.

iii) Fungi can be useful as well as harmful for humans.

iv) Saprophytes are called cleaners of the environment.

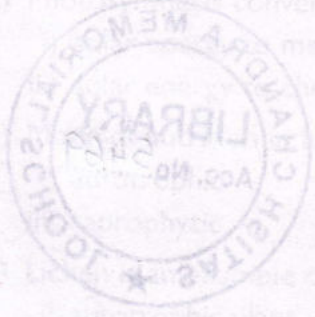
i) Give one similarity and one dissimilarity between parasites and saprotrophs.

## Extended learning

1. Conduct the following experiment.
   Take three potted plants of the same height. Label them A, B, and C. Water pot A with distilled water, pot B with tap water, and pot C with salt water for a week.
   Note down your observations and give reasons for your answer.
2. What type of relationship would you like to have with your friend—symbiotic or parasitic? Justify.

HIGHER ORDER THINKING SKILLS
**HOTS**

1. Leaves are called the kitchens of the plants. We also make our food in the kitchen. Are we autotrophs too?
2. Why are plants not found on the ocean bed?
3. Raju is a poor farmer. He cannot spend money on buying fertilizers. What suggestion will you give him to increase fertility of his farmland?
4. Sumit had lunch in school but forgot to take home his lunch box on Saturday. When he opened it on Monday, he found that it had some blackish brown cotton-like stuff in it. What was it? How do you think it got there?




For more information
http://www.ncagr.gov/cyber/kidswrld/plant/
http://www.mastergardenproducts.com/gardenerscorner/plant_nutrients.htm
http://biology.clc.uc.edu/courses/bio104/photosyn.htm

# 3 Nutrition in Animals

**You will learn about**

- Modes of nutrition in animals
- Human digestive system
- Digestion in grass-eating animals
- Digestion in amoeba

All living things need food to survive. Food contains special substances called *nutrients*. There are five different types of nutrients that give us energy, help in the growth and repair of body tissues, and keep us free from diseases.

You have learnt about the different nutrients in your previous classes. Write down the names of these nutrients and their specific functions in the table provided below.

| Nutrient | Function |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

There are basically two modes of nutrition—*autotrophic* and *heterotrophic*.

As discussed in Chapter 2, green plants manufacture their own food. So, they are called *autotrophs* and their mode of nutrition is called *autotrophic nutrition*.

## Modes of nutrition in animals

Animals are heterotrophs. They depend on plants directly (herbivores) or indirectly (carnivores) for their food. Some animals (omnivores) depend on both plants and animals for their food. Some living organisms feed on dead and decaying organic matter. These organisms are called *saprophytes*. Some living organisms get their food by living on or in another living organism. These are called *parasites*.

Since animals eat different types of food, they have different types of feeding organs. *Herbivores* have sharp front teeth for biting and strong broad teeth for chewing. *Carnivores* possess sharp pointed and curved teeth for tearing the flesh. *Omnivores* have strong grinding teeth for chewing flesh and bones.

Animals obtain their food through a broad variety of feeding patterns.

- Mosquitoes and leech have their mouth parts adapted for piercing and sucking blood from the body of human beings.
- Snakes swallow their food whole.
- Elephants have long trunks. They lift their food with the trunk and put it into their mouths.
- Birds have beaks and claws.
- Rabbits, rats, and squirrels have sharp front teeth to gnaw seeds and fruits.

- Animal species such as sponges, which are the simplest organisms, feed on small particles of food suspended in water that enter their body through their pores. This is called *filtering*.
- Oysters feed by filtering materials through a layer of mucus in their gills.
- Butterflies and moths have coiled mouth parts (*proboscis*) that unwind to straight tubes when feeding. With the proboscis the insects probe to the base of the flowers to suck up liquid nectar.
- Some animals feed on food masses and they usually have organs for seizing, chewing, capturing, and biting food.

*(a) Leech and mosquito sucking blood* *(b) Squirrel gnawing seeds*

*Fig 3.1 Different feeding methods*

Given below are some modes of feeding shown by certain animals. Find out the animals which show these feeding modes and write their names in the space provided.

**Infobit**

Starfish graze on the surface of the rocks present in the seabed scraping off the layer of algal growth similar to the action of a suckerfish in an aquarium.

**Infobit**

- For hundreds of years, the ancient Greeks were of the view that all food contained a single essential nutrient since people were able to survive on varied diets. It was not until the 1700s that people started analyzing food and began realizing that a range of different food stuffs was necessary for staying healthy.
- In 1800s, a soldier, Alexis St Martin, shot in the stomach survived the gunshot wound but was left with a gaping hole in his abdomen. William Beaumont, an American doctor, observed the inner workings of the soldier's stomach through this hole and concluded that the stomach did not grind food mechanically but dissolved it with the help of fluids released from the stomach at different rates, depending on the type of food eaten.

| | |
|---|---|
| Sucking | |
| Scraping | |
| Cutting/chewing | |
| Sponging | |
| Siphoning | |
| Gnawing | |
| Swallowing | |

## Digestion

Can the body use the food in the form in which it is eaten? Surely not! Every morsel that you put in your mouth and swallow is processed in the digestive system of the body. The nutrients present in food are complex substances. These need to be broken down into simpler substances. The process of breaking down complex food molecules into simpler molecules that can be used by the body is called *digestion*.

Different animals have different digestive systems according to the food they take in and how they take it in.

## Human digestive system

The digestive system is made up of a long tube called the *alimentary canal* or *digestive tract*, which starts from the mouth and ends at the anus. It is about 9–10 m long and consists of:

- mouth and pharynx
- oesophagus (foodpipe)
- stomach
- small intestine
- large intestine (caecum, colon, rectum)
- anus

Digestion has two parts—mechanical and chemical. Mechanical digestion is the physical breakdown of food by chewing and churning of food. In chemical digestion, chemical compounds, called *enzymes*, secreted by different organs of the digestive tract break down large and complex substances like carbohydrates, fats, and proteins into their simplest form.

Have you ever thought what happens to the yummy sandwich which you eat? How do we get energy from it?

Let us understand the role of various body parts during the journey of food through the digestive tract. The time taken for food to go from the mouth to the anus varies from person to person

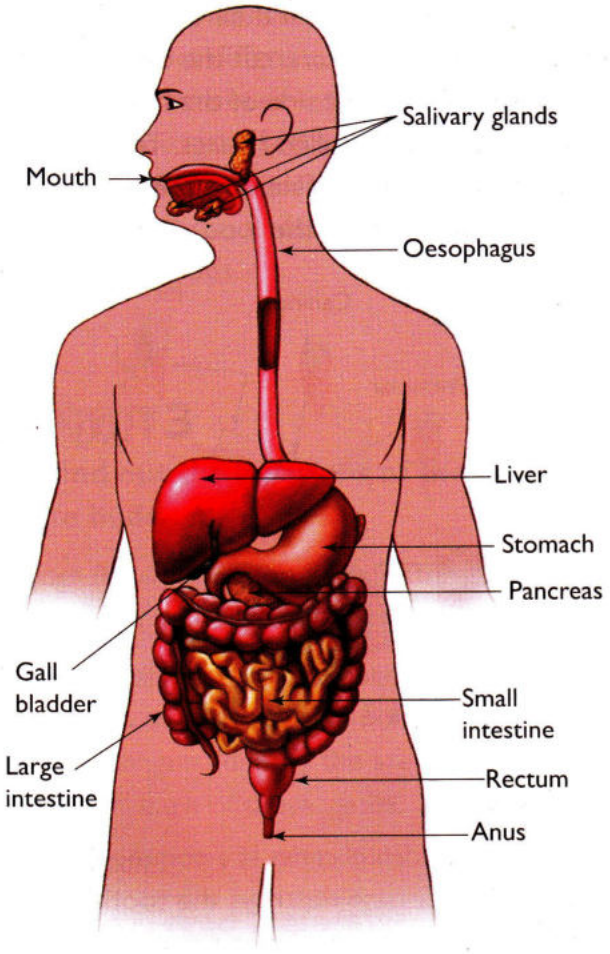



*Fig 3.2 Human digestive system*

but can range from 12 to 48 hours, depending on the type of food eaten.

## Mouth and buccal cavity

Most animals, including humans, take food inside their body through the mouth. The process of taking food into the body is called *ingestion*.

Our mouth starts watering at the sight or smell of an ice cream or even at the thought of yummy foods. Do you know what this watery liquid is? It is *saliva*, a digestive juice produced by the *salivary glands* present in our mouth underneath the back of our tongue.

The teeth break down food into smaller pieces. This is called *mastication*.

An adult human being has 32 teeth. Teeth vary in shape based on their function. Look at your teeth

and use your finger to feel their shape. The teeth in the front, called *incisors*, cut the food into bite-sized pieces. On either side of the incisors are sharp, pointed teeth called *canines*. These tear the food. Behind the canines are the *premolars* and *molars*, which grind the food.

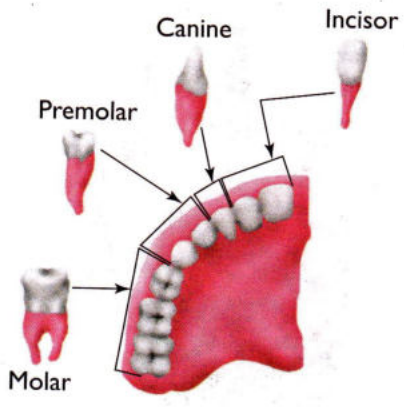



*Fig 3.3 Human teeth*

## Dental care

*Tooth decay* or *dental caries* is a common dental disease. This disease destroys the tooth's structure and produces holes called *cavities*. When food particles get stuck in the space between two teeth, they are acted upon by the bacteria which are already present in the mouth. Bacteria form a sticky colourless film on the teeth called *plaque*. This leads to production of certain acids that slowly damage the teeth leading to cavities.

When plaque is not removed, it accumulates on the gums and teeth and hardens into a lime-like substance called *tartar*. This leads to a disease called *pyorrhoea*. People suffering from pyorrhea have shiny and bright-red swollen gums which tend to bleed easily.

Do you now realize why it is so important to brush your teeth twice a day?

*Fig 3.4 Diseased teeth*

The process of digestion starts in the mouth the moment you chew the food. *Mechanical digestion* of food happens when teeth break it into small pieces.

*Chemical digestion* of food in the mouth is done by saliva.

Take a small piece of bread and chew it. Do you feel the difference in its taste after chewing? It starts tasting sweet. This is because saliva contains an enzyme called *amylase* that converts carbohydrates into simple sugar molecules. Let us perform the following activity to see the action of saliva on carbohydrates.

### ACTIVITY 1

- Ask one of your friends to open his mouth. Count the number of each type of teeth in the upper and lower jaw and complete the table given below.

| Teeth type | Number in the lower jaw | Number in the upper jaw |
|---|---|---|
| Incisors | | |
| Canines | | |
| Premolars | | |
| Molars | | |

## ACTIVITY 2

**Action of saliva on carbohydrates**

*Things required:* Two test tubes, boiled rice, iodine

*Method:*

1. Label one test tube as A.
2. Put some boiled rice in it.
3. Add a few drops of iodine on the boiled rice.
4. Look for a change in colour.
5. Label the other test tube as B.
6. Take some boiled rice and chew it.
7. Put the chewed rice in the test tube B and add a few drops of iodine on it. Again, look for a change in colour?

*Observation:*

- In test tube A, when iodine is added to boiled rice, it turns blue-black due to the presence of starch in rice.
- In test tube B, there is no change in the colour as the starch present in the rice has been acted upon by saliva and changed into sugar.

**Infobit** The body produces about one litre of saliva every day and 95 per cent of the saliva is water.

## Tongue

The tongue is a fleshy muscular organ, attached at the back to the bottom of the mouth. It is unattached at the front, which enables it to move freely.

The surface of the tongue is not smooth; it is quite rough due to the presence of thousands of tiny bumps, called *taste buds*. The taste buds help us to detect different tastes. There are four kinds of taste buds—salty, sweet, sour, and bitter. Can you identify the location of each of these kinds of taste buds? Let us perform the following activity to find out the location of different taste buds.

## ACTIVITY 3

**To find out the locations of the different taste buds**

*Things required:* Lemon juice, bitter gourd juice, sugar solution, salt solution

*Method:* With the help of cotton swabs, put a few drops of each solution in different parts of your tongue. Identify the areas where you could feel each of these tastes.

*Observation:*

- Salty and sweet buds are present at the tip of the tongue and about half way back along its sides.
- Sour taste buds are present all the way back along the sides.
- Bitter buds are denser at the back of the tongue.

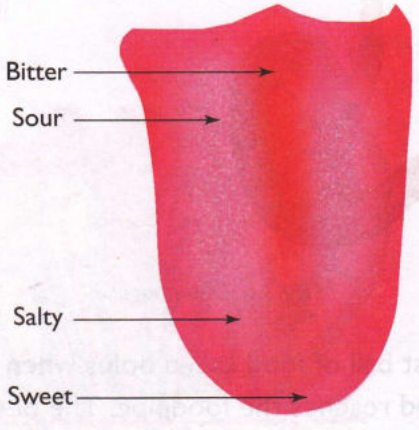



*Fig 3.5 Tongue*

In addition to identifying taste, the tongue also helps us in the following ways:

- It helps us to talk.
- It moves food around our mouth while we chew it.
- It mixes saliva with food while chewing and helps us swallow the chewed food.

## The oesophagus

The tongue pushes the food from the mouth towards the pharynx from where it reaches the foodpipe, also known as the *oesophagus*.

It is always advised not to talk or laugh while eating and never to eat in a hurry. Do you know the reason for it?

The windpipe and foodpipe lie close to each other but pharynx is a common passage for the food and the air. There is a flap-like structure, called *epiglottis*, which closes the opening of the windpipe while eating. This prevents the entry of food into the windpipe. If we talk or eat in a hurry, the epiglottis may not close and entry of food particles in the windpipe may result in choking, coughing, or hiccups.

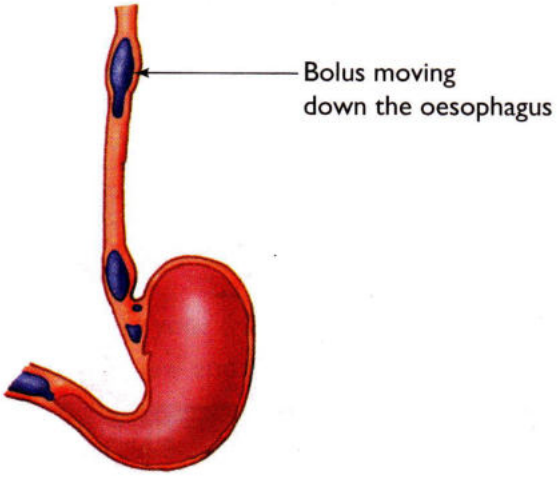



*Fig 3.6 Oesophagus*

The moist ball of food called bolus when swallowed reaches the foodpipe. The oesophagus is a long muscular tube in the chest that connects the mouth and throat to the stomach. Muscles in the wall of the oesophagus work in a coordinated manner by contractions and relaxations to push food and liquids down into the stomach. This movement of the wall muscles of the oesophagus is called *peristalsis*.

## Stomach

The food passes through the foodpipe into the stomach in just 10 seconds. Stomach is a J-shaped thick-walled pouch located on the left side of the abdomen. It is about 12 inches long and 6 inches wide at its widest point. An average adult's stomach can hold about two litres of food. The thick muscular walls of the stomach contract to churn the food to mix it with digestive juice produced by the cells lining the stomach. The digestive juice contains the enzyme pepsin that helps in breaking down proteins into amino acids.

**ACTIVITY 4**

*Things required:* A flexible straw, a small bead

*Method:* Take a flexible straw. Hold the straw vertically. Insert a small bead into the top of the straw. The bead should fit into the top of the straw. Pinch the straw above the bead so that the bead begins to move down the length of the straw. Continue to do so until the bead comes out from the other side.

Is this action similar to peristalsis? What do the straw and the bead represent?

The inner lining of the stomach muscles secretes hydrochloric acid. The acid kills bacteria present in the swallowed food. Some cells of the lining release mucous, which coats the stomach cells and protects them from the acid.

In the stomach, food is processed into a thick liquid called *chyme*. It then moves down towards the small intestine.

## Liver, gall bladder, and pancreas

The liver is the largest gland of our body weighing up to three kilograms in adult humans. It is reddish-brown in colour. It is located in the upper part of the abdomen, to the right of the stomach, and immediately below the diaphragm. It performs many important functions.

The liver produces bile, which is yellowish-green in colour.

Bile juice is stored in an elongated sac-like structure called *gall bladder*, which is connected to the liver by a duct called the *bile duct*. Bile helps to neutralize the acids from your stomach, so that digestion can continue. Bile is not an enzyme. It does not digest the food chemically. It mixes with the fats in the food to form small fat droplets. The droplets are then chemically broken down by enzymes produced in the pancreas.

The *pancreas* is an organ located between the stomach and the first part of the small intestine. It manufactures a number of enzymes, which act on all kinds of nutrients and change them into simpler forms.

## Small intestine

The small intestine (also known as the small bowel) is the longest portion of the digestive tract. It is more than six metres long and is located within the middle of the abdomen.

**Infobit** The small intestine was given this name because of its small diameter though it is very long. It is about half the diameter of the large intestine.

Much of the small intestine is coiled and suspended in a thin layer of fat, which gives the intestine a lot of flexibility and mobility. Most of the digestion process takes place in the small intestine. As the chyme enters the small intestine, it is mixed with a variety of intestinal juices which complete the digestion of all the complex components present in the food. It also receives enzymes from the associated organs like the liver, gall bladder, and pancreas.

***Digestion and absorption in the small intestine*** Pancreatic juice contains enzymes—pancreatic amylase, lipase, and trypsin. Amylase converts starch into sugar. Lipase converts fats into fatty acids and glycerine (or glycerol). Trypsin acts on proteins that were not digested in the stomach.

The intestinal juice released from the small intestine contains another protein digesting enzyme called *erepsin*. This enzyme completes the digestion of proteins into amino acids. The intestinal juice also contains sugar-splitting enzymes namely maltase, lactase, and sucrase. Maltase converts maltose into glucose. Lactase converts lactose into glucose and galactose. The enzyme sucrase acts on sucrose to convert it into glucose and fructose. Thus, digestion of food is completed in the small intestine.

The digested food can be utilized by our body only if it gets absorbed. The surface area of the small intestine is not sufficient to absorb all of the nutrients our body needs. The inner walls of the small intestine have many folds which contain millions of microscopic finger-like projections called *villi*.

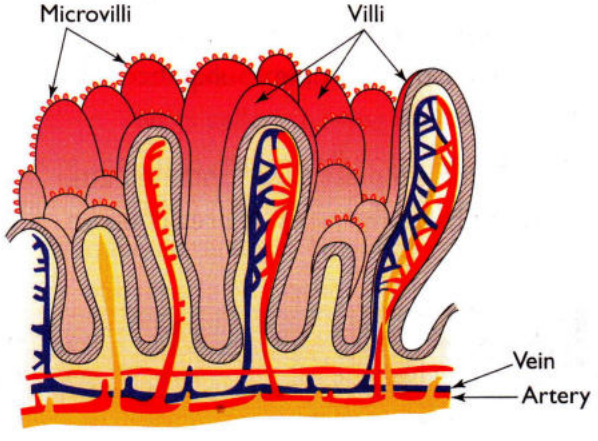



*Fig 3.7 Villi*

**Summary of digestion**

| Place of digestion | Glands | Secretion | Enzymes | Digestive activity |
|---|---|---|---|---|
| Mouth | Salivary gland | Saliva | Salivary amylase | Changes starch to sugar (maltose) |
| Stomach | | Digestive juices | Pepsin | Breaks proteins to smaller fragments called peptones |
| | | Hydrochloric acid | | Kills bacteria in the food<br>Activates pepsin |
| | Liver | Bile | | Breaks down fats |
| | Pancreas | Pancreatic juice | Pancreatic amylase | Changes starch into maltose |
| | | | Lipase | Changes fats into fatty acids and glycerine (or glycerol) |
| | | | Trypsin | Breaks down proteins into peptides |
| Small intestine | Intestinal gland | Intestinal juice | Erepsin | Breaks down peptides into amino acids |
| | | | Maltase | Changes maltose into glucose |
| | | | Lactase | Changes lactose into glucose and galactose |
| | | | Sucrase | Changes sucrose into glucose and fructose |

These projections increase the available surface area to absorb food and water. Each of these villi (singular: villus) contains many folds, known as *microvilli,* and a set of small blood vessels. The blood vessels transport the absorbed nutrients. The absorbed substances are carried to different organs where they get utilized to build proteins and other complex substances. This is called *assimilation.*

Glucose is the simplest sugar obtained after digestion of carbohydrates. It breaks down into carbon dioxide and water with the help of oxygen that we inhale. This process also releases energy.

**Infobit** The absorptive surface area of the small intestine is almost the size of a tennis court!

**Infobit** Do you know how we get energy from the digested food?

## Large intestine

After all the useful and digestible nutrients have been absorbed during the digestive process, a mixture of water and indigestible waste such as the fibres remains. It helps in the bowel movement and in getting rid of the waste. The mixture moves into the upper part of the large intestine known as the *colon.* The colon

is primarily responsible for absorbing water and some remaining salts from this mixture. The remaining matter compacts into a dense bundle known as faeces and reaches the rectum. It is finally removed through the anus by the process called *egestion*. This marks the end of the digestive process and the digestive tract.

To maintain a healthy digestive system, eat a healthy diet and eat moderately, slowly, and regularly.

**Infobit** There are some creatures which live in the digestive systems of other animals. For example, the tapeworm lives in the human intestine.

The large intestine has a tiny tube with a closed end called the *appendix*. It is a part of the digestive tract, but it does not seem to do anything. It can however cause problems if it gets infected and needs to be removed.

## Some digestion-related ailments

***Heartburn*** It is a discomfort or burning sensation caused in the chest. It is due to the contents of the stomach travelling upwards into the gullet (lower part of the oesophagus). The gullet cannot withstand acid and is irritated when acid from the stomach travels into it.

***Belching*** If you drink bubbly beverages or swallow air while eating, air collects in the stomach. It is then pushed back through the oesophagus and quickly comes out of the mouth. This is called *belching*. Three to four burps after a meal is considered normal—more than that may be the sign of a medical condition like ulcer.

***Vomiting*** Vomiting is the forceful expulsion of stomach contents from the mouth through the oesophagus.

***Diarrhoea*** It is the passage of three or more loose or liquid stools per day. It is usually a symptom of gastrointestinal infection, which can be caused by bacteria, virus, or parasites spreading through contaminated food, unclean drinking water, or as a result of poor hygiene. It leads to loss of fluids from the body, *i.e.*, dehydration, which may even prove fatal particularly in young children. Diarrhoea should not be neglected. The patient should be rehydrated by giving oral rehydration solution (ORS). ORS is a mixture of clean water, salt, and sugar, which can be prepared easily at home. Key measures to prevent diarrhoea are:

- access to safe drinking water
- improved sanitation
- personal and food hygiene
- education about how infections spread

## Digestion in grass-eating animals

As discussed earlier, herbivores like cow, buffalo, goat, sheep, etc., are plant-eating animals. You must have seen cows chewing continuously. Why do they chew continuously?

Actually, when cows go for grazing, they quickly swallow plenty of grass without much chewing. This is an adaptation by which cows need very little time for feeding. The food is partially chewed and mixed with saliva. Before being swallowed and passed down the oesophagus, it is stored in a part of their four-chambered stomach called *rumen*. Here, partial digestion of food occurs and the product is called *cud*. When the animal is resting, the cud is brought back into the mouth in small quantities and the animal chews it further. This is called *chewing the cud*. This helps in the digestion of cellulose. Animals with a rumen are called *ruminants*. Cattle, sheep, goats, and deer are ruminants. The rumen contains billions of bacteria and other microbes that break down the cellulose. The cellulose returns to a large sac-like structure called *caecum*, where the cellulose gets digested completely by the symbiotic bacteria to form sugars and fatty acids.

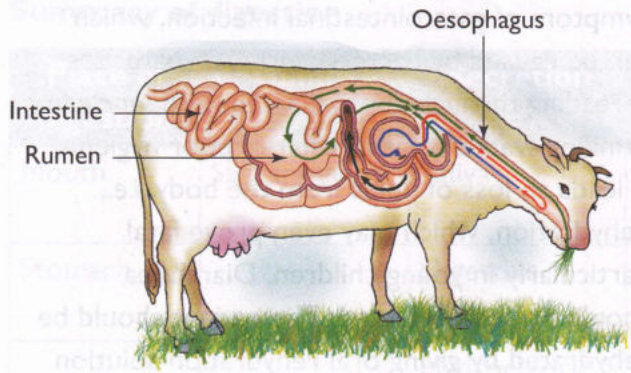



*Fig 3.8 Digestive system of a ruminant*

*Can human beings eat grass?*

We cannot digest grass as our digestive system lacks the bacteria which help in the breakdown of cellulose.

## Digestion in amoeba

Amoeba, a unicellular microorganism found in pond water, is the simplest living organism. It has a cell membrane and a round dense nucleus which controls all its functions. There are many bubble-like vacuoles in its cytoplasm which help in the digestion. Amoeba feeds on other microorganisms found in its surroundings. When it senses any food, it sends out its finger-like projections, called *pseudopodia*, around the food particle to engulf it. Within a food vacuole, the digestive juices act on the engulfed food to break it down into simpler substances that are absorbed by the amoeba. The undigested and unwanted substance is thrown outside the body through the vacuole.

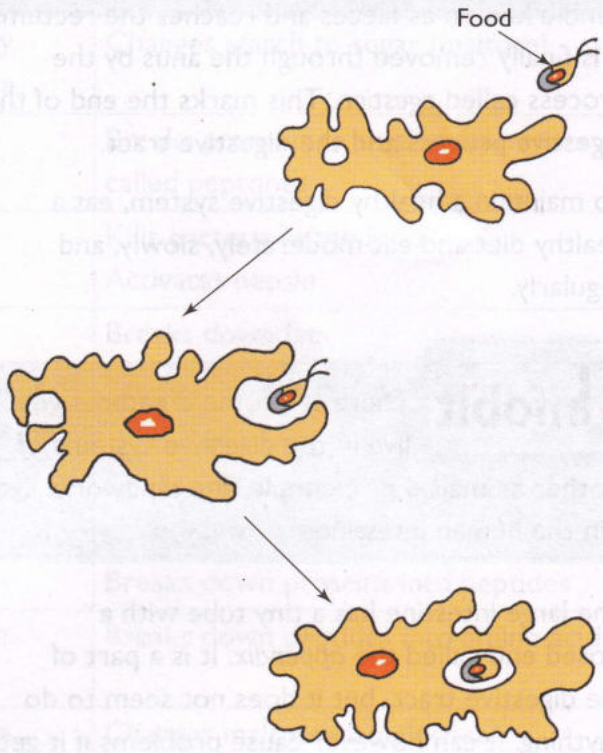



*Fig 3.9 Amoeba engulfing food*

The mode of nutrition and digestion differs from animal to animal but the basic process of digestion remains the same. It is the breakdown of food so that it can be used to release energy for all their activities.


**Modes of nutrition:** the mechanisms by which organisms obtain their food

**Digestion:** the process of breaking down complex molecules into simpler molecules

**Saprophytes:** the organisms which feed on dead organic matter

**Parasites:** the living organisms that get their food by living on or in other living organisms

**Ingestion:** the process of taking food into the body

**Assimilation:** building of proteins and other complex substances from absorbed substances

**Egestion:** removal of waste from the body


- Animals are heterotrophic. They can be herbivores, carnivores, omnivores, parasitic, saprophytic, or symbiotic.
- Digestion involves the processes of ingestion, digestion, absorption, assimilation, and egestion.
- Different kinds of teeth are used for different functions like incisors for cutting, canines for tearing, premolars and molars for chewing and grinding.
- Digestion of food begins in the mouth by the action of saliva. Starch is the first substance to be digested.
- Pancreatic and the intestinal juices help in completing the process of digestion.
- The nutrients are absorbed in the small intestine through the blood vessels present in villi.
- The undigested waste is thrown out of the body as faeces through the anus.
- Amoeba engulfs its food with the help of pseudopodia and the food gets digested within a food vacuole.

## Put on your THINKING CAP!

*1. **Select the correct option.***

a) The organisms which make their own food are called
   i) heterotrophs ii) autotrophs
   iii) parasites iv) saprophytes

b) The mechanical digestion of food starts in
   i) oesophagus ii) mouth
   iii) large intestine iv) stomach

c) The pipe which connects the mouth with the stomach is
   i) epiglottis ii) oesophagus
   iii) intestine iv) pharynx

d) Which of the following helps in mixing food with saliva?
   i) oesophagus ii) teeth
   iii) tongue iv) lips

e) What carries nutrients from digested food to all parts of the body?
   i) blood ii) mucous
   iii) bile iv) saliva

f) Which of these swallow food whole?
   i) ant ii) snake
   iii) deer iv) cow

g) In humans, the type of teeth used to tear the food is
   i) molar i) premolar
   iii) incisor iv) canine

h) The enzyme that breaks down peptides into amino acids is

i) trypsin ii) erepsin

iii) lactase iv) sucrase

**2. *Fill in the blanks to know the complete process of digestion.***

All animals need to eat _____ to get _____ to live. But in order to be useful to the body, the food has to be broken down through a process called _____. So, all animals have a group of connected organs which constitute the _____. In humans, the process of digestion begins in the _____ where food is _____ into small pieces by the teeth. The _____ in the mouth secretes saliva which contains an enzyme called _____. This enzyme changes _____ to sugars. Once the food is swallowed, it passes through the _____. After reaching the stomach, the food is mixed with digestive juices and is further churned. The digestive juices contain enzyme called _____. It changes proteins into _____. From the stomach, the food goes to the _____. The small intestine releases intestinal juice. It has four enzymes called _____, _____, _____, and _____.

The _____ helps in the digestion of fat by producing bile. The pancreas too releases a juice into the small intestine called the _____. It contains three enzymes which are _____, _____, and _____. The simple form of nutrients obtained after digestion gets absorbed in _____. The remaining matter goes into the _____ where excess of _____ is absorbed. The remaining waste is called _____ and it is pushed into the _____ where it waits before leaving the body through the _____.

**3. *Name the part where the following takes place.***

a) Process of digestion begins _____

b) Completion of digestion _____

c) Absorption of digested food _____

d) Killing of bacteria _____

e) Absorption of water and release of faeces _____

**4. *Give one word for the following:***

a) Mechanical digestion of food in mouth

b) Bony structure that grinds and cuts food

c) Special substances present in food

d) Finger-like projections present in the small intestine

e) Largest gland of our body

**5. *Define the following terms.***

a) Assimilation b) Ingestion

c) Mastication d) Egestion

e) Digestion f) Peristalsis

**6. *Answer in details.***

a) How is mechanical digestion different from chemical digestion?
b) What is the role of the stomach in the digestive process?
c) What happens to the food in the small intestine?
d) How does digested food get absorbed?
e) What is rumination? Explain with an example.
f) How does amoeba get its nutrition?

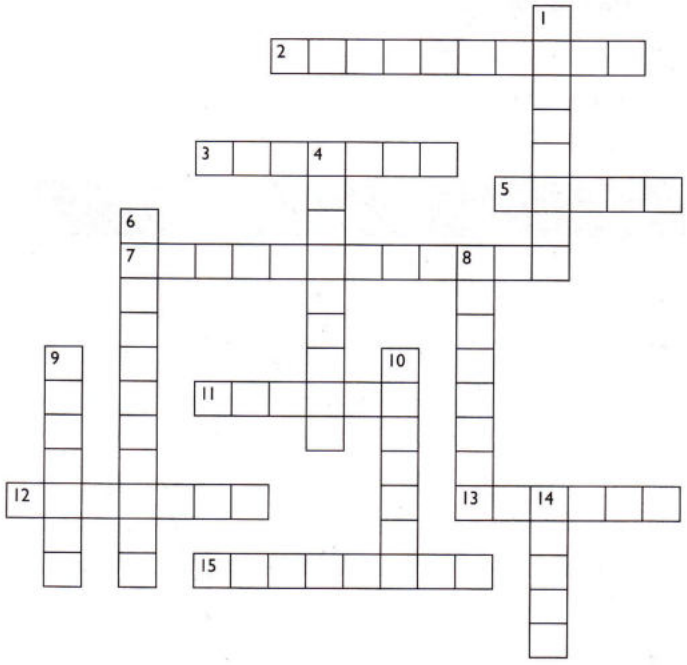
**7. *Complete the crossword with the help of the clues provided.***

**Across**

2. The tube that connects stomach to mouth
3. Part of throat which is a common passage for food and air
5. Finger-like projections in small intestine
7. The process by which absorbed food is utilized
11. Undigested food gets stored in it
12. The teeth that help in tearing the food
13. It is secreted by salivary glands
15. Trypsin is secreted by this gland

**Down**

1. The process by which undigested food is removed from the body
4. Animals which chew cud
6. Chewing of food
8. Flat teeth which help in biting
9. This part of the digestive tract secrets hydrochloric acid
10. This enzyme is present in saliva
14. It produces bile



## Extended learning

You must have heard of people suffering from acidity. Find out the reasons why the doctor advises them not to remain on an empty stomach for too long.

HIGHER ORDER THINKING SKILLS **HOTS**

Raman's mother does not allow him to talk while eating. She also does not allow him to eat food while lying down. What could be the reason for it?


For more information
http://www.enchantedlearning.com/subjects/anatomy/digestive/
http://library.thinkquest.org/22016/digestion/index.html
http://library.thinkquest.org/5777/dig2.htm
http://www.biology4kids.com/files/systems_digestive.html
http://www.emc.maricopa.edu/faculty/farabee/biobk/biobookdigest.html

# 4 Fibre to Fabric

**You will learn about**

- Wool
- Rearing of sheep
- Processing fibre into wool
- Silk
- Silk production

In Class VI, you learnt about the types of fibres and their sources.

*Can you recall which plant and animal fibres you learnt about?* List them below along with what they are used for.

| Name of the fibre | Use |
|---|---|
| | |
| | |
| | |

In this chapter, we will be studying about animal fibres—wool and silk. We will learn about the sources from which these fibres are obtained and the process used to convert the fibre into fabric.

## Wool

The bodies of certain animals like sheep, goat, and yak are covered by a thick coat of hair. This coat of hair is called *fleece*. It protects the animals from cold.

*Fig 4.1 Sheep gives wool*

Wool is obtained from the fleece of animals. It was probably the first animal fibre to be made into cloth. There are a number of properties that make it a very good fibre to use. Some of them are described here.

- Take a woollen garment and crinkle it. What do you observe? You will notice that when you crinkle a piece of wool, it springs back into shape. This is because *wool is elastic in nature.* This feature also makes it more resistant to tearing.
- The *fibre of wool is the poorest conductor of heat* of all the fibres used for clothing. It locks in the heat which is why garments made of wool are warm.
- Take a woollen sock and a cotton sock. Wash them and leave them out to dry. Record the time taken for each of them to dry. You will observe that the *woollen fabric dries much faster.* Thus, wool is convenient to use in winters.

## Rearing of sheep

Sheep are reared all around the world for the purpose of obtaining wool. There are 40 different breeds of sheep in the world producing approximately 200 types of wool. The Alpaca sheep yields fleece that is very warm, soft, and shiny.

*Lohi*, *Nali*, *Rampur ushair*, *Bakharwal*, *Patanwadi*, and *Marwari* are some names of Indian breeds of sheep that yield wool. *Find out the states in India where they are bred and the quality of wool they yield.*

The major producers of wool in the world are Australia, Argentina, China, and South Africa.

There are various breeds of sheep that provide varieties of wool. Some exotic breeds of sheep that provide fine quality of wool are Merino and Rambouillet.

**ACTIVITY 1**

On a political map of India, mark the states where wool is produced.

### Other animals that yield wool

Besides sheep, there are some other animals that produce wool as described below:

- The Angora goat furnishes beautiful white wool, commercially known as *mohair.*
- The hair obtained from the undercoat of camel is extremely soft.
- *Cashmere* is the wool obtained from the undercoat of the Kashmir goat. The soft hair can also be blended with silk, cotton, or wool. The famous *Pashmina* shawls are made from this wool.
- The vicuna, a member of the llama family, yields the softest wool in the world.
- The yak is also a source of wool.
- Angora rabbit provides less but very fine wool. This wool is very expensive and is usually combined with other fibres.

Yak

Llama

Goat

*Fig 4.2 Other animals that give wool*

**Infobit**

Vicunas are being killed on a large scale to obtain fleece. Its fibre is rare and very expensive, costing a few thousand rupees per yard. The vicuna is being protected by rigorous conservation measures.

## Processing fibre into wool

The process of conversion of fibre into wool yarn is an elaborate process and involves the following steps.

### Shearing

It is the process in which the fleece, along with a thin layer of skin, is removed from the body of the animal. In many parts of the world, sheep are sheared once a year. This is done in early spring or early summer. This relieves the animal from the warm covering on its body. This also enables the animal to grow back its fleece by winter time. Shearing is done with the help of machines. It is similar to shaving in human beings. It does not harm the sheep and is painless as the uppermost layer of the skin is made up of dead cells.

*Fig 4.3 Shearing a sheep*

## Scouring

The sheared hair is washed thoroughly with detergent to remove the impurities such as sand, dirt, grease, and dust. This process is called *scouring*. Nowadays, this also is done by machines.

## Grading and sorting

In this process, any stained, damaged, or inferior wool is removed. The rest of the wool is sorted according to the quality of the fibres depending on their fineness, length, waviness, and colour.

*Fig 4.4 Sorting wool*

## Carding

After the wool is dried, it is passed through rollers that have thin wire teeth. The teeth untangle the fibres and arrange them into a flat sheet called a *web*. The web is then formed into narrow untwisted fibres known as *slivers*. This process is called *carding*.

*Fig 4.5 Carding machine*

## Dyeing

The natural fleece of sheep and goats is white, brown, or black. The slivers are dyed to get wool fibres of various colours.

*Fig 4.6 Dyeing of wool*

## Yarn making

The process of yarn making depends on the length of the fibres. Long fibres are used to make woollen yarn for sweaters and other garments. Short fibres are made into *worsted yarn*. Fine worsted wool can be used for making the attire of athletes, because it is not very hot to wear and the weave of the fabric absorbs perspiration, allowing the body to breathe.

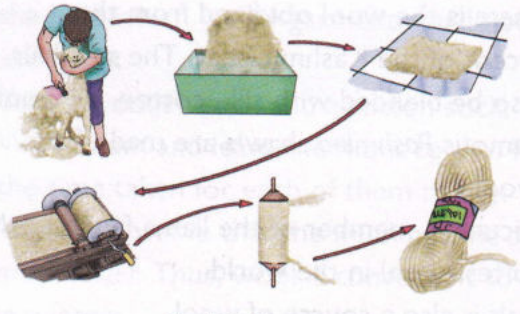


*Fig 4.7 Yarn making*

**Infobit**

- The art of spinning wool into yarn developed in about 4000 B.C.
- The first wool factory was established in 50 A.D. in Winchester, England, by the Romans.

### Health hazards associated with wool production

People working in the wool industry have to lift sheep and bend down to hold them during the shearing process. This causes the workers to develop skeletal and muscular injuries.

Male sheep called *rams* have horns. Sometimes they butt them into workers. The workers are also subjected to kicks by the sheep.

Some workers also develop respiratory diseases like asthma as they constantly breathe in dust and fine wool fibres.

Orf is a viral disease of the skin transmitted to humans by contact with infected sheep and goats. Shearers are at high risk of getting the disease. It causes blisters on the hands, wrists, and sometimes on the face.

The chemicals, detergents, and dyes used during processing can lead to other skin allergies.

## Silk

Silk fibre is obtained from silkworm. According to Confucius, one day in 2640 B.C. the Chinese princess Xi Ling Shi stood with a cup of tea under a mulberry tree. Suddenly, a silkworm cocoon fell into her tea, and she observed its shining fibre as it began to unwind. From that historic moment, the Chinese discovered silk fibre and kept the art of silk making a secret for the next 3000 years.

It is said that the eggs of the silkworm were smuggled to India in the head-dress of another Chinese princess. *Sericulture*, the art of growing silkworms for silk, then slowly spread to other parts of the world.

*Fig 4.8 Items made of silk*

Chinese and Indian silk are popular throughout the world.

**Infobit**

The Silk Route is a convenient name for the Asian trade routes to Europe and the Mediterranean world.

### Characteristics of silk

Silk is a shiny and soft fabric. It remains cool in summer and warm in winter. It absorbs moisture and can be dyed easily. It is the strongest of all natural fibres.

**ACTIVITY 2**

On a political map of the world, indicate the silk producing regions. Take the help of your teacher to identify the countries that produce silk.

### Life cycle of a silk moth

The silk moth has a complicated life cycle. The female moth lays around 400 eggs at a time on the leaves of a plant. The silkworm *larva*, called the *caterpillar*, emerges out of an egg after 10 days. It grows to about three inches long and feeds on the leaves for about five weeks.

It then spins a cocoon or case around itself in three to seven days. The silkworm has a pair

of glands which produce a liquid protein that solidifies when exposed to air. The outer part of the case thus becomes like a tough, coarse tissue-paper. The inner part of the case is a fine thread, about one thousand feet long, which is wound around the body of the worm. This thread or filament is used in the silk industry. Inside the cocoon, the caterpillar changes into the *pupa*.

Ten to twelve days after the completion of the cocoon, a perfect moth emerges from the cocoon. In four to six days, the female moth lays around 400 eggs and another life cycle starts.

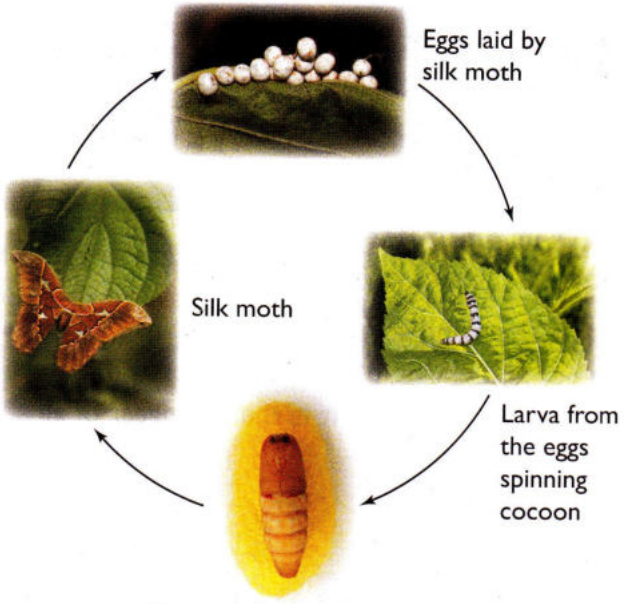



*Fig 4.9 Life cycle of a silk moth*

India produces several kinds of silk. If the silkworms are fed on mulberry leaves, it is called *mulberry silk*. If silkworms are fed on leaves of trees like sal, *arjun*, and *saja*, the silk is known as *tussar*. *Eri silk* is produced when silkworms feed on the castor-oil plant leaves and *muga silk* is produced when silkworms feed on polyanthus leaves. Silkworms fed with other leaves produce *wild silk*. Each type of silk produces a different kind of yarn.

Find out the states in India where mulberry, *tussar*, *eri*, and *muga* silks are produced.

## Silk production

The silk moth eggs are placed in open containers of wood or cardboard. The eggs are kept in a moist, warm, and well ventilated place. A temperature of 85°F (fahrenheit) is maintained.

Once they hatch into caterpillars, they are fed on plenty of mulberry leaves or an artificial silkworm diet. The amount of food they eat directly transforms into the amount of silk they produce. The caterpillars spin a cocoon around them.

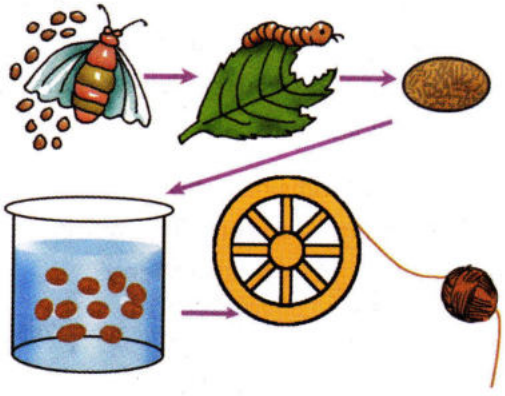


*Fig 4.10 Silk production process*

The cocoons are collected and put into very hot water, passed through hot air, or exposed to the scorching heat of the Sun. This kills the silkworm and loosens the silk fibres. The silk fibres are then taken out and unwound from the cocoon. This process is called *reeling*. This is done by machines. The fibres are then spun into silk threads. These are then woven into silk fabric.

**Infobit** It takes approximately 630 cocoons to make a silk blouse.

### Health hazards associated with silk production

Burns are common as workers continuously work with boiling water. Arthritis of the hands and fingers is also common as people reel silk into yarn.

Exposure to loud noise during weaving and spinning can result in permanent hearing damage.


**Fleece:** thick coat of hair on an animal's body

**Shearing:** the process which involves the removal of fleece and a thin layer of skin from the body of the sheep

**Scouring:** the process in which the wool is washed in detergents to remove impurities

**Reeling:** unwinding silk fibres from a cocoon

**Sericulture:** rearing of silkworms for obtaining silk


- Wool was the first animal fibre to be made into cloth.
- Wool is elastic, resistant to tearing, a poor conductor of heat, light weight, soft, easy to dye, dries fast, and it does not crinkle.
- Wool is obtained from sheep, goat, camel, llama, rabbit, and yak.
- The processing of wool includes shearing, scouring, grading and sorting, carding, dyeing, and yarn making.
- Silk is obtained from the silk moth.
- Silk is the strongest of all natural fibres, absorbs moisture, and can be dyed easily.
- The cocoon of the pupa stage yields silk.

## Put on your THINKING CAP!

*1. Choose the correct option.*

a) Which of these is not a property of wool?

i) tears easily ii) dries fast

iii) can be dyed easily iv) traps heat

b) Which of these countries produces wool?

i) Greenland ii) South Africa

iii) Poland iv) Jamaica

c) Mohair wool comes from

i) Angora goat ii) Angora rabbit

iii) Kashmir goat iv) Alpaca sheep

d) The art of growing silkworms for silk is called

i) pisciculture ii) aquaculture

iii) sericulture iv) apiculture

e) Unwinding silk fibres from a cocoon is called

i) reeling ii) peeling

iii) scouring iv) carding

f) Which animal yields the softest wool in the world?

i) vicuna ii) sheep

iii) yak iv) goat

g) The process in which the wool is washed in detergents to remove impurities is known as

i) reeling ii) scouring

iii) dyeing iv) sorting

h) A viral disease of the skin transmitted to humans by contact with infected sheep and goat is

i) hepatitis ii) flu

iii) chickenpox iv) orf

**2. *Complete the following table.***

| Types of silk | Leaves of plants on which the silkworms feed |
|---|---|
| Mulberry | Mulberry |
| Muga | |
| Eri | |
| Tussar | |

**3. *Correct the given statements by replacing one word in each of them.***

a) Wool is a plant fibre.

b) Woollen fabric dries slower than cotton.

c) Alpaca sheep wool is the softest wool in the world.

d) Scouring is done after carding.

e) Indians were the first to produce silk.

f) The pupa feeds on the mulberry leaves.

**4. *Write short answers.***

a) What are the qualities of wool?

b) Name the Indian breeds of sheep that yield wool.

c) What is vicuna?

d) Why are woollen clothes warm?

e) What is tussar?

f) What hazards do people working in the wool industry face?

g) What hazards do people working in the silk industry face?

**5. *Answer in details.***

a) List and explain the steps of wool extraction.

b) How is carding of wool done?

c) Explain the steps involved in extracting silk from the silk moth.

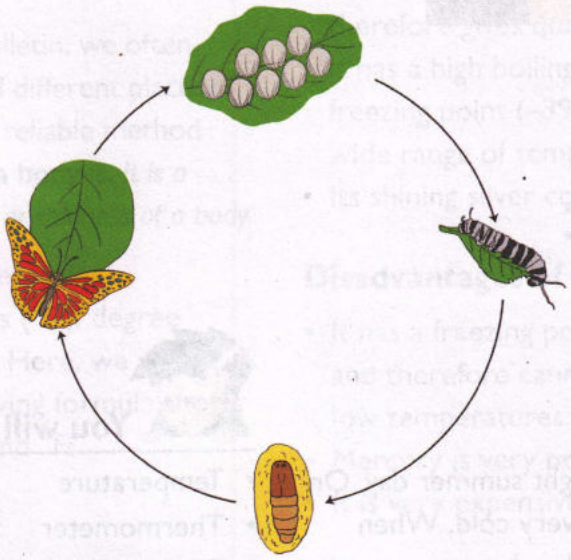
**6. *Label the life cycle of a silk moth given below and answer the questions.***

a) In which stage does the silk moth feed on the plant leaves?

b) In which stage is the cocoon formed?

c) How is the cocoon formed?

d) What happens to the caterpillar inside the cocoon?



## Extended learning

1. What is acrylic? What is the test that can be performed to differentiate it from wool?
2. What is felt and what are its uses?

HIGHER ORDER THINKING SKILLS
**HOTS**

Give reasons for the following:

- Woollen clothes are worn in winter.
- Grading and sorting is done during the processing of wool.
- Worsted wool is used for making uniforms for athletes.
- Shearing does not hurt sheep.


For more information

http://www.historyforkids.org/learn/clothing/wool.htm
http://www.factmonster.com/ce6/society/A0818602.html
http://library.thinkquest.org/C004179/wool.htm#History
http://www.silk-road.com/artl/silkhistory.shtml

# 5 Heat

## You will learn about

- Temperature
- Thermometer
- Effects of heat
- Transfer of heat

It is very hot outside on a bright summer day. On a winter night, however, it is very cold. When we rub our hands in winter, they become warm. We wear woollen clothes in winter as they keep us warm. The things kept in the refrigerator become cold while the things kept inside an oven become hot. Thus, in our daily life we frequently come across terms like *hot, cold,* and *warm.*

The property that helps us to understand the difference between hot and cold objects is *heat,* which is a form of energy. If we add heat to a substance, it becomes hot. If we take heat away from an object, it becomes cold or comparatively less hot. The more heat a body possesses, the hotter it gets.

But how do we find out how hot or cold a body is? We normally use the sense of touch to differentiate between hot and cold objects. However, this is not a very reliable method of measuring the extent of hotness or coldness of a body as the following activity shows.

### ACTIVITY 1

**To show that sense of touch is not a very perfect way to measure heat**

*Things required:* Three tubs, normal water, warm water, cold water

*Method:*

1. Label the tubs as A, B, and C.
2. Put warm water in tub A, cold water in tub B, and normal water in tub C.
3. Dip one hand in tub A and the other hand in tub B.
4. After a few minutes, remove both hands from tubs A and B and put them in tub C.
5. Record your observation.

*Observation:* You will observe that the hand that was in cold water (tub B) feels warm while the hand that was in warm water (tub A) feels cold. So, it is really difficult to make out whether the water in tub C is actually hot or cold.

*Conclusion:* The above observation shows that touch is not a very reliable way of measuring the hotness or coldness of an object.

## Temperature

While watching the weather bulletin, we often hear about the temperatures of different places. The quantity 'temperature' is a reliable method of finding out how hot or cold a body is. *It is a measure of the degree of hotness or coldness of a body.*

The different units used for measuring temperature are degree celsius (°C), degree fahrenheit (°F), and kelvin (K). Here, we will be using only °C or °F. The following formula shows the relationship between °C and °F:

$$\frac{C}{5} = \frac{F-32}{9}$$

You can use the above formula to convert temperature from one unit to another.

*Example:* Convert 98.6°F to °C.

*Solution:* F = 98.6°F, C = ?

$$\Rightarrow \frac{C}{5} = \frac{98.6-32}{9} \Rightarrow C = \frac{66.6}{9} \times 5 = 37°C$$

*Example:* Convert 40°C to °F.

*Solution:* C = 40°C, F = ?

$$\Rightarrow \frac{40}{5} = \frac{F-32}{9} \Rightarrow \frac{40}{5} \times 9 = F - 32$$

$$\Rightarrow F = 72 + 32 = 104°F$$

## Thermometer

The temperature of a body is measured with a device called *thermometer.*

The most common types of thermometers are the *alcohol* thermometer and the *mercury* thermometer. They are named so because of the liquid used in the bulb of the thermometer. Let us see the advantages and disadvantages of mercury and alcohol thermometers.

### Advantages of mercury thermometers

- Mercury is a good conductor of heat and so quickly reaches the temperature of the surroundings.
- It does not stick to the surface of the tube and therefore gives quite accurate readings.
- It has a high boiling point (~357°C) and low freezing point (–39°C). So, it can measure a wide range of temperatures.
- Its shining silver colour is easily visible.

### Disadvantages of mercury thermometers

- It has a freezing point of approximately –39°C and therefore cannot be used to measure very low temperatures (*i.e.*, below –39°C).
- Mercury is very poisonous.
- It is very expensive.

### Advantages of alcohol thermometers

- Alcohol is cheaper, easily available, and safe to use.
- It has a low freezing point (–115°C) and therefore can be used to measure very low temperatures (*i.e.*, up to –115°C).

### Disadvantages of alcohol thermometers

- Alcohol has a low boiling point (–78°C) and therefore cannot be used to measure high temperatures (*i.e.*, above 78°C).
- It does not react quickly to changes in temperature.
- Since alcohol is colourless, it needs to be dyed before being used as a thermometer liquid.

There are two types of mercury thermometers—clinical and laboratory.

### Clinical thermometer

It is smaller in size with the temperature range from 35°C to 42°C. The corresponding markings in °F are also usually marked on it. These thermometers are used for measuring human body temperature. The normal human body temperature is about 98.6°F. These thermometers have a kink or slight bend just above the bulb of the thermometer so as to stop the mercury from coming back into the bulb

after the thermometer has been removed from contact with the body.

A clinical thermometer consists of a narrow glass capillary. It has a bulb at one end and is sealed at the other end. As the temperature rises, the mercury expands and moves up to show the temperature against the printed scale.

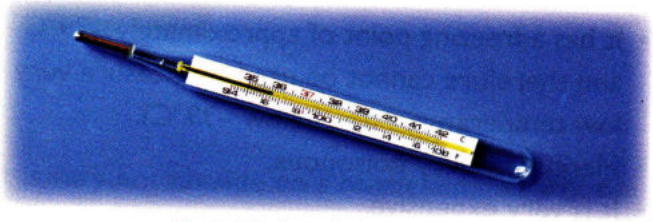


*Fig 5.1 A clinical thermometer*

Precautions while reading a clinical thermometer:

- Wash the thermometer before and after use.
- Handle the thermometer with care to prevent breakage.
- Hold the thermometer horizontally (parallel to the floor) at the eye level.
- Make sure the mercury level is below 35°C before use.
- Do not touch the bulb of the thermometer while reading it.

## Laboratory thermometer

Laboratory thermometer is longer with no kink in the capillary above the bulb. The range of this thermometer varies but usually is between –10°C and 110°C.

*Fig 5.2 A laboratory thermometer*

## Calibrating a laboratory thermometer

To calibrate a laboratory thermometer, the bulb is first put in melting ice (since the melting ice will have the temperature of 0°C). Wherever the mercury level gets stable, that point is marked as 0°C and is referred to as the lower fixed point of the thermometer. Next, the thermometer is kept in contact with boiling distilled water from which steam is coming out. The level at which the mercury level stabilizes is marked as the upper fixed point.

The space between the two fixed points is equally divided and further sub-divided. The larger the number of sub-divisions, the more accurate is the thermometer. To use the thermometer, it is kept in contact with the object whose temperature is to be measured and the level of mercury in the capillary is read against the scale printed.

**Infobit** The thermometer used to measure the maximum and minimum temperatures during a given period of time is called the *maximum–minimum thermometer.* This is generally used by the meteorology department to measure the highest and lowest temperatures recorded in a day.

## Effects of heat

Heat has the following effects:

- *It makes things hotter.* For example, if you put a metal spoon over a flame for a few seconds, it will feel hot when touched.
- *Heat can change the state of a substance.* For example, if you heat a beaker containing ice cubes, you will see the ice cubes melting. This shows a change of state from solid to liquid.
- *Heat causes things to expand,* as seen in the following examples:
  1. *Metals expand on heating*: You might have seen your mother putting the metal lid of a new jam bottle in warm water so that it can be opened easily. The metal lid expands on heating and becomes loose. It can then be opened easily.
  2. *Liquids expand on heating*: The mercury (liquid) in the thermometer expands when put in contact with a hot body.
  3. *Gases also expand on heating*: Fix a small balloon on the mouth of an empty bottle.

Put the bottle in a hot water tub. You will observe that the balloon expands. It is because air inside the balloon expands on heating and occupies the space in the balloon.

The above examples make it clear that substances expand on heating. This is referred to as *thermal expansion.*

### Practical applications of thermal expansion

1. A thick glass tumbler breaks when hot liquid is poured in it. Due to contact with the hot liquid the inner surface of glass expands. As glass is a poor conductor, the outer surface does not expand that much. This unequal expansion causes the glass to break. This can be avoided by placing a metal spoon in the tumbler. The metal being a good conductor effectively removes the heat and does not allow the inner surface to expand that much.
2. Rail tracks have gaps left at the places where two sections are joined. This is because the tracks are made of iron. The summer heat and friction between train and tracks causes iron to expand. The gaps provide the iron tracks space for expansion.

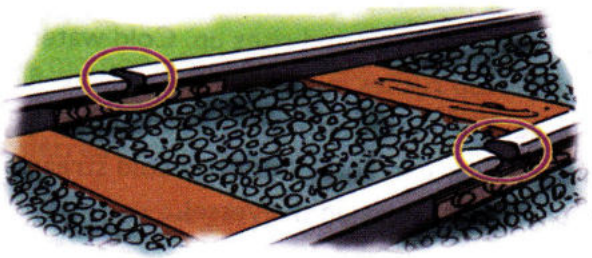


*Fig 5.3 Rail track*

3. The cable wires between two poles are left loose. This is done so that in winters when the temperature drops, the wires do not break on contracting.

## Transfer of heat

Observe what happens to the hot milk pot that your mother removes from the gas burner after boiling milk and keeps it aside.

You will notice that the milk pot cools down after some time. It happens because the heat from the milk pot has been transferred to the surroundings.

Put a hot object in contact with a cold object. After some time, you would notice that the cold object becomes hot while the hot object becomes less hot. This happens because the hot object transfers some of its heat to the colder object.

The above two examples show that *heat is always transferred from a hot object* (an object at higher temperature) *to a cold object* (an object at lower temperature).

The transfer of heat takes place through the three methods—*conduction*, *convection*, and *radiation.*

### Conduction

Take a metal rod and fix pins using wax along its length at different intervals. Heat one end of the rod and observe.

You will notice as the rod starts heating, the wax melts and the nails start falling off. The nail which is closest to the flame falls off first while the nail farthest from the flame falls off the last. This shows that the heat is being transferred from the end of the rod that is being heated (hot end) to the other end (cold end).

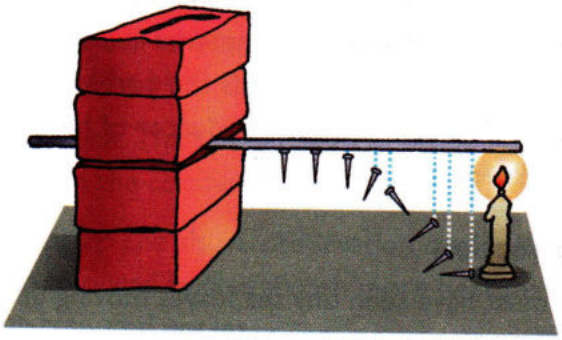


*Fig 5.4 Heat transfer through conduction*

This process of heat transfer from the hotter end

of an object to the colder end is called *conduction*. The conduction of heat takes place without the actual displacement of atoms or particles.

Conduction of heat also takes place when two bodies at different temperatures are brought into contact. In this case, the heat is transferred from the hotter object to the colder object.

***Conductors and insulators*** Having learned about conduction, you may ask whether all the substances conduct heat. To have an answer to this question, observe the cooking vessels used in the kitchen. The cooking vessels are generally made up of metals. They get very hot when heated. The heat from the vessels is transferred to the food which helps it to cook. Thus, the metals conduct heat. Such substances that conduct heat are called *conductors*.

Metal vessels are generally provided with wooden handles. The wooden handles do not get hot when the vessels are heated. This shows that wood does not conduct heat. Such substances that do not conduct heat are called *poor conductors* of heat or *insulators*. Air and water are also poor conductors of heat.

Let us perform the following activity to show that water is a bad conductor of heat.

We use both conductors and insulators in our everyday life.

1. Bricks, mud, and concrete (all insulators) are used in building houses.
2. Vehicles carrying inflammable material are covered with insulating material like asbestos.
3. Wool is warm in winter as the pores in wool trap air which is a bad conductor of heat and so keeps us warm.

## Convection

You must have seen tiny tea leaves moving up and down in water while being heated. This is because the bottom surface of the beaker gets heated first. The water in contact with this surface gets hot and rises up. Cold water from the top rushes in through the sides to fill its place. This water also gets hot and rises up. Thus, circular currents of hot and cold streams of water are set up inside the vessel.

Such a method of heat transfer in which there is actual movement of molecules of the substance being heated is called *convection*. This method of heat transfer occurs in fluids, *i.e.*, liquids and gases.

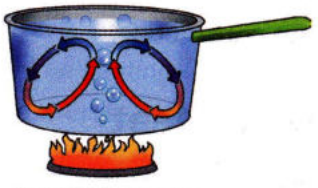


*Fig 5.5 Convection*

### ACTIVITY 2

(*Note: Activity to be performed under adult supervision*)

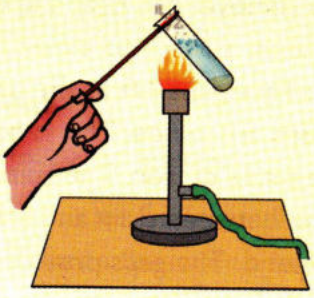
*Things required:* A test tube, burner, wax, water

*Method:*

- Put a piece of wax in the test tube.
- Heat the test tube so that the wax melts and sticks to the bottom of the test tube.
- Fill two-thirds of the test tube with water.
- Heat the test tube near the upper level of water for some time.

*Observation:* The water near the top starts boiling after some time but the wax does not melt.

*Conclusion:* The above observation shows that water is a poor conductor of heat.



***Applications of convection*** The following are some applications of convection:

- Ventilators are located near the ceilings of rooms. This allows hot air of the room which has risen up to move out of the ventilator. The fresh cool air from the window rushes in to take the place of rising warm air.
- Land and sea breeze near the coastal areas are a result of the convectional currents set up in air. Since land surface is a better conductor of heat than water, it gets heated faster during the day. This makes the air close to the land surface warmer. The warmer air rises up and the cool air from the sea rushes to take its place. This gives rise to the *sea breeze*.
  At night, the land cools faster than water in the sea. So, the air above the sea is warmer than the air over the land surface. The warmer air over the sea being lighter rises up and the cool air from the land takes its place. This gives rise to *land breeze*.
- Air conditioners are installed near the roof. The cool air moves down and the warm air near the surface of the room rises up thereby setting up convectional currents which cool the whole room effectively.

## Radiation

In the method of conduction or convection, we need a medium through which heat is transferred.

We know that we get heat from the Sun. But in most of the space between the Sun and the Earth there is little material medium. So, how is the heat from the Sun transferred to the Earth?

This method of heat transfer that does not require a medium is called *radiation*. The heat from the Sun reaches us through the method of radiation. The Earth absorbs some of this heat and gets heated.

Just like the Sun, all hot bodies radiate heat. The higher the temperature of a body, the more heat it radiates. The objects which absorb this heat get hot.

People sitting around a bonfire receive heat by the process of radiation only.

The colour of a body is also responsible for the amount of heat it absorbs. Let us conduct Activity 3 to see how the colour of a body affects the ability of a body to absorb heat.

Activity 3 shows why we prefer to wear dark-coloured clothes in winter and light-coloured clothes in summer.

### ACTIVITY 3

*Things required:* Two containers, black and white paint, water, a thermometer

*Method:*

1. Paint the outer surface of one container black and the other white.
2. Pour equal amount of water into both the containers.
3. Note the temperature of water in both the containers and close each one of them with a lid.
4. Place both the containers in the Sun next to each other.
5. Measure the temperature of water in both the containers after 30 minutes. In which container do you think the temperature would be higher?

*Observation:* The temperature of water is higher in the container painted black.

*Conclusion:* The above observation shows that dark-coloured bodies absorb more heat than light-coloured bodies.


**Temperature:** the measure of the degree of hotness or coldness of a body

**Thermometer:** the device used to measure the temperature of a body

**Conduction:** the process of heat transfer from a hot body to a cold body, provided the bodies are in contact with each other

**Convection:** a method of heat transfer in which there is actual movement of molecules of the substance being heated

**Radiation:** a process of heat transfer in which a material medium is not necessary

**Conductors:** the substances that conduct heat or allow heat to pass through them

**Insulators:** the substances that do not conduct, *i.e.*, do not allow heat to pass through them


- Heat is a form of energy which gives us the sensation of warmth.
- The process of heat transfer from the hotter end of an object to the colder end is called conduction.
- In a fluid, the transfer of heat takes place by the actual movement of molecules. This method of heat transfer is called convection.
- Light colours are good reflectors and poor absorbers of heat, whereas dark colours are good absorbers and poor reflectors of heat.

## Put on your THINKING CAP!

***I. Choose the correct option.***

a) The range of a clinical thermometer is
   i) 0°C to 100°C
   ii) 35°C to 42°C
   iii) –10°C to 110°C
   iv) 32°C to 45°C

b. Normal human body temperature is
   i) 35°C
   ii) 37°F
   iii) 35°F
   iv) 37°C

c) There is a lot of concern over the use of mercury as a thermometric liquid as
   i) mercury has a uniform rate of expansion
   ii) mercury has a high boiling point
   iii) mercury is an opaque and shiny substance
   iv) mercury is a poisonous substance

d) 0°C is the same temperature as
   i) 0°F
   ii) 32°F
   iii) 212°F
   iv) 100°F

e) Mercury does not rise or fall in a clinical thermometer when taken out of the mouth because
   i) it is smaller than a laboratory thermometer
   ii) it has a thin stem
   iii) it has a kink just above the bulb of the thermometer
   iv) none of the above

f) Heat from the Sun reaches us by the process of
   i) conduction
   ii) convection
   iii) radiation
   iv) all of these

g) The inside of a solar cooker and the pipes of a solar water heater are painted black because black surface is a
   i) good reflector of heat
   ii) good absorber of heat
   iii) poor absorber of heat
   iv) good radiator of heat

h) Why are metal vessels generally provided with wooden handles?
   i) wood is a poor conductor of heat
   ii) wood is a good conductor of heat
   iii) metal vessels are poor conductors of heat
   iv) none of these

**2. *Fill in the blanks.***

a) On cooling, the temperature of an object _____.
b) The unit of measurement of temperature is degree _____.
c) Most substances _____ on heating and _____ on cooling.
d) If a hot iron spoon is put in water at room temperature, heat flows from the _____ to _____. As a result, the temperature of _____ increases while the temperature of _____ decreases.
e) Radiation is the process of transfer of heat in which a _____ is not required.

**3. *Write short answers.***

a) Why is mercury preferred as a thermometric liquid?
b) Name one liquid apart from mercury which is commonly used as a thermometric liquid. Give one use of that thermometer.
c) Why does the capillary of a clinical thermometer have a kink?
d) Explain why you would not use
   i) a laboratory thermometer for measuring your body temperature.
   ii) a clinical thermometer for measuring the temperature of hot milk.
e) Differentiate between conduction, convection, and radiation.
f) Why is a clinical thermometer given a jerk before use?

**4. *Answer in details.***

a) Explain the application of convectional currents in land and sea breezes.
b) State the basic characteristics or effects of heat.
c) What is thermal expansion? Describe three applications of thermal expansion.

## Extended learning

1. Make a project on the astronomer who devised the Celsius scale. Also, write about the various other thermometric scales and the inter-conversions between them.

HIGHER ORDER THINKING SKILLS
**HOTS**

Give reasons for the following:

- Light-coloured clothes are suitable for summers and dark-coloured clothes are suitable for winters.
- A metal teapot is provided with a wooden handle.
- It saves fuel if we cook food in a vessel which is blackened at the bottom and polished from the sides.
- Birds puff up their feathers in winter.
- Two thin woollen sweaters are warmer than a thick woollen sweater.


For more information

http://coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/measure.html
http://www.weatherwizkids.com/weather-temperature.htm
http://www.buzzle.com/articles/types-of-thermometers.html

# 6 Acids and Bases

**You will learn about**

- Acids
- Bases
- Indicators
- Neutralization

We have learnt in our previous classes that all things that we see around us and the various substances that we use in our daily life consist of matter. Matter exists in different forms.

Substances show various properties that help us to categorize them.

For the time being, let us talk about one such property—*taste*. We can differentiate substances on the basis of their taste. The following blindfold activity will help you identify common edible things on the basis of their taste.

## Acid

The curd we eat tastes sour. Different types of chutneys, like tamarind chutney and *pudina* chutney, that we use while having snacks like samosa or *kachori* also taste sour. Some fruits and vegetables like oranges, grapes, tamarind, lemon, and grape fruit also taste sour.

What makes things taste sour? Do they have something in common that makes them sour?

The sour taste of most of the fruits and vegetables is due to the presence of a substance called *acid*. The word 'acid' comes from the


Collect the edible things given below which are easily available at home. Blindfold your friends and ask them to identify different substances one by one just by tasting them. Record their observations in the format given below:

| Substance | Taste | Substance | Taste |
|---|---|---|---|
| Sugar | | Grapes | |
| Salt | | Orange | |
| Lemon juice | | Gooseberries | |
| Curd | | Tamarind | |

[**Caution:** Use things which are edible and safe. Do not use any unknown substance.]

Latin word *acere* which means sour. Different substances contain different types of acids.

- Lemon, grapefruit, and orange contain citric acid, which is responsible for their sour taste. These acids are called *natural acids*.
- Some fruits and vegetables are rich sources of vitamin C, which is also known as *ascorbic acid*. *Amla* (gooseberry) is a rich source of vitamin C.

*Fig 6.1 Food items containing acids*

- *Boric acid* is a substance that is sometimes used to wash the eyes.
- The cola drink also contains an acid called *carbonic acid*, produced by carbon dioxide which makes it fizzy.

Acids are classified as *mineral acids* and *organic acids*.

The acids like hydrochloric, sulphuric, and nitric acid available in your chemistry lab are examples of mineral acids. These acids are called mineral acids because they can be prepared from naturally occurring compounds called *minerals*. Mineral acids should be handled with great care because they can burn skin and clothes.

Acids that occur naturally in plant and animal materials are called organic acids. Carbonic acid, lactic acid, and acetic acid are examples of organic acids.

Given below is a list of some common things we use in our daily life and the acid they contain.

| Substance | Acid |
|---|---|
| Tomato | Malic acid, citric acid, ascorbic acid |
| Orange, lemon | Citric acid |
| Curd | Lactic acid |
| Banana, tamarind, grape | Tartaric acid |
| Tea | Tannic acid |

Acids can be strong or weak. Nitric acid and sulphuric acid are strong acids. Organic acids found in fruits and vegetables are generally weak acids.

Also, acids can be either concentrated or dilute. When no or very small amount of water is present in an acid, it is concentrated.

If more water is added in an acid, it becomes diluted acid.

Let us now have some fun through the following activity.

## Properties of acids

1. *Acids are sour in taste.* All citrus fruits (lemons, orange, berries, grapes, etc.) taste sour due to the presence of acids.
2. *Acids are corrosive in nature.* They react with metals and even cut through their surface. That is why they are never stored in metal or plastic containers. You will find the acids kept in glass containers in your chemistry lab.
3. *Acids are soluble in water.* They release hydrogen ions ($H^+$) when dissolved in water.
4. In general, when certain acids react with metals, hydrogen gas is released.
5. The aqueous (water) solutions of acids conduct electric current (*i.e.*, act like electrolytes).

6. Acids react with bases to form salt and water.
7. Acids react with carbonates to form carbon dioxide, water, and salt.

**ACTIVITY 2**

**Writing a secret message!**

*(Note: Activity to be performed under adult supervision)*

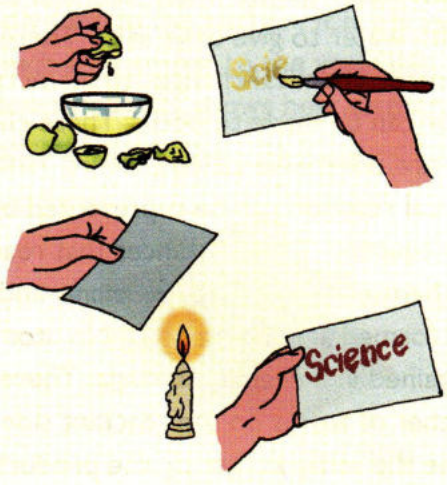
*Things required:* Lemon juice, a sheet of paper, a brush or cotton swab, a candle, a matchstick

*Method:*

1. Take the sheet of paper.
2. Dip the brush in the lemon juice and write your message on the sheet of paper with it.
3. Let the sheet dry up. What do you see when the sheet dries?

*Observation:* When the sheet dries, the message disappears from it. To read the message, light the candle and hold the sheet a few inches above the candle flame. [**Note:** Be careful not to burn the paper when trying this.] The message becomes visible on the sheet. You will see that the message has turned brown.

*Explanation:* The lemon juice contains carbon atoms that turn black/brown when they come in contact with heat.




## Uses of acids

1. Acids present in fruits and vegetables provide us with essential acids required for our body.
2. Hydrochloric acid is a part of the gastric acid in humans and many other animals, secreted within the stomach to help digestion.
3. Acids are added to food as preservatives. For example, acetic acid is put in pickles to give it a sour flavour and for preservation.
4. Acids act as rust removers. Steel used in the construction of buildings is treated with acid before painting. Can you think of a fruit which will help to make your old coin sparkle again?
5. Sulphuric acid is used in car batteries.
6. Acids like sulphuric acid ($H_2SO_4$) and nitric acid ($HNO_3$) are used for manufacturing fertilizers for agriculture.
7. Acids are cleaning agents. They are used in homes for cleaning sanitary ware, windows, and floors.
8. Acids are used in the manufacture of paints and dyes.

**Infobit** Nitric acid is also used in the preparation of explosives such as dynamite and TNT.

## Base

Your mother puts salt and a pinch of another white powder while making yummy pakoras? What could it be? It is baking powder. Take a pinch and find its taste. Does it taste salty, sour, or bitter? Its bitterness confirms that it is neither an acid nor a salt. Such substances which have a bitter taste and feel soapy and slippery to touch are called *bases*.

Most of the bleaches, soaps, toothpastes, and cleaning agents contain bases. Some common bases are sodium hydroxide (NaOH) or caustic soda found in soap, calcium hydroxide [$Ca(OH)_2$] or limewater, ammonium hydroxide

($NH_4OH$) or ammonia water found in window cleaners, and sodium bicarbonate [$NaHCO_3$] or baking soda.

## Properties of bases

1. *Bases taste bitter.* It is the presence of a base that gives unflavoured milk of magnesia its bitter taste.
2. *Bases feel slippery.* Put some drops of window cleaner between your fingers, you get slippery feeling of a base. That is why detergent or soap left on a wet floor makes it slippery.
3. *All bases are not soluble in water.* Bases which are soluble in water are called *alkalies*. They produce hydroxide ions ($OH^-$) in water.
4. Bases react with acids to form salt and water.
5. Strong bases like caustic soda and caustic potash are corrosive and dangerous to skin and eyes.

## Uses of bases

1. Ammonium hydroxide (window cleaner) is a base which generally dissolves grease. They help in eliminating stains and tarnish by reacting with oils and fats. So, they are often used in strong household cleaners.
2. Drain cleaners contain sodium hydroxide and ammonia which has a choking smell.
3. Milk of magnesia (magnesium hydroxide) is used as an antacid that acts as an agent to reduce acidity in stomach.
4. Sodium hydroxide is used for making soap, rayon, and paper.

Acids and bases are everywhere around us. They are used in everyday life, from the food we eat to the soap we use. Acids when dissolved in water give *acidic* solutions while bases (alkalis) make *alkaline* solutions. The substances which are neither acidic nor basic are called *neutral substances*. Pure water is neutral.

### Infobit

- Every substance has another unique characteristic—its pH value. The pH of a substance indicates its level of acidity or alkalinity. The pH values range from 1 to 14.
  - If a solution contains more hydrogen ions than hydroxide ions, it is considered *acidic*. An *acidic* solution has a pH value of <7.
  - If a solution contains more hydroxide ions than hydrogen ions, it is considered *basic* or *alkaline*. A basic solution has a pH value of >7.
  - If the amount of hydrogen ions equals the amount of hydroxide ions, the solution is considered *neutral*. A neutral substance has a pH value of 7. Water is a neutral substance.
- The pH scale used for measuring acidity was invented by Søren Sørensen.
- In the seventeenth century, the Irish writer and amateur chemist Robert Boyle first labelled substances as either acids or bases.

## Chemical reactions

A chemical change occurs when substances react among themselves. We have learnt that acids react with water to give acidic salts and bases react with water to give basic salts. There are several other chemical changes which occur in nature or can be made to occur. These chemical changes are otherwise called *chemical reactions*. A chemical reaction can be represented by a *chemical equation*. The substances that react among themselves are called *reactants* and those that are formed are the *products*. No atoms are lost or gained in a chemical change. Therefore, the number of atoms on the reactant side should always be the same as that on the product side in

case of every element. Then the equation will be a *balanced equation.*

For example:

$H_2 + O_2 \rightarrow H_2O$ is not a balanced equation because there are two atoms of oxygen on the product side and one atom on the product side. To balance the equation, we put a numerical 2 before $H_2$ on the reactant side and $H_2O$ on the product side. Hence the balanced equation is $2H_2 + O_2 = 2H_2O$ where there are four molecules of hydrogen and two molecules of oxygen on both sides.

## Indicators

Many acids and bases look similar. How does one differentiate between them?

Remember, we should never taste and touch any unknown substance. Then, how do we find out if a substance is acidic or basic.

There are some special substances which help us in identifying whether a substance is acidic or basic. These substances are called *indicators*. They change their colour when added to an acidic or basic solution.

## Natural indicators

There are some indicators present in nature. These are called *natural indicators*.

***Turmeric*** This is a natural indicator that is commonly used in the kitchen. It is the yellow spice which adds colour to the vegetable curry. The following activity shows how turmeric acts as an indicator.

*Fig 6.2 Turmeric*

**ACTIVITY 3**

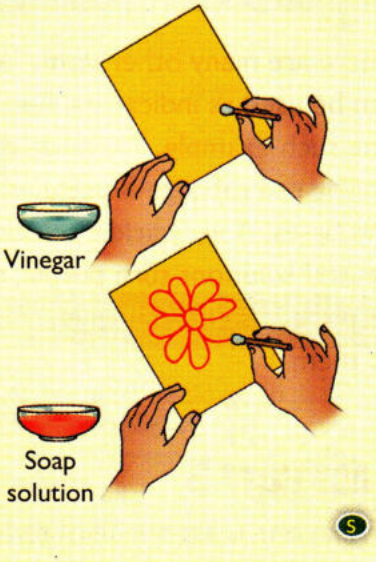
*Things required:* Turmeric powder, dishwashing powder, vinegar, water, a large bowl, two small bowls, tissue paper, cotton ear bud

*Method:*

1. Put some turmeric powder in the bowl.
2. Add a little water to make a smooth paste.
3. Smear the paste evenly over a tissue paper and let it dry completely.
4. Take small amounts of dishwashing solution and vinegar in separate bowls.
5. Use a cotton ear bud to draw a flower on the dried yellow tissue paper, once with vinegar and then with soap solution. What do you see?

*Observation:* The flower drawn with vinegar is not visible whereas the one drawn with soap solution turns red. How does this occur?

*Explanation:* Curcumin, an active ingredient of turmeric, acts as an indicator. It remains yellow in acidic (vinegar) or neutral solutions and turns red in basic solutions (soap solution). *So, now you know why the yellow curry stain on your uniform turns red when you apply a soap solution on it.*




Now, perform the following activity to see how the colour of turmeric changes when it comes in contact with different substances.

## ACTIVITY 4

**Test with turmeric**

Make a test solution of the following substances and observe the change they bring in the turmeric solution.

| Solution | Colour of turmeric solution |
|---|---|
| Vinegar | |
| Baking soda | |
| Lime water (dissolve lime juice in water) | |
| Glucose water | |
| Pineapple juice | |

In India, turmeric (*Curcuma longa*) is often used as an antiseptic for burns, cuts, and stomach problems. Curcumin, the active ingredient in turmeric, is being investigated for its potential to treat cancers, Alzheimer's, and arthritis.

There are many other items in your kitchen that can be used as indicators. Red cabbage juice is one such example. The juice that is produced by boiling red cabbage is useful in identifying acids and bases. A very acidic solution will turn red, neutral solutions turn purple, and basic solutions turn greenish-yellow when cabbage juice is added to them.

## ACTIVITY 5

Take one teaspoonful of red cabbage juice and add it to each of the following substances: vinegar, ammonia, and water.

Note the colour changes and find out their acidic or basic nature.

Repeat the activity with a beetroot.

***Litmus*** Litmus is another natural indicator which is most widely and commonly used in laboratories. It is a water-soluble mixture of different dyes extracted from lichens, especially *Roccella tinctoria*.

It is often absorbed onto filter paper to produce red and blue litmus paper. Blue litmus paper turns red under acidic conditions and red litmus paper turns blue under basic conditions. Neutral litmus paper is purple in colour. Litmus can also be prepared as an aqueous solution. It is called *litmus solution*.

***China rose*** China rose or hibiscus is a flower whose petals can be used as a natural indicator.

China rose or hibiscus indicator turns the colour of acidic solutions to dark pink and that of basic solutions to green.

## Synthetic indicators

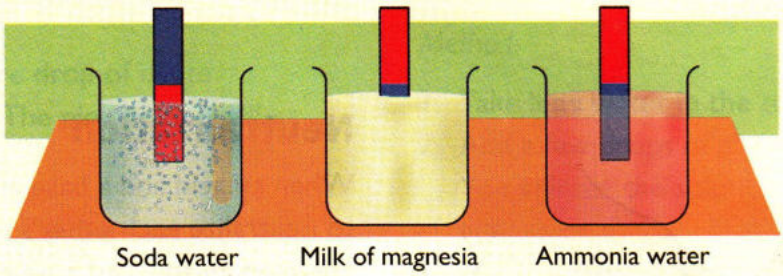
Apart from the natural indicators, there are some synthetic indicators which are made from chemicals like phenolphthalein, methyl orange, and thymol blue. These indicators show specific colour change in acidic and basic solutions. *Phenolphthalein* is a common indicator because

## ACTIVITY 6

**Test with the litmus paper**

Collect samples of the given solutions and dip red and blue litmus papers in it. Do you observe any change in their colour? Record the colour change. What do you conclude about the nature of each substance?

| Test solution | Red litmus | Blue litmus | Nature |
|---|---|---|---|
| Soda water | | | |
| Milk of magnesia | | | |
| Window cleaner (ammonia water) | | | |
| Lemon juice | | | |
| Apple juice | | | |




Testing substances with litmus paper

its colour change is very obvious which makes it easy to use. It is colourless in acidic solutions and turns pink in basic solutions.

**Common indicators and their colour change**

| Indicator | Colour in acid | Colour in base |
|---|---|---|
| Phenolphthalein | Colourless | Pink |
| Methyl orange | Red | Orange/Yellow |
| Methyl red | Red | Yellow |
| Thymol blue | Red | Blue |

## Universal indicators

Universal indicators are used to determine the strengths of acids and bases. If there are two acidic solutions, a universal indicator helps us to identify which one is more acidic. Similarly, the alkalinity of solutions can be identified through these. Thus, *a universal indicator is a mixture of acid and basic indicators that show different colours over a range of pH values.*

## ACTIVITY 7

### Test with China rose indicator

Collect some China rose flowers. Separate the petals from the flower and grind the petals into a fine paste. Add little warm water and keep the mixture for some time till it becomes a coloured solution. This solution acts like an indicator. Add few drops of this solution to each of the following solutions.

| Solution | Effect on China rose indicator |
|---|---|
| Detergent | |
| Vitamin C tablet (ascorbic acid) | |
| Sugar | |
| Mouthwash | |

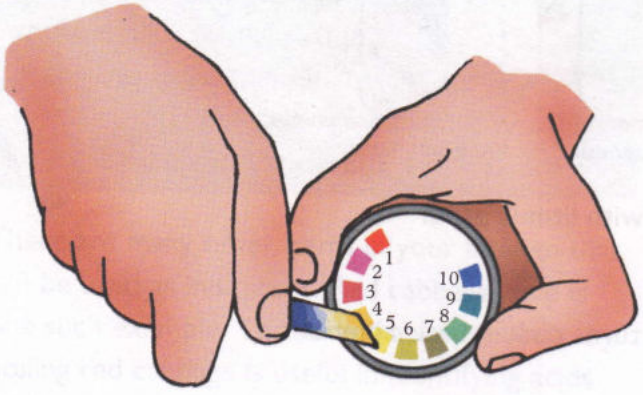



*Fig 6.3 pH meter*

You can dip the indicator in the solution to be tested and match it with the pH meter to determine the pH value.

**Infobit**

*Hydrangea* flowers are of different colours depending on whether the soil where they grow is acidic or basic. In acidic soil they are blue while in basic soil they are red.

## Neutralization

When an acid and a base are mixed, they try to neutralize each other's effect. This reaction between an acid and a base is called *neutralization*.

The neutralization reaction results in the formation of water and a new substance called *salt*.

$$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

The reaction is also accompanied by evolution of heat. Because of formation of water, the neutralization reaction is also referred to as *water-forming* reaction. The salt formed may be acidic, basic, or neutral. The table salt (NaCl) is an ideal product of such a reaction. Hydrochloric acid (HCl) is a strong acid and sodium hydroxide (NaOH) is a strong base. When the two are mixed in equal amounts, water and sodium chloride (NaCl) are formed. The reaction is represented by the following chemical equation:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

Guess the salt you will get when sulphuric acid is added to lime water.

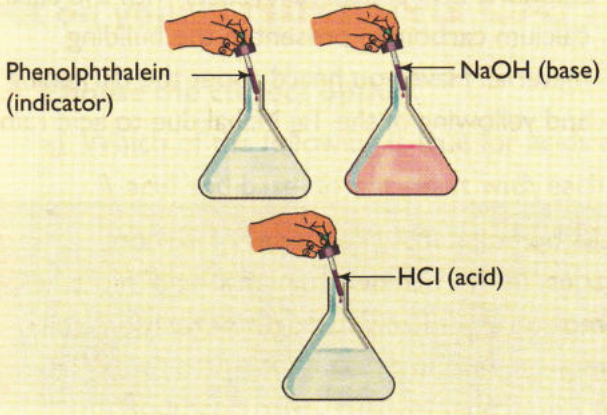
## ACTIVITY 8

*(To be done under the teacher's guidance)*

*Things required:* Dilute hydrochloric acid, phenolphthalein, sodium hydroxide, a conical flask, a dropper

*Method:*

1. Fill the conical flask with dilute hydrochloric acid.
2. Add a few drops of phenolphthalein and shake the test tube gently. Do you find any change in colour?
3. Use a dropper to add sodium hydroxide drop by drop and keep stirring. Is there any change? Continue till you can see the pink colour.
4. Now, add one more drop of dilute hydrochloric acid. The pink colour will disappear.




*Observation:* On adding phenolphthalein, no colour change happens. On adding sodium hydroxide, the solution becomes pink. When one more drop of acid is added, the pink colour disappears again. When you touch the test tube, it feels warm.

*Explanation:* Phenolphthalein is colourless in an acidic solution, so there is no change in colour initially. On adding sodium hydroxide the solution becomes basic and the earlier added phenolphthalein turns pink. When one more drop of acid is added, the acid and base neutralize each other's effect. Thus, the solution becomes neutral.

*Conclusion:* When an acidic solution is mixed with a basic solution, the two neutralize the effect of each other. As the tube becomes warm, it shows that the neutralization reaction is accompanied by evolution of heat.

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## ACTIVITY 9

*Things required:* Lime water, phenolphthalein, a test tube

*Method:*

1. Take lime water in the test tube.
2. Add a few drops of phenolphthalein to it. You will see the solution turns into a light pink colour.
3. Now, ask a friend to blow into the solution.

*Observation:* The colour disappears. Why does it happen?

*Explanation:* We breathe out carbon dioxide which reacts with water to form carbonic acid.

$$CO_2 + H_2O \longrightarrow H_2CO_3$$

The carbonic acid then reacts with the limewater (calcium hydroxide) and a neutralization reaction takes place. The phenolphthalein is pink in the presence of base and turns colourless when the whole base has been neutralized and there is a slight excess of the carbonic acid.

$$Ca(OH)_2 + H_2CO_3 \longrightarrow CaCO_3 + 2H_2O$$

S

## Neutralization in everyday life

1. **Soil treatment:** Neutralization of soil is necessary to promote plant growth Excessive acidic soil can be treated with basic compounds like ammonia-based fertilizers before cultivating. Soil that is too basic can be treated with calcium sulphate ($CaSO_4$) and sulphur for neutralization. Organic matter also releases organic acids which neutralize the basic nature of the soil.
2. **Indigestion:** Gastric juices present in your stomach contain hydrochloric acid. It helps in digestion of food and kills harmful bacteria. But sometimes due to excessive acid you get a burning feeling which is called indigestion or acidity. What medicine does the doctor prescribe to ease the pain? These indigestion remedies are called *antacids*, such as milk of magnesia (magnesium hydroxide) and sodium bicarbonate which are basic in nature. They react with acids to neutralize them. Some carbon dioxide gas is also formed, which you tend to burp out.
3. **Insect bite:** Neutralization can also be used to reduce the pain of insect stings. When an ant or a bee stings, baking soda is applied on the skin for relief. Ant sting is acidic (due to formic acid) and baking soda is basic (due to sodium bicarbonate), so neutralization takes place. Wasp sting, on the other hand, is basic and vinegar (which contains acetic acid) is used for relief from wasp sting.
4. **Disposal of factory wastes:** Acidic wastes from factories in rivers are first treated with bases so as to neutralize the wastes and prevent the river water from getting acidic which is harmful for the aquatic life.
5. We brush our teeth with toothpaste as they contain bases which neutralize the acids found in fruit juices. This helps to protect our teeth.
6. Acid rain can damage buildings and statues made of limestone, marble, and plaster. Such materials are made of calcium carbonate ($CaCO_3$), a basic substance that is neutralized by acid rain. These structures decay and get coated with a black substance that contains gypsum salt ($CaSO_4$). It is formed when the sulphuric acid in acid rain reacts with the base calcium carbonate present in the building material. Have you heard about the darkening and yellowing of the Taj Mahal due to acid rain?

**Infobit** Acid rain occurs when precipitation picks up pollutants like oxides of carbon, sulphur, and nitrogen released by industries. In this manner, sulphuric acid, nitric acid, and other acidic substances are produced. This acidic moisture gradually damages vegetation, soil, and many organisms. Think of ways to prevent acid rains.


**Minerals:** naturally occurring compounds

**Acidic solution:** acidic substances dissolved in water

**Basic solution:** basic substances dissolved in water

**Neutral solution:** solutions of substances which are neither basic nor acidic

**Chemical change:** change that occurs when substances react among themselves

**Indicator:** substances that undergo a change of colour with a change of acidic, neutral, or basic medium

**Litmus:** a natural indicator extracted from lichens which turns blue in base and red in acid


- The sour taste of most of the fruits and vegetables is due to various types of acids present in them. The digestive fluids of most of the animals and humans also contain acids.
- A chemical change occurs when substances react among themselves.
- Acids taste sour, are corrosive to metals, turn blue litmus paper to red, and react with bases to form salt and water.
- Acids react with metals to form hydrogen gas. They react with carbonates to form carbon dioxide, water, and salt.
- Bases are bitter in taste and soapy to touch. They change red litmus to blue and react with acids to form salt and water.
- Acids and bases are corrosive in nature. This helps them in removing tarnish from metal surfaces and makes them useful for household cleaning purposes.
- Acids contain more hydrogen ion and bases contain more hydroxyl ion.
- The pH of a substance indicates its level of acidity or alkalinity.
- Carbonic acid is responsible for the 'fizz' in soft drinks.
- The reaction of an acid with a base to produce salt, water, and heat is called a *neutralization reaction*.

## Put on your THINKING CAP!

***1. Choose the correct option.***

a) Which of the following is true for acids and bases?
   i) acid and base do not react with each other
   ii) acid and base neutralize each other
   iii) acid and base make stronger acids
   iv) acid and base make stronger bases

b) Which is the correct set of acid properties?
   i) sour, corrosive, changes blue litmus to red ii) sour, corrosive, changes red litmus to blue
   iii) sweet, slippery, changes red litmus to blue iv) sour, slippery, changes blue litmus to red

c) Which of these is not a base?
   i) soap ii) lime water
   iii) curd iv) ammonia

d) Vinegar, fruit juice, and cola are examples of
   i) strong bases ii) strong acids
   iii) weak bases iv) weak acids

e) Which of these is not an indicator?
   i) turmeric ii) phenolphthalein
   iii) tomato juice iv) red cabbage

f) Which food item contains ascorbic acid?

i) curd ii) banana

iii) orange iv) gooseberry

g) _____ is an antacid that reduces acidity in the stomach.

i) magnesium hydroxide ii) potassium hydroxide

iii) sodium hydroxide iv) calcium hydroxide

h) When an excess amount of water is added in an acid, it becomes

i) diluted acid ii) concentrated acid

iii) neutral substance iv) both (ii) and (iii)

**2. *Write T for true and F for false and correct the false statements.***

a) Vinegar is dilute lactic acid. ☐

b) Chemical name of vitamin D is ascorbic acid. ☐

c) When an acid reacts with a base neutralization occurs. ☐

d) Acids feel slippery to touch. ☐

e) Acids produce hydrogen ions when dissolved in water. ☐

**3. *Arrange the given substances under the suitable group.***

Soda water, glass cleaner, grapes, baking powder, yogurt, magnesium sulphate, vinegar, lemon juice, sodium chloride, lime water, calamine

| Acid | Base |
|---|---|
| | |

**4. *Fill in the blanks.***

a) Distilled water is a _____ solution.

b) Phenolphthalein turns _____ in colour in a base.

c) Lemon juice contains _____ acid.

d) _____ is an indicator extracted from lichens.

e) An ant bite can be treated by applying a _____ solution.

**5. *Name the acid.***

a) present in curd _____ b) in lemon juice _____

c) in an ant bite _____ d) in car batteries _____

e) brings the fizz in cold drink _____

**6. *Match the following:***

a) pH i) a product of reaction of an acid with a base

b) phenolphthalein ii) the scale used to measure acidity/basicity

c) salt
d) acid
e) base
f) corrosive
g) indicator

iii) damaging material it touches
iv) has a high concentration of $H^+$ ions
v) a type of indicator
vi) a substance which changes colour in acid or base
vii) has a high concentration of $OH^-$ ions

**7. *Write short answers.***

a) What is a chemical change? Give an example of a chemical reaction.
b) What is the rule for a balanced equation? Show with an example, how you can balance a chemical equation.
c) Differentiate between acid and base.
d) What are antacids? Why are they used?
e) What happens when vinegar is added to baking soda?
f) What is acid rain?
g) Why should industrial waste be treated before disposing of it into the rivers?
h) What are indicators? Name some natural and synthetic indicators.

**8. *Answer in details.***

a) Define neutralization. Give examples of neutralization reaction in everyday life.
b) Mention three major characteristics of acids. Mention the use of acids in everyday life.

**9. *Give reasons for the following:***

a) Gardeners add lime to soil.
b) When bitten by an ant, sodium bicarbonate solution is applied quickly.
c) You must brush your teeth after eating grapes.
d) You can use a lemon for cleaning copper vessels.
e) Acids are never stored in metal or plastic containers.
f) A turmeric stain turns red when soap solution is applied to it.

## Extended learning

S Make your own volcano.

Take a soda bottle and set it firmly in a baking pan. Mix flour, salt, oil, and water in a large mixing bowl. To make a fairly firm dough, mould the dough around a soda bottle. Leave the opening at the top open. Take little warm water and fill the bottle nearly to the top. Add a few drops of red colour, few drops of dishwashing detergent, and some baking soda as well. This prepares the volcano for eruption. Slowly pour the vinegar into the bottle opening. It should immediately start to foam and pour over the top of the volcano. This is because of the reaction between the vinegar and baking soda. This process also gives off carbon dioxide, which is what real volcanoes emit as well.

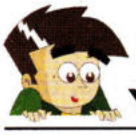
## HOTS

HIGHER ORDER THINKING SKILLS

1. Ritu was stung on her hand by a wasp. Her mother applied baking soda on it. There was no relief from pain and irritation. But when she applied vinegar, she felt relieved. Why?
2. Mr. Suresh took some antacids. This resulted in burping. Why?
3. Why is the Taj Mahal turning yellow?
4. A scientist visited a farmer's field and found the soil to be highly acidic. He suggested the farmer add ammonia-based fertilizers. Why?


For more information
http://www.chem4kids.com/files/react_acidbase.html
http://www.funsci.com/fun3_en/acids/acids.htm

# 7 Changes of Matter



**You will learn about**

- Physical change
- Chemical change
- Characteristics of physical and chemical changes
- Chemical reactions

Change is the law of nature. There are many changes taking place around us all the time. Day changing to night, flowers changing to fruits, seeds germinating into seedlings, a bud blooming into a flower, a caterpillar transforming into a beautiful butterfly, little puppies becoming big dogs, and water changing to ice are just a few changes that we see around us.

You might have heard the weather report during television news bulletin. Is it the same every time? The weather keeps changing from time to time.

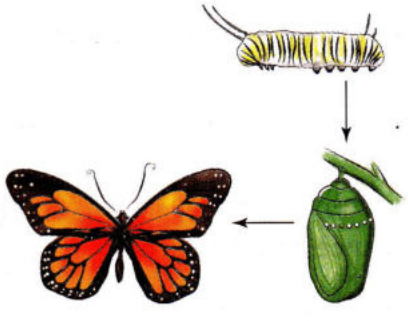


*Fig 7.1 Transformation of a caterpillar into a butterfly*

Make a list of some more changes around you.

We recognize different people by the differences in characteristics like facial features, colour, height, etc. These are the external characteristics. [There are certain properties like DNA, finger prints, etc., which cannot be seen from outside but are very unique.] We can identify the changes in a person by noticing the changes in any of these properties. Similarly, changes in matter around us can be identified by observing changes in the characteristics of matter.

## Physical change

The properties of a substance like volume, state, temperature, shape, size, colour, weight, and texture are called its *physical properties*. Some changes bring a change in the physical properties of substances. Change of state occurs during melting, freezing, boiling, and sublimation, but the material remains unchanged. There are, however, some changes where the composition of the substance also changes.

Let us look at a few examples of changes occurring around us.

Take some ice in a glass tumbler and keep it outside. What do you observe? It starts melting. Now, place the mixture of ice and water in the refrigerator. You will notice that the water again converts into ice. This changing of ice (solid) into water (liquid) and then the water (liquid) back into ice (solid) represents a *change of state* caused by the change of temperature.

*Fig 7.2 Melting ice*

- Take a ball of clay. Take turns moulding the clay into various shapes. What change do you notice? Does the clay change its state? No, the clay changes shape but there is no change in its state. The solid clay remains in the same state.
- Goldsmiths alter gold coins to make different articles like gold bracelets, rings, or earrings. All of them are made of the same substance—gold. Here, the shape of the substance changes but its composition remains the same.
- Take some water in a pan and start heating it. After some time, you can see water vapour rising up. Hold a cold plate above the steam. What do you see? You will see that the water vapours on contact with the cold plate convert back into water droplets. Here, the change of water into water vapour has been reversed.
- Take water in a tub. Now, put a towel in it so that all the water is absorbed. Can this change be reversed?
- Freezing of the famous Dal Lake of Kashmir is reported during the winter season. What do you think happens during summers? The ice melts in summer, thus reversing the change.
- Pull copper into a thin wire. What is the change that takes place? You only notice a change of shape, but not a change of composition, as it still remains copper.
- When you enter a dark room you switch on the light, electricity flows through the filament in the bulb, and it glows to give out light. When you leave the room, you switch off the light. The room again becomes dark.

Do you find anything common in the above examples?

In each case, there was a change in some physical property. On reversing the process, it was possible to get back the original substance. However, no new substance was formed in any of these examples.

Such changes where the physical properties like shape, size, appearance, or state of a substance change without any change in its chemical composition are called *physical changes*.

The starting and ending materials of a physical change are the same, even though they may look different. When you wash your hands, they dry after some time. It is a physical change. Sharpening of a pencil, stirring sugar in tea and coffee are also examples of physical change.

**Infobit** Mount Everest, the highest mountain peak in the world, rises by an inch every year. It is an example of a physical change.

When two substances are put together in a container any of the following will happen.

- They will remain separate and show no change, or
- They may mix together and still show no change, or
- They may react with each other and form a new substance or substances.

Which of these is a physical change?

## Chemical change

Take two similar sheets of paper. Cut one of the sheets into smaller pieces using a scissor. Burn the other sheet of paper using a matchstick. What do you observe?

A change takes place in each case. However, the changes are quite different. The paper which was cut into smaller pieces of paper changes its shape, but each smaller piece of paper retains the properties of the original sheet.

## ACTIVITY 1

Observe the given changes and fill in the suitable words from the box.

Size state shape colour

Melting, condensation, and evaporation

**Change in** _____

Drawing copper into a wire

**Change in** _____

Breaking glass

**Change in** _____

Blowing of balloons

**Change in** _____

Heating an iron nail till it is red hot

**Change in** _____

## ACTIVITY 2

Given below are some more examples of physical changes. Identify the property which gets changed in each of them.

- Cutting a log of wood into chips of wood
- Deflating and inflating a basketball
- Tearing a piece of aluminium foil
- Cloud formation in the sky
- A tailor cutting cloth to stitch your shirt
- Melting of butter

Melting butter

Chips of wood

On the other hand, the burned sheet of paper turns into ash and a gas is released during this process. In this case, new substances are formed and we cannot reverse the change.

[**Try this:** Sugar shows different changes on burning and dissolving in water. What are the two types of change?]

Let us perform the following activity to observe a chemical change.

## ACTIVITY 3

**Baking a cake**

*(To be performed under adult supervision)*

*Things required:* Flour, sugar, eggs, butter, chocolate powder

*Method:*

1. Take a bowl and put in it all the necessary ingredients.
2. Mix the ingredients well to make a smooth batter.
3. Observe any change. [So far, it is a physical change because the ingredients retain their original properties.]
4. Put the batter in the oven. What change do you observe now?

*Observation:* You will see the batter rising and turning brown. You start getting a different smell. Once the cake is baked, you can feel the spongy texture.

Is there any way to get back the batter from this cake? Does the cake have similar properties as that of its ingredients?

The answer to both the above questions is 'No'. In this activity, the original ingredients react with the help of heat to form a new substance. This process cannot be reversed now.

Such a change which results in the formation of new substance(s) is called a *chemical change*.

A chemical change requires the interaction between two substances. It is a change in which a new substance is formed that has an entirely different composition from the original substances. You can see several chemical changes in the kitchen while working. Imagine, if you had to eat raw french fries or vegetable curry. Cooking makes the food taste better. The properties of the food items are different before and after cooking. Changes like rotting of vegetables, eggs, etc., are also chemical changes. None of these can be reversed under any condition.

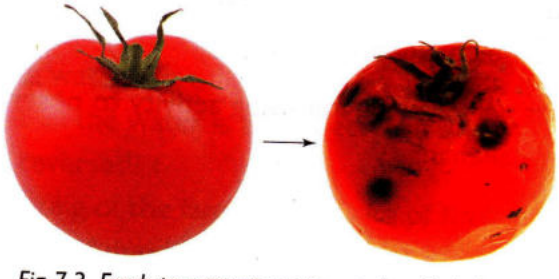


*Fig 7.3 Fresh to rotten tomato—a chemical change*

In our surroundings, there are several chemical changes displayed by living and non-living things. Photosynthesis is an important chemical reaction which takes place in green plants. The food we eat undergoes a chemical change when it is digested completely and gives us energy. The explosion of a fire cracker is also a chemical change that produces heat, light, sound, and some unwanted gases.

Some activities involve both chemical and physical changes. Have you seen a burning candle? Can you identify the different changes which are taking place in it? The two processes occur simultaneously—the burning of the wick and melting of the wax. The first is a chemical change where a gas is given out, carbon gets deposited on the wick and the wick keeps reducing in size.

This change cannot be reversed. The second is a physical change where the solid wax is changed to molten wax.

Some substances dissolve in water very easily. This is a change which can be reversed very easily. Take a beaker half filled with water. Add some salt into it and stir it vigorously. Heat the solution till all the water evaporates. You will see the salt at the bottom of the beaker. Thus, dissolving salt in water is a physical change that can be reversed.

**How do we get salt from sea water?**
Sea water is collected in pits made on the sea shore. As water evaporates, salt is left behind in the pits.

Some materials react with water to make a new material. For example, cement when mixed with water forms a new material—concrete. You cannot get the cement back from concrete. Thus, it is a chemical change. Plaster of Paris, a very useful compound used in art, architecture, fireproofing, and medical applications, also shows a similar change. Have you seen a plaster put over a fractured arm?

**Infobit** The term Plaster of Paris was first used in the 1700s due to large quarry deposits of gypsum (calcium sulphate dihydrate) located in Montmartre, a district of Paris, which was a leading centre of plaster at the time.

Some solids react with water to produce a gas that escapes as bubbles. Can you think of an example? Many times when you complain of a stomach ache your mother gives you an antacid.

What happens when it is added to water? Do you see some bubbles coming out?

Given below are some signs of a chemical change.

- A gas (fizz) is produced
- A solid (precipitate) is formed
- Sound or light is produced
- Temperature changes
- A colour change occurs
- A substance disappears
- A new odour is produced

Look at the following examples:

- Baking soda (sodium hydrogen carbonate) forms fizz with vinegar (acetic acid). Can we get back the baking soda?
- When you place an old coin in vinegar and take it out after some time you will get a shiny coin.
- Cut a slice of an apple, a potato, and a brinjal and keep them aside. Do you find a change in their colour? A new substance must have formed which brings about a change in colour.

What changes take place when an incense stick burns? The molecules of gas from the incense stick spread in the room. The solid particles of the incense stick change into gaseous state. Thus, a chemical change takes place in this case. A chemical change occurs only under favourable conditions.

*Fig 7.4 Burning incense sticks*

Wood is used for making many things. Cutting wood is a physical change, but burning wood is a chemical change. Do you know why? Because the wood when cut still remains wood and retains all its original characteristics. Cutting wood is thus a physical change. Burning wood, on the other hand, produces ash with the release of certain gases. The ash formed does not retain any of the characteristics of wood.

The table below lists some basic characteristics of physical and chemical changes.

### Characteristics of physical and chemical changes

| Physical change | Chemical change |
|---|---|
| No new or different substance is formed. The composition of the substances remains unchanged. | It results in the formation of at least one new substance. The constituent particles of the new substance are different from the constituent particles of the original substances. |
| It is a temporary change that can be reversed easily. | It is a permanent change that cannot be reversed easily. |
| No change occurs in the mass of the substances undergoing the change. | Mass of the individual substances may either increase or decrease. However, the total mass of all the reactants is equal to the total mass of the products. |

**ACTIVITY 4**

Arrange the following changes suitably under chemical or physical changes:

- boiling of water
- lighting a match
- ripening of a fig
- rusting of a nail
- melting ice cream
- digestion of food
- tearing of clothes
- chewing a food
- breaking of a stick
- burning gas in a stove
- sawing wood
- stretching a rubber band

Perform the following activity to test your understanding of physical and chemical changes.

## Chemical reactions

We have seen that when a chemical change takes place, new substances are formed.

The process by which a chemical change takes place, *i.e.*, by which two or more substances react to form new substances, is called *chemical reaction*. A chemical reaction is represented by means of a *chemical equation*.

The following activity demonstrates a chemical reaction between vinegar and baking soda.

Remember the fluffy cake you baked in Activity 3. It is the same carbon dioxide that made your cake so fluffy, soft, and nice.

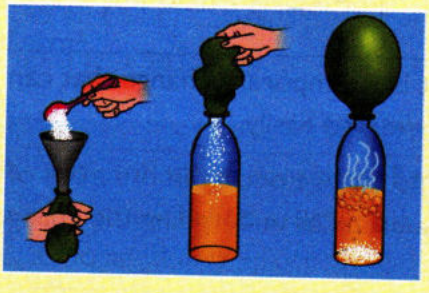
Carbon dioxide can be tested by passing it through lime water (calcium hydroxide) which turns milky due to the formation of calcium carbonate (limestone).

### ACTIVITY 5

*Things required:* A teaspoon, baking soda, vinegar, a funnel, bottle, a balloon

*Method:*

- Put three teaspoons of baking soda into a balloon by using a funnel.
- Fill one-third of the bottle with vinegar.
- Without dropping in the baking soda, fit the balloon over the mouth of the bottle.
- Hold up the balloon and let the baking soda fall into the vinegar.
- Observe the changes as the baking soda mixes with vinegar.



*Observation:* You will see bubbles coming out. Also, the balloon blows up.

*Explanation:* The bubbles are formed due to the release of carbon dioxide. Carbon dioxide finds no way to escape, so it enters the balloon and blows it up.

*Conclusion:* When vinegar (an acid) reacts with baking soda (a base), carbon dioxide is produced. This is a chemical change represented by the following chemical equation:

Vinegar (acetic acid) + Baking soda (sodium hydrogen carbonate) → Carbon dioxide + New substance

There are various types of chemical reactions. We will discuss just a few chemical reactions here.

### Rusting

Why are the iron benches, gates, and railings of the park in your locality painted regularly?

When a piece of iron is left in an open place with lots of humidity or in a wet place for a few days, a reddish-brown colour appears on its surface. This is due to the presence of a substance called *rust* that forms naturally.

*Rust* is an iron compound that forms due to the reaction of iron with water and oxygen. The process of formation of rust is called *rusting*. It is a chemical reaction that takes place over a period of time. It should be noted that oxygen and water must be present for iron to rust.

Iron + Oxygen + Water → Rust

Rusting eats away the surface of objects made from iron and destroys them. This happens

with several other metals also. *Tarnish* (called *patina*) is a thin layer that forms over copper, brass, silver, aluminium, and other semi-reactive metals as their outermost layer undergoes a chemical reaction.

Rust destroys the iron quite fast but *patina* takes much longer to destroy the copper. This process by which metals are destroyed progressively by chemical action is known as *corrosion*. Let us perform the following activity to show that water and oxygen are required for rusting.

**Infobit**

Rust destroys iron, which is undesirable. In the case of silver and copper, however, tarnish can actually preserve the underlying metal and may be considered desirable.

**Infobit**

- You must have seen the famous iron pillar at the Qutub Minar complex. It is one of the world's foremost metallurgical curiosities. It has withstood rusting for the last 1600 years, despite harsh weather. The pillar is a testament to the high level of skill achieved by ancient Indian ironsmiths in the extraction and processing of iron.
- The Statue of Liberty is made of shiny brown copper. Due to its interaction with carbon dioxide and water, a natural *patina* formed on the metal surface which made it turn green.

## ACTIVITY 6

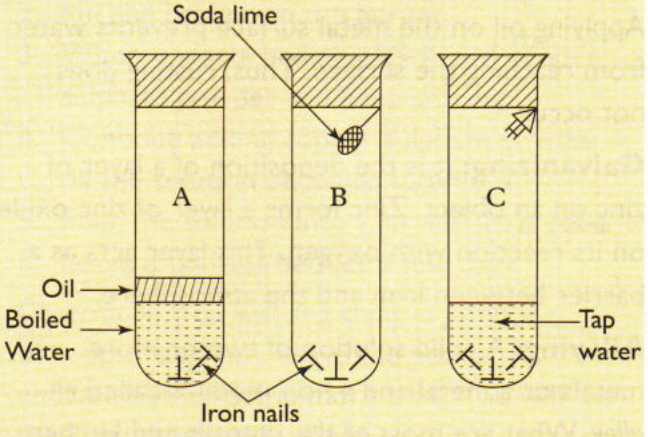
**To demonstrate that oxygen and water are necessary for rusting to occur**

*(Note: Activity to be performed under adult supervision)*

*Things required:* Three test tubes, iron nails, oil, soda lime, tap water

*Method:*

1. Take three test tubes. Label them A, B, and C. In test tube A, add some boiled water and a little oil. Drop two iron nails in it.
2. In test tube B, suspend a small cloth bag containing soda lime and drop in two iron nails.
3. In test tube C, add some tap water and drop two iron nails and also suspend two iron nails.
4. Observe the three test tubes after a few days.




*Observation:*

- In test tube A, the iron nails do not rust. This is because boiled water does not contain any oxygen. The thin layer of oil also prevents oxygen from reaching the water in the test tube.
- In test tube B, the nails do not rust. This is because the soda lime absorbs the carbon dioxide and water vapour though there is oxygen in the test tube.
- In test tube C, the nails dropped in water and the ones suspended both rust. This is because the water contains oxygen and the air contains oxygen and water vapour.

***Effects of rusting*** The chemical formula of rust is $Fe_2O_3.xH_2O$. It is a mixture of iron oxide ($Fe_2O_3$) and iron hydroxide ($Fe(OH)_3$). The rust is in the form of flakes. The flakes gradually break off and the lower iron layer that gets exposed also starts rusting.

The presence of impurities like salt, water vapour, and carbon dioxide fastens rusting. This is why rusting is seen mostly during the rainy season or often near coastal areas. Ships suffer a lot of damage due to rusting; the saline water makes the process faster. It causes heavy damage to objects.

We use iron and steel rods to construct buildings. Steel is widely used in making trains, cars, ships, wires, tools, hulls of ships, rail tracks, major appliances, cutlery and knives, and rulers. Hence, rusting is a common problem that needs to be tackled.

***Prevention of rusting*** Rusting can be avoided by preventing the iron surface from getting exposed to air (oxygen) and water. Given below are a few methods by which we can prevent metal objects from rusting:

**Painting:** Painting the metal surface prevents it from coming in contact with the moisture and oxygen present in the atmosphere, thus preventing it from rusting.

**Applying oil:** Water and oil do not mix. Applying oil on the metal surface prevents water from reaching the surface. Thus, rusting does not occur.

**Galvanizing:** It is the deposition of a layer of zinc on an object. Zinc forms a layer of zinc oxide on its reaction with oxygen. This layer acts as a barrier between iron and the atmosphere.

**Alloying:** A solid solution of two or more metals or a metal and a non-metal is called an *alloy*. What are most of the utensils and kitchen sink made up of? Steel is an alloy of iron and carbon. When mixed with other metals like chromium, nickel, molybdenum, and titanium it becomes stainless steel. The presence of these metals prevents rusting.

**Infobit** In 1913, an English metallurgist Harry Brearly, working on a project to improve river barrels, accidentally discovered that adding chromium to low carbon steel makes it stain resistant, makes it resist rust, or stain 'less' than other types of steel. This was called *stainless steel.*

## Displacement reaction

Have you heard of the food chain in nature? In a food chain, the higher order animals dominate the lower order animals. In the same way, in the world of elements a more reactive element displaces the less reactive element from its salt solution. Such kinds of reactions are known as *displacement reactions*. For this, we need to take compounds of elements which differ in their reactivity. Let us perform the following activity using copper and iron to understand what happens in a displacement reaction.

**ACTIVITY 7**

(*To be performed under teacher's guidance*)

*Things required:* Beaker, copper sulphate crystals, an iron blade, sulphuric acid, water

*Method:*

1. Take some copper sulphate crystals (also called *blue vitriol* because of their bright blue colour) in the beaker.
2. Add half cup water and a few drops of dilute sulphuric acid in the beaker.
3. Stir the mixture well. You will get a blue coloured $CuSO_4$ solution.
4. Put an iron blade into the solution and keep it undisturbed for about half an hour.
5. Do you find any change? Is the colour of the solution same as before?

*Observation:* A chemical reaction takes place in the beaker. Iron being more reactive than copper has a tendency to remove copper from its salt solution and form its own salt. In other words, it displaces copper from its salt solution (displacement reaction). After this reaction, blue colour of $CuSO_4$ changes to green due to the formation of iron sulphate ($FeSO_4$). Copper is left behind as red deposit on the iron blade.

The reaction is

$$Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$$

(Iron) (Copper sulphate) (Iron sulphate) (Copper)

Based on the above activity, fill in the blanks.

| Before reaction | After reaction |
|---|---|
| Iron is _____ in colour. | Iron gets _____ _____ deposits. |
| The solution is _____ in colour. | The solution is _____ in colour. |

t S

## Combustion

Combustion is a type of chemical reaction that takes place in the presence of oxygen to produce heat and light, as demonstrated in the following activity.

The burning of magnesium also produces ash. You can see ash at the bottom of the jar. The walls appear milky due to the smoke given out. Add little water to the ash and mix it well. The new substance formed is magnesium hydroxide. Use red litmus paper to see if it is acidic or basic in nature. The litmus paper turns blue indicating that it is basic in nature.

## Crystallization

*Crystallization* is the process by which pure crystals of a substance are obtained from its impure solution.

### ACTIVITY 8

*(To be demonstrated by the teacher)*

*Things required:* Magnesium ribbon, sand paper, candle, glass jar

*Method:*

1. Take a small strip of magnesium ribbon.
2. Rub its tip with a sand paper to remove the oxides present on it.
3. Light the magnesium ribbon with a candle and put it in a glass jar. What do you observe?

*Observation:* The magnesium ribbon burns with a bright white light like that of a cracker. It is a chemical change as a new substance is formed. Burning of any substance is called *combustion*. It is a reaction where metal combines with oxygen to form its oxide. S

$$2Mg + O_2 \rightarrow 2MgO$$

### ACTIVITY 9

*(Note: Activity to be performed under adult supervision)*

*Things required:* Beaker, jar, dilute sulphuric acid, copper sulphate solution, burner, water, a stirrer

*Method:*

1. Take a cup of water in the beaker and add a few drops of dilute sulphuric acid in it.
2. Put the beaker on the burner.
3. When it starts boiling, slowly add copper sulphate powder and keep stirring.
4. Continue adding copper sulphate powder till the solution becomes saturated.
5. Pour the solution into a jar and let it cool.
6. Leave it undisturbed for a few days.

*Observation:* You will see shiny crystals of copper sulphate. Leave the beaker undisturbed for some more time. You will see the crystals growing bigger.

[**Note:** If you do not see any crystals, leave the beaker undisturbed for a longer period of time.] S

Pure salt crystals can be obtained from sea water by the method of crystallization.

The table below lists the chemical names of some common compounds.

| Common name | Chemical name |
|---|---|
| Rock salt | Sodium chloride |
| Washing soda | Sodium carbonate |
| Sugar | Sucrose |
| Baking soda | Sodium hydrogen carbonate |
| Dry ice | Solid carbon dioxide |
| Chalk | Calcium carbonate |
| Gypsum | Calcium sulphate dihydrate |
| White vitriol | Zinc sulphate |


**Alloy:** a homogenous mixture of two or more metals

**Hydrate:** a compound associated with a particular number of water molecules

**Reactants:** the starting substances present before the beginning of a chemical change

**Product:** the substance formed after occurrence of a chemical change

**Corrosion:** the process by which metals are destroyed progressively by chemical action

**Rusting:** the process of formation of an iron compound on the surface of iron objects

**Combustion:** burning of any substance in the presence of air


- A *physical change* is a change in the physical properties like shape and size of a substance.
- A *chemical change* is a change in which a new substance with different composition and properties is formed.
- The processes involving change of state like melting and freezing are examples of physical change.
- Cooking of food, burning of paper, and ripening of fruits are examples of chemical change.
- The deposition of a layer of zinc on an object is called *galvanization*.
- The formation of crystals of pure substances from their solutions is called *crystallization*.

## Put on your THINKING CAP!

***I. Choose the correct answer.***

a) Freezing of water is a
   i) chemical change
   ii) physical change
   iii) irreversible change
   iv) none of these

b) Which of these is a chemical change?
   i) photosynthesis
   ii) mixing sugar in water
   iii) mixing salt in water
   iv) cutting of wood

c) The necessary condition for rusting is

i) presence of carbon dioxide
ii) presence of hydrogen
iii) presence of air and water
iv) presence of nitrogen

d) Which of these is *not* a method for preventing rusting in metals?

i) painting
ii) alloying
iii) galvanizing
iv) watering

e) Combustion takes place in the presence of

i) carbon dioxide
ii) nitrogen
iii) copper
iv) oxygen

f) The activity which shows both physical and chemical changes is

i) burning of a candle
ii) photosynthesis by plants
iii) melting of butter
iv) melting of ice

g) The iron compound that forms due to the reaction of iron with water and oxygen is known as

i) rust
ii) alloy
iii) tarnish
iv) both (i) and (ii)

h) _____ is an alloy of iron and carbon.

i) stainless steel
ii) steel
iii) brass
iv) bronze

**2. *Match the following to show changes. Identify each as a physical or chemical change.***

a) decomposition of
b) cutting a
c) blowing of
d) stretching of a
e) souring of
f) burning of

i) a magnesium ribbon
ii) old leaves
iii) rubber band
iv) balloons
v) copper wire
vi) milk

**3. *Write T for true and F for false and correct the false statements.***

a) Tearing of paper is a physical change. ☐
b) The presence of oxygen and water is necessary for rusting of iron. ☐
c) Copper is more reactive than iron. ☐
d) A physical change can be reversed. ☐
e) With a chemical change, no new substance is formed. ☐

**4. *Complete the analogies.***

a) Acetic acid : vinegar : : _____ : sodium hydrogen carbonate
b) Copper sulphate : blue vitriol : : _____ : green vitriol
c) Physical change : _____ : : chemical change : permanent
d) Oxide of iron : _____ : : oxide of magnesium : MgO
e) Saline water : salt in water : : soda water : _____

**5. *Write P for physical change and C for a chemical change.***

a) You cut your hair _____
b) Making a fruit and cornflakes mixture _____
c) Baking soda reacts with vinegar _____
d) Rotten food _____
e) A piece of metal is bent in half _____
f) Aspirin tablet is crushed into fine powder _____

g) Baking cookies _____
h) A tree burns to form ashes _____
i) A piece of paper is crumpled up _____
j) Water freezes to form ice _____
k) A candle is burning _____
l) A candle is melting _____

**6. *What happens to the following substances in the given conditions?***

| Substance | Condition | Result | Type of Change |
|---|---|---|---|
| a) Iron rod | Kept outside | _____ | _____ |
| b) Glass window pane | A ball hits and passes through it | _____ | _____ |
| c) Raw egg | Broken and whipped | _____ | _____ |
| d) Cake mix | Mixed and baked | _____ | _____ |
| e) Camphor | Lit with a matchstick | _____ | _____ |

**7. *Define the following terms.***

a) Galvanization
b) Crystallization
c) Sublimation
d) Rusting
e) Corrosion
f) Alloy

**8. *Answer in details.***

a) What are the two types of changes in matter? Explain with examples.
b) What is rusting of iron? Name two factors which cause rusting and suggest two ways to prevent it.
c) List some examples of chemical changes.
d) Write an activity to show a chemical change.
e) Differentiate between chemical and physical changes.

**9. *Give reasons for the following:***

a) Rusting is seen mostly during the rainy season.
b) Explosion of crackers is a chemical change.
c) Carbon dioxide turns lime water milky.
d) Baking soda fizzes with vinegar.
e) A shiny copper object turns green after sometime.

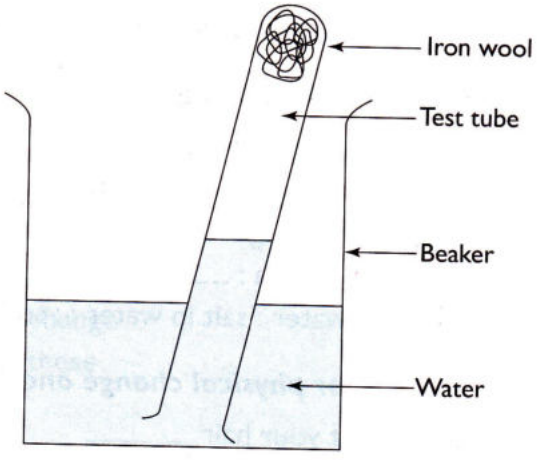
HIGHER ORDER THINKING SKILLS **HOTS**

1. Name the characteristic of a substance that never changes during a physical change.
2. Is the popping of popcorn a physical or chemical change? Justify.

## Extended learning

S Perform the following experiment and find out how much of air is used during rusting.

1. Take a beaker of water and put 50 ml of water into it.
2. Take a test tube and put in 3 cm of iron wool into the test tube and wet it with water. Drain away the excess water.
3. Invert the test tube and place it in the beaker as shown
4. Measure the column of air in the test tube using a ruler.
5. Leave the setup undisturbed for a week and then measure the column of air again. Is there a change? If so, give reason.



# 8 Weather, Climate, and Adaptations

**You will learn about**

- Weather
- Climate
- Polar adaptations
- Tropical forest adaptations

## Weather

One of the first things you notice when you wake up in the morning is the weather. If you have to leave for school on a cold morning, you wear your winter uniform which includes a woollen sweater and a coat. If you have to go out for shopping on a hot and humid day, you wear light-coloured cotton clothes which will keep you cool.

Weather changes almost every day. It may change even during the course of the day. It may rain for an hour in the morning and then become sunny and clear right after that. The maximum temperature of any place occurs in the afternoon and the minimum temperature occurs in the early morning. The sunrise and sunset timings are also different throughout the year.

We watch the weather report during the television news every night. When you open the newspaper in the morning, you get a fair idea of what the weather of the day will be like.


The weather report of a city from a newspaper is shown here.

| | | | |
|---|---|---|---|
| Minimum temperature | 25.8°C | Sunrise | 5.55 am |
| Maximum temperature | 31.1°C | Sunset | 6.55 pm |
| Humidity | 79% | Weather | Rainy |

Compare the given report with the weather forecast of your city reported today in a local newspaper. Using data given in both the reports fill in the table given below.

| | Report 1 | Report 2 |
|---|---|---|
| Minimum temperature | | |
| Maximum temperature | | |
| Humidity | | |
| Sunset | | |
| Weather | | |

What do you conclude from the two reports?

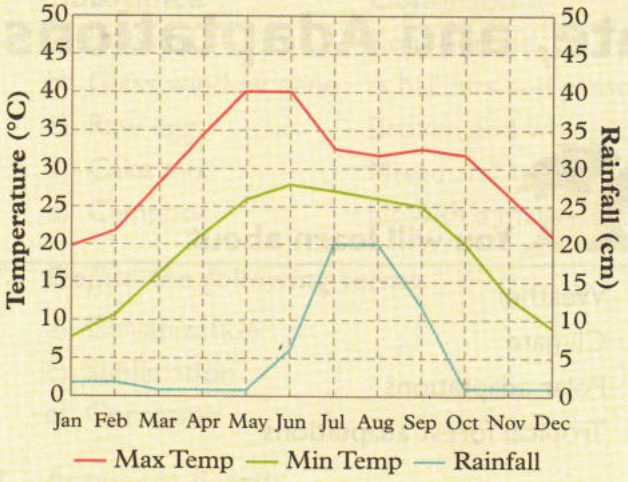
*Weather* includes daily changes in precipitation, pressure, temperature, humidity, and wind conditions at a given place.

Weather experts use computer technology and data from Earth stations and satellites to predict the weather. This is known as *weather forecasting.*

The weather forecast that helped you plan activities for this week was probably made by a *meteorologist.* A meteorologist is a person who studies the weather.

## ACTIVITY 2

**Monthly average temperature and rainfall in Delhi**




From the graph given above, find out the following information:

a) The hottest months _____

b) The highest temperature _____

c) The coldest months _____

d) The lowest temperature _____

e) The months with maximum rainfall _____

f) The highest rainfall _____

The weather affects our lives every day.

It has an impact on the type of clothing we wear and the way we spend our free time.

Snow causes hazardous driving conditions.

Thick fog slows down road traffic and causes delays at railway stations and airports.

Weather also affects agriculture, transportation, and industry.

### What causes changes in weather?

The Earth's weather is driven by the Sun. The Sun is the source of all energy on the Earth.

Sunlight heats the Earth, but it does not heat it evenly. The energy which is absorbed and reflected by the surface of the Earth, the atmosphere, and the seas and oceans determines the weather of a particular place.

## Climate

Another commonly used term relating to the atmospheric conditions is climate. Climate tells us what it is usually like in the place where you live. Bengaluru is known to have a mild climate, Chennai a humid climate, Kashmir a snowy climate, and Cherrapunji a rainy climate. How would you describe the climate of the place where you live?

The climate refers to the common, average weather conditions at a particular place over a long period of time.

It describes the total of all weather conditions occurring over a period of years in a given place. This includes average weather conditions, regular weather sequences like winter, spring, summer, and autumn, and special weather events like cyclones and floods.

## ACTIVITY 3

Find out any three types of climates of the world. Choose three climates and provide the information in the columns for each type of climate.

| Categories | Climate 1 | Climate 2 | Climate3 |
|---|---|---|---|
| Type | | | |
| Where is it found? | | | |
| Average temperature | | | |
| Animals found | | | |

There are a number of factors which affect the climate of a place. They are latitude, altitude, distance from the sea, ocean currents, and direction of the wind.

## Polar adaptations

Polar regions are the icy areas around the North Pole and the South Pole. The northern polar region is called the *Arctic*. The southern polar region is called *Antarctica*.

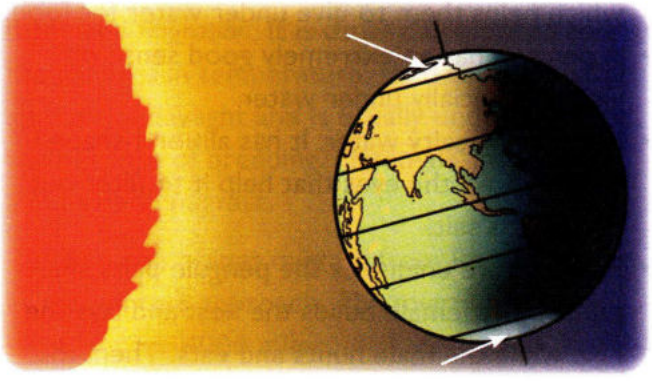


*Fig 8.1 Polar regions of the Earth*

Antarctica is the coldest, windiest, and driest place on Earth. The coldest temperature ever recorded here was approximately –129°F. During the winters, the Sun never rises here. When the Sun does shine, it has very low intensity. Even in the summer, it rarely gets above freezing point.

The climates of these places are extremely harsh. The animals inhabiting these areas have developed a number of adaptations that help them to live and survive in such conditions. Let us look at some of them.

### Polar bear

Polar bears live in icy Arctic areas of Alaska, Canada, Greenland, Norway, and Russia. They show many adaptations that enable them to survive in extreme cold and harsh conditions.

#### *Adaptations for surviving the cold*

- It has two thick layers of fur to keep it warm on land.
- It has long hair between the pads on its feet. This helps to keep it warm and to walk on the ice.
- It has a thick layer of fat, called *blubber*, under its skin that keeps it warm while swimming in icy cold water.

*Fig 8.2 Polar bear*

#### *Adaptation for hunting prey and protection from predators*

- The white colour of the fur camouflages it against the snow. It is thus able to sneak up close to the seals and hunt them.
- There are five very sharp claws on each foot for grasping the ice and its prey.
- It can smell its prey from a great distance. The polar bear finds the seal's breathing holes in the ice and waits patiently. When the seal pokes its head out of the hole, the bear quickly snatches the seal.
- The polar bear's huge teeth help in tearing its prey apart.

#### *Adaptation for staying in water*

- It has a streamlined body that helps it to swim well.
- The polar bear has stiff hair on its front legs and very broad front feet to help it to swim.
- The hind legs are held flat and are used as rudders. It can close its nostrils and remain underwater for long periods of time.

## ACTIVITY 4

Fill two slider storage bags with vegetable shortening. Seal the bags and place them into another slider storage bag. Slip your hand in between the two bags of shortening and close the outside bag around your hand. Then place your hand into a tub of icy water. Does your hand feel cold?

[**Note:** The vegetable shortening is similar to the blubber found in polar bears.]

**Infobit** If there is plenty of prey, the polar bear eats the seal's skin, fat, and internal organs but not the meat.

### Penguin

Penguins spend most of their time in the icy water of Antarctica. They show a number of adaptations, as detailed below, to survive in such cold climates.

#### *Adaptations for surviving the cold*

- The penguin's feathers are densely packed, with no gaps between them. It has a layer of *blubber* (fat) under the skin that keeps it warm in the sea.
- After the chicks are born, they all huddle together. This helps keep them warm.

#### *Adaptation for hunting prey and protection from predators*

- A penguin's body is white on the front and black on the back. In water, this gives it a camouflage. Being white, it cannot be easily seen from below against the lighter surface of the sea. From above, they blend in with the darker sea depths.
- They love to live in communities, which also protects them from predators like the walrus or sea lion.

#### *Adaptation for staying in water*

- A streamlined body, paddle-like feet, and wings shaped like flippers help the penguin to swim through water at a speed up to 15 miles per hour. At such high speeds, they seem to be flying through the water.
- Heavy and solid bones make penguins heavier, which helps them to dive under water for food.
- A penguin has an extremely good sense of vision, especially under water.
- It can drink salty water. It has almond-shaped glands above the eyes that help it to filter out the excess salt.
- Penguins are unique as the penguin pairs share duties. The female builds the nest and lays the egg, while the male hunts and eats. Then, the female hunts and eats, while the male hatches the egg. Once the egg is hatched, both parents collect food and feed the young one. A penguin can pick its own baby out of a crowd of thousands to feed it.

*Fig 8.3 Penguins*

Other animals which inhabit the polar regions are reindeer, walrus, seal, caribou, musk ox, fish, and birds.

### Migration

Migration is an adaptation shown by animals in order to protect themselves from the cold.

**Infobit**

- Emperor penguins don't build nests; they hold the egg on top of their feet under a loose fold of skin. The Emperor penguin is the only bird that never touches dry land.
- Penguins nest in groups that may reach a population of a million birds at a time.

The seasonal movement of the complete population of animals from one area to another is termed *migration*. It is usually a response to the changes in temperature, food supply, or the amount of daylight and is usually undertaken for the purpose of breeding. Mammals, insects, fish, and birds all migrate.

The Siberian cranes migrate from Russia to India as the winters approach. The migration route stretches for 4000 miles.

*Fig. 8.4 Migratory birds*

## Rainforest adaptations

Most rainforests lie between the Tropic of Cancer and the Tropic of Capricorn. This is why they are often called *tropical rainforests.*

The rainforests have a very wet climate and that is why they are named so. The total rainfall in a year ranges between 1500 and 2500 mm with no dry season at all. It rains almost every day. The temperature during the day is between 30°C and 35°C while at night, it falls down to between 20°C and 25°C.

**ACTIVITY 5**

On a world map, mark out the countries in each continent where the rainforests are found.

Due to the continuous rainfall, a rainforest is filled with lush green vegetation. The climate is very humid due to the warm sunlight, rain, and the canopies of the trees. The rainforests are home to a vast variety of animals and birds because they do not have to worry about looking for shade in summers or freezing in winter. Food is available in plenty and there is enough water to drink.

*Fig 8.5 Tropical rainforest*

Since there are so many kinds of animals and birds living in a rainforest, there is a fierce competition for food, water, and shelter. Then, how do they all survive together? This is because of the adaptations that the different animals and birds show. Let us study a few of them.

### Toucan

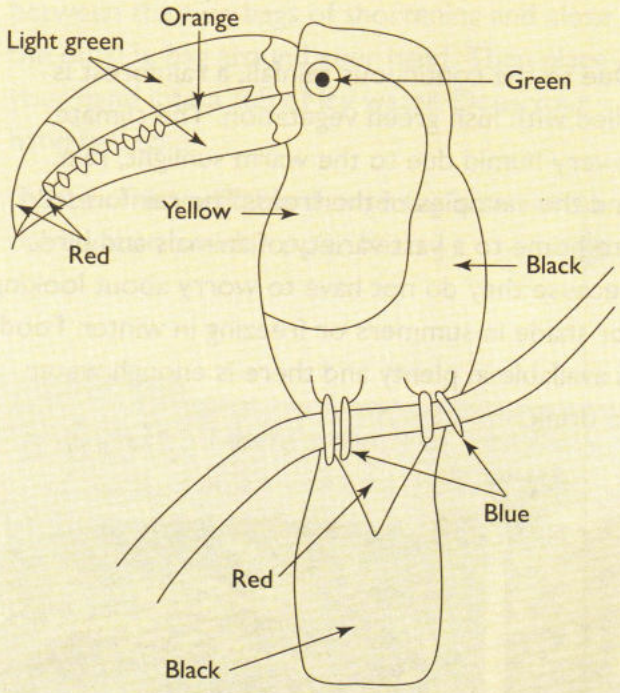
Have you ever seen a toucan bird?

Toucans have the following adaptations that help them to survive:

- A toucan has a big and long beak that enables it to eat fruits and nuts which are not accessible to other animals. The large beak serves as a

## ACTIVITY 6

Colour the toucan as per the colours specified and find out what a beautifully coloured bird it is.




nut cracker and helps it to hunt insects and small reptiles.

- Toucans have four claws in each leg, two in front and two at the back. This helps them to perch on trees while looking for food.
- Toucans also have the ability to camouflage themselves with the surrounding to avoid predators.

**Infobit** The toucan sleeps in holes in the trees. If it does not fit into a hole, it turns itself into a feathery ball to make its body smaller.

### Macaws

The macaw is another bird found in the rainforests. The macaw mostly thrives on fruits and nuts. Its hooked beak is perfect for breaking nuts. The beak is a protection against predators such as snakes and birds of prey.

*Fig 8.6 Macaw*

### Lion-tailed macaques

Lion-tailed macaques are found in the Western Ghats of India. They spend most of their lives on treetops where they find food and safety. They resemble lions and hence the name. They are omnivores and eat fruits, nuts, seeds, leaves, and insects.

*Fig 8.7 Lion-tailed macaque*

They live in groups that help them to guard against danger. They have many ways of communicating with one another. It can be in the form of gestures, growls, or screams. This communication helps them to warn each other of the forthcoming danger.

**Infobit** The lion-tailed macaque is an endangered animal and there are only about 2500 of these animals left, scattered over several areas of Karnataka, Kerala, and Tamil Nadu.

### Monkeys

Many types of monkeys live in the rainforests. Most monkeys have a very long tail which enables them to grasp the branches of trees or

hold objects. Such a tail is called a ***prehensile tail.*** This makes the hands of a monkey free to handle other things. The forelimbs and hindlimbs of these animals are also very long and this helps them to swing from tree to tree.

*Fig 8.8 Monkey*

## Elephants

Elephants are adapted to live in dense forests. Their tusks are straight since curved ones might get caught in the branches and vines of the forest. They possess large ears which they flap to create a cooling effect. An elephant's trunk has many uses including picking up food, drinking water, and communicating with other elephants. Elephants also make very low-pitched sounds that help them to communicate with each other.

*Fig 8.9 Elephant*

**Infobit** The hoolock gibbon is the only ape found in India. They are an endangered species because poachers hunt them down. Parts of hoolock gibbons are used extensively for medicinal purposes by the people in Myanmar and China.

## Poison arrow frog

The poison arrow frogs are brilliantly coloured and warn their enemies that they are dangerous. They have special poison glands in their skin that secrete a deadly poison, probably the result of their diet of poisonous ants. This helps them wade off enemies. One frog carries enough poison to kill about 100 people. Native hunters use it on the tips of their arrows which is how the frog got its name.

They also have sucker-like toes that help them to climb up trees.

The rainforests are home to other animals like sloths, boa constrictors, tigers, lions, leopards, snakes, lizards, and many types of birds and insects.

These animals are capable of camouflage. They have a skin colour that merges with the surroundings thereby making them invisible to the predators. Their keen eyesight and sharp sense of hearing helps them in their hunt for food and protects them from being hunted.

*Fig 8.10 Poison arrow frog*


**Weather:** the daily changes in precipitation, pressure, temperature, humidity, and wind conditions in a given place

**Weather forecasting:** the use of computer technology and data from Earth stations and satellites all over the world to predict weather

**Meteorologist:** a person who studies the weather

**Climate:** the average weather conditions at a particular place over a long period of time

**Migration:** the seasonal movement of a complete population of animals from one area to another


- Weather changes from day to day and sometimes even during a single day.
- The changes in weather on Earth are driven by the Sun.
- The different climates that exist around the world are tropical, dry, temperate, cold, and polar.
- Latitude, altitude, distance from the sea, ocean currents, direction of the wind, humidity, and human activities affect the climate of a place.
- Polar and rainforest animals have a number of adaptations that help them survive in these climates.
- Polar animals have thick fur, blubber, sharp claws, streamlined bodies, and limbs that help them to walk on ice and swim in icy cold waters.
- Migration is an adaptation shown by animals in order to protect themselves from the cold.
- Rainforest animals show camouflage, have prehensile tails, live high on trees, possess long and strong beaks, a loud voice, keen eyesight, and have a good sense of hearing.

## Put on your THINKING CAP!

*1. Choose the correct option.*

a) _____ have streamlined body, paddle-like feet, and wings shaped like flippers.

i) poison arrow frogs
ii) penguins
iii) macaws
iv) monkeys

b) Which of the following animals possesses almond-shaped glands above the eyes?

i) monkey
ii) toucan
iii) penguin
iv) macaw

c) Which animal turns itself into a feathery ball so that it can sleep in holes in the trees?

i) pigeon ii) sparrow

iii) toucan iv) macaw

d) In which season do the Siberian cranes migrate from Russia to India?

i) summer season ii) winter season

iii) rainy season iv) both (i) and (ii)

e) In rainforests, the total rainfall in a year ranges between

i) 1500 and 2500 mm ii) 900 and 1200 mm

iii) 500 and 900 mm iv) 300 and 500 mm

f) _____ huddle together in groups to stay warm.

i) penguins ii) bears

iii) poison arrow frogs iv) lion-tailed macaques

g) This animal possesses blubber under its skin

i) polar bear ii) monkey

iii) elephant iv) toucan

h) Which of these elements affect the climate of a place?

i) latitude ii) altitude

iii) humidity iv) all of these

**2. *Match the following:***

| | |
|---|---|
| a) meteorologist | i) the average weather conditions at a particular place over 30 years |
| b) weather forecasting | ii) the daily changes in precipitation, pressure, temperature, humidity, and wind conditions in a given place |
| c) migration | iii) a person who studies the weather |
| d) weather | iv) the use of computer technology and data from Earth stations and satellites all over the world to predict weather |
| e) climate | v) the seasonal movement of a complete population of animals from one area to another |

**3. *Given here are some types of adaptations. Write an 'R' if it is a rainforest adaptation or a 'P' if it is a polar adaptation against each.***

1. Migration
2. Beautiful coloured feathers
3. Long tails
4. Streamlined bodies
5. Poison glands
6. White fur
7. Padded feet
8. Longer beaks
9. Fruit and nut eaters
10. Keen eyesight

4. ***Given below is a picture of a polar bear. A number of adaptations are written in the boxes around it. Put a tick mark in the box if the polar bear has that particular adaptation.***

has sharp claws

lives in large groups

feeds on seals

drinks salty water

possesses a thick layer of blubber

has a keen sense of vision

has flippers

shows camouflage

5. ***All of these animals have special features that help them to survive in their environment. Put each animal in the column where it belongs. Some animals may belong to more than one column.***

Penguin macaw
Poison arrow frog
Lion-tailed macaque
Monkey
Toucan
Hoolock gibbon

**Adaptation table**

| Has a prehensile tail | Has a beak | Can climb trees | Shows camouflage | Is poisonous/ harmful to touch |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

6. ***Given below are some adaptations seen in various animals. In the space provided beside each adaptation, write how it is useful to the animal.***

a) Huge teeth of a polar bear _____
b) Almond-shaped glands in a penguin _____
c) Community living among penguins _____
d) Big and long bill of a toucan _____

e) Loud communication among lion-tailed macaques _____

f) Prehensile tail in monkeys _____

g) Large ears of an elephant _____

h) Trunk of an elephant _____

i) Camouflage in frogs _____

j) Flippers of a penguin _____

**7. *Write short answers.***

a) Discuss some adaptations shown by polar bears.

b) How does a penguin get rid of all the excess salt in its body?

c) How do penguin pairs share their duties?

d) Why do siberian cranes migrate?

e) How do the following communicate?

i) Lion-tailed macaques ii) Elephants

**8. *Answer in details.***

a) List the factors that affect the climate of a place.

b) Contrast the climate of the polar region with that of a rainforest.

c) Why is the rainforest home to more than half of the animal life on Earth?

## Extended learning

1. Find out details of the phenomena called El Nino and La Nina.
2. Research about the instruments used in weather forecasting. Write a brief description of each and draw or stick pictures of the same.
3. According to scientific research, humans are responsible for the climatic changes that occur in the world. What activities of humans have led to the change? How have they been caused and what is their impact on all living organisms?

HIGHER ORDER THINKING SKILLS
**HOTS**

1. A polar bear accidentally fell in a pool of red paint. What impact will the red colour have on it?
2. What will happen if the tusks of an elephant are removed?
3. What will happen if trees are felled extensively in a rainforest?


For more information

http://library.thinkquest.org/26804/weather.html

http://www.factmonster.com/ce6/weather/A0851700.html

http://www.factmonster.com/dk/encyclopedia/climate.html

http://www.planetozkids.com/oban/animals/environment.htm

http://www.enchantedlearning.com/subjects/rainforest/animals/Rfbiomeanimals.shtml

http://library.thinkquest.org/11353/trforest.htm

# 9 Wind, Storms, and Cyclones

The weather of the place we live in has a tremendous effect on our daily life. From the shelter we build to the clothes we wear and the food we eat, everything is affected by the weather of the place. Also, if the weather turns severe, like strong winds or a cyclone or heavy rains, it can have a great impact on the lives of the people. These natural calamities affect everything including agriculture, communication, transport, and electric supply, and can even cause the place to become isolated from the rest of the world.

Now, we shall study more about these natural phenomena and some basic concepts concerning them. Let us begin by studying some important properties of air.

**You will learn about**

- Properties of air
- Wind generation
- Thunderstorms and cyclones
- Destruction caused by cyclones
- Effective safety measures to be taken during a cyclone

## Air exerts pressure

Air is all around us and it exerts pressure on us. We can feel the force exerted by air on our face when we sit on a fast riding motorbike. The following activities will help us to demonstrate that air exerts pressure.

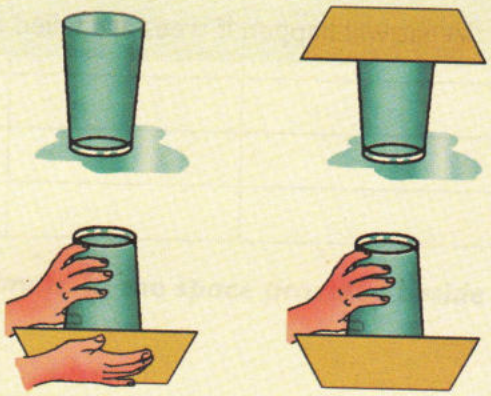
### ACTIVITY 1

**Air exerts pressure**

*Things required:* A tumbler, a piece of cardboard, water

*Method:*

1. Fill the tumbler with water and cover its mouth with the cardboard.
2. Holding the cardboard in place with one hand, carefully turn the tumbler upside down.
3. Remove your hand from the cardboard gently.
4. Record your observation.



*Observation:* You will see that the cardboard does not fall off and the water remains inside the inverted tumbler. This is because of the air pressure being exerted on the cardboard from below.

*Conclusion:* This shows that *air exerts pressure.*

## ACTIVITY 2

[**Caution:** This activity requires the use of a burner, so the activity should be carried out under adult supervision only.]

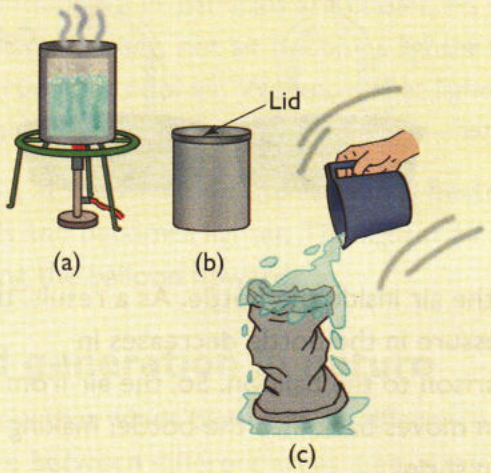
*Things required:* A tin container with a lid, burner, water

*Method:*

1. Half fill the container with water.
2. Boil the water till steam starts coming out of the container.
3. Stop heating and close the lid of the container.
4. Remove the container from the burner carefully.
5. Allow the container to cool or pour cool water over the closed container.

*Observation:* You will see that the container gets deformed.

*Explanation:* The steam drives out the air from the container. So, when the container is covered with the lid it only contains water and steam. On cooling, the steam condenses to water and creates a vacuum in the container above the water. The air from outside exerts more pressure than that is exerted from inside the can, thereby deforming it.




## High speed winds result in reduced air pressure

Wind has an ability to lift things. To demonstrate this, take a paper strip. Hold it between the thumb and the forefinger and bring it closer to your mouth. Blow strongly over the paper strip. Record your observation.

You will notice that the paper strip rises upwards. Let us try to understand how this happens.

When you blow over the strip, the air above it moves. Moving air (wind) reduces the pressure above the strip. Thus, the air pressure below the strip becomes more than the air pressure above it. This lifts the strip upwards.

The following activity will help us understand this effect better.

*Fig 9.1 A child blowing over a paper strip*

## ACTIVITY 3

**High-speed wind results in lower air pressure**

*Things required:* Two balloons, a scale

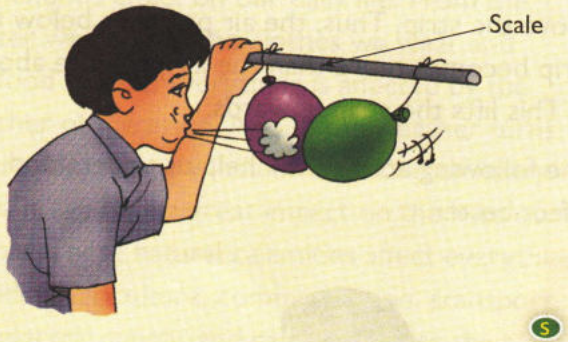
*Method:*

1. Take two identical air-filled balloons and tie them at the ends of the scale, at least 10 cm apart.
2. Blow air in the space between the balloons. What do you observe?

*Observation:* You will notice that on blowing between the balloons they move towards each other.

*Explanation:* As air is blown between the two balloons, the speed of air increases. This reduces the air pressure between the balloons. The pressures on the opposite sides of the balloons being higher, pushes the balloons towards each other.

*Conclusion:* This shows that *high-speed wind reduces air pressure.*




It is clear from the above activity that if wind speed increases there is a drop in the air pressure. When high-speed winds blow over the roofs of buildings which are weakly attached to the building, the roofs can be lifted and blown away.

## Air moves from high pressure to low pressure

We know that water flows from an area of high altitude to an area of low altitude. In a similar way, air always moves from an area of high pressure to an area of low pressure.

Let us perform the following activity to understand this effect.

In Activity 4, if you further put the bottle with the inflated balloon in a bath of cold water, you will observe that the balloon shrinks. This happens because the cold water cools the air inside the bottle. As a result, the air pressure in the bottle decreases in comparison to the balloon. So, the air from the balloon moves back into the bottle, making the balloon shrink.

### ACTIVITY 4

*(To be performed under the teacher's guidance)*

*Things required:* A balloon, an empty bottle, a hot water tub

*Method:*

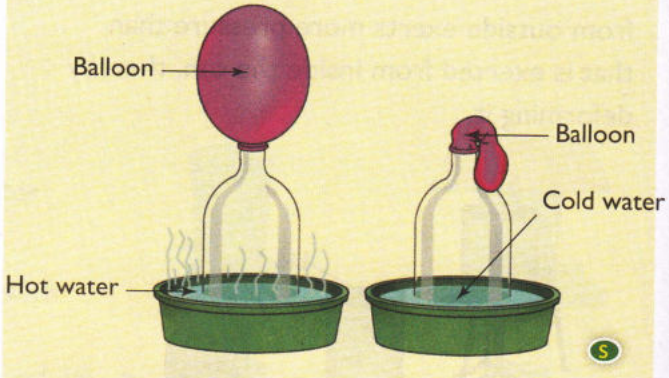
1. Loosen the balloon by filling it with air and then letting the air out.
2. Take the empty bottle and cover its mouth with the balloon.
3. Place the bottle in a tub of hot water.

*Observation:* You will notice that when placed in hot water the balloon expands.

*Explanation:* When the bottle is put in the hot water bath, the air molecules start heating. The heat makes the air molecules move faster and cover more space, *i.e.*, air expands. This increases the air pressure inside the bottle. The air pressure inside the balloon is lower than that inside the bottle. Thus, the air moves into the balloon, which starts inflating.

*Conclusion:*

- Air expands on heating.
- Air moves from an area of higher pressure to an area of lower pressure.



The previous activity makes it clear that air moves from an area where the air pressure is high to an area where the air pressure is low. The greater the pressure difference, the faster is the movement of air or, in other words, the greater is the wind speed.

## Air expands on heating

We have seen in the previous activity that air in the heated bottle moves to occupy the space in the balloon. This shows that air expands on heating.

You might have noticed smoke coming out of a chimney in houses or in factories. The smoke always seems to go upwards. Do you know why?

Also, you might have seen hot air balloons rising up in the sky. How do they rise up?

*Fig 9.2 Smoke from a chimney*

*Fig 9.3 Hot air balloon*

Let us try to answer the above questions. The smoke from a chimney contains hot air particles. The surrounding air particles are cooler. As air expands on heating, hot air becomes lighter than the surrounding cool air. We know that lighter things always rise above heavier things.

Similarly, as the air inside the balloon is heated, it expands and becomes lighter. The lighter air rises up taking the balloon upwards.

## Wind generation in nature

We know that winds blow due to difference in pressure between different areas. Let us try to understand how this happens in nature.

- *Uneven heating of the Earth's surface between the equator and the poles:*

  When the Sun shines directly above the equator, the air in this region gets heated and rises up, creating a region of low pressure. This makes the cooler air from the surrounding region on either side of the equator move towards this low pressure area.

  Similarly, at the poles the air is very cold and sinks close to the surface creating a high pressure area. The air above the areas surrounding the poles is warmer and hence lighter. This warm air rises up creating a low pressure area and the cold air from the polar region rushes to take its place.

- *Unequal heating of the land and water surfaces:*

  Land absorbs heat better than water. So, during the day when the Sun is shining, the land gets hotter than water. This makes the air close to the land surface warmer. The warmer air rises up, creating a low pressure area on the land surface. The cool air from the sea rushes to take its place. This is called *sea breeze.*

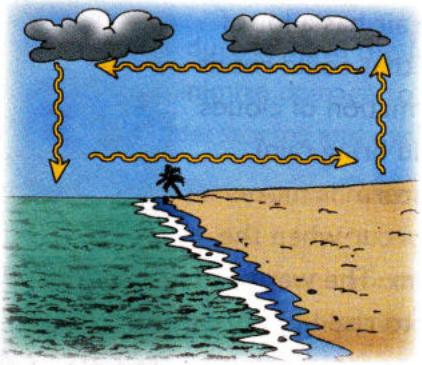


*Fig 9.4 Sea breeze*

At night, the land cools faster than water in the sea. So, the air above the sea is warmer than the air over the land surface. As it is lighter, the warmer air over the sea rises up, creating a low pressure area above the water surface. So, the cool air from the land rushes to take its place. This is referred to as *land breeze.*

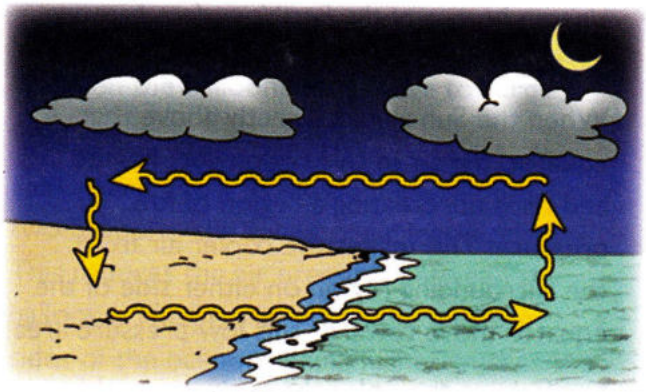


*Fig 9.5 Land breeze*

Due to sea breeze blowing during the day and land breeze during the night, the coastal areas have a pleasant climate throughout.

The winds blowing from the sea towards the land are laden with moisture and bring rain. These winds that bring rain are called *monsoon*. Rain brings relief in the hot regions and aids agriculture. Excessive rains, however, can cause havoc and result in floods which can cause a lot of damage directly and indirectly to humans. Let us study some of the natural effects of wind.

## Thunderstorm

Thunderstorm develops when the air has a lot of moisture that could result in the formation of clouds (that could bring rain). Thunderstorm is more likely to occur when the air is warm. The warm air tends to rise up. If the air rises rapidly, it tends to be unstable and the probability of a thunderstorm occurring increases.

*Fig 9.6 Lightning and thunderstorm*

Thunderstorms, accompanied by lightning, can cause loss of life and material. One should take the following precautions in such a situation:

- Do not take shelter under an isolated tree.
- If in a forest, take shelter under a small tree.
- Do not lie on the ground.
- Do not use an umbrella with a metal end.
- Do not take shelter in metal sheds, garages, etc.
- Do not sit near a window.
- If in water, go out and take shelter in a building.
- If in a car or a bus, roll up the windows and stay there.

## Cyclone

We have understood so far that difference of temperature between two regions sets up convention currents in air. Warm air rises up creating a low pressure area and cool air from the surrounding areas rushes towards this low pressure area. The warm air cools down on rising up and the water vapour condenses to form clouds. The heat released due to condensation of water vapour warms the air around. The warm air tends to rise up, leading to a drop in air pressure. More air rushes towards this low pressure area. This cycle is repetitive and results in a system of low pressure region with high-speed winds revolving around it. This weather condition is referred to as a *cyclone*. Wind speed, direction, temperature, and level of humidity are some of the factors affecting the development of a cyclone.

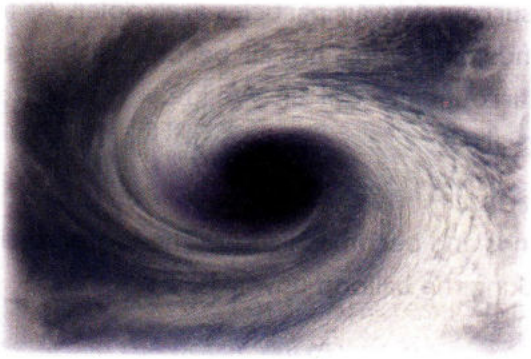


*Fig 9.7 Image of a cyclone*

[**Note:** Wind speed is measured by an instrument called *anemometer*.]

Damages caused by cyclones:

- Water in the water bodies gets pushed towards the shore, which is indicative of an approaching cyclone. This surge of water can wash away everything on the shore leading to loss of life.
- The low pressure in the centre of the cyclone, also called the *eye* of the cyclone, can lift the water in the seas high as the cyclone moves towards the shore. This results in sea water entering the low-lying areas near the coast and causing damage to life and property. It reduces the fertility of the soil.
- If a cyclone is accompanied by strong winds, nothing can stand in its way leading to a huge loss of life and property.

[**Note:** A cyclone is referred to as a *hurricane* in America and as a *typhoon* in Japan and the Philippines.]

## Tornadoes

A *tornado* is a funnel-shaped rapidly rotating column of air which is very high. Tornadoes are formed in thunderstorms when unstable hot air on the ground rises and meets cooler air above. The wind speed in tornadoes in extreme cases can reach up to 500 km/h. Tornadoes can cause extensive damage to life and property.

*Fig 9.8 A tornado*

## Precautions

If one lives in an area that is prone to cyclones/ thunderstorms, one should take the following precautions:

- Keep good quality torch lights, a reliable battery-powered radio, and spare batteries handy.
- A first-aid box should be kept with the above mentioned things.
- Store enough water for family members in air-tight containers.
- Some essential commodities like food items should also be kept ready in case you need to leave home in an emergency.
- In case you need to leave your home, turn off the gas/electricity/water supply and unplug all electrical appliances.
- Cooperate with and help your neighbours and friends.
- When outdoors, look out for electricity cables that may have been brought down by the storm. Do not touch them.
- Avoid pools of water with power cables lying in them.
- Keep away from loose overhanging objects and branches of trees.
- Beware of snakes that may have come out due to the flooding of their holes.

## Safety measures to be taken by the government

It is the government's duty to have the following in place in order to minimize damage to life and property due to thunderstorms and cyclones:

- An efficient cyclone forecast and warning system
- Arrangement of rapid communication of the warning to ports, fishermen, ships, and the general public
- Construction of cyclone shelters in areas prone to cyclone and developing awareness about them amongst people
- Fast and effective ways of moving people to safe places in the event of an approaching cyclone

People living in cyclone prone areas should also take the following precautions:

- Do not drink water that could be contaminated.
- Do not touch a wet electrical appliance, switch, or cable.
- Do not go out just for the sake of fun.
- Do not make any undue demands on the rescue forces and cooperate with them.

### Use of advanced technology

Due to pictures sent by satellites, the weather conditions of a place can be continuously monitored. In the event of a developing cyclone, a cyclone alert or a 'cyclone watch' is issued 48 hours in advance of the expected storm. In case the situation worsens, a cyclone warning is issued 24 hours in advance. This message is broadcast at regular intervals to create awareness among people.


**Monsoon winds:** the winds that carry water vapour and bring rain

**Cyclones:** high-speed winds which arise due to difference in air pressure

**Anemometer:** an instrument that monitors wind speed and duration

**Tornado:** a funnel-shaped very high rotating column of air


- Air exerts pressure.
- Wind arises due to two factors: (a) uneven heating of the Earth near the equator and the poles and (b) uneven heating of land or water bodies.
- Large difference in air pressure and high-speed winds give rise to cyclones.
- Advanced technology helps in tracking cyclones and an efficient communication system can help in reducing loss of life and property due to such disasters.
- Alertness and awareness on the part of an individual can not only save his life but also of others around him.

## Put on your THINKING CAP!

1. ***Choose the correct option.***

   a) Air moves
      i) from region of low pressure to high pressure
      ii) from region of high pressure to low pressure
      iii) between regions of equal pressure
      iv) all of these

   b) Which of the following sentences is correct?
      i) Increased wind speed is accompanied by increased wind pressure.
      ii) Increased wind speed will not affect the air pressure.

iii) Reduced wind speed is accompanied by reduced air pressure.
iv) Increased wind speed is accompanied by reduced air pressure.

c) The winds from the ocean carry water and bring rain. These winds are referred to as
   i) monsoon
   ii) cyclone
   iii) typhoon
   iv) none of these

d) The swift movements of the falling water droplets along with rising air create lightning and sound. We call this event
   i) monsoon
   ii) cyclone
   iii) typhoon
   iv) thunderstorm

e) Which of the following statements about air is correct?
   i) air moves from high pressure to low pressure
   ii) air moves from low pressure to high pressure
   iii) heating leads to reduction in air pressure
   iv) both (i) and (ii)

f) In case of thunderstorm, we should
   i) take shelter in a metal shed
   ii) take shelter in a building
   iii) lie on the ground
   iv) use an umbrella with a metal end

g) The factor that affects the development of a cyclone is
   i) temperature
   ii) wind speed
   iii) level of humidity
   iv) all of these

h) A cyclone is referred to as a typhoon in
   i) Japan
   ii) Philippines
   iii) America
   iv) both (i) and (ii)

**2. *Fill in the blanks.***

a) Air around us exerts _____.
b) Air _____ on heating and contracts on _____.
c) _____ speed winds are accompanied by reduced air pressure.
d) Air moves from a region where air pressure is _____ to where air pressure is _____.
e) Warm air is _____ than cold air and therefore _____ up, whereas cooler air tends to _____ towards the Earth's surface.
f) As warm air rises, air pressure at that place is _____ and the _____ air moves to that place.
g) The _____ air is called wind.
h) _____ heating of the Earth is the main cause of wind movements.
i) A change in the direction of wind current is caused by _____ of the Earth.
j) Cyclones are called _____ in the Philippines.

**3. *Write short answers.***

a) What is a tornado?
b) What is 'eye' of a cyclone?
c) If we blow on top of a thin paper strip, it moves upwards. Why?

4. ***Answer in details.***

a) How do high speed winds result in reduced air pressure?
b) Show with the help of an activity that air exerts pressure.
c) What is a sea breeze and how is it created?
d) What are causes of wind generation in nature?

## Extended learning

C 1. *Making an anemometer:*

You will not be able to measure wind speed accurately by the anemometer that you make here. It will however give you an idea of how an actual one works.

*Things required:* Cardboard strips (3 cm × 20 cm), four paper cups, pen, pencil with eraser at one end

Mark the centres of the cardboard strips.

Fix the two strips such that they make a '+' shape taking care that their centres coincide. Now, fix the cups at the end of each strip ensuring that all of them are facing the same direction. Colour the outer surface of one of the cups with a black marker. Pass the pin through the centre of the strips and push the pin into the eraser end of the eraser end of the pencil. Blow into the cups to see that the strips rotate freely on the pin.

To use this anemometer, count the number of rotations per minute. The coloured cup will make the count of rotation easy. Use this anemometer at different locations and at different times of the day.

2. Collect pictures of storms and cyclones from newspapers/magazines.

S 3. Develop a plan to create awareness among the people about measures that could be a part of the plan to reduce suffering of the people hit by the cyclones.

HIGHER ORDER THINKING SKILLS
**HOTS**

Give reasons for the following:

1. If gales or high speed winds blow over houses, the roofs of the houses can be lifted and blown away.
2. Why do houses have ventilators near the ceilings?


For more information
http://www.weatherquestions.com/What_causes_wind.htm
http://www.buzzle.com/articles/what-causes-wind.html
http://www.weatherwizkids.com/weather-winter-storms.htm
http://library.thinkquest.org/10136/cyclones/cycltq.htm

# 10 Soil

Do you know some of the natural resources necessary for our survival?

*Fig 10.1 Soil*

The most important natural resource which sustains all life on the planet is right beneath your feet. It is the soil. This precious material is present at the top of the Earth's crust. It enables the growth of a diverse variety of flowers, trees, and food-giving plants. It is also the home of billions of different organisms. Our buildings, roads, and railways too are supported by the soil.

Let us see how soil affects life on Earth. We know that carnivores feed on herbivores. The herbivores in turn feed on plants which grow on the soil. Thus, all life on Earth is directly or indirectly dependent on soil. Even human beings will not be able to survive without soil.

*Fig 10.2 Grass growing on soil*

**You will learn about**

- Soil formation
- Soil profile
- Composition of soil
- Soil texture
- Types of soil
- Properties of soil
- Soil erosion
- Soil conservation

## Soil formation

The formation of soil takes place over a very long period of time as it is a slow process. A layer of soil of as little as 1 cm thickness can take 500 years or more to be formed.

Soil is formed by the weathering of rocks and minerals.

*Weathering* is the process of breaking down of rocks into smaller pieces. There are three different types of weathering—physical, chemical, and biological.

### Physical weathering

In physical weathering, rocks break down into finer particles over a period of time under the

influence of processes such as freezing and thawing, wetting and drying, and shrinking and swelling. Physical weathering does not change the chemical composition of the rock.

Freezing and thawing takes place in cold or mountainous areas. When it rains, water enters the cracks in the rocks. In winter, the water freezes and expands putting pressure on the rocks. The ice melts during the summer. The repeated freeze–thaw cycles crack the rock from inside and eventually break it down.

Let us try to understand this with the help of Activity 1.

The weathering process continues in smaller rock pieces until they break into very fine particles.

Physical weathering also takes place in areas experiencing extreme temperatures. Heating due to relatively high temperature causes rocks to expand and cooling to much lower temperature at night results in contraction. The constant expansion and contraction of the rocks may result in pieces being broken off.

Physical weathering is a continuous process in nature, which helps to produce new soils.

### Chemical weathering

Chemical weathering is the decomposition of rocks through a series of chemical processes. It is more common in warmer areas with lots of water. It brings in a change in chemical composition and thus makes soil different from the original rock. The chemical changes make the rocks softer that helps in breaking bigger pieces into smaller particles.

### Biological weathering

Biological weathering is caused by living organisms, mostly plants and some microorganisms. The roots of plants grow deep into rock cracks in search of water and nutrients.

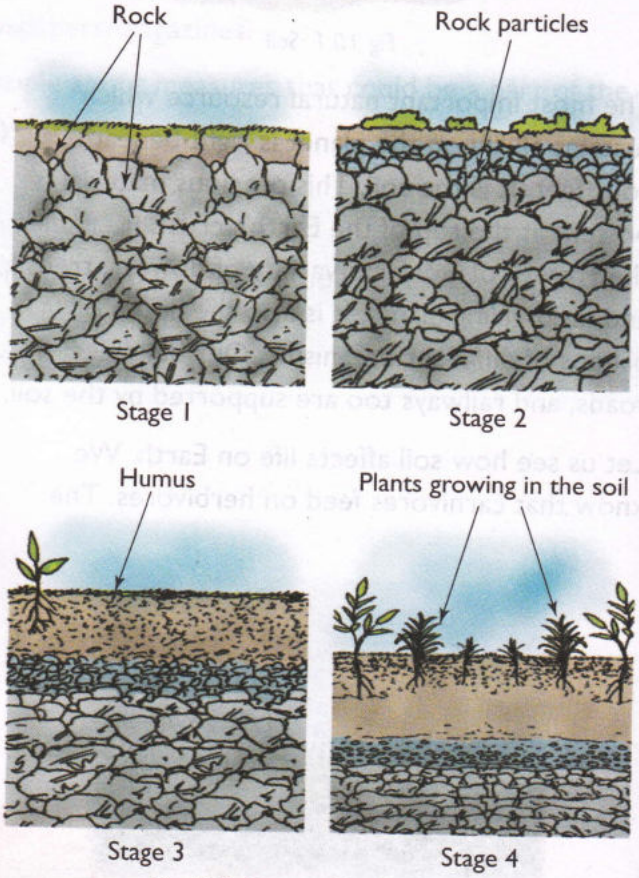



*Fig 10.3 Stages of soil formation*

**ACTIVITY 1**

*(To be performed at home)*

Take a small balloon and fill it with water to make it to the size of a table tennis ball. Tie the mouth of the balloon tightly. Take some Plaster of Paris and mix some water in it to bring it to the consistency of curd. Pour Plaster of Paris into two empty containers. Push the water-filled balloon into one of them. Hold the balloon till the plaster sets so that the balloon does not rise up. Allow the plaster to harden for about an hour. Put both containers in a freezer. Remove the containers the next day.

*Observation:* You will observe that the plaster with the balloon has developed cracks. This happens because inside the freezer, the water in the balloon freezes and expands. This causes cracks in the plaster.

In the process, they widen and extend the cracks resulting in breakdown of rocks.

Also, lichens (combination of algae and fungi) growing on the surface of rocks very slowly decompose the rocks by secreting certain acids. The process of weathering can be divided into four stages (Fig 10.3).

## Soil profile

Soil is made up of distinct horizontal layers called *horizons*.

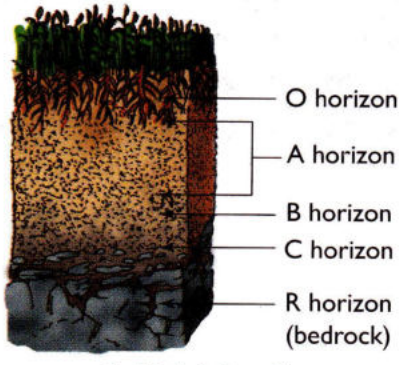



*Fig 10.4 Soil profile*

### O horizon

It is the top *organic* layer of the soil, made mostly of leaf litter and partially decomposed organic matter. It is the most prominent layer in forests where there is accumulation of debris fallen from trees.

### A horizon

This dark coloured layer is called *topsoil*. It is found below the O horizon. It is rich in decomposed organic matter called *humus*. Humus is formed by the decomposition of plant parts like leaves and dead and decayed animal remains. It is mixed with soil and gives the soil a loose texture that holds water and allows air to diffuse through it. It makes soil more fertile. Many organisms like earthworms, fungi, and bacteria are present in this layer. The soil particles in this layer are smallest and finest as compared to the lower horizons of the soil. In this layer, seeds germinate and plant roots grow.

### B horizon

This layer is called the *subsoil*. It contains higher mineral content than the top soil. It is reddish or brownish due to the presence of oxides of iron and clay.

### C horizon

This layer is also called *regolith*. It consists of slightly broken-up bedrock. Roots of plants do not penetrate into this layer. Very little organic material is found in this layer.

### R horizon

It consists of the unbroken solid rock, called *bedrock*, present beneath all the other layers.

### Composition of soil

Most soils contain four basic components—soil particles, water, air, and organic matter. Organic matter can be further divided into humus, roots, and various types of living organisms.

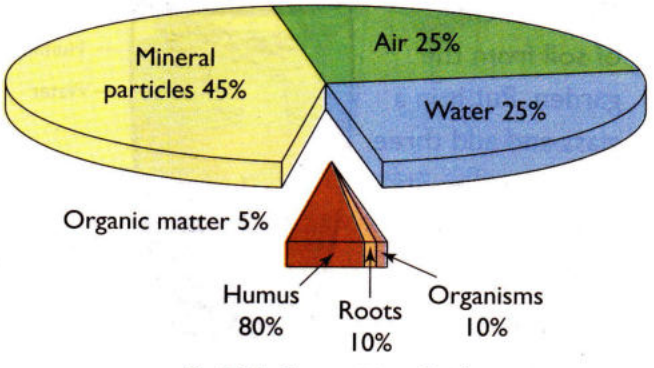



*Fig 10.5 Composition of soil*

### Soil texture

Squeeze some soil between your fingers. Is it crumbly? Is it sticky or grainy? A soil's texture depends on the size of the particles present in it.

The texture of a soil refers to the size distribution of the soil particles found in the soil. Particles are normally grouped into three main types—sand, silt, and clay. Besides these particles, soil may also contain small stones called *gravel*.

***Particle size range***

| Type of mineral particle | Size range (mm) |
|---|---|
| Sand | 2.0–0.06 |
| Silt | 0.06–0.002 |
| Clay | < 0.002 |

## Types of soil

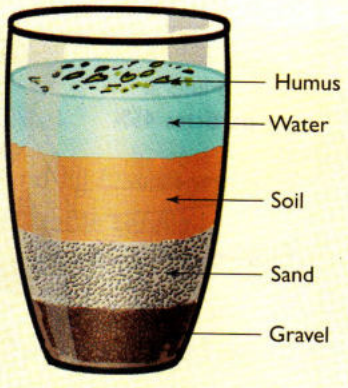
Every type of soil is a mixture of sand, silt, clay, and organic matter. Soil texture affects the water-holding capacity of soil, movement of water through the soil, and ease of cultivation.


**To separate the main components of the soil**

*Things required:* A glass jar, a cup, soil, water

*Method:*

Collect a cup of soil from the garden. Put it in a glass and add three cups of water. Stir it well and let it settle.




*Observation:*

Observe the sample and compare it with the layers shown in the above figure. Do you observe the presence of the particles mentioned above? Repeat the same activity at home with soil collected from a potter. Is it same as the garden soil?

Repeat the same experiment with soil collected from other places like a roadside. Observe both the jars carefully.

Describe the composition of each soil and explain the differences.

### Sandy soil

It is coarse in nature with very little clay. It has big spaces between the particles and thus allows air into the soil but is not able to hold water or nutrients. Plant roots cannot hold on to this soil. There are some plants that are able to grow in sandy topsoil by putting their roots deep through the sand to the subsoil.

### Silt

It is light but gritty since it consists of silt particles which are finer than sand. Silt is commonly found in floodplains and is the soil component that makes mud. Soils with a lot of silt make excellent farmland, but erode easily. This is the soil blown away in dust storms and carried downstream in floods.

### Clayey soil

It consists of very fine clay particles. Clayey soil is heavy and dense. It is as hard as concrete when dry. The spaces between soil particles are very small. Plant roots cannot push through it. No air can get in from the surface. Most bacteria and other soil organisms that need oxygen cannot breathe here. This type of soil is not good for growing plants.

### Loam

It is the perfect soil for plants and soil organisms. It has about the same amount of sand and silt along with a smaller amount of clay. This soil has enough large and small spaces for air and water to flow in. It also has enough clay to let it stick together and hold humus. Plant roots can easily grow through these spaces.

### Soil colour

Soils tend to have distinct variations in colour because of a variety of factors. Soils may be red or yellow because of the oxidation of iron or aluminium. The presence of humus makes

soil black. High water tables in soils cause the reduction of iron, and these soils tend to have greenish and grey-blue hues. The combination of iron oxides and organic content gives many soil types a brown colour. Other colouring materials sometimes present include white calcium carbonate, black manganese oxides, and black carbon compounds.

**Infobit** One cubic centimetre of soil can be the home to more than 1,000,000 bacteria. One hectare of pasture land in a humid mid-latitude climate can contain more than a million earthworms and several million insects.

## Properties of soil

The composition of soil has important consequences on its permeability towards water and on its ability to retain it.

### Absorption of water by soil

Different types of soils absorb or retain different amounts of water as shown by the following activity.

Activity 3 shows the water absorption capacity of different types of soils. To measure the amount of water absorbed by the soil, subtract the volume of water left in the measuring bottle from the initial volume of water. If $V_1$ and $V_2$ are the initial and final volumes of water in the measuring bottle, then

Volume of water absorbed by the soil (ml)
= Initial volume of water in the measuring bottle (ml) – Final volume of water in the measuring bottle (ml)

$= V_1 - V_2$

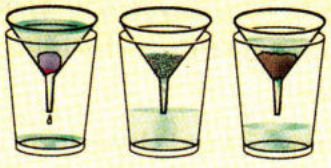
Since 1 ml of water has a weight equal to 1 g, therefore

**ACTIVITY 3**

*Things required:* Three glasses, three funnels, filter paper, soil samples, measuring bottle, water

*Method:*

1. Put one funnel over each of the three glasses.
2. Fold the filter papers in conical shapes and fit them in the three funnels.
3. Prepare three soil samples—(i) sandy soil, (ii) clay, and (iii) loamy. Put the three soil samples separately in the three funnels. Label the three funnels as 1, 2, and 3, respectively.
4. Take about 500 ml of water in a measuring bottle. Pour this water on the sandy soil in funnel 1 till it starts dripping.
5. Repeat step 4 with the other two soil samples.



*Observation:* You will notice that different soils absorb different amounts of water.

Weight of water absorbed by the soil

$= V_1 - V_2$

Percentage of water absorbed

$$= \frac{\text{Weight of water absorbed}}{\text{Weight of the soil}} \times 100$$

### Percolation rate of water in soil

The rate at which water moves through soil is called the *percolation rate* of water in the soil. Let us perform Activity 3 to find out the percolation rate of water in different soil types. Pour equal amount of water in all the soil samples. Carefully observe the soil samples. Note down the initial

time when you started pouring water in the three samples. Also, note down the time for each sample when there is no water left over the soil in each sample. To calculate the percolation rate of water, use the following formula:

$$\text{Percolation rate (ml/min)} = \frac{\text{Amount of water (ml)}}{\text{Percolation time (min)}}$$

You will notice that sandy soil absorbs water but has high percolation rate. It thus drains quickly and retains very little amount of water. Clay, on the other hand, holds water for a very long time but has very low percolation rate, *i.e.*, it does not drain well. In the loamy soil, water is uniformly distributed. It also drains well. For its ability to retain water and drain well, loamy soil is best suited for growing crops.

Some of the common crops and their soil requirements are described below:

**Paddy:** Paddy can be grown in all types of soils, except sandy soil. However, due its high water-holding capacity soil rich in clay is best suited for rice cultivation.

**Wheat:** Loamy soil and clayey loam are considered good for growing wheat.

**Lentils:** Lentils and pulses require soil with good water drainage. Thus, loamy soils are best suited for these crops.

**Cotton:** Cotton needs soil that drains well and can hold air. Sandy soil meets this requirement.

**Sugarcane:** Sugarcane can grow in different types of soils ranging from sandy soils to clayey loams.

## Soil erosion

Soil erosion is the process of removal of soil by wind or running water. It is a naturally occurring process on Earth. In general, erosion removes soil at roughly the same rate as soil is formed. However, this balance is being disturbed by human activities which are resulting in heavy loss of soil.

The main causes of soil erosion are deforestation, overgrazing, extensive construction work, and floods.

## Soil conservation

Soil conservation is the process of preventing loss of precious soil due to erosion. Afforestation and terrace farming are two main methods by which soil erosion can be prevented or minimized.

*Afforestation:* Planting more and more trees is known as afforestation. Roots of the plants hold soil firmly so by planting trees we can help in controlling soil erosion.

*Terrace farming:* It is done in hilly areas. It consists of building a series of steps like benches. Each step slows down the flow of water, thereby reducing soil erosion.

Let us perform an activity to understand soil erosion and soil conservation.

### ACTIVITY 4

*(To be performed in groups in an open area)*

**Group I**

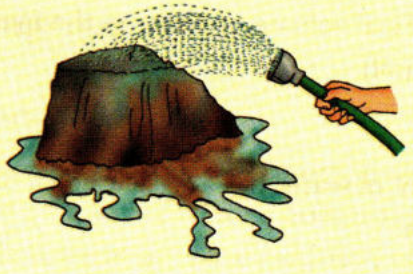
Take some soil and make a small mountain, at least 20 cm high, with steep walls and a flat top.

Pour water on the mound with a water sprinkler.

Observe and describe what happens during this artificial rain.

**Group II**

Make a similar mountain.



Put a layer of clay on top of the mountain and then put some regular soil. Pour water on the mountain as done previously. What happens this time?

**Group III**

Build a similar mountain with stones, clay, sand, and soil in different positions.

Observe the behaviour of different materials towards the pouring of water.

**Group IV**

Make another mound and sow grass on it. After a few days when the grass has grown, pour water on it.

What difference do you observe in all the four experiments? Have a group discussion.


**Bedrock:** unbroken solid rock

**Humus:** organic material in soils, produced by the decomposition of plant or animal matter

**Soil horizon:** distinct horizontal layers of soil

**Topsoil:** the uppermost fertile layer of soil

**Soil erosion:** the removal of the topmost layer of soil

**Weathering:** gradual physical, biological, and chemical wearing off of rocks


- Weathering is the process of breaking down of rocks into smaller pieces.
- Chemical weathering is the decomposition of rocks through a series of chemical processes.
- Biological weathering is caused by living organisms, mostly plants and other microorganisms.
- The dark-coloured layer below the O horizon is called topsoil.
- Humus is formed by the decomposition of plant parts like leaves and dead and decayed animal remains.
- The subsoil contains higher mineral content than the topsoil.

## Put on your THINKING CAP!

1. ***Select the correct option.***

   a) Soil erosion affects topsoil by

   i) washing it away

   ii) moving it to another area where it is needed more

   iii) keeping it moist

   iv) making it more fertile

b) Decayed organic matter is turned into dark coloured material called

i) litter ii) humus

iii) clay iv) soil

c) Which of the following activities prevents soil erosion?

i) construction ii) overgrazing

iii) deforestation iv) afforestation

d) Which of the following lists soil particles from the smallest to the largest?

i) sand, gravel, clay, silt ii) clay, silt, sand, gravel

iii) gravel, silt, sand, clay iv) silt, sand, clay, gravel

e) Soils are classified into different types on the basis of

i) weather ii) types of plants growing in them

iii) soil composition iv) size of animal populations

f) Water holding capacity of soil depends on

i) composition of soil ii) temperature of soil

iii) colour of soil iv) texture of soil

g) C horizon of the soil profile is also known as

i) regolith ii) subsoil

iii) humus iv) bedrock

h) Which type of soil is considered best for growing crops?

i) sandy soil ii) clayey soil

iii) loamy soil iv) slit soil

**2. *Fill in the blanks.***

a) Loose, weathered material on Earth's surface in which plants can grow is _____.

b) The solid layer of rock beneath the soil is called _____.

c) Soil made of equal parts of clay, silt, and sand is called _____.

d) As plants shed leaves, they form a loose layer called _____.

e) Sandy soil is not able to hold water as it has _____ spaces between soil particles.

f) Organic matter in the soil is contributed by decomposition of _____ and _____.

**3. *Write short answers.***

a) How does soil form?

b) List the three types of weathered rock particles found in the soil.

c) Why is sandy soil not good for plantation?

d) How are organisms present in soil beneficial to the soil?

e) Mention two methods of soil conversation.

f) What is weathering?

g) What is responsible for soil colour?

**4. *Answer in details.***

a) i) How is physical weathering caused?

ii) How is physical weathering different from chemical weathering?

b) i) What do you mean by the percolation rate of water?
ii) Explain how you will calculate the percolation rate of water.

**5. *Match the columns.***

| | |
|---|---|
| a) A horizon | i) solid rock |
| b) B horizon | ii) broken rocks |
| c) C horizon | iii) litter |
| d) R horizon | iv) humus |
| e) O horizon | v) subsoil |

## Extended learning

S Collect soil samples from different places. Compare the water absorption capacity and percolation rate of water for each soil sample. Identify the type of soil in each soil sample and find out the different types of plants that can grow in each type of soil.

HIGHER ORDER THINKING SKILLS
**HOTS**

1. What consequences can a storm have on lands with clayey soil?
2. Ravi had grown a flowering plant in a pot. Every time he watered the plant, water would not get drained. What should he add in the soil to improve the drainage of water?
3. Vinita sterilized the soil to grow some plants. Is this going to benefit the growth of the plants?


For more information
http://library.thinkquest.org/J003195F/newpage4.htm
http://eusoils.jrc.ec.europa.eu/library/themes/erosion/
http://www.public.wsu.edu/gened/learn-modules/top_agrev/2-soil/soil1.html

# Little Encyclopaedia

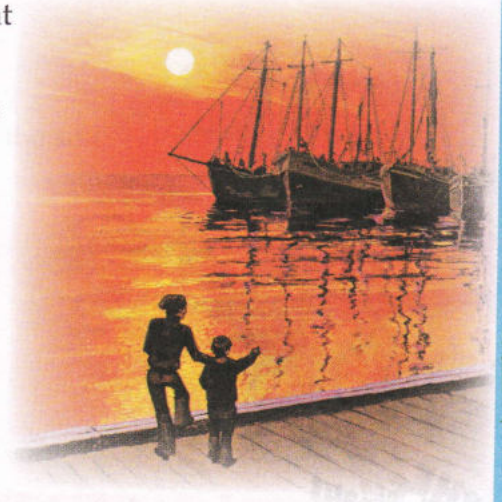
## DID YOU KNOW ?...

### Why is the sky blue?

The light from the Sun looks white. But it is really made up of all the colours of the rainbow: violet, indigo, blue, green, yellow, orange, and red. Light energy travels in waves. Some light travels in short waves. Other light travels in long waves. Blue light waves are shorter than red light waves. All light travels in a straight line unless something gets in the way to

- reflect it (such as a mirror)
- bend it (such as a prism)
- scatter it (such as the molecules of the gases in the atmosphere)

Sunlight reaches the Earth's atmosphere and is scattered in all directions by all the gases and particles in the air. Blue light is scattered more than other colours because it travels as shorter, smaller waves. This is why we see a blue sky most of the time.



### What makes the sunset red?

At the time of sunset, the Sun is very low in the sky. The blue light gets scattered and only the red and yellow lights pass through the air and reach our eyes. This is the reason why the sunset appears red!

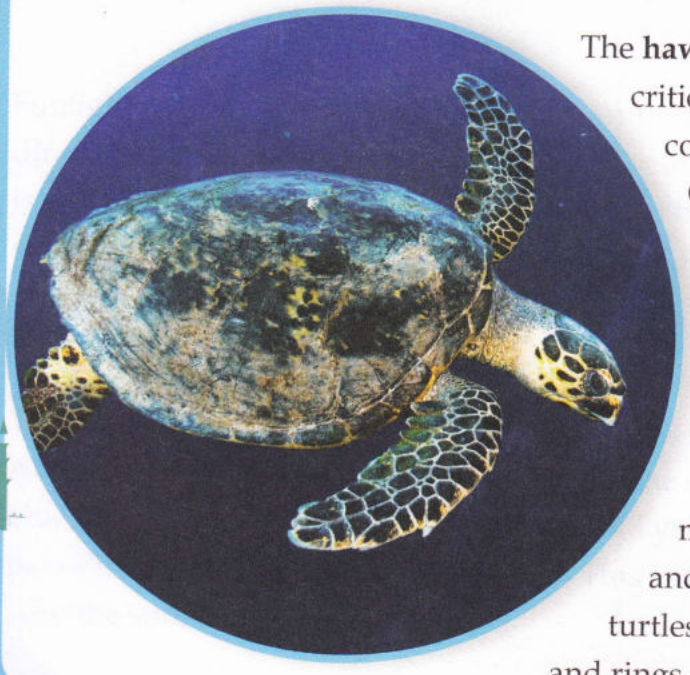
# HEALTHY EATING

Semolina is a form of cereal made from wheat. It contains the nutritious endosperm (the part of the seed that provides food for the growing sapling) of the grain, which is left behind during milling when the finer flour is sifted. Semolina is made from durum wheat, a hard variety of wheat quite unlike the wheat used to make bread.

Do you know what vermicelli is? It is a food item used to make several dishes like, *kheer, pulao, upma,* etc. Vermicelli is generally made from white flour, semolina, or rice flour. The flour is made into a dough and passed through vermicelli machines and is collected in the form of thin, long threads. These threads are dried and packed for the consumers.

# USEFUL PLANTS AND ANIMALS

1. **Create space for wildlife:** With the help of elders you can plant shrubs and trees in your surroundings. They will provide food and shelter for birds and other animals like burrowers.
2. **Attract winged friends:** Keep a bird feeder and bird bath in your balcony, rooftop, or window sill. Grow flowering plants that will attract humming birds and butterflies. Find out which colours and odours attract them to your garden.
3. **Make a compost pile:** Ask your mother to help you save kitchen scraps for the compost pile. Use vegetables and fruit peels, left-over food, eggshells, etc., to make a compost pile.
4. **Avoid use of chemicals and fertilizers:** Ask your elders not to use harmful chemicals in your garden or home for this will harm animals.
5. **Family feeling:** The animals that are living with you are of course a part of your family. Make time everyday to play with your pets.



The **hawksbill turtle** (*Eretmochelys imbricata*) is a critically endangered marine animal found on coral reefs in the Indian, Pacific, and Atlantic Oceans. Its mouth resembles the beak of a hawk. It is distinguished from other sea turtles by its sharp, curved beak and the saw-like edges of its shell margins. It is hunted by humans in many countries including India. It is eaten as a delicacy. The shells of this turtle are also used to make decorative items. The ancient Greeks and Romans collected the shells of hawksbill turtles, to make articles such as combs, brushes, and rings.

# AMAZING FACTS !

## A medicinal plant: Neem

Do you know that there are several health benefits of the neem tree? Here are some you may want to know about, and you can put them into use in your day-to-day life:

1. In the Indian ayurvedic system, neem is attributed with medicinal and antiseptic qualities. According to it, neem, in the form of paste, can be directly applied to the skin if you have pimples on your face, minor wounds, swellings, or chickenpox marks.
2. Neem leaves can be used as an antiseptic in bath water.
3. According to ayurveda, dandruff, hair loss, hair fall, and early greying of hair can also be prevented by applying neem oil.

## MAMMAL SEARCH

Some of the animals below are mammals. Some are not. Circle the animals that are mammals.

| | | | | |
|---|---|---|---|---|
| ANTEATER | ELEPHANT | MANATEE | PORPOISE | TIGER |
| BAT | HORSE | MOUSE | SALAMANDER | TURTLE |
| CAMEL | HUMAN | PARROT | SEAL | WHALE |
| CHICKEN | KANGAROO | PENGUIN | SHARK | ZEBRA |
| COBRA | KOALA | PLATYPUS | SQUIRREL | |
| DOLPHIN | LLAMA | POLAR BEAR | TARANTULA | |

Answers:
anteater, horse, bat, human, squirrel, camel, kangaroo, platypus, koala, polar bear, tiger, llama, porpoise, dolphin, manatee, whale, elephant, mouse, seal, zebra

# 11 Respiration in Organisms

**You will learn about**

- Respiration
- Human respiratory system
- Breathing in other animals
- Respiration in plants

We all consume food every day. Why do we need to eat food? We eat food to get energy to perform various physical activities. The body also requires energy to perform other metabolic processes. In fact, the body requires energy even when we are fast asleep. What happens to the food consumed by us? It gets digested. What happens to the digested food? The digested food gets absorbed by the small intestine. How do we get energy from the food absorbed? We will find out the answer to this question in this chapter.

## Respiration

The food that is digested by our body contains glucose, which after absorption is transported to each cell of the body. In the cells, glucose is oxidized in the presence of oxygen to release energy, water, and carbon dioxide. This process is called *respiration*. It is also called *cellular respiration* as it takes place in the cells. It takes place in all living organisms. Even water animals and water plants also respire.

$$\text{Glucose} + \text{Oxygen} \rightarrow CO_2 + \text{Water} + \text{Energy}$$

### Aerobic and anaerobic respiration

The process of respiration which occurs in the presence of oxygen is called *aerobic respiration*. But under certain conditions respiration also takes place without oxygen. Respiration without oxygen is called *anaerobic respiration*. Very little energy is released during anaerobic respiration as glucose is not completely broken down into carbon dioxide and water. It is broken down into lactic acid or alcohol, carbon dioxide, and very less energy.

$$\text{Glucose} \xrightarrow[\text{respiration}]{\text{anaerobic}} \text{Alcohol} + CO_2 + \text{Energy}$$

(very less)

Anaerobic respiration in humans takes place when a muscle undergoes extreme contraction due to vigorous exercise. The lactic acid released during anaerobic respiration begins to build up in cells causing pain and irritation. The only way to remove this acid is to rest for a while and breathe in deeply to get extra oxygen. It helps convert lactic acid into carbon dioxide and water and thus the pain slowly subsides.

*Fig 11.1 Activities during which we respire anaerobically*

Anaerobic respiration also takes place in yeast. Yeast breaks down glucose into ethanol (alcohol), carbon dioxide, and a small amount of energy. This process is used in baking and brewing, and is called *fermentation*.

Glucose → Ethanol + Carbon dioxide + Energy

**Let's Talk**

Where does oxygen in the cells come from for aerobic respiration?

## Breathing

The air that we breathe in contains oxygen. This oxygen is used by our body for aerobic respiration. Thus, breathing is part of respiration. Do you now realize that breathing and respiration are related?

*Respiration* is the process of breaking down of food to release energy.

*Breathing* is a mechanical process in which air rich in oxygen is taken into the body and air rich in carbon dioxide is given out.

The process of taking in air is called *inhalation* and the process of giving out carbon dioxide is called *exhalation*. Each breath consists of one inhalation and one exhalation. The number of times a person breathes in a minute is called *breathing rate*.

The structures and organs used in breathing make up the respiratory system.

### ACTIVITY 1

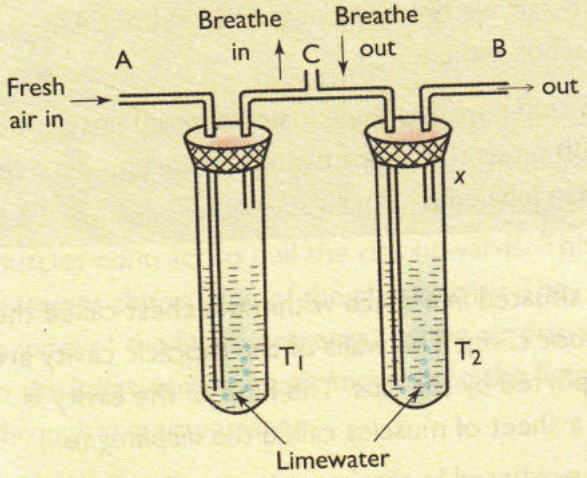
**To compare the carbon dioxide content of inhaled and exhaled air**

*Things required:* Two boiling tubes, a T-tube section, long and short delivery tubes, limewater, two-holed corks

(Assemble the parts as in the illustration)

*Method:*

Cover the opening C with your mouth.




Breathe in gently through the mouth and look for a change in colour of limewater in tube $T_1$.

Breathe out gently through the mouth and look for a change in colour of limewater in tube $T_2$.

Repeat the process three to four times.

*Observation:* When you breathe out, the limewater in tube $T_2$ turns milky.

*Explanation:* Carbon dioxide turns limewater milky. When you breathe in, fresh air is drawn in through the opening A. It passes through the limewater in tube $T_1$. As there is no change in colour of limewater, it shows that inhaled air contains very little amount of carbon dioxide.

When you breathe out, the exhaled air passes through limewater in tube $T_2$ and turns it milky.

It shows that exhaled air contains considerable amount of carbon dioxide.

## Human respiratory system

The human respiratory system consists of the nasal cavity, pharynx, voice box (larynx), windpipe (trachea), bronchi, and lungs. The lungs

**Infobit** The air we breathe in contains about 0.04% carbon dioxide. The air we breathe out contains about 4% carbon dioxide.

In other words, the exhaled air contains about 100 times the concentration of carbon dioxide than inhaled air does.

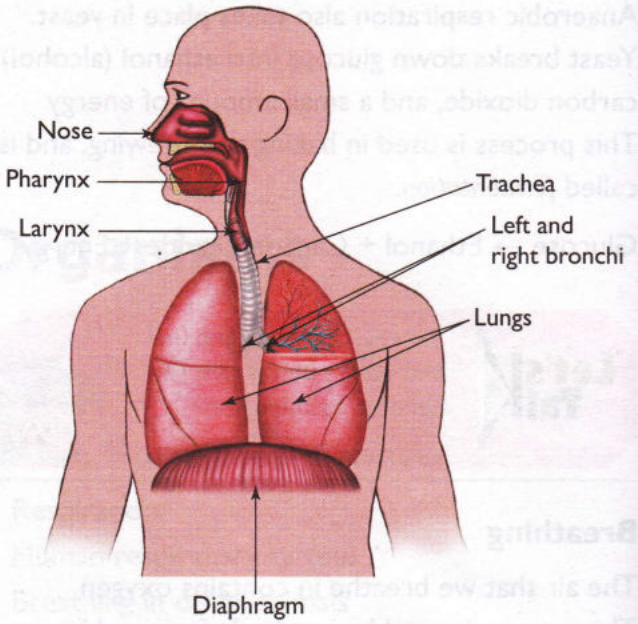



*Fig 11.2 Human respiratory system*

are situated in a space within the chest called the *thoracic cavity*. The walls of the thoracic cavity are supported by the ribs. The base of the cavity is like a sheet of muscles called the *diaphragm*.

We breathe through our *nose* which consists of two nostrils. The air inhaled may contain dust, pollen grains, and germs. As the inhaled air passes through the nostrils, it gets filtered through the hair lining the nostrils. The dust particles and germs get trapped in the hair. The nostrils contain blood vessels. The warm blood flowing through the vessels warms the air. The cells lining the nostrils produce mucus. This sticky material moistens the air. It also helps in trapping germs. That is why you are advised to breathe through your nose and not through the mouth.

After passing through the nostrils, the air enters the *pharynx*, the region where the nasal cavity and mouth meet at a part of the throat. The pharynx is the only part of the respiratory system which is shared with the digestive system.

From here, two tubes open downward, one for food (oesophagus) and the other for air (trachea). The upper part of trachea contains *larynx*, also called the *voice box*.

From the larynx, air goes down the *trachea* or *windpipe*. Like the nose the trachea is lined with cells which release mucus. The air continues to get moistened in the trachea due to the mucus. If some foreign particles irritate the cells of the trachea, we cough or sneeze and the particles come out of the body into the air.

The end of the trachea gets divided into two tubes called *bronchi* (singular: bronchus). Each bronchus leads to its respective lung. Bronchi are further divided into extremely narrow tubes called *bronchioles*.

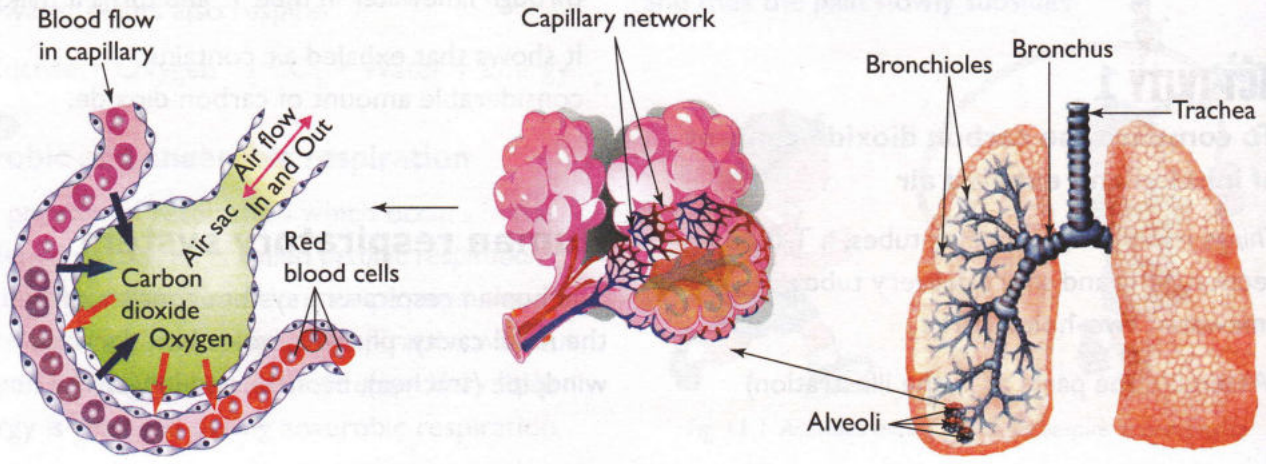



*Fig 11.3 Process of breathing in humans*

The bronchioles end in bubble-shaped air sacs called *alveoli* which resemble a bunch of grapes (Fig 11.3). Air from trachea enters the bronchi, then the bronchioles, followed by the alveoli. Each alveolus is surrounded by a network of capillaries. The walls of the capillaries and the alveoli are very thin and gases can pass through easily. The capillaries absorb oxygen from the air in the alveoli and release carbon dioxide into the alveoli.

**Infobit** An adult's lung contains about 300 million alveoli.

## How do we breathe?

Can you guess the number of times you breathe in a day? On an average, we breathe more than 20,000 times in a day. We breathe all the time—even when we are asleep or not doing any activity. While exercising our body needs more oxygen, so the breathing gets faster.

Breathing is controlled by the intercostal muscles between the ribs and the *diaphragm*, at the base of the lungs.

***Inhalation*** During the process of breathing in (inhalation), the diaphragm muscles contract and become flat. At the same time, intercostal muscles contract to pull the ribs upwards. This increases the volume of the chest cavity. The volume of the lungs increases. As the air pressure in the lungs decreases, air moves into the lungs through the air passage.

***Exhalation*** During the process of breathing out (exhalation), the diaphragm muscles and the intercostal muscles relax. The diaphragm returns to its dome shape. The chest cavity becomes smaller and the lungs return to their original volume. This squeezes air out of the lungs through the air passage.

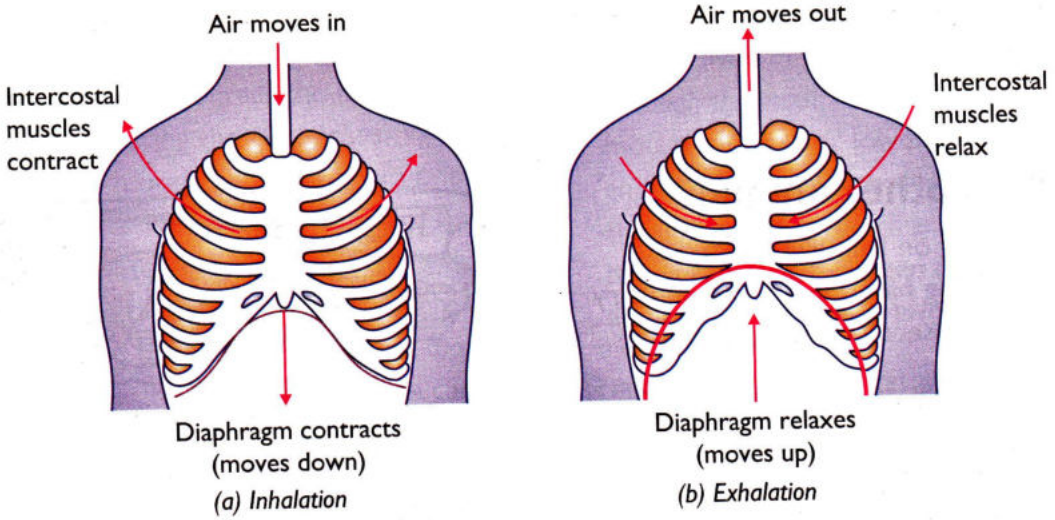



*Fig 11.4 Mechanism of breathing in humans*

**ACTIVITY 2**

**To demonstrate the working of diaphragm during breathing**

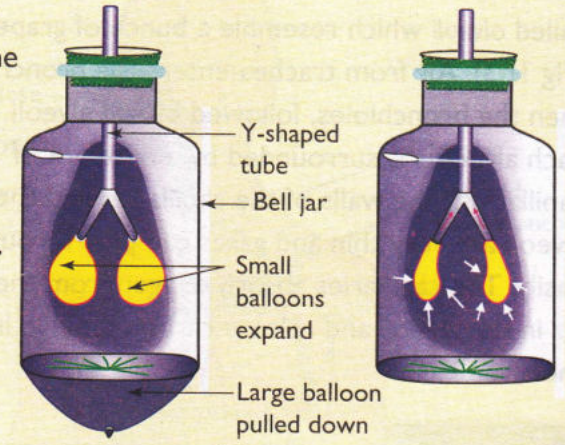
*Things required:* A bell jar, two small balloons, a large balloon, a Y-shaped tube, a cork

*Method:*

1. Fix the Y-shaped tube at the mouth of the bell jar as shown. On the open ends of the two branches of the Y-tube, tie a balloon each. On the bottom of the bell jar, fix the large balloon.

Here, the Y-shaped tube represents the trachea, the two small balloons the lungs, and the large balloon the diaphragm.

2. Pull the large balloon down and observe the small balloons.
3. Now, release the large balloon and allow it to flatten.
4. Repeat the process three to four times.




*Observation:*

- When the lower balloon is pulled, the small balloons expand.
- When the lower balloon is released, the small balloons contract.

*Explanation:*

- When the lower balloon is pulled, the space (or cavity) inside the bottle increases. Air from the open end of the Y-tube rushes in to fill the cavity. This expands the small balloons. This is similar to the expansion of lungs during inhalation.
- When the lower balloon is released, it relaxes. The excess air in the cavity rushes out and the small balloons contract. This is similar to the contraction of lungs during exhalation.
- The lower balloon acts like the diaphragm in our respiratory system. When pulled down, it replicates the downward movement of the diaphragm during contraction. When released, it represents the relaxed state of the diaphragm.

## Breathing in other animals

Vertebrates dwelling on land like lion, cow, elephant, cat, and dog have lungs as respiratory organ. But how do insects, earthworms, frogs, and fish breathe?

### Breathing in cockroach

Insects like cockroach and housefly have small openings, called *spiracles*, on the side of their body. These spiracles are connected to tubes called *tracheae*. The tracheae further branch into smaller tubes that are in contact with the body cells. The air enters through the spiracles, passes through tracheae and their branches. The exchange of gases takes place between the body cells and the smaller tubes.

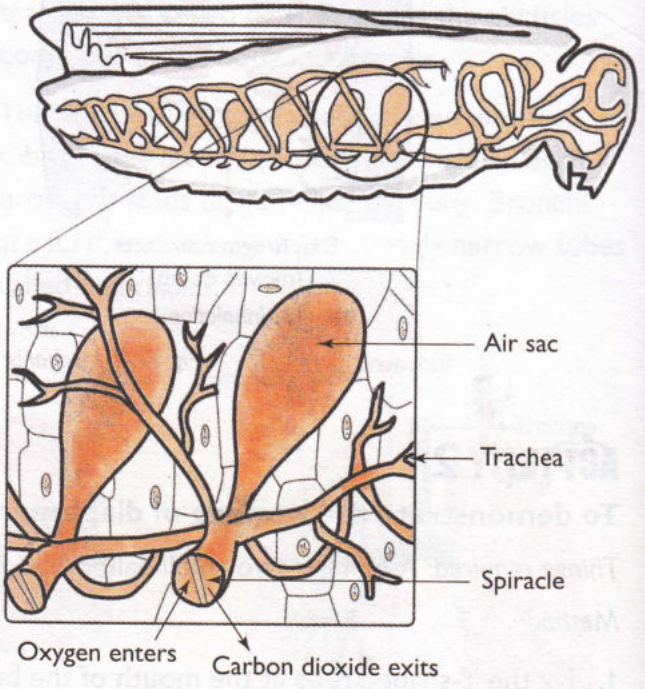



*Fig 11.5 Spiracles in a cockroach*

**Infobit** Most spiders breathe through organs called 'book lungs'. Book lungs consist of space into which numerous layers of membrane-bound structures are present. These are called book lungs since the layers of membrane look like leaves of a book. Some spiders have tracheal tubes for breathing just like insects, whereas others may have both a trachea and book lungs.

### Breathing in earthworms

Earthworms do not have a respiratory system. They have very thin and moist skin and can exchange oxygen and carbon dioxide directly through their skin.

### Breathing in fish

Fish are found in water and have specialized structures, called *gills*, for breathing. These are richly supplied with blood capillaries. The gills are covered by a flap called *operculum*. When a fish opens its mouth, water enters the mouth and the operculum covering the gills closes. When the fish closes its mouth, the operculum opens, allowing freshwater rich in oxygen to cross the gills. As the water flows through the gills, exchange of gases takes place. Oxygen from the water diffuses into the blood and carbon dioxide is given out into water. This water rich in carbon dioxide moves out.

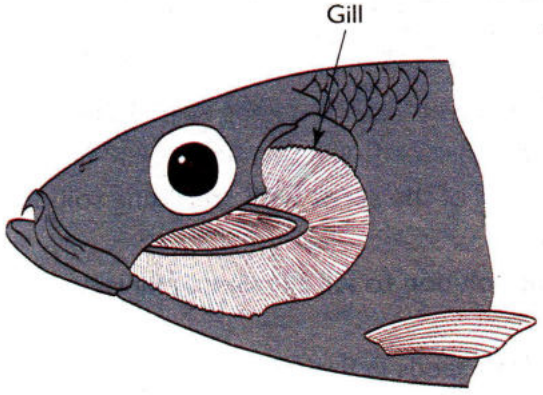



*Fig 11.6 Gills in a fish*

### Breathing in frogs

Frogs have three ways of breathing. They breathe through their skin, lungs, and mouth.

- *Through the skin*: Frogs have moist and slimy skin and an extensive network of blood vessels running throughout their skin. Oxygen passes through the skin, thereby entering directly into the blood. When a frog submerges beneath the water, it respires entirely through the skin.
- *Through the lungs:* They have paired sac-like lungs. As in humans, air enters the body through the nostrils, passes through the windpipe, and is received by the lungs. The mechanism of breathing, however, is different from that in humans. The frog uses its throat to pump air into the lungs. The throat moves down drawing air into the mouth through the nostrils. The nostrils close and the throat moves up, forcing air into the lungs of the frog. In humans, breathing is aided by the ribs, the diaphragm, and the chest muscles. The frog has no ribs or diaphragm, and its chest muscles are not involved in breathing.
- *Through the mouth:* The floor of the frog's mouth is raised or lowered and air moves in and out of the mouth through the nostrils. As the lining of the mouth is richly supplied with blood capillaries, oxygen diffuses into the blood and carbon dioxide is given out.

## Respiration in plants

Like all living beings plants also breathe. Plants take in and give out air through pores, called *stomata*, present on the surface of their leaves. Stomata are also present in green stems.

During respiration, plants take in oxygen and give out carbon dioxide. Although respiration takes place all the time, the rate of photosynthesis during the day is much greater than the rate of respiration. Thus, the oxygen released by plants is much more than the oxygen consumed. During the night, photosynthesis does not take

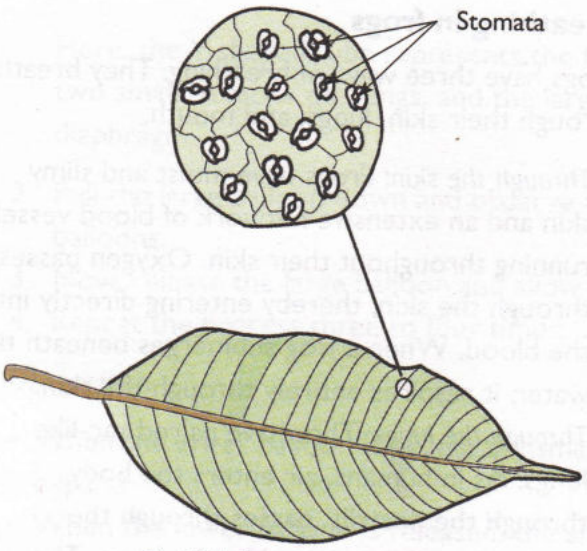



*Fig. 11.7 Respiration in plants*

place due to the absence of sunlight. Therefore, only respiration takes place during the night. Plants, therefore, take in oxygen and release only carbon dioxide.

**Infobit** The average number of stomata per square millimetre of leaf is around 300. The smallest number is found on *Tradescantia* leaves which have 14 per $mm^2$. The highest number of stomata, around 1200 per $mm^2$, is found on the leaves of the Spanish oak tree.

The roots of a plant also need oxygen for respiration which they obtain from the air spaces in the soil.

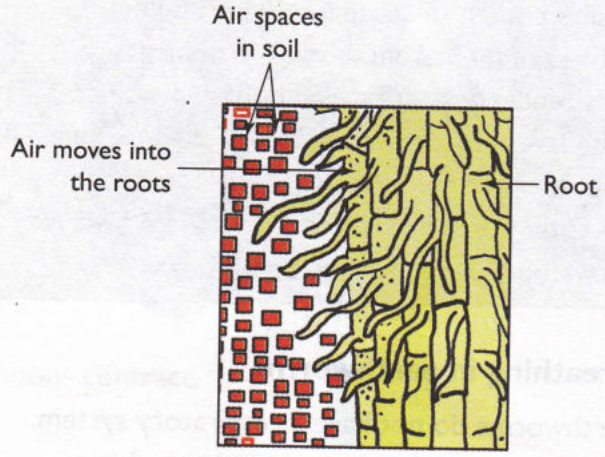



*Fig. 11.8 Air spaces in soil*

## Respiration in seeds

It is not just the cells of the root and leaves which respire but all parts of plants including the seeds respire. In fact, dry seeds are dormant stages of living plants as they contain a baby plant. The baby plant grows only when the seeds are provided with the right conditions which include water, air, and warmth of the sunlight. The germinating seeds have high rate of respiration. The seeds use this energy released to develop the roots and stem.

**ACTIVITY 3**

**To show that respiring organisms produce heat energy**

*Things required:* Gram seeds, water, cloth, sterilizing solution, two vacuum flasks

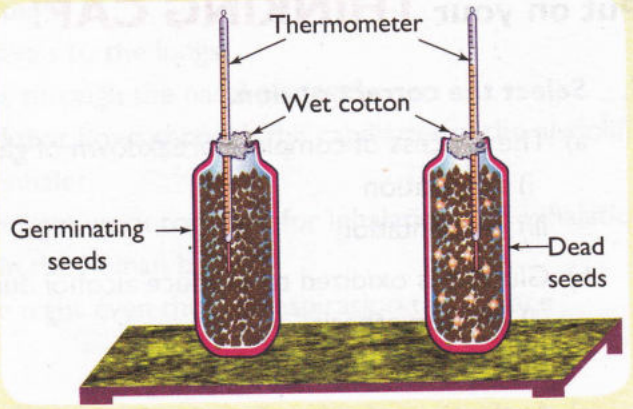
*Method:*

1. Soak some seeds in water overnight. Wrap the seeds in a wet cloth and keep it in warm conditions for a day. Ensure that the cloth remains wet. The seeds will germinate.
2. Put half of the seeds in boiling water and sterilize the rest of the seeds with sterilizing solution to kill microorganisms present on the surface.
3. Wash the inside of two vacuum flasks with a sterilizing solution to kill all microorganisms.
4. Label them as A and B.
5. Place the sterlized sprouted seeds in flask A and the dead seeds in flask B.

6. Insert a thermometer into each flask, record the temperature, and seal the flask with cotton wool.
7. Record the temperature of each flask daily over the next five days.

*Observation:* There will be no change in temperature of flask B. But there will be steady rise in temperature each day in flask A.

*Conclusion:* Only the living seeds caused a temperature rise, therefore respiring organisms produce heat.





**Breathing:** mechanical process of taking in oxygen and giving out carbon dioxide

**Cellular respiration:** oxidation of glucose in the cells to release energy, water, and carbon dioxide

**Anaerobic respiration:** incomplete oxidation of glucose in the absence of oxygen

**Aerobic respiration:** complete oxidation of glucose in the presence of oxygen

**Alveoli:** small air sacs in the lungs

**Diaphragm:** a sheet of muscles that separates the chest cavity from other internal organs

**Trachea:** wind pipe in the human respiratory system; tubes present in insects through which exchange of gases takes place


- Movements of ribs and diaphragm contribute in the process of inhalation and exhalation of air.
- Earthworms breathe through skin. They do not have a respiratory system.
- Insects take in air through openings called *spiracles* which lead to a network of tubes called *tracheae*.
- Fish have gills which aid in the diffusion of gases.
- Frogs breathe through skin, lungs, and mouth.
- Plants exchange gases through openings on the lower surface of leaves called *stomata*.

## Put on your THINKING CAP!

**1. *Select the correct option.***

a) The process of complete breakdown of glucose to produce energy is called
   i) respiration ii) transpiration
   iii) fermentation iv) breathing

b) Glucose is oxidized to produce alcohol during
   i) photosynthesis ii) aerobic respiration
   iii) anaerobic respiration iv) breathing

c) At the time of exhalation, the diaphragm
   i) moves upwards ii) does not move
   iii) moves downwards iv) vibrates

d) Exchange of gases in insects take place through
   i) spiracles ii) alveoli
   iii) bronchioles iv) gills

e) Fish exchange gases through
   i) lungs ii) stomata
   iii) gills iv) operculum

f) The intercostal muscles between the ribs and the diaphragm control
   i) breathing ii) transportation of food
   iii) circulation of blood iv) excretion

g) The small air sacs in the lungs are called
   i) bronchi ii) bronchioles
   iii) alveoli iv) tracheae

h) Plants take in and give out gases from the air through
   i) stomata ii) petiole
   iii) veins iv) leaf blade

**2. *Fill in the blanks.***

a) The _____ muscles are present between the ribs.
b) The microscopic air sacs in the lungs are called _____.
c) The chemical breakdown of food to release energy is called _____.
d) _____ does not require oxygen.
e) Breathing out is also called _____.
f) _____ is a sheet of muscle present below the lungs.
g) _____ respiration produces alcohol.
h) The trachea divides into two branches called _____.
i) The _____ is the common passage for food and air.
j) The voice box is also called the _____.

**3. *Write short answers.***

a) How is aerobic respiration different from anaerobic respiration?
b) What is the relation between respiration and breathing?

c) What are the functions of the respiratory system?
d) What structure does air pass through as it travels to the lungs?
e) What changes take place in the air as it passes through the nasal passage?
f) What happens to carbon dioxide in the blood that flows through the capillaries in the alveoli?
g) Why does air rush into your body when you inhale?
h) How do the intercostal muscles and the diaphragm work together for inhalation and exhalation?
i) When does anaerobic respiration take place in the human body?
j) Plants give out carbon dioxide only during the night even though respiration takes place throughout the day. Why?

**4. *Answer in details.***

a) Describe how a fish produces a continuous flow of water over its gills.
b) Draw the spiracles and describe the breathing process in cockroaches.
c) Explain the difference between breathing and respiration.
d) Draw and label the diagram of the human respiratory system. Both humans and frogs use lungs to breathe, the mechanism though is different. Explain.

## Extended learning

1. Find out how respiration is similar to the burning of kerosene.
2. All cigarette packets carry a statutory warning 'Smoking is injurious to health'. Find out why.

HIGHER ORDER THINKING SKILLS
HOTS

1. Reshma was cleaning her aquarium. She was transferring the fish to a bucket. One of the fish fell out. Before she could put the fish back in water, it died. Why?
2. Raghu loves to water his plants. He was watering them three times a day even during the rainy season. To his surprise, his potted plants started dying. What could be the reason?
3. Manish's legs started aching after a 1000 m race. He rested and practised deep breathing. This gave him lot of relief and the pain disappeared after some time. Why?


For more information
http://www.oxygen-review.com/respiration.html
http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/P/Pulmonary.html
http://www.biology4kids.com/files/systems_respiratory.html
http://www.nhlbi.nih.gov/health/dci/Diseases/hlw/hlw_when.html
http://science.howstuffworks.com/question386.htm
http://animals.howstuffworks.com/insects/question555.htm
http://www.petplace.com/fish/how-do-fish-breathe/page1.aspx

# 12 Transportation of Substances

**You will learn about**

- Transportation in animals
- Circulatory system in humans
- Circulatory system in other animals
- Disposal of waste materials in animals
- Transportation in plants
- Disposal of waste materials in plants

You have learnt that all organisms require food, oxygen, water, and other substances for their survival. Every living organism is made of cells that need energy to do their respective functions. Thus, food, water, and other substances need to reach every cell of a living organism to provide energy. The waste products produced during various life processes like digestion and respiration too need to be removed from the body.

In this chapter, we shall study how all these materials are transported to the various parts of animals and plants and how waste products are excreted.

## Transportation in animals

In multicellular organisms like humans, transportation is carried out through the circulatory and excretory systems.

## Circulatory system in humans

The circulatory system consists of the blood, the heart, and the blood vessels.

**Infobit** The volume of blood in a human adult is 4–5 litres.

### Blood

Blood is the red-coloured fluid that flows in our body. It carries oxygen and digested food to various parts of our body. It also carries waste material for removal from our body. Blood is made of two parts—plasma and cells.

***Plasma*** Plasma is a yellow or grey-yellow fluid portion of the blood in which the blood cells are suspended. It contains dissolved gases, nutrients, wastes, salts, and proteins. Plasma proteins help in transporting large organic molecules.

***Cells*** There are three types of cells present in the blood.

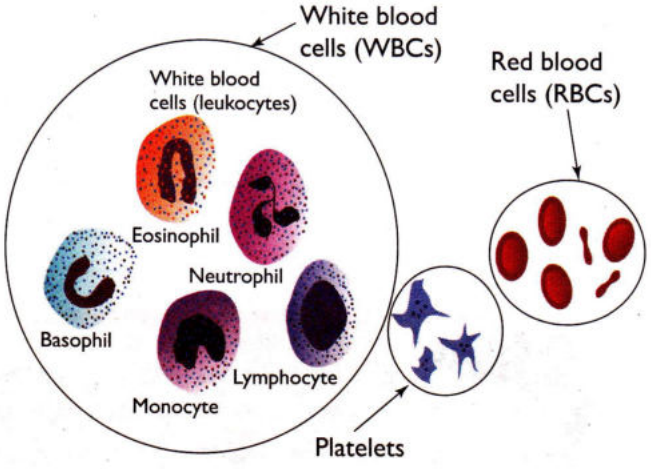



*Fig 12.1 Blood cells*

*Red blood cells (RBCs) or erythrocytes* RBCs are bi-concave discs filled with haemoglobin. Haemoglobin combines with oxygen from the lungs to be transported to body tissues. Haemoglobin gives red colour to the blood. It also plays a key role in transporting waste carbon dioxide from the tissues to the lungs, where it can be breathed out.

**Infobit** Human red blood cells have a life span of approximately 120 days. Anaemia occurs when there is an insufficient number of red blood cells or when the cells lack sufficient haemoglobin.

*White blood cells (WBC) or leukocytes* WBCs provide immunity to the body against diseases and infections. They are far less in number than RBCs, but their number usually increases in response to infection. There are many kinds of WBCs (Fig 12.1).

*Platelets* If someone gets a cut and blood starts coming out, what happens after some time? The bleeding stops and the cut gets covered with a dark red clot. This is due to the presence of a type of blood cells called *platelets*. Platelets are small, colourless cell-like structures. Together with the damaged tissues they release substances that cause the formation of a mesh-like structure that traps blood cells. The resulting plug seals the leak and prevents further blood loss.

## Blood vessels

Blood vessels are tube-like structures that transport blood throughout the body. There are three types of blood vessels—arteries, veins, and capillaries.

***Arteries*** Arteries carry oxygen-rich (oxygenated) blood from the heart and distribute it to all parts of the body. The *pulmonary artery* is an exception as it carries deoxygenated blood from the heart to the lungs. Arteries have thick elastic walls to allow stretching and to deal with the high pressure of blood coming from the heart.

***Veins*** Veins are the blood vessels which carry carbon dioxide rich blood or deoxygenated blood from the body organs back to the heart. *Pulmonary vein* is an exception as it carries oxygenated blood from the lungs to the heart. Veins have thin elastic walls. The diameter of veins is greater than that of arteries. These are superficially placed. The blood pressure in the veins is low. There are a series of valves present in veins. They help prevent backflow and allow blood to flow only towards the heart.

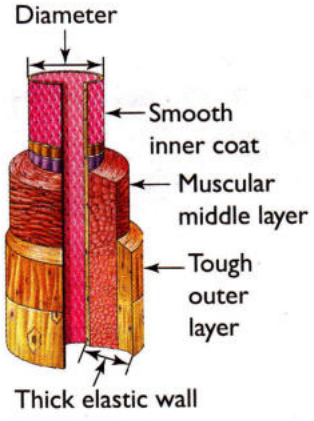


*Fig 12.2 Artery*

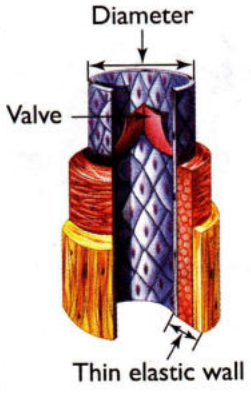


*Fig 12.3 Vein*

**ACTIVITY 1**

**To show the valves**

Tie a band around your upper arm and make a fist. Rub the area in the direction away from the heart. You will observe blue vessels. These are veins. On a closer look, you will also observe little knots on the veins. These are the valves.

***Capillaries*** Arteries branch into finer and smaller blood vessels called *capillaries*. Capillaries join to form veins. The smallest blood vessels are capillaries. They are typically less than 1 mm long. The capillary wall is so thin that the diffusion of gases and substances happens easily. The exchange of substances between blood and the body cells occurs in the capillaries. These are specialized for the exchange of substances with the *interstitial fluid*. Interstitial fluid is the fluid that surrounds the cells.

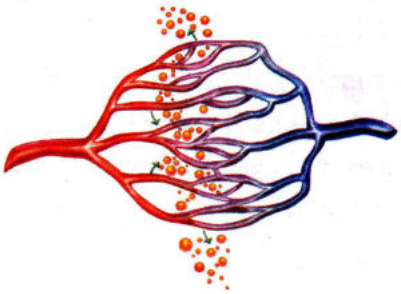


*Fig 12.4 Capillary network*

**Infobit** The total length of capillaries in a person is over 50,000 miles. This would go around the Earth twice.

## Heart

The heart is a muscular organ present in the chest cavity, located between the lungs, slightly tilted towards the left. Its function is to pump the blood to all parts of the body. Your heart is approximately the size of your fist. The heart is divided into four chambers so that the oxygenated blood and deoxygenated blood do not mix inside it.

***Chambers of the heart*** The heart is divided into two separate sides. The left side pumps oxygenated blood to the body (systemic circulation) and the right side pumps deoxygenated blood to the lungs (pulmonary circulation). Each side has an atrium (plural: atria) and a ventricle.

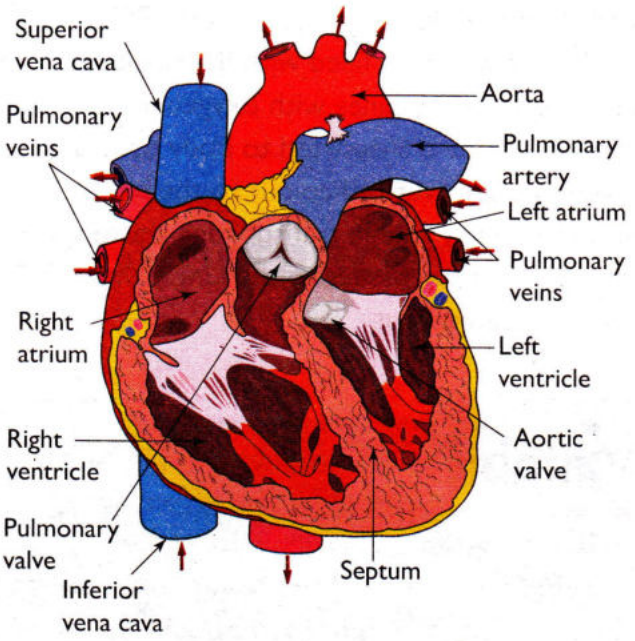



*Fig 12.5 Human heart*

The vena cava brings deoxygenated blood from all parts of the body to the right atrium. The right atrium pumps this blood into the right ventricle, which then pumps it into the pulmonary artery. This artery takes the blood to the lungs for oxygenation.

The oxygenated blood is received by the left atrium through the pulmonary veins (two each from the right and left lungs). It is then pumped into the left ventricle. The left ventricle in turn pumps the blood into the aorta through which it is supplied to the rest of the body.

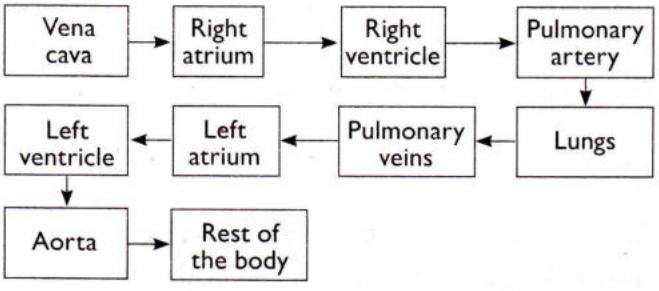



*Fig 12.6 Schematic representation of blood flow through the human heart*

*Valves* separate each of the chambers and allow blood to flow in one direction only. They prevent backflow.

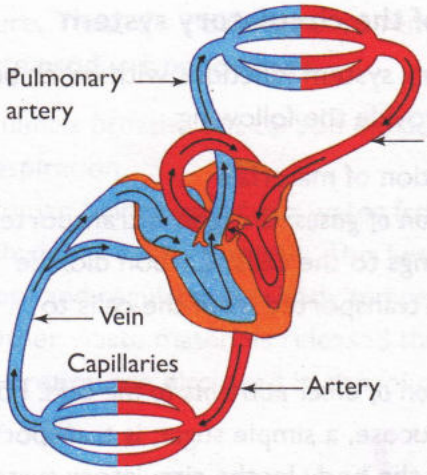



*Fig 12.7 Circulation of blood through the human heart*

The left side and the right side are separated from each other by a *septum*. This prevents the mixing of oxygenated and deoxygenated blood.

The direction of flow of blood between the heart and the blood vessels is shown below:

heart → arteries → capillaries → veins → heart

***Heartbeat*** The walls of different chambers of the heart are made of muscles. These muscles contract and relax rhythmically to pump the blood. This rhythmic contraction and relaxation of different chambers produces the heartbeat. Doctors use an instrument called *stethoscope* to listen to the heartbeat.

***Pulse*** During each heartbeat, the muscles of the heart contract causing a wave of pressure which forces blood through the arteries. This wave of pressure is known as a *pulse*. In other words, the stretching and relaxing of arteries with each heartbeat is felt as a throbbing movement called pulse. There is one pulsation for each heartbeat. The pulse can be felt at various points on the body where the arteries are just under the skin, such as the temples, neck, crook of the elbow, wrist, back of the knee, and the inside back of the ankle. The normal pulse rate varies with age.

With exercise or physical activity, the heartbeat increases to supply the muscles with more oxygen to produce extra energy. The heart

## ACTIVITY 2

**To make your own stethoscope**

Take a rubber pipe about fifteen inches long. Take a small funnel and attach it firmly to the pipe with the help of a rubber band and electrical tape. Attach another funnel, slightly bigger, at the other end in the same way.

Press the wider end of the large funnel against a friend's chest and place the small funnel on your ear. Listen and count the heartbeats of your friend. How many times did the heart beat in one minute? You will observe that the heart beats 60–75 times in a minute.

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## ACTIVITY 3

1. Locate your pulse points either on the wrists or neck. Place your right index and middle finger on the palm side of your left wrist. On the neck, the pulse point is located beneath the ear and jaw bone.
2. Count the number of beats for 15 seconds. Multiply this by four (15 × 4 = 60, there are 60 seconds in one minute). This is how many times the heart beats in one minute. Note the readings of a person at rest. A child's pulse rate at rest will vary between 60 and 110 beats per minute. Adult rates are lower.
3. Do some exercise such as running or jumping for one minute. Stop and calculate the pulse again for 15 seconds. What difference do you observe?

Also calculate the heart rate for each activity.

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can beat up to 200 times per minute with extreme exercise.

When we are excited, scared, or anxious, our heart gets a signal to beat faster. During a fever, the heart beats faster to bring more blood to the surface of the body to release heat and thus cool the body. The heartbeat increases during and after a meal to send more blood to the digestive system.

*Fig 12.8 Activities which increase heartbeat*

The amount of time the heart takes to return to a normal at-rest pulse rate after exercise is called *recovery time*. This is a measure of the body's general fitness. The shorter the recovery time, the higher is the level of fitness. Determine recovery rate by first measuring and recording the pulse rate at rest. Next, run for two minutes. Now, measure the pulse rate every minute until the at-rest rate is reached. How long did it take the heart to return to the normal rate?

## Circulatory system in other animals

Certain animals like sponges and *Hydra*, which are found in water, do not possess a well-developed circulatory system. These organisms live in water, from which they obtain food and oxygen. Excretory material moves out of their bodies through water only.

### Functions of the circulatory system

The circulatory system functions with other body systems to provide the following:

- Transportation of materials
- *Transportation of gases:* Oxygen is transported from the lungs to the cells. Carbon dioxide (a waste) is transported from the cells to the lungs.
- *Transportation of other nutrients to the cells:* For example, glucose, a simple sugar, is transported throughout the body by the circulatory system.
- *Transportation of other wastes from cells:* For example, ammonia is a waste product. It is transported to the liver where it is converted to less toxic urea. Urea is then transported to the kidneys for excretion in the urine.
- It contains cells that fight infection.
- It helps maintain body temperature by transporting heat. This is particularly important in homeothermic animals such as birds and mammals.

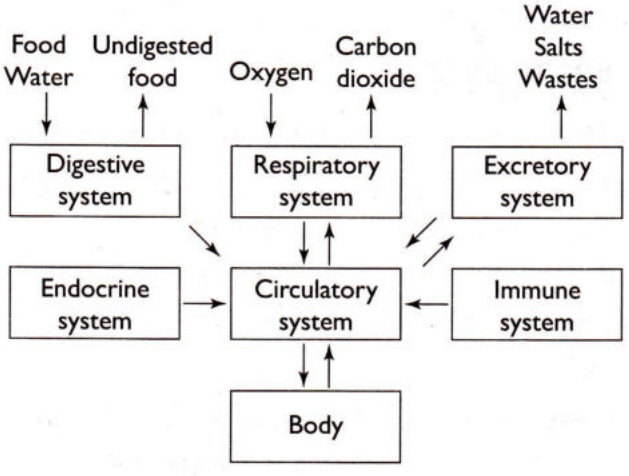


*Fig 12.9 Relationship between circulatory and other body systems*

## Disposal of waste materials in animals

Several chemical reactions continuously take place in the body of an organism. As a result of these reactions, many waste products are produced in the body. Accumulation of these products is harmful because they are toxic in

nature. Thus, the body needs to remove these waste products periodically.

- Animals breathe out carbon dioxide during respiration.
- Human beings sweat out water from the skin which has a salty content. This keeps the body cool and regulates the body temperature.
- Other waste materials released through excretion are discussed in the following section.

### Excretory system in humans

Recall that after the food is digested and absorbed, the undigested food in the large intestine is converted to faeces which is then excreted from the body. Similarly, carbon dioxide is the waste product. *Can you name the process of which it is the excretory product?*

The excretory system in humans consists of a pair of kidneys, a pair of ureters, a urinary bladder, a urethra, and a urinary opening.

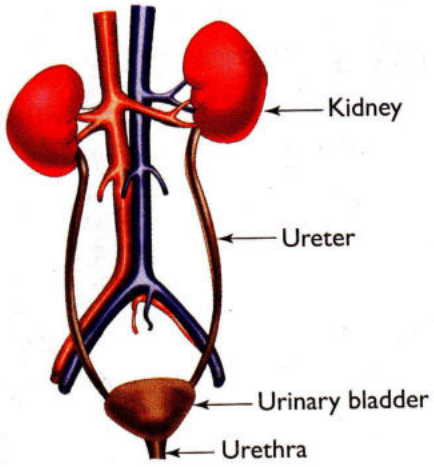


*Fig 12.10 Excretory system in humans*

***Kidneys*** The kidneys are dark red, slightly flattened, bean-shaped organs. They are placed against the back wall of the abdominal cavity just below the diaphragm, one on either side of the vertebral column. They are protected by the last two ribs. Their position is slightly asymmetrical, the left kidney being a little higher than the right. Each kidney is composed of numerous microscopic coiled tubules called *nephrons*.

***Ureters*** They are a pair of narrow, muscular, tubular structures which arise from the kidney, run backward along the dorsal body wall, and open on the dorsal wall of the urinary bladder. These conduct urine from the kidneys to the urinary bladder.

***Urinary bladder*** It is a pear-shaped sac situated in the pelvic region of the abdominal cavity. It can store about 0.5 to 1 litre of urine. It receives the ureters through the lower part of its back wall.

***Urethra*** The urethra starts from the neck of the urinary bladder and leads to the exterior by the urinary opening.

The act of disposing of urine is called *micturition*.

***Urine*** The first nitrogenous waste to be formed from the breakdown of protein is ammonia, a highly toxic chemical. It is quickly converted by the kidneys to urea which is less toxic than ammonia. Urea is excreted from our body in the form of a pale yellowish colour fluid called urine. Urine consists of about 90% water, 5% urea, uric acid, and other organic substances.

## Transportation in plants

Roots take water and minerals from soil and transport these to the leaves for photosynthesis. Leaves make food by the process of photosynthesis. The food made in the leaves is in the form of simple sugar (glucose) and has to be transported to all the parts of the plants like roots, stems, growing regions, etc. How is it done? Let us see how transportation of things takes place in plants.

### Transport of water and minerals

Plants extract water and minerals from the soil through roots. Roots have many root hairs that have direct contact with the water inside the soil. The water and minerals dissolved in it move

through a special pipe-like tissue present in plants called *xylem*. Xylem has a wide network spread in all the parts of the plant and thus carries water and minerals from the root hairs to the leaves.

**ACTIVITY 4**

Take a raw potato. Scoop it from within to make a hollow cup of potato. Put this cup in a beaker half filled with water. Add sugar solution inside the cup and mark the initial level of sugar solution in the cup with the help of a pin. Leave the setup for some time. What will you observe after some time? You will see a rise in the level of sugar solution in the potato cup. This is because of the movement of water from the outside to the inside of the cup. This is how water moves in the plants.

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### Transportation of food

Leaves make food and store it in the form of glucose. The movement of food from leaves to other parts of the plant is called *translocation*. In plants, a tissue called *phloem* translocates food and other substances.

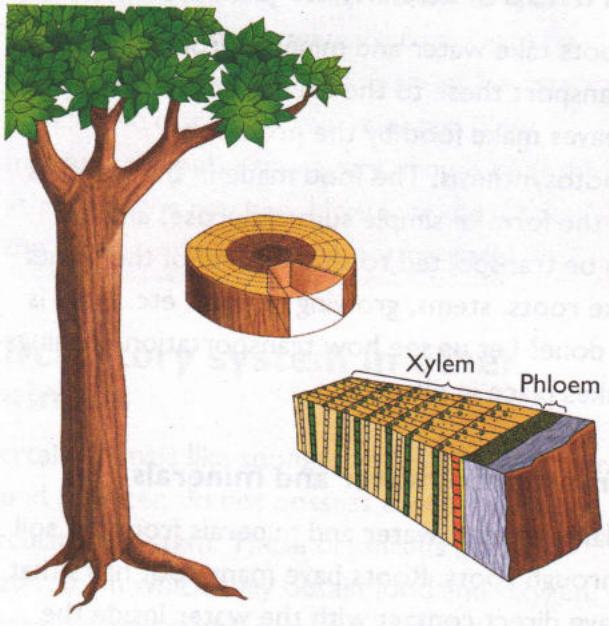


*Fig 12.11 Vascular tissues*

Xylem and the phloem together are called the *vascular tissues*.

## Disposal of waste material in plants

- Plants lose oxygen during the process of photosynthesis.
- Many plants like eucalyptus, pine, and rubber tree release toxic wastes in the form of oil, rubber, and resin.
- Plants lose water through the process of *transpiration*.

### Transpiration

Transpiration in plants is similar to sweating in humans. It refers to the loss of water vapour from a plant through the stomata of leaves. The evaporation of water creates a suction pull, similar to the one created by us while drinking from a straw. This is called *transpirational pull*. This pulls water from the xylem cells to great heights in tall trees.

**ACTIVITY 5**

Wrap the leaves of a potted plant with a cellophane sheet. Remove it after four days. What do you observe? The cellophane sheet has droplets of water on its surface. This is because of the transpiration.

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### Significance of transpiration

Transpiration results in loss of water from the plant. Yet it is an essential process for the plants.

1. It transports water and dissolved minerals from the soil throughout the plant.
2. It also keeps the plants cool.


**Plasma:** yellow or grey-yellow fluid portion of blood in which the cells are suspended

**Platelets:** small cell-like structures in the blood which are important for blood clotting and plugging damaged blood vessels

**Arteries:** blood vessels that carry oxygenated blood away from the heart

**Capillaries:** smallest blood vessels

**Veins:** blood vessels that carry deoxygenated blood from body organs back to the heart

**Translocation:** movement of food from the leaves to other parts of the plant

**Transpiration:** loss of water in the form of vapour from the aerial parts of the plant


- The circulatory system helps in transportation of nutrients and gases. It also helps in the removal of waste products from the body.
- The circulatory system in humans consists of blood, heart, and blood vessels.
- Blood has plasma and blood cells like RBCs, WBCs, and platelets.
- Blood vessels like arteries, veins, and capillaries transport the blood to the entire body.
- The heart pumps the blood to all the organs. The left side deals with oxygenated blood and the right side deals with deoxygenated blood.
- The excretory system in humans is formed of a pair of kidneys, a pair of ureters, a urinary bladder, a urethra, and a urinary opening.
- Xylem transports water and minerals to the leaves of the plants.
- Phloem carries food from the leaves to all parts of the plant.
- Plants lose water through transpiration.
- Resin, gum, and latex are the waste products released by plants.

## Put on your THINKING CAP!

1. ***Select the correct option.***

a) Which blood cells contain haemoglobin?

i) RBCs
ii) WBCs
iii) platelets
iv) all of these

b) Which of the following blood cells help in blood clotting?

i) RBCs
ii) WBCs
iii) platelets
iv) none of these

c) The function of the heart is to

i) purify blood
ii) separate excretory products from blood
iii) circulate blood
iv) all of these

d) How many chambers are present in the human heart?

i) 1 ii) 2

iii) 3 iv) 4

e) Urine mainly consists of

i) uranium ii) urea

iii) carbon dioxide iv) starch

f) Which of the following is associated with the transport of water in plants?

i) xylem ii) phloem

iii) chloroplast iv) none of these

g) The blood vessels that have thick muscular walls are

i) capillaries ii) arteries

iii) veins iv) none of these

h) The right side of the heart deals with

i) deoxygenated blood

ii) oxygenated blood

iii) mixture of oxygenated and deoxygenated blood

iv) none of these

**2. *Use the words in the box to fill in the blanks.***

| | | | |
|---|---|---|---|
| veins | transport | circulatory | blood |
| arteries | oxygen | lungs | heart |
| nutrients | energy | carbon dioxide | pumped |
| capillaries | dark | bright | atmosphere |
| away | heat | to | |

a) All animals need to _____ materials to different parts of their body. This is the function of the _____ system. The circulatory system consists of a liquid called _____, a pump called the _____, and a series of vessels called _____, _____, and _____.

b) One thing that must be transported around is a gas called _____ that enters the blood through the _____. It is then _____ through the heart around the body where it is used along with food to make _____. The body produces another gas called _____, which is a waste product. This gas is carried back to the heart and then to the lungs where it is released back into the _____.

c) The vessels that transport blood _____ from the heart are called arteries. The blood in arteries is _____ red because it is rich in oxygen. The vessels that transport blood _____ the heart are called veins. The blood in veins is _____ red because it is low in oxygen. _____ are small vessels that join the arteries and veins.

d) _____ from food are also transported around the body by the circulatory system. The circulatory system also helps to regulate temperature by transporting _____ around the body.

3. ***Rearrange the statements below the title into the correct order.***

**Blood Flow through the Heart**

a) Deoxygenated blood enters the lungs, releases excess carbon dioxide, and picks up oxygen and becomes oxygenated blood.
b) Deoxygenated blood fills the right atrium.
c) Left ventricle contracts and oxygenated blood leaves the heart.
d) Oxygenated blood enters the heart and fills the left atrium.
e) Deoxygenated blood enters the right atrium.
f) Both ventricles contract and deoxygenated blood leaves the right ventricle through the pulmonary artery.
g) Both atria walls contract and the deoxygenated blood goes down to fill the right ventricle.
h) Oxygenated blood travels back to the heart through the pulmonary veins.
i) Both atria contract and oxygenated blood travels down to fill the left ventricle.

4. ***Match the columns.***

| | |
|---|---|
| a) arteries | i) pumps blood to the entire body |
| b) veins | ii) carry deoxygenated blood to the heart |
| c) capillaries | iii) deliver oxygen-rich blood to every cell in body |
| d) plasma | iv) the smallest blood vessels |
| e) white blood cells | v) made mostly of water |
| f) heart | vi) protect you from infections |

5. ***Write short answers.***

a) Name the oxygen-carrying pigment of blood.
b) What are the constituents of urine?
c) Which tissue is involved in translocation of food in plants?
d) Which structure in heart prevents the mixing of oxygenated and deoxygenated blood?
e) Which blood cells in our body can also be called the soldiers of the body?

6. ***Answer in details.***

a) Give three points of difference between veins and arteries. What is the function of a capillary?
b) What are the components of blood? Write the function of each of the components.
c) How does transportation of water take place in the plants?
d) Draw a well-labelled diagram of human excretory system.
e) What is transpiration? Why is it necessary?
f) How is waste disposal carried out in plants?

## Extended learning

1. a) Compare the heartbeats of the students in a class. Are the heartbeats the same or different?
b) What is the average heartbeat of the students? The average heartbeat can be found by adding up all the heartbeats listed and dividing this number by the total number of students.
c) Collect pulse rates from various adults. Calculate the average heartbeat of adults. How does this compare with the students' average heartbeat?
d) Keep a record of their heartbeats for one week by taking their pulse a few times every day. Note time of the day and activity at that time.

2. Research about the structure of the heart in the following animals.
   a) Fish  b) Frog  c) Snake
   d) Crocodile  e) Birds

3. When is International Organ Donation Day celebrated? Collect some inspiring stories and share it with your friends and teacher.

HIGHER ORDER THINKING SKILLS
**HOTS**

1. Why do veins appear blue in colour when they carry blood which is red in colour?
2. Shalini is suffering from anaemia (a condition in which there is deficiency of haemoglobin in blood). She often complains of tiredness and lack of energy. Why does she show these symptoms?
3. Arjun was involved in an accident and his kidneys got damaged. How will this affect him?
4. What would happen if a person did not have platelets?


For more information
http://library.thinkquest.org/5777/cir1.htm
http://kidshealth.org/kid/htbw/heart.html
http://kidshealth.org/parent/general/body_basics/blood.html
http://health.howstuffworks.com/human-body/systems/circulatory/blood.htm
http://www.healthline.com/galecontent/blood-vessels
http://health.howstuffworks.com/human-body/systems/circulatory/heart.htm

# 13 Reproduction in Plants

**You will learn about**

- Asexual reproduction
- Sexual reproduction
- Seed dispersal

You might have observed that if you plant small saplings along a hedge and water them regularly for a few days, you will have a green patch. How do you think this happened? This is because the saplings you planted produced new plants. This is called reproduction.

*Reproduction* is defined as a process by which new individual organisms are produced. Reproduction is a fundamental feature of all living organisms including plants. There are mainly two known methods of reproduction in plants—asexual and sexual.

In this chapter, we will discuss the two methods of reproduction and their types.

**ACTIVITY 1**

Write down all the parts of a plant that you have studied in your previous classes.

## Asexual reproduction

In asexual reproduction, only a single parent plant is involved and no seeds are produced. Asexual reproduction takes place in many ways in different plants. The flow chart in Fig 13.1 lists the types of asexual reproduction in nature.

Let us look at each type of asexual reproduction one by one.

### Vegetative propagation

Vegetative propagation is a type of asexual reproduction in which the stems, roots, leaves, and buds give rise to new plants. These are called the vegetative parts of a plant.

#### *Vegetative propagation through stem*

**Runner:** If you wish to have a lawn of grass, do you know how it is done? The gardener plants a few grass plants at equal intervals on a small piece of land. After some time, the piece of land turns lush green. This happens because grasses produce underground stems. As these stems

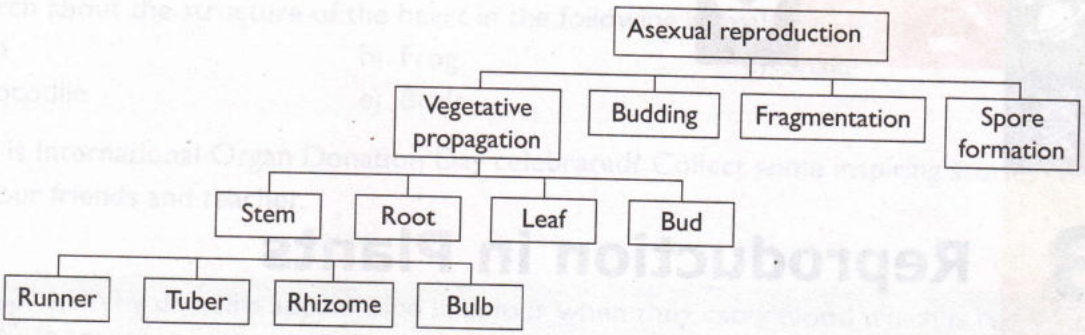



*Fig 13.1 Types of asexual reproduction*

grow through the soil, they produce new roots and shoots at definite intervals above the ground. Another example of a runner is the strawberry plant (Fig 13.2).

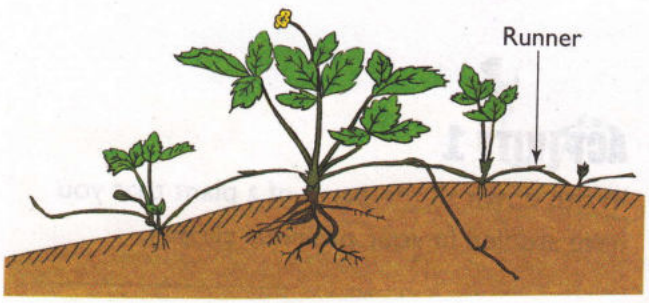



*Fig 13.2 Strawberry runner*

**Tuber:** Take a potato and closely examine the depressions on it. What do you think they are? Potatoes are underground stems called *tubers*. They are swollen because they store food in them. Just as normal stems have buds, they too have buds called 'eyes' (depressions). New potato plants sprout from these eyes.

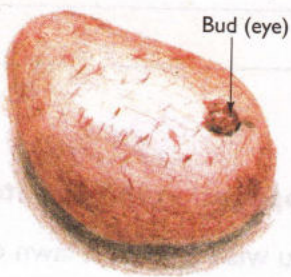



*Fig 13.3 Potato tuber*

**Rhizome:** Rhizomes are underground stems that have buds to give rise to new plants. Ginger and turmeric are thick horizontally growing stems in which buds develop into branches which grow upwards into the air and then produce normal green leaves. Roots develop from the lower surface of the underground stems.


*Fig 13.4 Rhizome of turmeric*

**ACTIVITY 2**

Cut out a small piece of potato with an eye and another without any eye and plant them into small flower pots containing soil. Mark them as A and B. Water the pots regularly and see what happens in each flower pot.


In 1995, potato plants were taken into space with the space shuttle Columbia. This was the first time any food was ever grown in space.

**Bulb:** Onions and lilies are bulbs, which too are underground stems. The scales present on them are modified leaves that contain stored food. At the centre of the bulb is a bud called the *apical*

*bud.* The buds on the sides are called *lateral buds.* The apical bud produces leaves and flowers while the lateral buds produce new shoots of a new plant. As the plant grows and develops, it forms a new bulb underground.

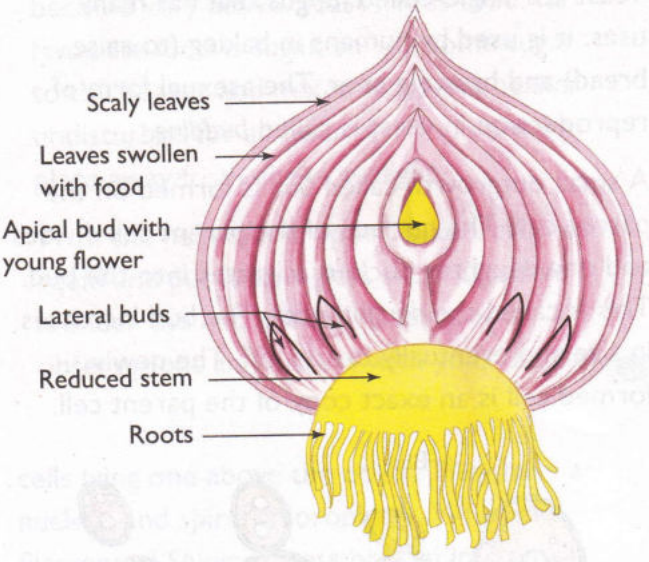



*Fig 13.5 An onion bulb*

**ACTIVITY 3**

*(To be done under adult supervision)*

Take an onion, slice it into two lengthwise portions and observe its fleshy, storage leaves (scales) and stem. Take another onion and plant it in moist soil. Water it every day and observe what happens.

In the spring season, the shoot tip begins to grow using the nutrients stored in the scales.

**Cutting:** Take a rose or a *champa* plant. Cut a portion of its stem from the node and place it in a suitable rooting medium that includes moist sand, a mixture of compost, and soil. After some time, a new plant will grow out of the cutting with roots and stem. This is an artificial way of producing plants. Many plants such as rose and coleus can be propagated by cuttings.

*(To be done under adult supervision)*

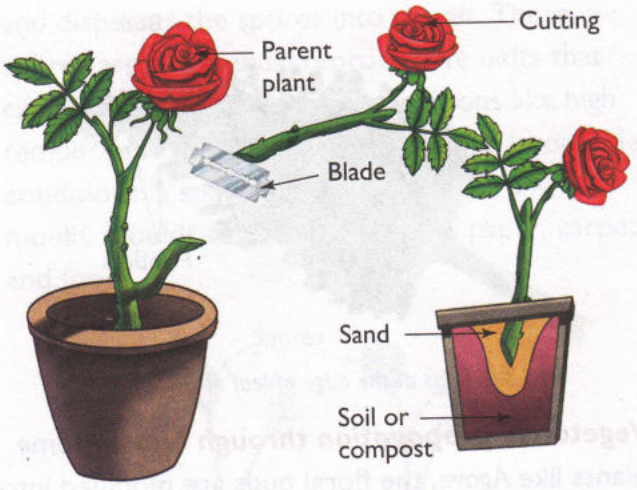



*Fig 13.6 Vegetative propagation through rose cuttings*

***Vegetative propagation through roots*** The main functions of a root are to provide support to the plant by anchoring it to the soil and to absorb water from the soil. Apart from these functions, some roots can also store food. Buds develop at the base of the stem of these plants. They grow into new plants by taking nutrition from these swollen, modified roots. Sweet potato is an example of vegetative propagation through roots.

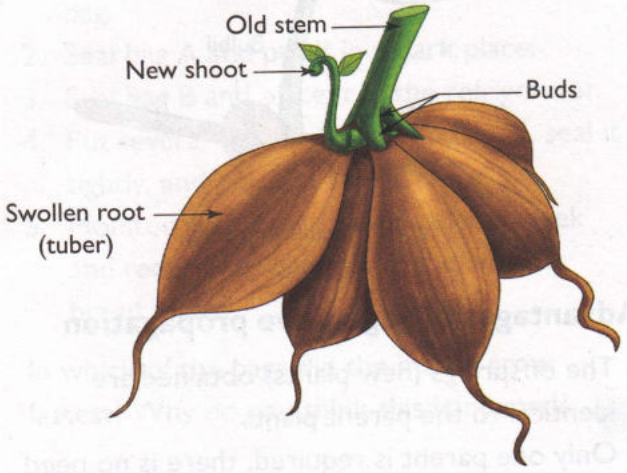



*Fig 13.7 New sweet potato plant growing through roots*

***Vegetative propagation through leaf*** In plants like *Bryophyllum*, the margins of the leaves contain buds. Small plants called *plantlets* arise from these buds. These plantlets fall off and develop into mature plants.

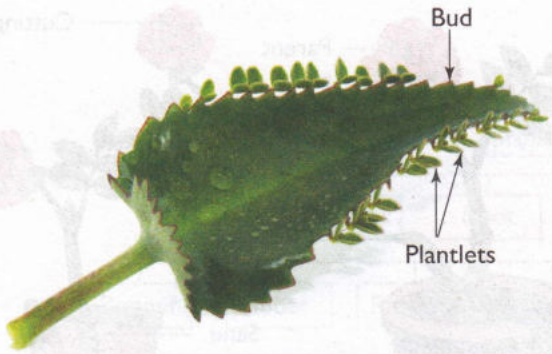



*Fig 13.8 Buds at the edge of leaf of Bryophyllum*

***Vegetative propagation through bud*** In some plants like *Agave*, the floral buds are modified into bulbils. When these bulbils are detached, they come in contact with the soil and develop into new plants.

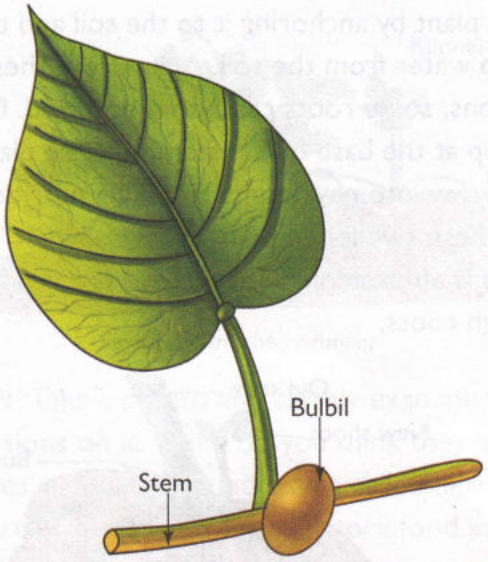



*Fig. 13.9 Bulbil on a stem*

## Advantages of vegetative propagation

- The offsprings (new plants) obtained are identical to the parent plants.
- Only one parent is required, there is no need for pollination.
- It is a faster method as the plants take less time to grow new plants.
- Many plants are able to tide over unfavourable conditions. This is because of the presence of organs of asexual reproduction like the tubers and bulbs.
- It is extremely beneficial to agriculturists as they can raise crops like bananas, sugarcane, potato, etc., that do not produce viable seeds.

## Budding

Yeast is a single-celled fungus that has many uses. It is used by humans in baking (to raise bread) and brewing beer. The asexual form of reproduction in yeast is called *budding*.

A small outgrowth called *bud* is formed on the parent cell. The nucleus of the parent cell divides and one daughter nucleus migrates into the bud. This is called the *daughter cell*. The bud increases in size and eventually breaks off. The newly formed cell is an exact copy of the parent cell.

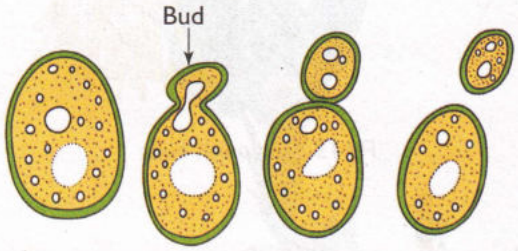



*Fig 13.10 Reproduction through budding in yeast*

Sometimes the buds do not detach from the parent and a chain of buds is formed. This is called a *colony*. Yeast requires three things in order to grow. These are moisture, food, and warmth.

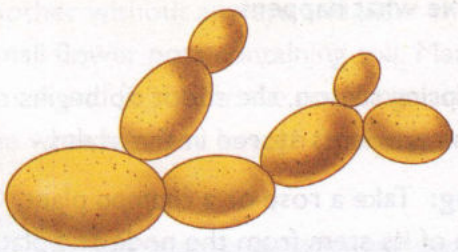


*Fig 13.11 Yeast colony*

## Fragmentation

*Spirogyra* is a multicellular alga, found in fresh water ponds and in slow streams. It occurs as a slimy dark-green scum in ponds. The body is filamentous, having a row of rectangular

## ACTIVITY 4

Take some dry baker's yeast in a beaker and mix it in warm water. In order to become very active, yeast needs food. Its favourite food is sugar, so add some sugar to the beaker and mix it. Keep the beaker undisturbed for an hour or two in a warm place away from direct sunlight.

With the help of a dropper, take a drop of liquid and put it on a glass slide. Observe it under the microscope. Record your observations and discuss with your teacher. S

cells lying one above the other. They have a nucleus and spiral chloroplasts. When the filament of *Spirogyra* gets broken into small fragments or pieces, the fragments grow into complete organisms.

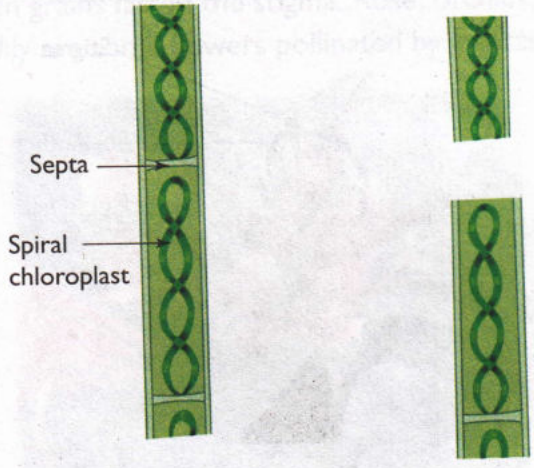



*Fig 13.12 Fragmentation in Spirogyra*

### Spore formation

In Chapter 2 you have read about mould growing on bread which is a form of fungus. If a sample of bread mould is examined under a microscope, you will be able to see fine threads called *hyphae* with knob-like structures called *sporangia*. Each knob has hundreds of minute spores inside it. When the sporangium is ripe it bursts open and disperses the spores into the air. These spores are the asexual reproductive units that can withstand unfavourable conditions like high temperature and low humidity. Under favourable conditions, a spore germinates into a new mould. Moulds can grow on wood, paper, carpet, and foods.

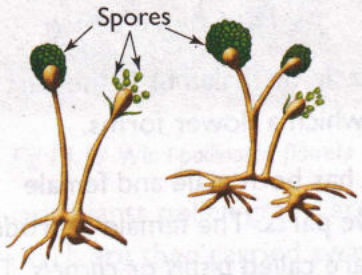



*Fig 13.13 Bread mould*

Spores are also found in ferns. Their leaves are called *fronds*. The underside of fronds have sori which are the spore bearing bodies.

## ACTIVITY 5

1. Label three plastic bags with the letters A, B, and C and put a piece of bread in each bag.
2. Seal bag A and put it in a dark place.
3. Seal bag B and place it in the refrigerator.
4. Put several drops of water in bag C, seal it tightly, and put it in a dark place.
5. Monitor your bread samples for a week and record any changes in the way the bread looks.

In which of the bags did the mould grow fastest? Why do you think this happened? S

## Sexual reproduction

In sexual reproduction, seeds are produced that give rise to the new plants. The *flowers* in plants are responsible for sexual reproduction. They are called the reproductive parts of a plant.

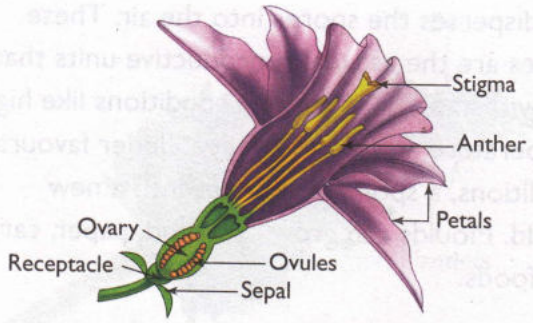



*Fig 13.14 Parts of a flower*

The receptacle or thalamus is the part of the branch on which a flower forms.

The flower has both male and female reproductive parts. The female reproductive structures are called *pistils* or *carpels*. The male reproductive structures are called the *stamens*.

***Pistil*** The carpel or pistil is made up of three parts—stigma, style, and ovary. The stigma at the top is sticky. The style is a long tube that attaches the stigma to the ovary. Ovules are present in the ovary. The ovules contain the female gamete or egg.

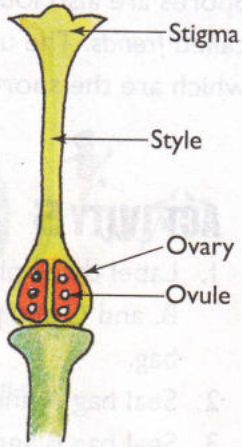



*Fig 13.15 Parts of a pistil*

***Stamen*** The stamen consists of an anther which contains pollen grains. The pollen grain produces the male gametes. Filament supports the anther.

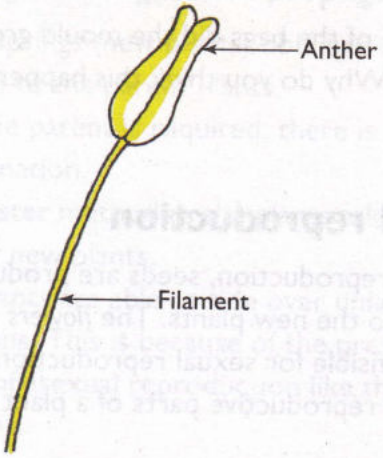



*Fig 13.16 Parts of a stamen*

Bamboo plants have amazing flowering habits. There are many different types of bamboo and they have different flowering cycles. A few flower each year, but most wait much longer. What is amazing is that all the bamboos of the same species will flower at exactly the same time, wherever they are growing! Nobody knows how they manage to do this.

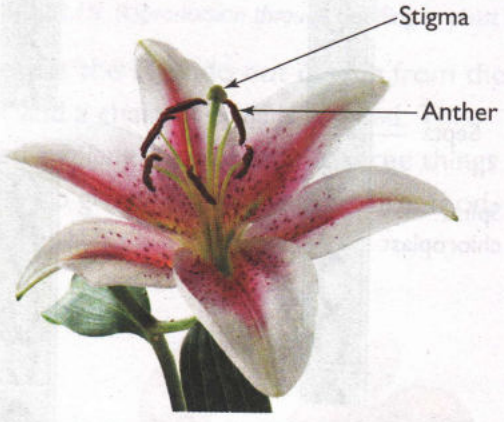
**ACTIVITY 6**

Take the flower of a China rose or *Petunia* and locate the pistil and the stamens.

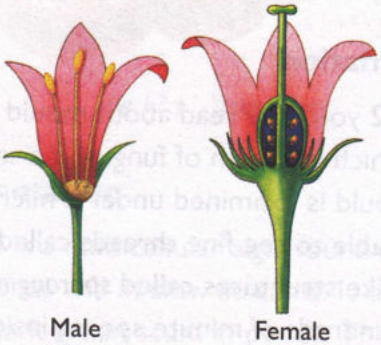
Take the flower of a cucumber or pumpkin and locate the pistil and the stamens.

What is the difference in the two flowers you examined?

The flowers of China rose, petunia, lily, and mustard have both the pistil and stamens.




*(a) Bisexual flower*




*(b) Unisexual flowers*

*Fig 13.17 Types of flowers*

They are called *bisexual* flowers. The flowers of cucumber, pumpkin, and papaya have either the pistil or the stamens. They are called *unisexual* flowers.

## Pollination

Sexual reproduction in plants occurs when the pollen from an anther is transferred to the stigma. The process of carrying the pollen grains from one flower to the stigma of the same or another flower is known as *pollination.*

But how do the pollen grains reach the stigma? This is done by pollinating agents like wind, insects, water, or bats.

Flowers pollinated by insects are big and brightly coloured. They have plenty of nectar and are scented. Insects get attracted towards them for nectar. When insects sit on them to collect nectar, the pollen grains stick to their bodies. When they visit another flower, the attached pollen grains fall on the stigma. Rose, orchids, and lily are some flowers pollinated by insects.

*Fig 13.18 Insect-pollinated flowers*

Flowers pollinated by the wind are very small, dull, have no nectar, and are not scented. Their stamens are exposed to enable the light weight pollen grains to be transported by the wind. The stigmas are long and also exposed to help them catch the pollen grains blowing in the wind. Grasses, maize, and wheat are some plants pollinated by wind.

*Fig 13.19 Wind-pollinated flowers*

In some aquatic plants pollen grains are released into water which are then carried away by the water to the female flower. *Vallisneria* and coconut are some flowers pollinated by water.

There are two main types of pollination:

***Self-pollination*** When pollen grains from a flower are carried to the stigma of the same flower or on the other flower of the same plant, it is called self-pollination.

***Cross-pollination*** When the pollen grains from a flower of one plant are carried to the stigma of another plant of the same kind, it is called cross-pollination.

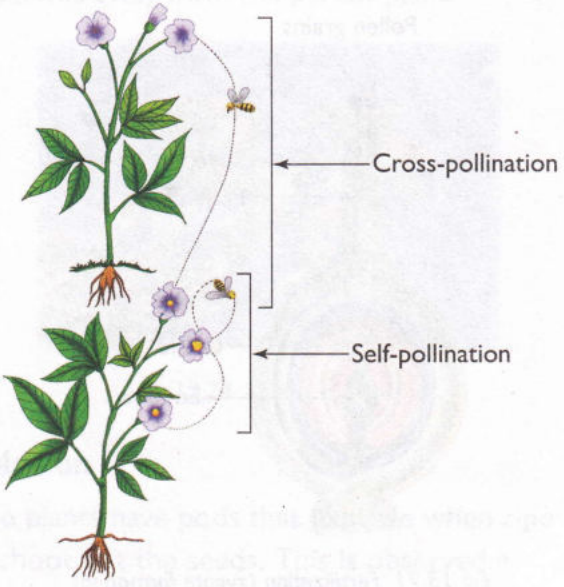



*Fig 13.20 Self- and cross-pollination*

**Infobit**

- The white flower of the Amazon water lily is of the size of a football and turns purple after it has been pollinated.
- Hummingbirds hover in front of flowers when they collect nectar. They use so much energy to do this that it would be like you needing to eat 150 kg of hamburgers every day!

### Fertilization

When the pollen grains land on the stigma of a flower, a pollen tube grows out from the pollen grain. This pollen tube travels through the style and reaches the ovule via the ovary. Two male gametes from the pollen grain then travel down the pollen tube. After reaching the ovule, one male gamete unites with the female gamete and forms a zygote. The process of fusion of the male gamete with the female gamete to form a zygote is called *fertilization*. The zygote is single celled which divides many times to form an *embryo*. The second male gamete fuses with another cell in the ovule to form the *endosperm*. This provides nourishment to the growing embryo.

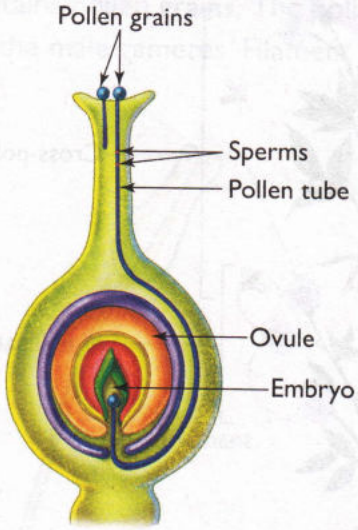



*Fig 13.21 Fertilization (zygote formation)*

### Fruits and seed formation

After fertilization, the petals drop off. Sometimes the sepals too drop off. The ovary turns into fruit and ovules into seeds. The seed contains the embryo enclosed in a seed coat. The seed coat helps to protect the embryo.

**ACTIVITY 7**

Given below are the names of some fruits which are commonly eaten.

Circle the ones which have sepals attached to them.

Apple, strawberry, mango, pear, grapes, banana, tomato, watermelon, brinjal, papaya

Did you notice that some of the names in Activity 7 are called vegetables though they are actually fruits? So, how is a vegetable different from a fruit?

Fruits can be classified into two categories:

1. Fleshy and juicy fruits like mangoes, peaches, pears, papayas, oranges, and apples.
2. Hard fruits like almonds and walnuts.

## Seed dispersal

If the seeds of a fruit simply fall and grow beneath or near the parent plant, after germination it would be too overcrowded and the new plants would be starved of nutrients and water. Also they will not receive enough sunlight. So, it is important that the seeds be dispersed over a wide area where they stand a better chance of finding the right conditions to grow. The process by which seeds are scattered to distant places is known as *seed dispersal*. Seed dispersal also helps plants in invading new habitats.

Seed dispersal is mainly carried out by agents like wind, water, and animals. Some seeds are dispersed by explosion.

## Wind dispersal

Some seeds are carried to a new place by the wind.

- Grasses have very light seeds.
- Dandelion has hairy growth which act like little parachutes and carry the seeds far away from the parent plant.

*Fig 13.22 Wind dispersal of dandelion*

- Drumstick and maple seeds have wings which help in dispersal.
- Madar (*aak*) and sunflower plants have fruits which are hairy and are blown away to far off places. The seeds then germinate into new plants in that place.
- Poppy fruits sway in the wind. This causes the seeds to fall out.

## Water dispersal

Fruits like the water lily and the coconut palm float on water. They form a spongy or fibrous outer coat that helps them to float. Coconuts can travel to thousands of kilometres across seas and oceans. Mangrove plants in the swamp regions of countries such as Thailand are another example whose seeds spread through water.

## Animal dispersal

Some plants have juicy fruits that animals like to eat. The animals eat the whole fruit but only the juicy part is digested. The seeds are thrown away or passed out through excretion. New plants grow from these seeds. This can be far away from the parent plant as the animals move from

*Fig 13.23 Water dispersal of coconut*

one place to another. Seeds of cherry and apple are dispersed in this manner.

Birds like parrots love to feast on fruits and they help to disperse seeds to other areas through their droppings.

The mistletoe plant has sticky berries which attract the birds. The sticky seeds stick to the beak of birds. When they rub their beaks on the bark of trees, the seeds are left on the bark to grow into new mistletoe plants.

Squirrels collect nuts and bury them as food for winter but they often forget where they have buried them. These seeds then grow into new plants.

The *Xanthium* plant has spiny seeds with hooks. These get attached to the body of animals and are carried away from the parent plant.

*Fig 13.24 Xanthium plant*

## Explosion

Some plants have pods that explode when ripe and shoot out the seeds. This is observed in balsam and castor. Such explosion is observed in pea and bean plants also.


**Reproduction:** the process by which new individual organisms are produced

**Vegetative propagation:** a form of asexual reproduction in which vegetative parts are involved

**Bisexual flowers:** flowers that have both the pistil and the stamens

**Unisexual flowers:** flowers that have either the pistil or the stamens

**Pollination:** the process of carrying the pollen grains from a flower to the stigma of the pistil of the same or another flower

**Fertilization:** the process of fusion of the male gamete with the female gamete to form a zygote


- Reproduction is defined as a process by which new organisms are produced.
- There are two types of reproduction in plants—asexual and sexual.

## Put on your THINKING CAP!

1. ***The plants mentioned below show asexual reproduction. Put them into the right category.***

bread mould, grass, turmeric, sweet potato, *Spirogyra*, potato, ginger, onion, *Agave*, yeast, *Bryophyllum*, fern

| Vegetative propagation | Budding | Fragmentation | Spore formation |
|---|---|---|---|
| | | | |

2. ***Select the correct option.***

a) Which part of the plant is not involved in vegetative propagation?

i) leaf ii) root

iii) flower iv) bud

b) Which of the following are not asexual reproduction involving stems?

i) rhizome
ii) budding
iii) runner
iv) bulb

c) Ginger can be propagated with the help of a

i) rhizome
ii) bulb
iii) tuber
iv) cutting

d) A pumpkin creeper has

i) bisexual flowers
ii) unisexual flowers
iii) complete flowers
iv) no flowers

e) Which structure is formed after fertilization?

i) seed
ii) pollen tube
iii) zygote
iv) flower

f) An ovary after fertilization turns into

i) pistil
ii) stamen
iii) seed
iv) fruit

g) *Xanthium* seeds are dispersed by

i) animals
ii) wind
iii) water
iv) explosion

h) Which of the following dispersal agents is used by the balsam plant?

i) animals
ii) wind
iii) water
iv) explosion

**3. *Match the term with the correct option on the right.***

| | |
|---|---|
| a) sepals | i) male reproductive part |
| b) petals | ii) produces pollen |
| c) stamen | iii) swollen base of pistil that contains eggs |
| d) anther | iv) the stalk of the stamen |
| e) pistil | v) sticky top of the pistil |
| f) ovary | vi) connects stigma and ovary |
| g) pollen | vii) female reproductive part of the flower |
| h) style | viii) colourful part which attracts insects |
| i) stigma | ix) tiny leaves that protect the flower bud |
| j) filament | x) male gamete that sticks to hair of insects |

**4. *Write short answers.***

a) How is grass grown by vegetative reproduction?

b) Why is the bulb of the lily called a stem though it is found under the ground?

c) How is a rose plant grown by using cuttings as a means of asexual reproduction?

d) Define

i) Budding
ii) Fragmentation
iii) Pollination
iv) Fertilization

e) What are the advantages of vegetative propagation?

f) Where are the male and female gametes located in flowering plants? How is the fruit of a mango different from that of an almond?
g) Why is seed dispersal necessary in plants?

**5. *Answer in details.***

a) Explain how *Spirogyra* reproduces.
b) What are spores? Name the plants they are found in and their location on these plants?
c) Differentiate between self-pollination and cross-pollination.
d) Explain the formation of the zygote and the endosperm in a mango plant.

**6. *Write down the dispersal agents of the following plants.***

| Plant | Dispersal agent |
|---|---|
| Dandelion | |
| Coconut | |
| Poppy | |
| Pea | |
| Cherry | |
| Mistletoe | |
| Castor | |
| Apple | |
| Maple | |
| Drumstick | |

**7. *Draw and label the following diagrams.***

a) Tuber of a potato
b) Rhizome of a ginger
c) Bulb of an onion
d) Storage roots of sweet potato
e) Budding in yeast
f) Fragmentation in *Spirogyra*
g) A bisexual flower
h) Parts of a pistil
i) Parts of a stamen
j) Male and female flowers of the pumpkin plant
k) A pistil showing the germinating pollen tube

## Extended learning

1. Perform the following experiment and record your observations.
   a) Cut two slices from a banana, each approximately 2 cm long.
   b) Place each slice in a separate plastic bag.

c) Add approximately half tablespoon of yeast on top of one of the bananas. (Make sure the yeast touches the banana.)

d) Seal both bags and label each bag with the date and contents (e.g., '23 August 2013, banana without yeast' and '23 August 2013 banana with yeast').

e) Record your observation for the first day. What does the content in each bag look like? For the next 3–4 days, observe the two bags and record all observations.

2. Grow your own rose plant:
   - Take a disposable plastic cup and cut two small drainage holes in its base.
   - Fill three-fourth of the cup with compost.
   - Take a potted plant like rose.
   - With a sharp knife, cut off one of the side branches. Cut the side branch just below the leaf closest to the main stem. This is the cutting.
   - Remove two or three leaves from the bottom so that the cutting has a few leaves at the top. This helps stop the cutting from losing too much water before the roots develop.
   - Gently push the cutting about 1–2 cm into the compost.
   - Water the compost so that it is moist but not soaking wet.
   - Place the cutting in a warm, well-lit position like on a window sill.
   - The cutting should produce roots in two to three weeks. Transfer it to a bigger pot and it will grow into a plant that is identical to the one it was taken from.

HIGHER ORDER THINKING SKILLS
**HOTS**

1. In many flowers, the pistils and stamens reach maturity at different times. How is this advantageous to plants?
2. If the pollen of a China rose is dusted on a stigma of a lily plant will it result in pollination and fertilization? Why or why not?
3. Why is cross-pollination said to be better than self-pollination?


For more information
http://www.biology4kids.com/files/plants_reproduction.html
http://library.thinkquest.org/28751/review/plants/6.html
http://www.historyforkids.org/scienceforkids/biology/plants/reproduction/

# 14 Time and Motion

**You will learn about**

- Ancient methods of measuring time
- Periodic motion
- Slow and fast motion
- Distance–time graph

From the moment we get up in the morning, to the time we go to bed, we do innumerable things for which we need to know the time. Our life runs through time. Whether we have to catch the school bus or a train, all is set according to time. We rush to reach school on time, our parents rush to reach their offices on time. Have you ever wondered how this world ran when there were no clocks and watches?

## Ancient methods of measuring time

In earlier days, periodic events such as sunrise, sunset, and phases of the Moon were used for measuring time intervals. A day was the time between two sunrises. A month was calculated from one new moon to another. Time within a day was approximated by the position of the Sun. Some of the instruments made by man in the earlier times to measure time are described here.

### Sundial

*Fig 14.1 Sundial*

It measures time by the position of the Sun. It has a stick put in the centre of a circular disc. The position and length of the shadow of the stick on the dial gives an indication of time. The limitation of this instrument is that it cannot function during cloudy weather and at night.

### Water clock

In a water clock, water is allowed to flow out from a hole made at the bottom of a bowl-shaped container into another bowl kept below. The emptying of the water-filled bowl to different levels corresponds to specific time periods.

*Fig 14.2 Water clock*

### Sand clock

The sand clock or hourglass consists of two bulb-shaped containers made of glass and connected through a narrow glass tube. Sand is filled in one of the containers. The clock is kept on a plane surface with the filled container at the top. When all

*Fig 14.3 Sand clock*

the sand trickles down to the lower container, a definite time period (usually an hour) is over.

### Candle clock

It uses a candle with nails put into it at fixed intervals. The candle is kept on a metal plate. When the candle burns to the point where the nail is fixed, the nail falls on the metal plate, producing a sound. This happens at regular intervals.

All these instruments were not able to give accurate time. The need for accurate time measurement therefore led to the invention of mechanical clocks. The mechanical clock had a weight that would slowly lower down and move the gears. The gears then moved a hand which showed the hour.

Mechanical clocks were built in tall towers as the weights needed space to fall or lower down. These clocks worked for a short period of time only (maximum for two hours). In 1656, Christiaan Huygens, a Dutch mathematician and physicist, invented the first pendulum clock which measured time using the periodic motion.

**Infobit** In Salisbury, England, you can see the oldest working mechanical clock of the world, built in 1386.

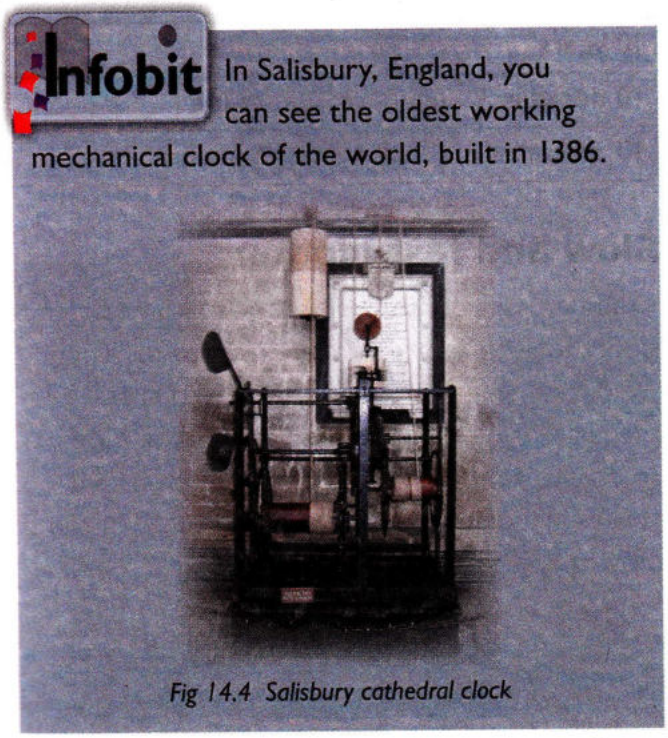


*Fig 14.4 Salisbury cathedral clock*

## Periodic motion

Any motion that repeats itself at fixed intervals is called a periodic motion. Some examples of periodic motion are rotation of Earth on its axis, revolution of Earth on its orbit, bouncing of a ball, etc. The motion of a simple pendulum is also an example of a periodic motion. Galileo was the first to experiment with pendulums, and find out their unique characteristics that could be used to measure time. The development of a simple pendulum made the measurement of time more accurate.

### Simple pendulum

A simple pendulum consists of a rod or thread attached at a pivot point fixed to a rigid support and a small mass (a metal bob) at the other end. When the bob attached to the thread is pulled to a side and released, it swings down due to the effect of gravity. The pendulum then moves back and forth at fixed intervals. This back and forth motion of a simple pendulum is an example of periodic or oscillatory motion.

In Fig 14.5, O is the point of support of the pendulum and A is the rest or mean position. B and C are the two extreme positions. The movement of the pendulum from one extreme position B to another extreme position C and then back to B completes *one oscillation*.

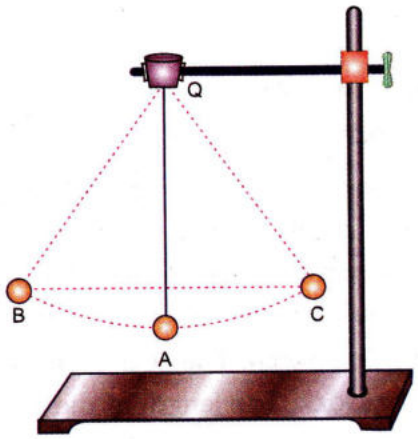



*Fig 14.5 Simple pendulum*

The path of the oscillation can be either way—B-A-C-A-B or C-A-B-A-C. We can also start the oscillations from the mean position. In this case, the path of the oscillation will be—A-B-A-C-A or A-C-A-B-A.

The time taken by the pendulum to complete one oscillation is referred to as the *time period* and is denoted by T.

**ACTIVITY 1**

Take a string and tie a stone at one of its ends. Now, tie the other end of the string to a rigid surface so that it can swing freely without touching any object. Release the string attached to the stone from an extreme position and let it oscillate freely. You have to count ten oscillations, that is the stone must return ten times to the same position from where you had released it. Use a stopwatch to note the time taken by the pendulum for ten oscillations. Now, divide the recorded time by ten. You will get the time period of oscillations. Repeat the activity with different number of oscillations and again calculate the time period. You will observe that the time period always comes out to be the same. This shows constancy of time period of the pendulum.

### Measurement of time using periodic motion

Pendulums have been used in clocks for hundreds of years. The regular motion of the pendulum controls the motion of the hands of a clock. As the pendulum completes one oscillation, it moves the gear by one notch. The gear then moves the hands of the clock. The length of the pendulum determines its time period. So, the length of the pendulum can be adjusted slightly, if the clock is running too fast or too slow. The weight of the bob does not affect the time period.

*Fig 14.6 Pendulum clock*

The principle of periodic motion is also applied to the study of wave motion in light, sound, and music.

After pendulum clocks, atomic clocks were introduced that are very accurate. Nowadays, we have digital clocks fitted in our mobile phones, computers, etc. The SI unit of time is second(s). Other units of time are:

| | |
|---|---|
| 60 seconds | 1 minute |
| 60 minutes | 1 hour |
| 24 hours | 1 day |
| 365 days | 1 year |
| 10 years | 1 decade |
| 10 decades | 1 century |
| 10 centuries | 1 millennium |

## Slow and fast motion

While crossing a road, we estimate how fast or slow the vehicles are coming towards us. Then, we decide whether we will be able to cross the road or not. The idea of how fast or slow an object is moving is found by the distance it covers in a unit time. This is called *speed* of the moving object.

$$\text{Speed} = \frac{\text{distance covered}}{\text{time taken}}$$

The SI unit of speed is metre per second, which can be written as m/s, mps, or $ms^{-1}$. Other units of speed are kilometre per hour (km/h), miles/hour, metre/minute, centimetre per second (cm/s), etc. Let us calculate the speed of a bike which has travelled 8400 metres in 1200 seconds.

Distance travelled by the bike = 8400 m,

Time taken = 1200 s

$$\therefore \text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{8400}{1200} = 7 \text{ m/s}$$

Now, let us calculate the speed of a truck which has covered 428 kilometres in 8 hours.

Distance = 428 km,

Time taken = 8 h

$$\therefore \text{Speed} = \frac{428}{8} = 53.5 \text{ km/h}$$

The speed of a moving vehicle is recorded in a device called *speedometer*. It indicates the instantaneous speed of the vehicle, *i.e.*, the speed of the vehicle at an instant of time.

*Fig 14.7 Speedometer*

**Infobit**

- The peregrine falcon can achieve a speed of about 300 km/h. It is considered to be the fastest animal on Earth.
- The cheetah is the fastest land animal with a top speed of about 112 km/h.
- The fastest man on Earth is Usain Bolt. He holds the world record of 9.58 s as the fastest time in 100 m sprint. This comes to about 36.7 km/h.

**ACTIVITY 2**

Mark a distance of 100 m in your school playground. Now, along with your friends take turns to run down the distance from one end to another. One of your friends can note down the time taken by each one to cover the distance. Now, calculate the speed of each child and find out who is the fastest among you.

## Uniform and non-uniform motion

Given below are the distances covered by car A and car B with respect to time.

Car A

| Time | Distance (km) |
|---|---|
| 9.45 am | 0 |
| 10.00 am | 10 |
| 10.15 am | 20 |
| 10.30 am | 30 |
| 10.45 am | 40 |
| 11.00 am | 50 |
| 11.15 am | 60 |

Car B

| Time (min) | Distance (km) |
|---|---|
| 0 | 0 |
| 15 | 5 |
| 30 | 15 |
| 45 | 20 |
| 60 | 25 |
| 75 | 30 |
| 90 | 35 |

The car A travels equal distances in equal intervals of time whereas car B does not cover equal distances in equal intervals of time.

When a body covers equal distances in equal intervals of time then the body is said to describe *uniform motion*. When a body moves unequal distances in equal intervals of time or vice versa, then it is said to describe *non-uniform motion*.

Thus, motion of car A is uniform motion whereas the motion of car B is non-uniform motion.

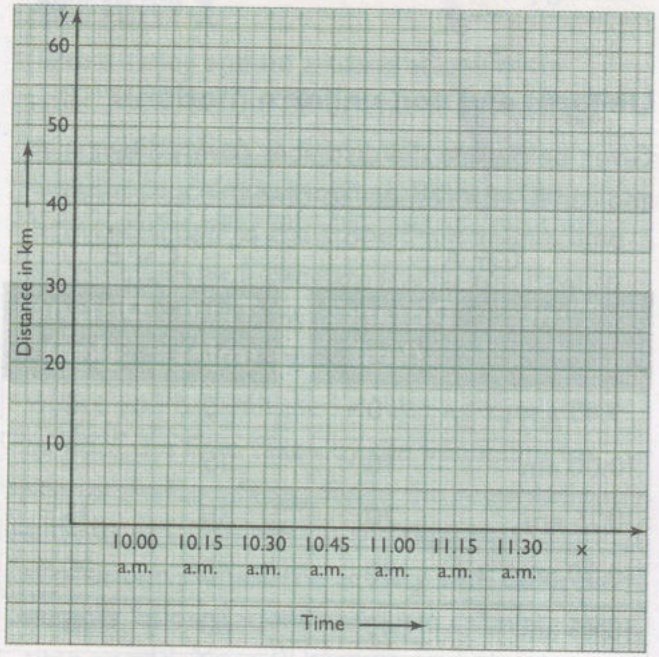
## Distance–time graph

The motion of an object can also be represented by the distance–time graph. The graphical

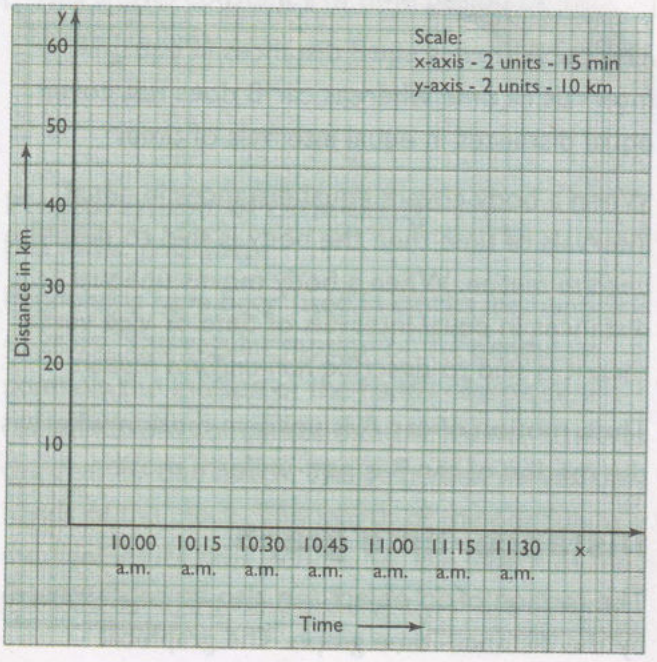
representation makes interpretation of motion of objects easier and more interesting. In a distance–time graph, distance is always taken along the y-axis while the time is taken along the x-axis.

Let us depict the motion of car A through distance–time graph. For this, follow the steps given below:

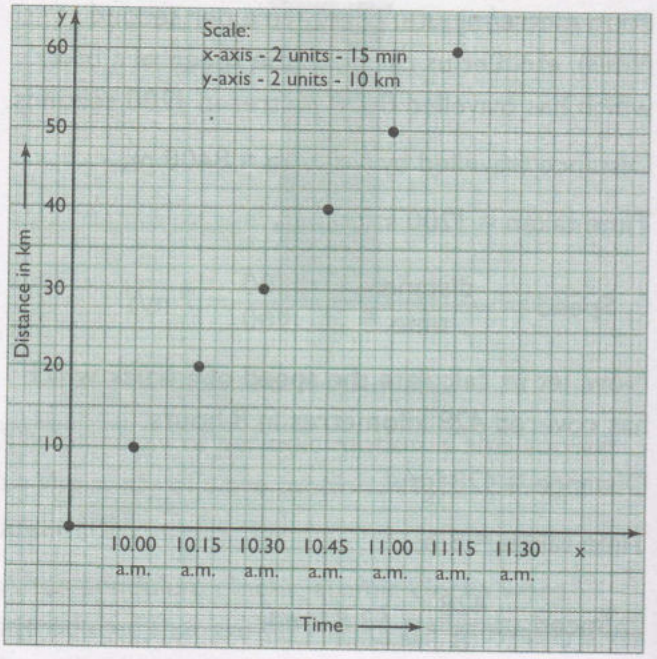
1. On a graph paper, take time along x-axis and distance along y-axis.



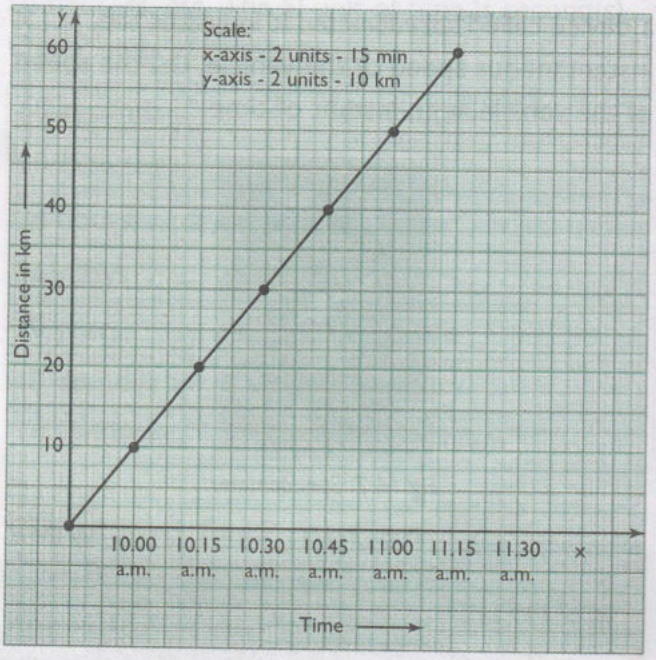

2. Analyse the given data and make a proper choice of scale for time and distance.




3. Plot the points on the graph where the vertical and the horizontal levels meet, as shown below:

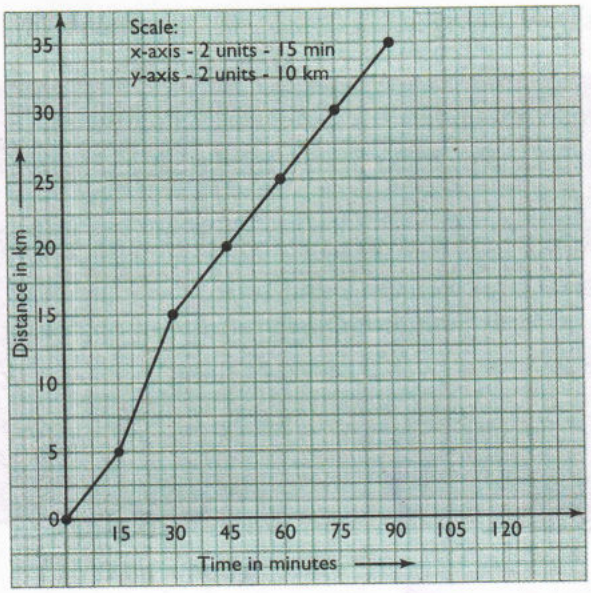



4. Join the points.




The graph obtained for uniform motion is a straight line.

Now, let us make the distance–time graph for car B, which described a non-uniform motion. The same steps are followed and we obtain the following graph:




The graph for non-uniform motion does not show a straight line.

The inclination that the line of the graph makes with the horizontal or the x-axis is called *slope of the line* or *gradient*. Here, it is indicating the speed of the vehicle. The more the inclination, the more is the speed of the vehicle.

The distance–time graphs easily interpret whether the given object is having uniform or non-uniform motion. They also tell the distance covered by an object in a given interval of time.

The distance–time graphs of two or more objects can be plotted in the same graph to compare the speeds. They will also tell whether any of the objects will meet with the other object at some point or not.

Distance–time graphs can also be made in the form of pie charts and bar graphs. The bar graphs representing the motions of car A and car B are shown here.

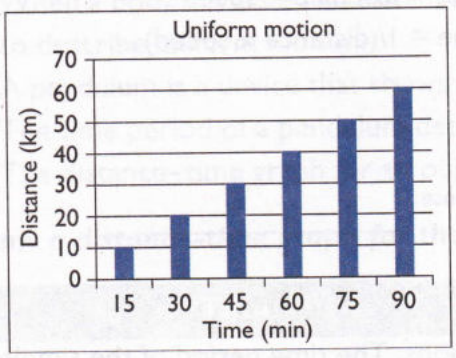



*Fig 14.8 Bar graph showing uniform motion of car A*

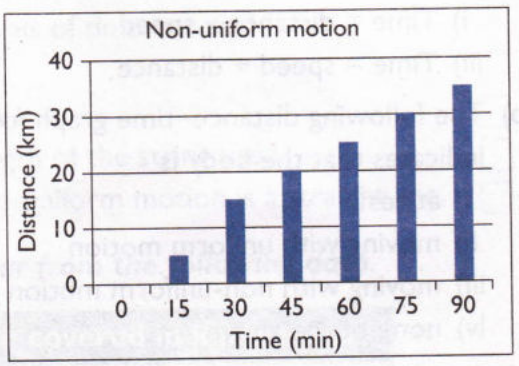



*Fig 14.9 Bar graph showing non-uniform motion of car B*


**Time period:** the time after which the motion repeats itself or the time taken by a pendulum to complete one oscillation

**Speedometer:** the device which gives us the instantaneous speed of a vehicle

**Instantaneous speed:** the speed of a vehicle at an instant of time

**Uniform motion:** the motion of a body that covers equal distances in equal intervals of time

**Non-uniform motion:** the motion of a body that moves unequal distances in equal intervals of time or vice-versa

**Slope of the graph:** the angle or the inclination that the line of the graph has with the horizontal or x-axis


- The measurement of time started with finding the time interval between periodic events and progressed to candle clocks, water clocks, sand clocks, pendulum clocks, and digital watches.
- The time period of a pendulum is the time it takes to complete one oscillation.
- The speed of a vehicle is the distance it covers in a unit time.
- The distance–time graphs can be used to interpret uniform or non-uniform motion of objects. It also tells us the speed and distance covered by an object in a given interval of time.
- If the distance–time graphs of two or more objects are plotted in the same graph, then we can compare their speeds.

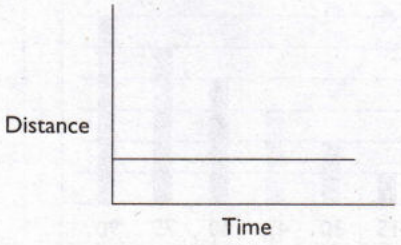
## Put on your THINKING CAP!

***1. Select the correct option.***

a) Which of the following relations is correct?

i) Time = distance x speed
ii) Time = distance ÷ speed
iii) Time = speed ÷ distance
iv) Time = 1/(distance x speed)

b) The following distance–time graph for a body indicates that the body is




i) at rest
ii) moving with uniform motion
iii) moving with non-uniform motion
iv) none of the above

c) A simple pendulum takes 42 s to complete 60 oscillations. The time period of the simple pendulum is

i) 66 s
ii) 4.2 s
iii) 2.2 s
iv) 0.7 s

d) How far would a roadrunner go travelling at a speed of 35 m/s in 700 s?

i) 245 m
ii) 24,500 m
iii) 2450 m
iv) 17,500 m

e) Which of the following is not a unit of time?

i) second
ii) sunset
iii) minute
iv) hour

f) Which of the following is closest to uniform motion?

i) car travelling on a busy road
ii) car travelling on a busy curved road
iii) car travelling on a straight empty road
iv) car travelling on a curved empty road

g) The earliest time piece on record is

i) hourglass
ii) candle clock
iii) water clock
iv) sundial

h) From a _____ graph, we can find out the speed of an object.

i) distance–time
ii) work–energy
iii) force–distance
iv) none of these

**2. *Fill in the blanks.***

a) For measuring _____ we need an event which repeats itself after regular intervals.

b) Our ancestors measured a month from one _____ to the next and a day from one _____ to the next _____.

c) A _____ is a device used for measuring time, by measuring the length of the shadow during the day time.

d) _____ clocks worked on the principle of weights and gravity.

e) The movement of the pendulum from one extreme position to another extreme position and then back to the same position makes one _____.

f) When a body covers _____ distances in equal intervals of time in a particular direction, it is said to describe non-uniform motion.

g) A _____ records the instantaneous speed of the vehicle.

**3. *Write T for true and F for false.***

a) A device in which falling sand is used as a timing device is called a water clock. ☐

b) When a body covers equal distances in equal intervals of time it is said to describe uniform motion. ☐

c) A pendulum is a device that shows periodic motion. ☐

d) The time period of a pendulum depends on the length of the string used. ☐

e) The distance–time graph for an object showing non-uniform motion is a straight line. ☐

**4. *Draw a distance-time graph for the motion of a car from the following data.***

| Time | Distance covered in kilometres |
|---|---|
| 9:00 am | 0 |
| 9:05 am | 2 |
| 9:10 am | 5 |
| 9:15 am | 6 |
| 9:20 am | 10 |

**5. *Write short answers.***

a) Name the ancient instruments used to measure time.

b) Explain the working of the hourglass.

c) Why were the ancient methods of measuring time abandoned?

d) How do mechanical clocks work?

e) What is a speedometer?

f) What is periodic motion? Give examples of periodic motion.

6. ***Answer in details.***

a) How is time measured using periodic motion?

b) Differentiate between uniform motion and non-uniform motion with examples.

c) i) What is speed? Mention the formula by which it is calculated.

ii) What is the SI unit of speed?

iii) Calculate the speed of a car which has travelled 750 km in 12 hours.

## Extended learning

Prepare a timeline for the different inventions and discoveries done in the field of time measurement.

HIGHER ORDER THINKING SKILLS **HOTS**

You are asked to plot a distance–time graph of two cars—A and B, which are moving with the same speed of 20 m/s but are separated by a distance of 10 m. How will the graph look like?


For more information

http://hyperphysics.phy-astr.gsu.edu/hbase/mot.html

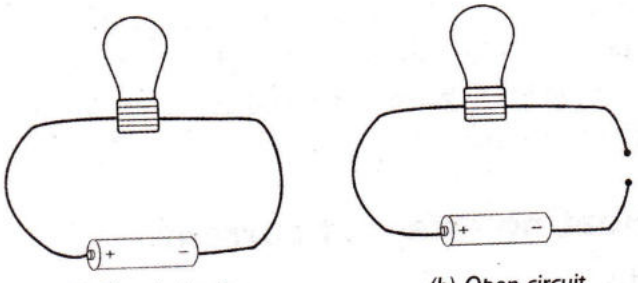
# 15 Electric Current and its Effects

## You will learn about

- Symbols of elements of an electric circuit
- Effects of electric current
- Heating effect of current
- Magnetic effect of current
- Electromagnets

You have studied in Class VI why electric current is such an important part of our lives. Most of the electrical equipments at our homes run on electric current. The lighting of an electric bulb is the most common example of electric current. The simplest source of an electric current is an electric cell. The current starts from the positive terminal of the cell, passes through the equipments connected to it, and terminates at the negative terminal of the cell. The path followed by electric current from the positive to the negative terminals of the cell is called an *electric circuit*. The electric circuit is complete if there are no breaks in the circuit. Such a circuit is called a *closed circuit* (Fig 15.1a). If there is a break in the circuit, it becomes incomplete. Such an incomplete circuit is called an *open circuit* (Fig 15.1b).

The circuit shown in Fig 15.1 is a simple circuit. It contains only a bulb and a cell. However, drawing electric circuits containing a large number of components becomes a tedious task.



(a) Closed circuit (b) Open circuit

*Fig 15.1 Types of electric circuits*

The electric circuits are therefore drawn by representing commonly used electric components with their symbols. The following table shows some of the commonly used electric components and their symbols.

The electric circuit of Fig 15.1 can now be represented using symbols for electric components (Fig 15.2).

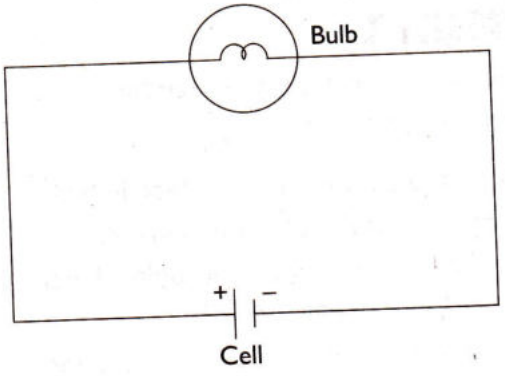



*Fig 15.2 Showing an electric circuit using symbols*

Usually copper wires are used for making connections in a circuit as they are good conductors of electric current. But they are covered by plastic, which is a bad conductor of current, so that the user does not get a shock.

| Component | Description | Symbol |
|---|---|---|
| **Wire**  | Represented by a straight line, provides a medium for the flow of current in a circuit, usually made of copper coated with plastic | |
| **Cell**  | The longer line represents the positive terminal, and the thicker and shorter one the negative terminal of the cell, simplest source of electric current | |
| **Battery** | A combination of two or more cells | |
| **Cell holder** | A crude cell holder is made by mounting two metal strips at an appropriate distance on a soft wooden strip using board pins or screws | |
| **Switch**  | Gives the control to open or close the circuit for a long time | |
| **Electric bulb**  | An electric appliance containing filament that glows when the current is provided | |
| **Fan** | An electric appliance containing a motor that rotates when the current is provided | |

**ACTIVITY 1**

Make the following electric circuits using the above symbols:

- A closed circuit with an electric bulb, battery of two cells, and a switch
- An open circuit with two bulbs, battery of three cells, and a switch
- A closed circuit with a fan, a cell, and a switch
- An open circuit with a battery of three cells, a fan, a bulb, and a switch

## Effects of electric current

Electricity is an important part of our life. It helps us run electric gadgets that are used in our daily lives. These gadgets run on the basis of the effects produced by the electric current. When the current flows through a circuit, we see various effects of the current, depending on the components being used. We have already observed the lighting effect of the electric current in the glowing of the bulb. Let us look into the heating, magnetic, and chemical effects of electric current.

## Heating effect of current

Have you ever wondered why an electric bulb lit for several minutes gets heated up? There are

other objects also that heat up due to electricity. Let us look at some of them.

## Bulb

A bulb contains a thin coiled wire called filament. With the passage of electric current, the filament of the bulb becomes hot and its temperature rises to an extent that it starts glowing. It is therefore very dangerous to touch a glowing bulb or a bulb that has just been switched off.

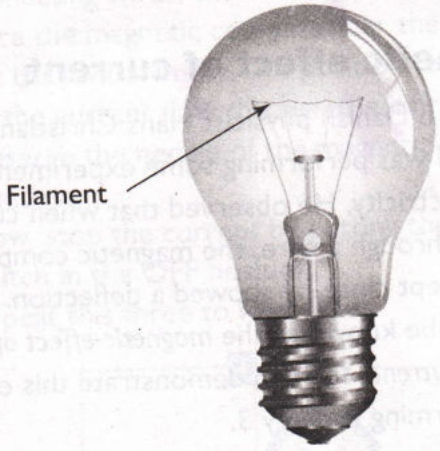



*Fig 15.3 Filament of a bulb*

## Fuse

Fuse is a safety device that is used in household circuits to protect the appliances. It prevents them from getting burnt out in case excess current flows through the circuit. A fuse is a small piece of wire of an alloy of adequately low melting point (usually 63 per cent tin and 37 per cent lead). There is a maximum limit of the current which can safely flow through a circuit. If the current exceeds the safe limit, then the fuse wire gets hot and melts. This creates a gap in the circuit and the appliance is saved from getting burnt.

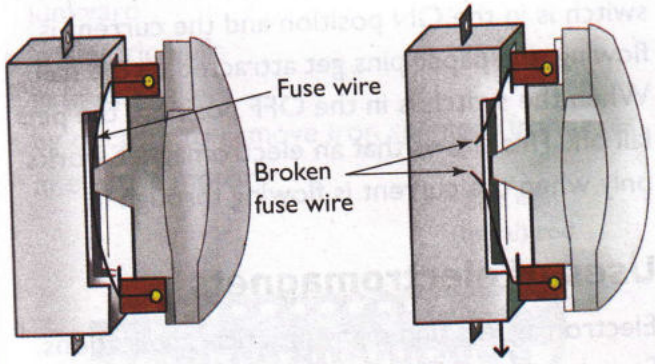



*Fig 15.4 Fuse used at homes in the mains circuit*

**Infobit**

- Excessive electric currents can be produced if there is improper insulation of wires.
- Excessive current can also be produced if many devices are connected to a single socket.
- Short circuits and overload of current have caused severe accidents of fire.

Let us perform the following activity to understand the working of a fuse.

## Miniature circuit breaker (MCB)

Nowadays, we have miniature circuit breakers (MCBs) in the household circuits that break or go off automatically on being heated by the overload of the electric current. These can be reset by hand, and the circuit becomes complete again.

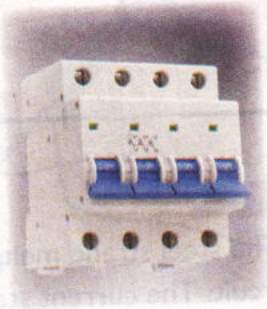


*Fig 15.5 MCB*

## Electrical appliances

An electric iron is a very common electrical appliance we use in our homes. It contains a coil of wire called *element*. When current passes through the element, it becomes red-hot and gives off heat. There are many other

## ACTIVITY 2

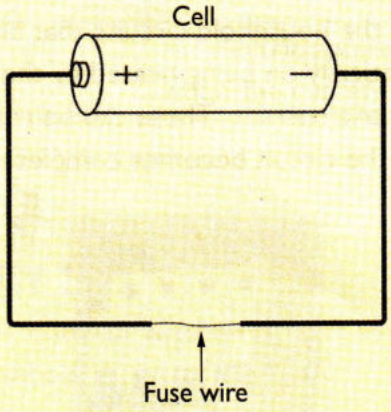
**To show the working of a fuse**

*(Note: Activity to be performed under adult supervision)*

*Things required:* A battery of four cells, a thin strand of steel wool (steel wool commonly used for cleaning utensils), two connecting wires

*Method:*

1. Peel off the end of the two connecting wires and connect the strand of steel wool between them. The steel wool will serve as a fuse wire.
2. Connect the loose end of one connecting wire to the negative terminal of the battery.
3. Now, touch the loose end of another connecting wire to the positive terminal of the battery. Observe the strand of steel wool.




*Observation:* The steel strand melts down and breaks the circuit. The current stops flowing through the circuit. This is how a fuse works.

appliances like electric heater, immersion rods, hot plates, geysers, electric kettles, etc., which have elements in them. They all work on the same principle based on the heating effect of electricity.

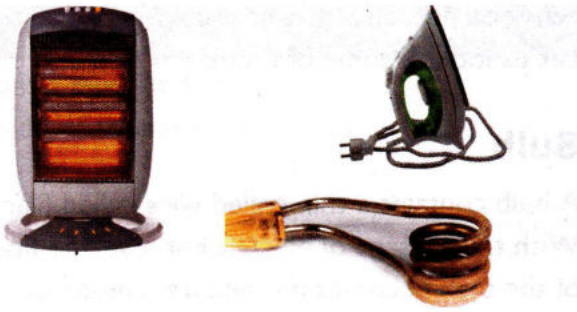


*Fig 15.6 Appliances working on heating effect of current*

## Magnetic effect of current

In 1820, a Danish physicist Hans Christian Oersted was performing some experiments with electricity. He observed that when current passed through a wire, the magnetic compass needle kept close-by showed a deflection. This came to be known as the *magnetic effect of electric current*. You can demonstrate this effect by performing Activity 3.

## Electromagnets

From Activity 3, you will learn that electric current has a magnetic field associated with it. This property of electric current is used to change magnetic materials like soft iron into magnets by passing electricity through them. Such magnets are called *electromagnets*. In Activity 4 we will learn how to make an electromagnet.

You will observe in Activity 4 that every time the switch is in the ON position and the current is flowing, the paper pins get attracted to the nail. When the switch is in the OFF position, the pins fall off. This shows that an electromagnet works only when the current is flowing through it.

## Uses of electromagnets

Electromagnets find many practical applications. Some of them are listed here.

## ACTIVITY 3

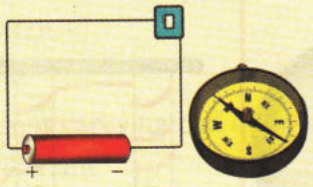
**To show the magnetic effect of current**

*(Note: Activity to be performed under adult supervision)*

*Things required:* Connecting wires, a magnetic compass, a cell, a switch

*Method:*

1. Make a circuit as shown below using the connecting wires, the switch, and the cell.
2. Place the magnetic compass near the wire.
3. Put the switch in the ON position to let the current flow through the circuit. Observe the needle of the magnetic compass.
4. Now, stop the current by putting the switch in the OFF position.
5. Repeat this three to four times.



*Observation:* Every time current passes through the wire, the needle of the magnetic compass shows deflection.

*Conclusion:* Current flowing through a wire has a magnetic field associated with it.

Electromagnets are used

- in cranes to pick magnetic materials from a junkyard
- in electric bells
- in loudspeakers
- by doctors to remove iron splinters from eyes
- in electric motors

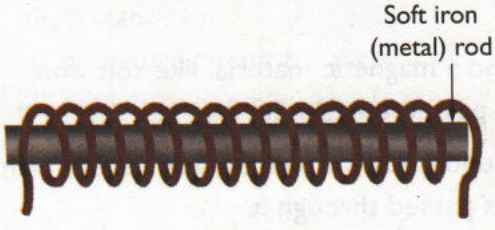



*Fig 15.7 Solenoid*

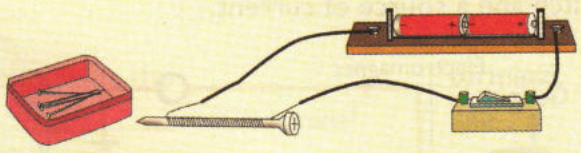
## ACTIVITY 4

*(Note: Activity to be performed under adult supervision)*

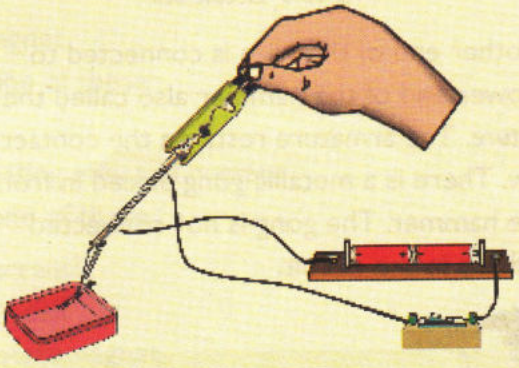
*Things required:* A long insulated wire, a big nail, few paper pins, a switch, a battery, plastic clip

*Method:*

1. Take a wire and wind it around a nail as shown below.



2. Connect the open ends of the wire to the battery through a switch to complete the circuit.
3. Now, put the switch in ON position.
4. Hold the nail with a plastic clip carefully and move it near the paper pins. You will see that the paper pins cling on to the iron nail.



5. Put the switch in OFF position. The paper pins will fall off.
6. Repeat the activity three to four times. The electromagnet is ready.

***Solenoid*** Solenoid is a loop of a long insulated wire wrapped or wound many times around a rod-shaped metallic core. It behaves like an electromagnet when electric current is passed

through it. It finds application in automobiles, motors, fuel injectors, dot matrix printers, etc.

***Electric bell*** Whenever someone comes to our house, he/she rings the door bell to inform us. But how is the bell able to make a sound? Let us understand the construction and working of an electric bell.

*Construction:* An electric bell consists of two soft iron rods mounted on a non-metallic strip. The connecting wire is wound like a coil on the rods, which work as an electromagnet. One end of the wire is connected to a contact screw through a switch and a source of current.

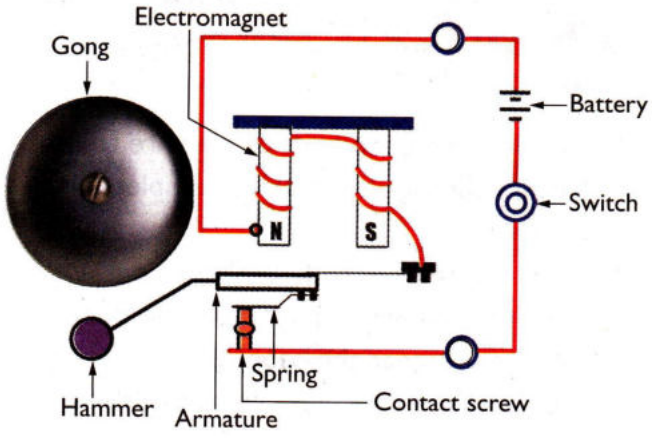



*Fig 15.8 Electric bell*

The other end of the wire is connected to the lower end of the hammer also called the *armature*. The armature rests on the contact screw. There is a metallic gong placed in front of the hammer. The gong is not connected anywhere in the circuit.

*Working of an electric bell*: When the switch is pressed into the ON position, the circuit gets complete and current starts flowing in it. As a result, the soft iron rods, with the wire wrapped around them, start behaving as electromagnets. They attract the armature towards themselves. In the process two things happen simultaneously. One, the armature moves towards the gong and strikes it producing the sound. Second, the connection between the armature and the contact screw breaks. As a result, there develops a gap in the circuit and current stops flowing. Due to this, the soft iron with the coil around it stops behaving like a magnet and the armature returns to its original position due to spring action. The process repeats when the switch is pressed again.

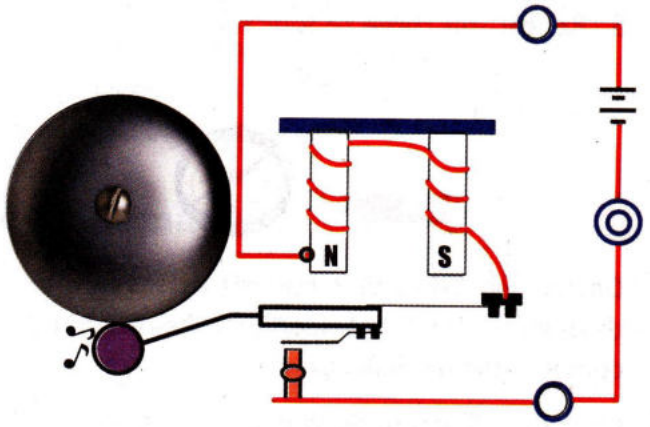



*Fig 15.9 Electric bell ringing*


- **Circuit:** a closed continuous path for the flow of the current
- **Switch:** a device which helps in controlling the flow of current
- **Fuse:** a safety device which helps in protecting the appliances in a circuit from getting damaged in case of heavy flow of current
- **Electromagnet:** a coil of wire wound around a magnetic material like soft iron, which behaves like a magnet when current is passed through it
- **Solenoid:** a loop of long wire wound many times around a rod-shaped metallic core, which behaves like an electromagnet when electric current is passed through it


- The heating effect of electric current finds many useful applications in electric appliances like electric geyser, electric iron, and immersion rod.
- A current-carrying wire also behaves like a magnet. This is referred to as the magnetic effect of electric current.
- Electromagnets find many uses in our everyday life. Appliances using electromagnets are electric bells, electric motors, cranes, etc.

## Put on your THINKING CAP!

***1. Choose the correct option.***

a) In the symbol of an electric cell, the longer line represents the _____ terminal, and the thicker and shorter line represents the _____ terminal.

i) negative, positive
ii) neutral, positive
iii) neutral, negative
iv) positive, negative

b) The device used to prevent the flow of excess current in the circuit is

i) switch
ii) fuse
iii) bulb
iv) coil

c) A current carrying coil of an insulated wire wrapped around a piece of soft iron becomes

i) a filament
ii) an electromagnet
iii) a fuse
iv) a conductor

d) The thin wire inside a bulb is a

i) coil
ii) magnet
iii) filament
iv) none of these

e) The bulb in an electric circuit glows because of

i) magnetic effect of current
ii) heating effect of current
iii) chemical effect of current
iv) none of these

f) Which of the following is not a source of electric current?

i) car battery
ii) dry cell
iii) cell
iv) electromagnet

g) Which electric component is represented by a pair of lines—a long one and a short one?

i) connecting wire
ii) battery
iii) switch
iv) cell

h) MCB stands for

i) miniature circuit breaker
ii) minute circuit breaker
iii) miniature complex breaker
iv) miniature circuit builder

2. ***Fill in the blanks.***

a) The closed path along which electric current flows is called an _____.

b) The electric path which starts from the _____ terminal of a cell or battery and ends at the negative terminal without any break is called a _____ electric circuit.

c) Circuits can be _____ or open depending on the connection.

d) Current has a _____ effect which can damage the electrical appliances through which it is flowing.

e) When electric current passes through a wounded coil around a soft iron piece, an _____ is made.

3. ***Write short answers.***

a) What are the essential components of an electric circuit?

b) What is the heating effect of electric current?

c) What is a fuse?

d) What is the magnetic effect of current? How was it discovered?

e) What are electromagnets?

f) What is a solenoid?

g) List some uses of electromagnets.

4. ***Answer in details.***

a) Draw and describe an electric circuit consisting of a battery of four cells, a switch, conducting wires, and a bulb.

b) Give reasons for the following:

i) Household electric wires are covered with plastic or rubber.

ii) An electrician only replaces a blown off fuse with a wire prepared from tin and lead alloy (63% tin, 37% lead).

c) Draw and explain how an electric bell works?

## Extended learning

S 1. The children can make a list of electric appliances they see around them and observe the change in energy taking place.

HIGHER ORDER THINKING SKILLS
**HOTS**

1. Why are copper wires used as connecting wires?
2. Name the instrument used for measuring
   a) current
   b) voltage


For more information
http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elecur.html
http://library.thinkquest.org/10796/ch13/ch13.htm

# 16 Light

## You will learn about

- Rectilinear propagation of light
- Reflection of light
- Mirrors
- Rays
- Real and virtual images
- Lateral inversion
- Kaleidoscope and periscope

*Light is an energy which gives us the sensation of sight.* When a beam of light enters a dark room through a crack or a tiny hole, it illuminates things that lie in its path. The beam of light appears to travel in a straight line. The same is true about the beams of light from a torch, a lighthouse, the headlamps of vehicles, etc. So, can we say that light travels in a straight line? Let us perform the following activity to verify this.

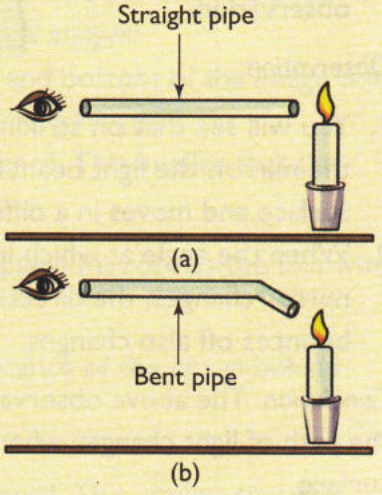
### ACTIVITY 1

(*Note: Activity to be performed under adult supervision*)

*Things required:* A sheet of paper, a candle, a matchstick

*Method:*

1. Fold the sheet of paper in the shape of a pipe and light the candle.
2. Point one end of the paper pipe towards the candle.
3. Bring your eye closer to the other end of the pipe and try to look at the flame through it. *Record your observation.*
4. Bend the pipe as shown in (b) and try to look again at the flame through the pipe. *Record the observation again.*




*Observation:* You will be able to see the flame through the straight pipe but not through the bent pipe.

*Explanation:*

- When the pipe is straight, it provides a straight line path for the light beam to travel from the candle to the eye. This makes the flame visible.

- When the pipe is bent, there is no straight line path for the light to travel from the candle to the eye.

  Therefore, the flame is not visible.

*Conclusion:* The above observation clearly shows that light travels in a straight line in a uniform transparent medium like air. This mode of travel of light is called rectilinear (straight line) propagation (movement).

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## Reflection of light

We have seen that light travels in a straight line. However, it is possible to change the path of light. You might have seen the change in the path of light when it falls on a shiny surface like a watch dial or a metal pencil box. This will be further clear from the given activity.

### ACTIVITY 2

*Things required:* A torch, a plane mirror

*Method:*

1. Hold the plane mirror in one hand.
2. Take the torch and shine it on the plane mirror. Record the observation.
3. Now, change the angle at which light falls on the mirror. Again, record your observation.

*Observation:*

1. You will see that on striking the surface of the mirror, the light beam bounces off the surface and moves in a different direction.
2. When the angle at which light falls on the mirror changes, the direction in which it bounces off also changes.

*Conclusion:* The above observation shows that the path of light changes when it falls on a surface.

S

The change in the direction of light after falling on a surface is called *reflection of light*. In other words, the bouncing back of light on striking a given surface is called *reflection*.

### *Important terms related to reflection*

- *Ray:* The path traced by a beam of light.
- *Incident ray ($\vec{i}$):* It is the ray of light moving towards the reflecting surface (such as a mirror).
- *Point of incidence (O):* It is the point on the surface where the incident ray strikes the surface.
- *Reflected ray ($\vec{r}$):* On striking the surface, the ray of light bounces off and moves away from the surface. This ray of light moving away from the surface after reflection is called the *reflected ray.*
- *Normal (N):* It is an imaginary straight line at the point of incidence drawn perpendicular to the surface.
- *Angle of incidence ($\angle i$):* It is the angle between the normal and the incident ray.
- *Angle of reflection ($\angle r$):* It is the angle between the normal and the reflected ray.

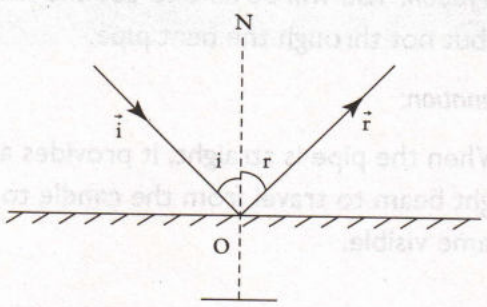



*Fig 16.1 Reflection of light*

When light bounces off a surface, it follows certain laws called the *laws of reflection*.

They are stated as follows:

1. The angle of incidence is equal to the angle of reflection.
2. The incident ray, normal, and the reflected ray all lie in the same plane.

## Reflection from a plane mirror

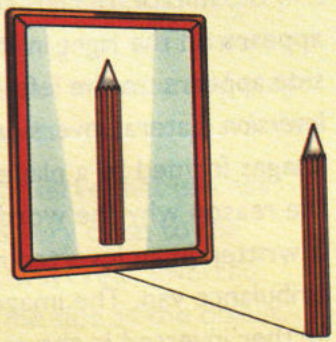
A plane mirror is a smooth polished surface that acts as a reflecting surface. When an object is held in front of a plane mirror, a copy of the object is visible in the mirror. The copy of the object in the mirror is called its *image*. When you look into a mirror, you see your image in the mirror.


### Studying the characteristics of an image formed in a plane mirror

*Things required:* A plane mirror, a pencil, a sheet of paper

*Method:*

1. Hold a pencil in front of a mirror and locate its image in the mirror.
2. Hold the pencil 10 cm from the mirror. Observe the position of the image in the mirror.
3. Move the pencil away from the mirror. Observe the change in the position of the image.
4. Put the sheet of white paper behind the mirror and try to get an image of the pencil on it.
5. Now, bring the white sheet in front of the mirror and again try to get the image of the pencil on it.



*Observation:*

1. If the pencil is kept 10 cm from the mirror, its image also seems to be 10 cm behind the mirror. So, the image distance is equal to the object distance.
2. The image formed by the plane mirror appears behind it. You cannot however touch it. Also, the image of the pencil cannot be obtained on a screen whether it is held in front of the mirror or behind it. Such types of images are not real. They are called *virtual images*.
3. The image formed by a plane mirror is always upright, *i.e.*, the top and bottom of the image are same as the top and bottom of the object. Such images are called *erect images*.
4. The size of the image of the pencil is the same as the size of the pencil. This implies that the image size is equal to the object size.

*Conclusion:* The above observations show that the image formed by a plane mirror has the following characteristics:

1. The distance of the object in front of the mirror is same as the distance of the image behind the mirror.
2. The image formed by a plane mirror is virtual and erect.
3. The size of the image of the pencil is the same as the size of the pencil. This implies that the image size is equal to the object size.

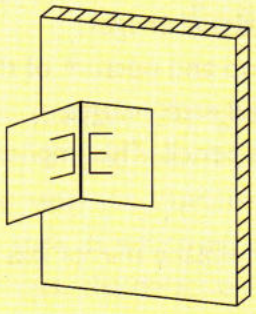
The image formed by a plane mirror shows certain characteristics. Let us study these characteristics by way of the following activity.

### Lateral inversion

Do you know why an ambulance has the word AMBULANCE written on it in an inverted manner? Let us perform the following activity to understand this.

**ACTIVITY 4**

Draw the symbol ∃ on a white sheet of paper and hold it in front of a plane mirror. You will see that the symbol ∃ appears as E in the mirror, *i.e.*, left side of the object appears on the right in the image and right side appears on the left. This is called *lateral inversion*. Lateral inversion is shown by all images formed by a plane mirror. This is the reason why the word AMBULANCE is written in an inverted manner on an ambulance van. The image of the word is further inverted in the rear-view mirrors of vehicles moving ahead of the ambulance van. The image thus appears as AMBULANCE. The persons driving the vehicles ahead of the ambulance van, then make way for it and allow it to go ahead.




Activity 4 shows that in the image formed by a plane mirror, the left appears as the right and the right appears as the left. This is known as *lateral inversion*.

***Uses of a plane mirror*** Plane mirrors are used in

- periscopes
- looking glasses
- kaleidoscopes
- box-type solar cookers

## Spherical mirrors

We have observed the images formed by a plane mirror. Let us now see the images formed by mirrors with curved surfaces, called *spherical mirrors*.

Take a new shining spoon and bring your face closer to its bulging side. You will see an erect image of your face in it. Now, turn to the inner side of the spoon and again see your face in it. You will see an inverted image of your face in it.

Thus, the spoon behaves as a curved mirror. The inner side of the spoon is referred to as the *concave side* whereas the back (outer) bulging side is referred to as the *convex side*.


*Fig 16.2 Image formed in the (a) inner and (b) outer sides of the spoon*

Spherical mirrors are the most common type of curved mirrors. A spherical mirror with a concave reflecting side is called a *concave mirror*. Similarly, a spherical mirror with a convex reflecting side is called a *convex mirror*.

(a) Convex mirror (b) Concave mirror

Fig 16.3 Spherical mirrors

***Nature of image formed by a concave mirror*** Take a concave mirror and hold it facing a building/tree outside the window. Try to move the mirror holding it in a manner that forms the image of the building or tree on a wall or a sheet of paper. You will find the image on the sheet or the wall is inverted and smaller in size as compared to the object. This image which can be taken on a screen is called *real image* and it is an inverted image.

Let us perform the following activity to further study the nature of images formed by concave and convex mirrors.

## ACTIVITY 5

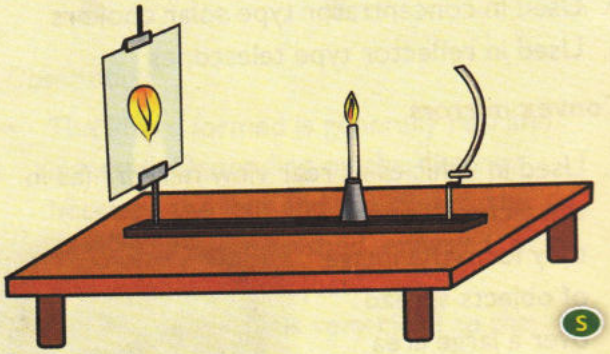
*(Note: Activity to be performed under adult supervision)*

*Things required:* A concave mirror, a candle, a matchstick, a white sheet of paper

*Method:*

1. Place the concave mirror on the stand so that its reflecting surface is perpendicular to the ground.
2. Light a candle and put it at a distance of about 50 cm from the reflecting surface of the mirror.
3. Take the white sheet of paper and hold it on the other side of the candle. The plane of the sheet should be parallel to the surface of the mirror.
4. Move the white sheet towards or away from the candle till you obtain a sharp image of the flame on it. *Record the nature of the image formed.*
5. Now, move the candle by a distance of about 10 cm towards the mirror and again adjust the position of the white sheet to obtain the image of the candle flame on it.
6. Repeat the previous step (step 5) three to four times, each time shifting the candle towards the mirror and obtaining the image on the white sheet. *Record the nature of image formed in each case.*
7. Now, repeat the activity by moving the candle away from the mirror and each time obtain a clear image of the flame on the white sheet. *Record the nature of image formed in each case.*

*Observation:* You will observe that (except for when the candle is very close to the mirror) the image is always real, inverted, and formed on the same side as the object. Also, depending on the distance between the object and the mirror, the image size can be diminished, enlarged, or of the same size as the object. When the object is very close to the mirror, the image is formed behind the mirror. It is virtual, erect, and larger in size than the object. It cannot be obtained on the white sheet.

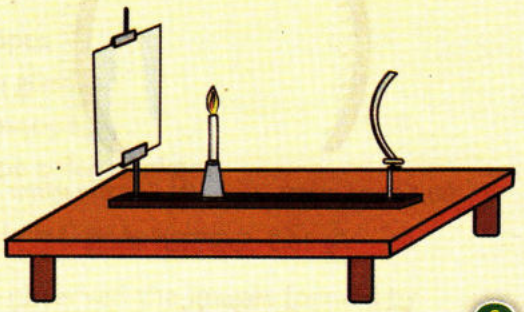


## ACTIVITY 6

*(Note: Activity to be performed under adult supervision)*

*Things required:* A convex mirror, a candle, a matchstick, a white sheet of paper

Repeat Activity 5 by using a convex mirror in place of the concave mirror and record your observations.



*Observations:* The image formed by a convex mirror is always virtual, erect, and diminished.

**Conclusions for Activities 5 and 6:** On the basis of the observations recorded in Activities 5 and 6, the following conclusions can be drawn about the nature of images formed by concave and convex mirrors.

| Mirror | Nature of image formed | | |
|---|---|---|---|
| | Real or virtual | Diminished or enlarged | Erect or inverted |
| Concave | Virtual when the object is very close to the mirror<br>Real in all other cases | Depending on the position of the object from the mirror, the image could be diminished, enlarged, or the same size as the object | Erect when virtual<br>Inverted when real |
| Convex | Virtual | Always diminished | Always erect |

### Uses of spherical mirrors

#### *Concave mirrors*

1. Used by dentists to obtain a large virtual image of the teeth
2. Used in headlights of cars/torches
3. Used as makeup and shaving mirrors
4. Used in concentrator type solar cookers
5. Used in reflector type telescopes

#### *Convex mirrors*

1. Used in vehicles as rear view mirrors (as in the picture), since they form the image of objects spread over a large area
2. Used in shops/malls for surveillance

## Lenses

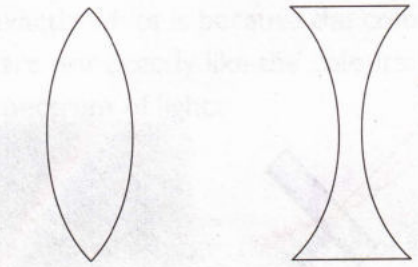
*A lens is a piece of transparent medium bound by two curved surfaces.* Lenses therefore allow light to pass through them.

You must have used a magnifying glass to focus sunlight on a sheet of paper which starts burning after some time. Also, the spectacles people wear are made of lenses. Here, we will learn about two basic lenses—convex and concave. A lens which is thicker in the middle and thinner at the edges is called a *convex lens* and a lens which is thinner in the middle and thicker at the edges is a *concave lens*.

### Convex lens

A convex lens is able to converge or focus sunlight at a point. If the point lies on a piece of

paper, the paper starts burning. This implies that *a convex lens is a converging lens*. The point where the rays of light meet is called the *focal point* (or *focus*) and the distance between the lens and the focus is called the *focal length*.



*(a) Convex lens* *(b) Concave lens*

*Fig 16.4 Lenses*

## Image formed by a convex lens

If a convex lens is placed very close to an object like a printed sheet, then the print appears magnified, virtual, and erect.


*Fig 16.5 Magnifying lens*

Due to this reason, in this case the convex lens is called a magnifying glass or a simple microscope. But if the object (well-illuminated like a tree outdoors or a candle) is far away from the lens, then its image can be taken on a screen on the other side of the lens. This image is inverted and real. If the object is brought closer to the lens, the image moves away from the lens and increases in size. To further verify this, let us perform the following activity.

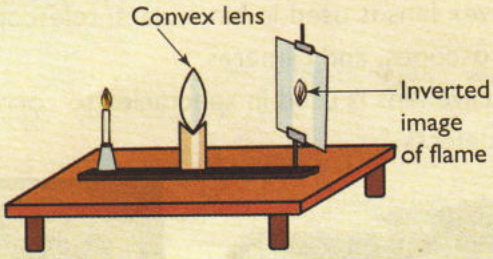
### ACTIVITY 7

*(Note: Activity to be performed under adult supervision)*

*Things required:* A convex lens, a candle, a matchstick, a white sheet of paper

*Method:*

1. Fix a convex lens on the table in the vertical position as shown in the figure.
2. Put the candle in front of the lens and light it.
3. Take the white sheet of paper and hold it on the other side of the lens. Look if you could see an image of the candle flame.
4. Move the white sheet forward or backward with respect to the position of the lens until you obtain a sharp and clear image of the flame.
5. Now, shift the candle a little towards the lens and again obtain the image of the candle flame on the white sheet.
6. Repeat the previous step (step 5) three to four times, each time shifting the candle towards the lens and obtaining the image of the candle on the white sheet in each case.




*Observation:*

- The image formed is generally real and inverted. Depending on the distance between the lens and the object, the image will be diminished, enlarged, or of same size as the object.
- When the object is very close to the object, the image formed is virtual, erect, and enlarged.

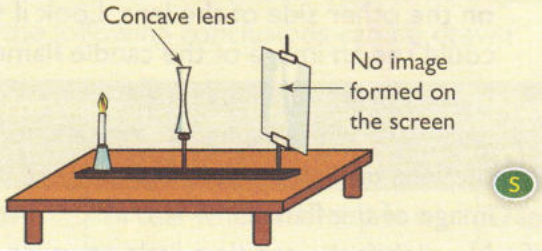
## ACTIVITY 8

*(Note: Activity to be performed under adult supervision)*

*Things required:* A concave lens, a candle, a matchstick, a white sheet of paper

Repeat Activity 7 by using a concave lens in place of the convex lens and record your observations.

*Observation:* The image formed by a concave lens is always virtual, erect, and diminished.




## Concave lens

If the concave lens is kept on a printed sheet it forms a small, virtual image. As the lens is moved away from the sheet, the print still remains small in size, erect, and virtual.

### *Use of lenses*

- Convex lens is used in binoculars, telescopes, microscopes, and cameras.
- Concave lens is used in spectacles to correct eye defects.

*(a) Binocular* *(b) Camera lens*

*Fig 16.6 Uses of lenses*

## Colours of light

Take a transparent ruler and hold it in sunlight. Adjust its position a little till you see a hue of various colours. Notice carefully, the white sunlight has been split into seven different colours. You can also see these seven colours in the sky in a rainbow formed after it has rained and the air is still laden with moisture. The sunlight on passing through the droplets of rain forms a band of colours which we call a rainbow.

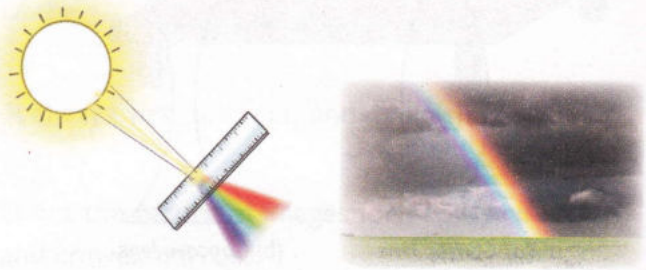


*Fig 16.7 Seven colours of white light*

This phenomenon of splitting of white light is called *dispersion* and the band of colours is called a *spectrum*. The seven colours in the spectrum of white light are violet, indigo, blue, green, yellow, orange, and red, known as VIBGYOR.

You can observe the spectrum around a fountain or water spray and also when light passes through a prism. A prism is a piece of a transparent material bound by two triangular and three rectangular surfaces.

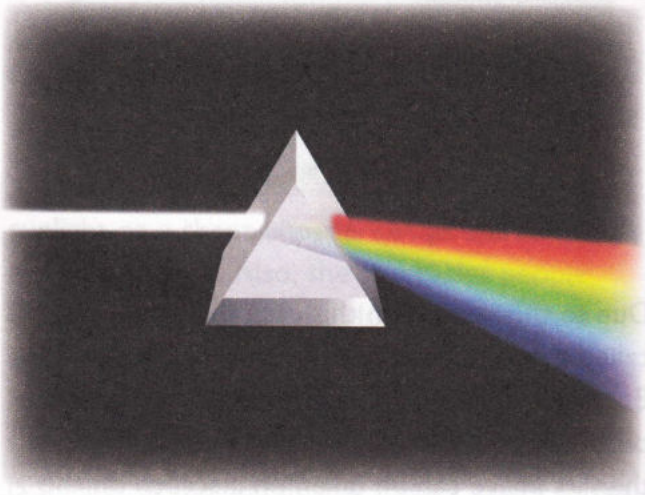
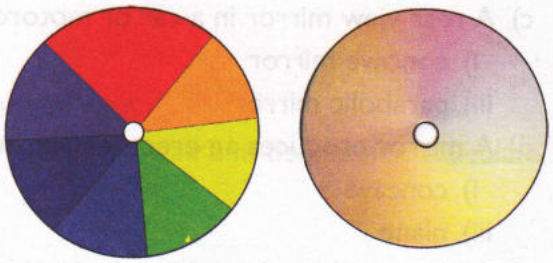


*Fig 16.8 The spectrum of white light*

***Newton's colour disc*** Newton's colour disc is a disc of cardboard or metal which is divided into seven sectors which are painted in the colours of VIBGYOR. When the disc is rotated very

fast, it appears almost white. This is because the image of each colour on the retina does not get erased before the image of the other colour forms on it due to the fast movement of the disc. This phenomenon is called *persistence of vision*. The reason why the colour on the disc does not appear exactly white is because the colours on the disc are not exactly like the colours in the natural spectrum of light.



*(a) Colours of white light* *(b) Rotating disc*

*Fig 16.9 Newton's disc*


**Real image:** the image of an object that can be obtained on a screen

**Virtual image:** the image that cannot be touched or obtained on a screen

**Spherical mirrors:** mirrors with curved surfaces

**Lens:** a piece of transparent medium bound by two curved surfaces

**Dispersion:** the phenomenon of splitting of white light into seven colours


- The movement of light along a straight line is referred to as *rectilinear propagation*.
- Bouncing back of light on striking a surface is called *reflection*.
- In an image formed by a mirror, the right side appears on the left and vice versa. This phenomenon is called *lateral inversion*.
- A lens that is thin in the middle and thicker at the edges is called *concave lens*. It always forms a virtual and diminished image.
- A lens that is thick at the centre and thin at the edges is called *convex lens*. It forms virtual as well as real images of different size depending on the object distance.
- White light on passing through rain drops or prism splits into a band of colours. The phenomenon of splitting of light is called *dispersion* and the band of colours is called *spectrum*.

## Put on your THINKING CAP!

***1. Choose the correct option.***

a) Which of the following shows lateral inversion?
   i) plane mirror
   ii) convex mirror
   iii) concave mirror
   iv) all of these

b) The angle of incidence is the angle between
   i) the incident ray and the mirror
   ii) the incident ray and the normal
   iii) the reflected ray and the mirror
   iv) the reflected ray and the normal

c) A rear view mirror in a car or motorcycle is a

i) concave mirror ii) convex mirror

iii) parabolic mirror iv) any one of the above

d) A mirror produces an erect, diminished, and virtual image. It is

i) concave ii) convex

iii) plane iv) none of the above

e) An image which cannot be obtained on a screen is called a

i) real image ii) virtual image

iii) magnified image iv) none of the above

f) While shaving, a man uses a

i) concave mirror ii) convex mirror

iii) concave lens iv) convex lens

g) A plane mirror produces a

i) virtual inverted image always

ii) real image always

iii) virtual or real image depending on the distance of the object from the mirror

iv) virtual erect image always

h) A girl sees a magnified image of a closely kept object by holding a simple clear glass device in her hand. This device is likely to be a

i) concave lens ii) concave mirror

iii) convex lens iv) convex mirror

i) When the angle of incidence is 50°, the angle of reflection is

i) 80° ii) 50°

iii) 40° iv) 30°

j) We are likely to see a rainbow when

i) it is raining heavily ii) the Sun is shining brightly before a rainfall

iii) the Sun shines again after a rainfall iv) a rainfall is followed by a snowfall

**2. *Fill in the blanks.***

a) Objects through which light can pass are referred to as _____ objects.

b) The process of bouncing back of light in the same medium in which it was travelling earlier after striking a surface is called _____ .

c) Polished metal surfaces are known as _____ reflectors.

d) The angle between the _____ ray and _____ is known as the angle of reflection.

e) A _____ lens can form both real as well as virtual images.

f) The image formed in a _____ mirror is _____, _____, and always smaller in size than the object.

g) In a _____ mirror when the object is placed very close to the mirror, the image is _____, virtual, and magnified.

h) The splitting of white light into its constituent colours is called _____ and the band of colours obtained is called _____ .

i) A _____ image can be obtained on a screen.

j) A _____ lens is a diverging lens whereas _____ lens is a converging lens.

**3. *Write short answers.***

a) State the laws of reflection.

b) List the characteristics of the image formed by a plane mirror.

c) Avni stands 7 m in front of a plane mirror with a painting on a wall 2 m behind her. Calculate the distance between:

i) Avni and the image of the painting.

ii) Avni's image and the image of the painting.

iii) Avni and her image.

iv) Avni's image and the painting if Avni moves 2 m towards the mirror.

d) How will the image of the word 'PHYSICS' appear in a plane mirror? Give reasons for the answer.

e) Define lateral inversion and identify the letters of the English alphabet which do not undergo lateral inversion.

**4. *Answer in detail.***

a) Differentiate between real and virtual images.

b) i) List the differences between concave and convex lenses.

ii) List two uses each of concave and convex lenses.

c) If a transparent ruler is held in sunlight you see various colours. Explain.

## Extended learning

1. Take a new shining metal spoon and hold it a little distance away from your face. With the concave side of the spoon towards you, slowly bring your face closer to the spoon. Observe the changes in the image being obtained on the spoon. Repeat the same for the convex side of the spoon.
2. Using a magnifying glass, try and obtain the image of a distant well-illuminated object on a wall or a screen. (The distance between the screen and the lens will give the rough focal length of the lens.)

HIGHER ORDER THINKING SKILLS **HOTS**

Between concave and convex lenses, which one forms a real image? What are the conditions for the formation of the real image?


For more information

http://science.howstuffworks.com/light.htm

http://library.thinkquest.org/26111/properties.html

http://hyperphysics.phy-astr.gsu.edu/hbase/phyopt/reflectcon.html

http://hyperphysics.phy-astr.gsu.edu/hbase/geoopt/raydiag.html

# 17 Water: An Essential Resource

## You will learn about

- Forms of water in nature
- Sources of freshwater
- Uses of water
- The journey of water from the river to a tap
- Water in India
- Scarcity of water
- Managing water resources

We all know water is essential for the existence of not only the human beings but also for plant and animal life. Plants need water to grow and manufacture their food in the presence of sunlight. Can you name this process? Water carries the nutrients present in the soil up to the plant parts.

If you forget to water the plants in your garden for few days, you will see that they start shrinking and drying up due to lack of water. This is called *wilting*. Without water there would be no life possible on Earth. So, it is a responsibility of all of us to save water.

Here are some newspaper clippings. Can you find the common message hidden in all of them?

- The Kashmir valley needs 110 million gallons of water a day but gets only 40 million now
- Shimla which was fondly called the 'Queen of Hills' by the British, has been experiencing an acute drinking water shortage despite heavy rains
- Gujarat villages endure acute water shortage
- Sambhar salt lake of Rajasthan may soon cease to exist
- Water riots have broken out in Madhya Pradesh this year
- The water table has gone down in several countries
- Yellow River—whose long history of floods made it known as 'China's Sorrow'—is now in such a state that most of the year, it does not even reach the sea

You too can collect some pictures and clippings from newspapers and magazines related to water shortage.

You have learnt in your previous classes that the Earth is called the blue planet. Do you remember why? Water covers about 70 per cent of the Earth's surface which makes the Earth look blue from the space. You might think that with all this water around, there ought to be plenty for everyone. But in spite of being the most abundant natural resource most of the water is not available for human use. Haven't you heard the famous line 'water water everywhere, not a

drop to drink' from the poem 'The Rime of the Ancient Mariner'?

## Forms of water in nature

Water is the only substance in nature which can exist in three states—solid, liquid, and gaseous. The water we drink every day is its liquid form. On Earth it is seen as surface water present in the rivers, oceans, lakes, etc. Water is present under the ground as *groundwater*. Oceans constitute about 97 per cent of the liquid water available on Earth, but the water is salty and unfit for drinking. So, we are left with just a tiny percentage of freshwater to rely upon.

On Earth, water is also found in the form of ice on mountain peaks, glaciers, icebergs, and in the Arctic and Antarctic polar regions. Slow moving mass of ice is called a *glacier*. River Ganga arises from the Gangotri glacier. Chunks of ice break off into the ocean to form icebergs. You must have heard about the sinking of the majestic ship 'Titanic' due to one such iceberg. Glaciers and icecaps are referred to as storehouses of freshwater.

Water is present in the atmosphere in the gaseous form as water vapour. The water vapour rises up and combines to form clouds. Have you ever thought how much water is actually available to us?

*(a) Gangotri glacier*

*(b) Iceberg*

*Fig 17.1 Water available in the form of ice*

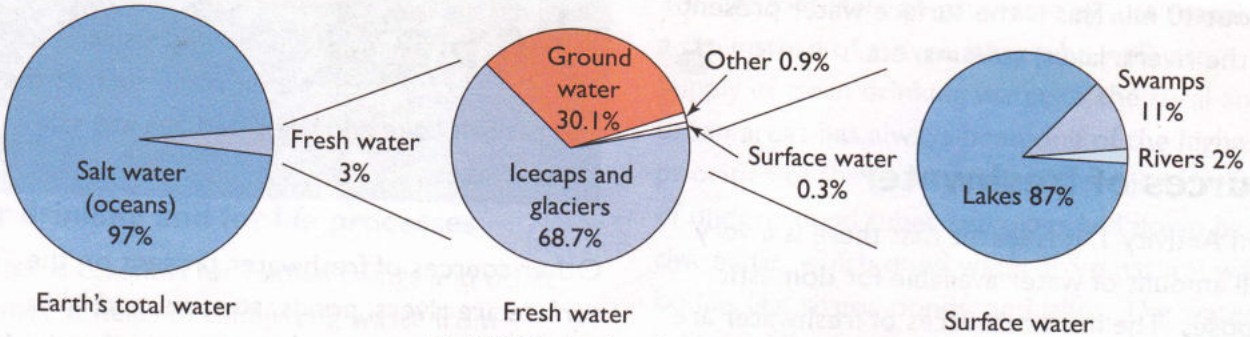



*Fig 17.2 Distribution of water on Earth*

**Infobit** Ice is solid yet lighter than liquid which makes it float on water. Isn't it an advantage for the aquatic life? Find out why.

It is rightly said that water is too much yet too little. We all depend on the surface water for all our needs like drinking, washing, gardening, irrigation, and recreation. The combined mass of water found on, under, and over the surface of the Earth is called *hydrosphere*. It includes the oceans, seas, lakes, ponds, rivers, and streams.

## ACTIVITY 1

Take a 2 litre empty bottle. Fill it with water and add a few drops of colour to it. This represents all the water present on Earth.

Now, use a measuring cylinder to take out 60 ml of this coloured water in a small glass jar.

This represents 3 per cent freshwater available on Earth. Add some salt to the remaining 1940 ml of the coloured water left in the bottle. This represents the saline water present in oceans which is not potable. It forms 97 per cent of the total water present on Earth.

From the freshwater jar, take out 36 ml water and place it in an ice tray and keep it in the refrigerator for freezing. This represents the frozen water in the ice-caps, glaciers, and mountains, which is not readily available for domestic use. Take another 14 ml water from the freshwater jar in a small bowl. This represents underground water that can be drawn out through wells and tube wells. The water left behind in the freshwater jar is just about 10 ml. This is the surface water present in the rivers, lakes, streams, etc.

## Sources of freshwater

From Activity 1, it is learnt that there is a very small amount of water available for domestic purposes. The main resources of freshwater are the surface water and groundwater.

### Surface water

The main source of surface water is rain water. It is the purest form of water. Though, sometimes the first rain of the season is acidic as it accommodates the impurities present in the environment. The subsequent showers are of pure water.

River

Lake

*Fig 17.3 Sources of surface water*

**Infobit** Although most lakes are fresh water, some such as the Great Salt Lake and the Dead Sea are salt water lakes.

Other sources of freshwater present on the surface are rivers, ponds, streams, and lakes in which water comes from rivers and melted glaciers. Rivers and lakes are the usual sources of water for large cities.

### Groundwater

Groundwater comes from the natural seeping, also called *percolation*, of different forms of precipitation like rain, snow, sleet, and hail, and other surface waters down through the Earth's

soil. It gets collected between the layers of hard bedrocks to form the *aquifer* (underground water). The upper level of this water zone is called the *water table*. The process of seeping water by its downward movement is called *infiltration*. This water helps to recharge the groundwater. Water from aquifer can be pumped out by the hand pumps and tube wells.

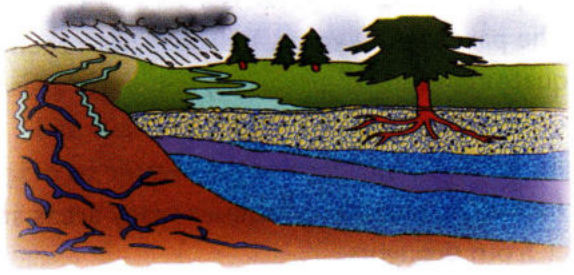


*Fig 17.4 Groundwater*

**Infobit** The water table is not flat as its name suggests. It has peaks and valleys.

## Uses of water

### For drinking and for life processes

Water is essential for human beings and other animals. It helps in eliminating waste from the body. It regulates the body temperature. Chemical changes in the body take place with water as the medium.

### In agriculture

Plants absorb nutrients from the soil with the help of water. Without water, plants cannot conduct the process of photosynthesis. Agricultural food crops grow under proper irrigation facilities, where regular water supply is available.

### In industries

Industries are the greatest consumers of water. It is used for purposes such as processing, cleaning, transportation, dilution, and cooling in manufacturing facilities. It is also used for hydroelectric power production.

### For recreational purposes

Water is used for swimming, fishing, sailing, and other water sports.

### For domestic purposes

Water is used for bathing, washing clothes and utensils, cleaning the house, and sanitation. Our household tasks will not be complete in the absence of water.

Let us see how water is supplied to our homes by the authorities.

## The journey of water from the river to a tap

You are fortunate to get water by just reaching a tap instead of a river, lake, tube well, etc. Supply of clean drinking water to the rural and urban areas has always been one of the highest priorities of the government. There is a network of underground tubes and pipes laid down by the *civic bodies* which draw water from natural water bodies like rivers, ponds, and lakes. The water is filtered, treated to make it pure, and then delivered to our homes.

### How does water circulate around us?

Water changes its form as it passes through the *water cycle*. It is also known as the *hydrologic cycle*. It is the journey water takes from the land to the atmosphere and back again. It involves many processes.

Name the following processes that form the water cycle:

- Solar energy converts the surface water into water vapour. _____
- Plants lose water to the atmosphere through pores on the leaves. _____
- Water vapour changes into water droplets on cooling. _____
- Tiny drops in the sky join together to form these. _____
- The clouds become too heavy and come down on Earth. _____
- The penetration of surface water through the layers of the soil. _____
- The process of seeping water by its downward movement. _____

The water cycle is powered by solar radiation which provides the energy to maintain the flow of water through the processes of evaporation, condensation, and precipitation.

Excess of rainfall in a particular area causes floods, whereas lack of rain leads to drought. Both the conditions cause massive loss of life and property. They spread several diseases. Find out about such natural disasters that happened in our country in the recent past.

## Water in India

In our country the amount of rainfall varies from place to place. Name the place with the heaviest rainfall in India. There are some areas of Rajasthan where there is hardly any rain.

*Fig 17.5 A drought-affected field*

**Infobit** Our country receives an overall rainfall of about 105 to 117 cm annually which is one of the highest in the world.

India is a country where 70 per cent of the population survives on agriculture. Thus, in our country availability of water is a serious concern. For the past several years, India has not received adequate rainfall in many areas. For these areas, the government has provided tube wells and canals, so that every farmer gets water to irrigate the fields. Despite these facilities many areas still suffer from droughts.

**ACTIVITY 2**

Pretend that your house has no running water for a few days. Your family will only be able to get water from a well that is located three kilometres from your home. How is it going to affect your daily schedule? Will you be left with enough time and energy to play, study, or do other recreational activities? Think about it. If you save water today it will save you tomorrow. Maybe now you will think twice before leaving a tap running after use!

S

### Scarcity of water

Water shortage is a matter of universal concern. Water is easily available to us in towns and cities running down the taps but this may not be a usual sight in villages. Long queues of people waiting for water at water tankers, wells, or tube wells is a common sight. Taps running dry in the summer season is also a common sight. Water becomes so scarce that people even fight over it. Water shortage occurs due to depletion of the water table. Let us discuss the major factors causing the depletion of the water table.

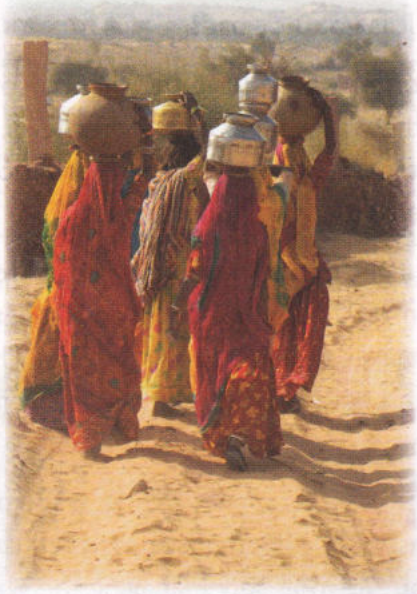


*Fig 17.6 Women carrying water in a village*

## Causes of depletion of water table

Due to the rapidly increasing demand for water, the amount of water replenished is much less than the amount of water withdrawn from the underground water source. Due to this the water table goes down, which is called *depletion* of the water table. The water table can be replenished by natural methods such as seepage of rain water, melting snow, water used in fields which is not absorbed by the plants, and water from the bottom of lakes and rivers. But due to many reasons, the natural recharge of the water table is not done. Groundwater can be compared to money kept in a bank account. If you withdraw money at a faster rate than you deposit it you will be left with no money.

**Let's Talk** Have you ever visited any construction site? You must have seen long tube-like structures used to get the groundwater. Is it possible to get a continuous supply of water from the ground? Think and talk about it with your teacher.

***Overpopulation*** Take a bottle filled with water. Four students pour water from it into their glasses and drink it. Fill the bottle again and now all the students pour water from it into their glasses one by one. Does the water reach the last student? No, it would not reach the last student or at best there would be a few drops left. The amount of water circulating between the Earth and sky remains almost constant due to the water cycle. But the population of the world and the demand for water is growing at an alarming rate. This situation may someday reach a level where the water available will soon become insufficient for us.

**Let's Talk** Think about some product you come across in your day-to-day life and the amount of water consumed in its manufacture. How does it affect the water table? Discuss with your friends how you can reduce the use of such goods and find an alternative that may help in water conservation.

***Growing industrialization*** Water is a useful component used in many industries. With the rise in the production of different substances, the water requirement has also risen. The increased demand for water adversely affects the groundwater resource. The waste from industries also pollutes the freshwater bodies. Major water-consuming industries include steel, chemical, paper, and petroleum refining.

**Infobit** Three hundred litres of water is needed to produce 1 kg of paper, so save paper to save water. One thousand litres of water is needed to grow 1 kg of potatoes.

***Climatic changes*** Global warming is a continuous threat that all of us are facing. It increases the temperature of the Earth. As a result the soil becomes very dry and absorbs a large amount of water. This does not let water go under the ground. Lack of rainfall also reduces the seepage of water and thus the water table does not get recharged.

***Extensive farming*** Indian farmers depend on rainfall for irrigating their crops. But most of the times the rainfall is insufficient. In such cases farmers use underground water from the wells, tube wells, canals, etc. This leads to a major downfall in the level of the water table.

**ACTIVITY 3**

Study the rainfall map of India. Identify the places with average, above average, and below average rainfall. Find out when and how much water these different places get. Does your house get a continuous water supply or is it available at a particular time, like in the rainy season?

***Increased urbanization*** As more and more people are settling down in the cities the requirement of land for construction of houses, parking lots, roads, etc., is also increasing. As a result more and more land is becoming concrete. Water cannot seep through this concrete layer and as a result the water table cannot be replenished.

**ACTIVITY 4**

Take two similar bowls and some wet soil. Spread the soil evenly in one bowl and let it dry. Now take some Plaster of Paris and make a paste by adding water to it. Put this in the other bowl and let it dry too. Now pour a glass of water in both the bowls simultaneously. Observe the bowls after some time. You will notice that the water in the bowl containing Plaster of Paris remains as it is. The water in the bowl containing soil seeps through it.

You must have seen that many parking lots and pedestrian footpaths in the residential areas are cemented. Considering the above activity discuss whether it is good or bad?

***Deforestation*** Plants have the capacity of bringing the water table to a higher level. Cutting down of trees leads to a further reduction of water seepage through their roots.

Water is a gift of nature we must learn to honour. In 1992, the UN declared 22 March of each year as the World Water Day. Think of some interesting ways to make it a very special day.

Water forms an essential ingredient for our life, yet we misuse it. Effective strategies must be planned out for not only managing the water supply but also managing the demands properly. Whenever you see a leaking tap in your house put a bucket below it and see how much water gets collected within hours. This is the amount of water which would have gone waste, so a plumber should be called to mend the leakage immediately.

Here are some methods to conserve water.

- Avoid leakage of water from the taps and pipes.
- Do not leave the tap turned on when you brush your teeth or wash clothes.
- Never throw water unnecessarily on the roads since it can be used for gardening and cleaning.

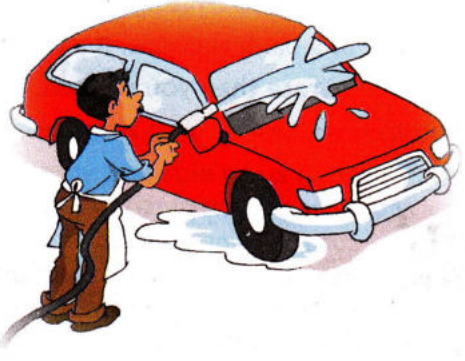


*Fig 17.7 Using hosepipe to wash a car wastes precious water*

- Avoid unnecessary flushing of the toilets.
- Use a mug and bucket instead of a shower to take bath or wash your car.
- Water your lawn only when it is needed.

- Use a broom instead of a hosepipe to clean the outdoors.
- Install taps with reduced flow of water.
- Reuse the water whenever and wherever possible.
- Use drip and sprinkle irrigation for agriculture. Drip irrigation prevents wastage of water by supplying water directly to the roots of the plants through narrow tubes.

*Fig 17.8 Leaking water pipe*

## Managing water resources

### Dams

One of the most efficient ways to manage water resources is the construction of dams across the rivers. A man-made lake called reservoir is made behind the dam that helps in storing water for future distribution. Dams are also called multipurpose projects since they also help in generating hydroelectricity besides irrigation.

*Fig 17.9 A dam*

They are helpful in controlling floods and even serve as a tourist attraction. Water management and conservation is the responsibility of not just the government but each one of us.

### Rainwater harvesting

Rainwater harvesting is one such method which helps to recharge the groundwater. In areas with inadequate groundwater supply or surface resources, rainwater harvesting offers an ideal solution. The basic principle behind this system is *'catch water where it falls'.*

Rainwater harvesting is the gathering and collection of water from the rooftops, roads, and surface run-offs and storing it in tanks. It can also be used directly to recharge the groundwater.

Rainwater harvesting has traditionally been practised in India. Some traditional water harvesting systems were *bawris*, step wells, *jhiries*, etc. Many of the modern water harvesting structures used in India are based on these models. Find out how many upcoming buildings in your neighbourhood are getting these systems installed.

In dry states like Rajasthan and Gujarat, the revival of traditional water harvesting structures is being done for water retention. Here is the story of the Rainmaker of Gujarat who solved farmers' water woes.

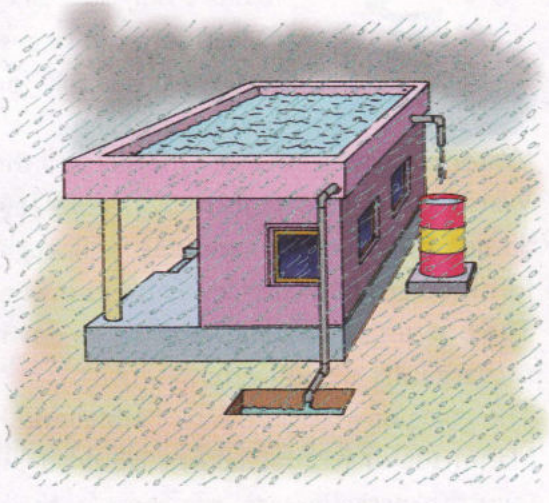


*Fig 17.10 Rainwater harvesting*

Shamjibhai Antala, a 75-year-old man, has been fighting single-handedly to save water in drought-prone Saurashtra (Gujarat). Saurashtra, a land with history of severe water scarcity, hostile climate, and rocky land is now self-sufficient in water availability. He made the fields of Saurashtra green by teaching people the importance of rainwater harvesting. He has revived hundreds of dead wells by a simple idea—recharge open wells by diverting rainwater into it.

He is a member of the Gujarat Ecology Commission, State Watershed Mission Advisory Committee (Government of Orissa), and Rajiv Gandhi Watershed Mission (Government of Madhya Pradesh). He was recently honoured with the Real Hero Award by CNN IBN.


**Glacier:** moving mass of ice

**Reservoir:** a huge collection and storage of water

**Potable water:** water that is suitable for drinking

**Water cycle:** the process by which water circulates between the sky and the Earth

**Drought:** a condition which occurs due to lack of rainfall

**Flood:** a natural disaster which results due to excess rainfall

**Infiltration:** the seeping down of water into the inner layers of the soil

**Underground water:** water which seeps down and collects over a layer of rocks

**Water table:** the topmost level of underground water

**Depletion:** reduction of the water table level

**Rainwater harvesting:** the gathering and collection of rainwater for future use


- Water is the most abundant natural resource available on Earth.
- It is the only substance that exists in all three forms in nature.
- Oceans are the largest reservoirs of surface water but are salty. This salty water is unsuitable for drinking. It forms 97 per cent of the total water present on Earth.
- Water circulates between the sky and the Earth in a continuous cycle known as the water cycle.
- Water can change its form by heating (evaporation) or cooling (condensation).
- Some of the surface water seeps through the soil and gets collected over a layer of rocks to form the groundwater level also known as the aquifer.
- The process of seeping water by its downward movement is called infiltration. This helps to recharge the groundwater.
- The going down of the water table level is called depletion of the water table.
- Man-made or natural factors like drought, lack of rainfall, increased population, agricultural and industrial activities, etc., are some of the main causes of depletion.

- Water is supplied to the urban and rural areas through a network of pipes.
- To prevent scarcity of water each one of us should try to avoid wastage and overuse of water.
- Dams are man-made structures built across rivers. These help us in many ways like in irrigation, controlling floods, and generating hydroelectricity.
- Rainwater harvesting helps in recharging the water table.

## Put on your THINKING CAP!

***1. Select the correct option.***

a) The percentage of freshwater present on Earth is
   i) 28%  ii) 97%
   iii) 3%  iv) 30%

b) The invisible form of water is
   i) ice  ii) water vapour
   iii) water  iv) none of these

c) We cannot drink sea water because it is
   i) polluted  ii) too salty
   iii) too sweet  iv) none of these

d) This is not a source of surface water.
   i) river  ii) lake
   iii) aquifer  iv) all of these

e) Which of these is not a form of precipitation?
   i) hail  ii) sea
   iii) fog  iv) none of these

f) The total amount of water on our planet
   i) increases  ii) decreases
   iii) remains constant  iv) none of these

g) 22 March of each year is celebrated as
   i) World Labour Day  ii) World No Tobacco Day
   iii) World Dry Day  iv) World Water Day

h) A moving mass of ice is called
   i) iceberg  ii) glacier
   iii) hail  iv) sleet

***2. Fill in the blanks.***

a) _____ are the largest reservoir of surface water.

b) A moving mass of ice is called _____.

c) The process by which water circulates between the sky and the Earth is called _____.

d) Excess of rainfall in a particular area causes _____ and lack of rain leads to _____.

e) The process of seeping water by its downward movement is called _____.

**3. *Write T for true and F for false. Also correct the false statements.***

a) Growing urbanization leads to recharge of the water table. ☐

b) The combined mass of water present on Earth is called atmosphere. ☐

c) Aquifer is the reservoir of surface water. ☐

d) Deforestation reduces the water table. ☐

e) 22 March is celebrated as World Water Day. ☐

**4. *Write short answers.***

a) Why is water essential for plants?

b) Suggest any two methods that can help to conserve water.

c) What is drip irrigation?

d) What are dams?

e) Name some traditional methods of rainwater harvesting.

**5. *Answer in details.***

a) What is water table? How is it formed?

b) What are the causes of depletion of the water table?

c) What is rainwater harvesting? Why is it important?

**6. *Give reasons for the following:***

a) A leaking tap should be repaired immediately.

b) Grass lawn is better than a cemented floor.

c) Tube wells dry up during summer season.

d) Dams are called multipurpose projects.

e) Planting trees prevents depletion of water table.

**7. *Identify the following jumbled words.***

a) ALEK _____

b) UPVORA _____

c) VERIR _____

d) PABOETL _____

e) WLEL _____

f) PSGRIN _____

g) EWRAT _____

h) ILDIUQ _____

i) LUDCOS _____

j) TRASEMS _____

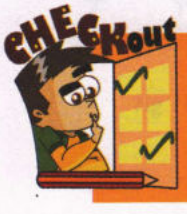
## Extended learning

p l 1. Organize street plays on ways and means to save water at home and school.

2. Water bank: Make 50 cutouts of water droplets. Make a group of three or more players. Distribute half droplets equally among the players. The other half remains with the banker. Now, prepare 10 cards with the labels 'water conservation' or 'water wastage'. If a player gets a water conservation card, he/she gets the water droplets. If a player gets a water wastage card, he/she loses the water droplets. The player with the maximum number of water droplets is the winner for he/she has conserved water the most.

C

3. Prepare a model based on the water distribution system of your city.
4. In June 2013, a cloudburst in the state of Uttarakhand caused devastating floods and landslides. This has been called a man-made disaster. Find out why.




For more information
http://science.howstuffworks.com/environmental/earth/geophysics/h2o.htm
http://www.buzzle.com/articles/causes-of-water-pollution.html
http://library.thinkquest.org/11353/water.htm

# 18 Forests: Our Lifeline

## You will learn about

- Forest layers
- Uses of forests
- Interdependence between plants and animals
- Deforestation
- Consequences of deforestation

In ancient times, India had vast forests. Increase in population and the alarming rate at which trees are being cleared for human use has greatly reduced the forest cover. It is important to understand that the survival of animals including humans is dependent on forests.

This is a poem written by a student of your age. It tells you why forests are our lifeline.

Read the poem and answer the questions that follow.

*What is a forest?*
*I'm sure you'd like to know.*
*It's a place where animals live,*
*And plants and trees grow.*

*It's got birds, amphibians, and mammals,*
*Reptiles, insects, and fish.*
*There are many kinds of fruits,*
*Which make a lovely dish.*

*There are millions and millions of species,*
*Of animals, plants, and trees.*
*But they're all disappearing,*
*They need your help, please!*

*The animals live in the forest,*
*Over one million kinds.*
*When the trees go, so do they,*
*So don't just act as if you're blind.*

*We need the trees for oxygen,*
*And the animals need it too.*
*The forest provides many products we need,*
*With many things to study and do.*

*The trees are all being cut,*
*Only seven percent remain.*
*What have we done to our world?*
*We must be completely insane.*

*We have to take care of the forests,*
*'Cause half the world's creatures live there.*
*So write a letter or talk to your friends,*
*to show you really care!*

1. Which animals live in the forest?

2. According to the poem what is the percentage of forests left on Earth?

_____

3. The forest provides many products we need. What are they?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Draw a forest in your drawing file using the description given in the poem.

## Forest layers

If you visit a forest or see pictures of it you will notice that different kinds of trees have different shapes. This is because of the difference in their crowns.

The *crown* of a woody plant like a tree or a shrub includes the branches, leaves, and reproductive structures extending from the trunk or the main stem.

*Fig 18.1 Different tree crowns*

One feature of the natural, undisturbed forests is the layering effect created by the trees and vegetation of different heights. Did you know that a forest is like a tall apartment building with many floors? Most forests have an emergent, canopy, understorey, and forest floor (or soil) layer.

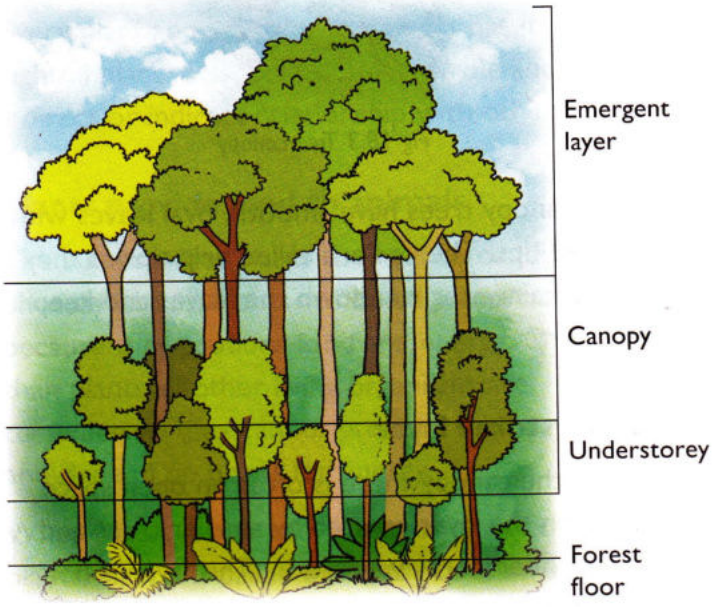



*Fig 18.2 Forest layers*

### Emergent layer

The tallest trees in the forest may reach a height of up to 200 feet and form the emergent layer. Trees of this height are rare and are found occasionally in the dense rainforests of Asia and the East Indies. Most of these trees are broad-leaved and evergreen. There is plenty of sunlight in this layer. Hornbills, butterflies, and bats are found here.

### Canopy

The trees in this layer are as high as 100 feet. They form a green roof over the lower layers. This roof is like an umbrella that lets the sunlight penetrate through it only partially and totally blocks it in the case of dense forests. The canopy is the busiest part of a forest. It is the habitat of many animal species like monkeys, orangutans, eagles, toucans, and sloths, as there is plenty of food available here.

*Fig 18.3 Tree canopy*

Most canopy trees have smooth, oval leaves with pointed tips. The tips are called drip tips as they let the rainwater run down the leaves and keep them dry.

### Understorey layer

Below the canopy there is often an open space and then the layer created by smaller trees and other understorey vegetation. This layer is hot and damp.

Very little sunshine reaches this area. So, the plants have to grow larger leaves to absorb maximum sunlight. Young trees, palms, and shrubs grow here. It is home to animals like owls, lizards, jaguars, red eyed tree frogs, and leopards.

### Forest floor

The forest floor is very dark. This is due to the canopy formed by the understorey trees that prevents the sunlight from entering the forest floor. Mosses and ferns grow on the forest floor where it is warm, damp, and shady. The soil on the floor is covered with a layer of leaves, twigs, and dead plants and animals. Numerous species of vines and decomposers like earthworm, bacteria, and fungi are found here, which make unique adaptations to survive through minimal levels of sunlight on the forest floor. The forest floor is home to millipedes, beetles, and large animals like rhinoceros, tigers, elephants, and cobras.

Look around at your surroundings and you will find a variety of grasses, herbs, shrubs, and trees.

*Fig 18.4 Forest floor*

**Infobit** World Forest Day is celebrated on 21 March every year.

These grow on their own without interference or help from human beings, and are called *natural vegetation*. Different types of natural vegetations are dependent on varied climatic conditions like rainfall, sunlight, wind, etc.

India being a vast country has different climatic conditions in different parts of the country. The main types of vegetations found in the country have been classified as tropical evergreen forest, tropical deciduous forest, thorny bushes, mountain vegetation, and mangrove forests.

**ACTIVITY 1**

On a political map of India point out the states that show the types of vegetation mentioned above.

**Infobit** Sixteen types of forests are recognized in India. The bulk of our forests is made up of

- Tropical dry deciduous forests: 38.7%
- Tropical moist deciduous forests: 30.9%
- Tropical thorny forests: 6.9%
- Sal and teak plantations: 13%

### Uses of forests

***Increase fertility of the soil*** Dead fallen leaves of the trees decay and form humus that increases the porosity and fertility of the soil. The layer of humus absorbs and holds rainwater, preventing flash floods.

***Absorb harmful gases*** Trees become dustbins for harmful gases. They absorb and lock away carbon dioxide and other harmful gases which make the environment warm. They also absorb the particulate matter suspended in the gases. The absorbed carbon dioxide is used by trees for making food during the process of photosynthesis.

***Prevent soil erosion*** The roots of trees in forests hold the soil particles together, preventing the soil from being blown or washed away. They help prevent floods. The leaves of trees reduce the force of the rain drops helping to keep the soil intact. The trees decrease the velocity of the wind to prevent dislodging of soil particles.

***Act as windbreakers*** Trees break the force of the wind and protect houses, farmlands, and vegetation.

***Regulate climate*** The process of transpiration by plants increases the humidity which makes the air cool and also attracts rainfall. Shade from trees reduces the need for fan, coolers, and air conditioning in summer.

***Provide aesthetic value*** Forests are pleasing to look at and add beauty to nature. People like to get away from the noisy life of towns and cities and go to the forests for recreation. They go there to take photos, to camp, to hike, or just for a picnic.

## Interdependence between plants and animals

Every plant and animal in the forest has its rightful place. Each plays a specific role and shares a direct or indirect relationship with others.

### Plants provide food to animals

The Sun provides plants the heat to conduct photosynthesis. Plants are called *producers*, because they produce food and energy. Other than plants all other living organisms are *consumers* as they cannot produce their own food and depend on plants for energy.

What does a rabbit eat? The answer of course is plants. Rabbit is called a primary consumer.

A *primary consumer* is an organism that gets its energy directly from plants. Animals that are primary consumers and get their energy from plants only are called *herbivores*.

There are some animals like the lion that eat only other animals. Such animals are called *carnivores*. There are animals like crows, bears, and humans which eat both plants and animals for energy and are called *omnivores*. Carnivores and omnivores are the *secondary consumers*. Find out what crows and bears eat?

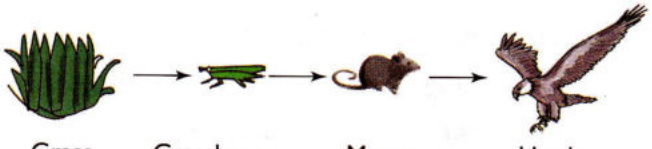
Vultures, kites, and eagles are *scavengers*. They feed on dead plants and animals and are called the *tertiary consumers*.

*Decomposers* take over where the scavengers leave off. By breaking down dead and decaying matter, they help plants get essential nutrients and clear the world of natural waste. Name some decomposers.

A *food chain* shows the relationship between animals in a certain habitat and the food that

they eat. It is a chain that shows 'who eats whom'. Energy is transferred through a food chain. There are many steps in a food chain. *Producers* make the first step of a simple food chain. *Consumers* are the next link in a food chain.

The animals at the end of various food chains are called the *top consumers or top carnivores*. They are also called *predators* as they prey on other animals. The animal that is hunted is called the *prey*. Consider the following food chain:



Grass (producer) → Grasshopper (primary consumer) → Mouse (secondary consumer) → Hawk (tertiary consumer)

*Fig 18.5 Food chain*

- How many steps are there in this food chain?
- Name the producer, the herbivore, and the carnivore in the given food chain. How many consumers are there in total? Which is the top consumer here?

There is actually more to this chain. After a hawk dies, fungi and other decomposers break down the dead hawk and turn the remains of the hawk into nutrients, which are released into the soil. The nutrients along with water and the sunlight help the grass to grow.

**ACTIVITY 2**

You may have eaten dal, vegetables, and roti yesterday for lunch. Today you may have had fried chicken for lunch. Yesterday you occupied the second step in the food chain as you had only vegetarian food but today you will occupy the third step in the food chain.

Draw the food chains in the two cases.

The above activity makes it clear that an organism can occupy different levels in different food chains.

In nature, you will find many food chains operating simultaneously. A grasshopper can be eaten by a lizard or a bird. The bird is then eaten by a snake or a bear. But the bear can also eat plants. Thus, a network of interconnecting food chains is formed, called a *food web*. Here is a picture of a food web in a forest. Write down all the food chains in the given food web.

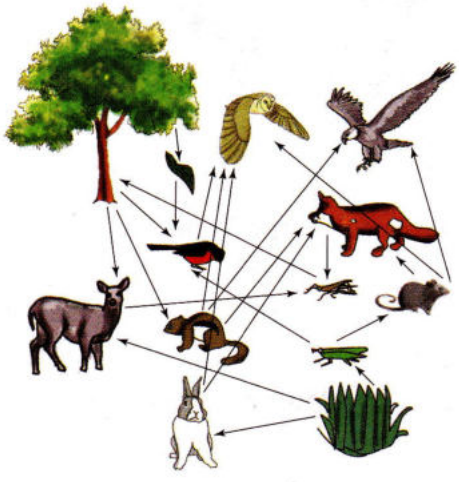


*Fig 18.6 Food web*

**ACTIVITY 3**

Study the following food chain:

Plants → Deer → Tiger

What do you think will happen if all the deer in a forest are killed?

If all the deer are killed, then soon the tigers will also die. Due to the death of these animals, the population of decomposers will rise in that area.

**Let's Talk**

According to the 2011 tiger census report released by the National Tiger Conservation Authority, there are only 1706 tigers left in India. What do you think will happen if all the tigers die?

**Infobit** Every single part of the tiger is used in traditional Chinese medicine.

### Plants provide oxygen to animals

Plants help maintain the oxygen content of the atmosphere. During the process of photosynthesis they take in the carbon dioxide produced by animals and give out oxygen. Forests are called the lungs of the Earth as they help in this gaseous exchange.

### Animals get shelter from plants

A variety of animals like the lion, tiger, leopard, elephant, monkey, bear, jackal, and a number of insects inhabit the forest. The plants provide a natural habitat to these animals. They ensure that food is available in plenty and provide shelter and security to the animals.

### Plants provide useful products to humans

Forests provide fuel wood, timber, paper, bamboo, cane, and so on. We also get essential oils, tannins, resins, gums, medicines, spices, wax, rubber, dyes, and cork from different plants in the forest.

Wood

Bamboo

Spices

*Fig 18.7 Forest products*

In the following table, fill in the uses of various plant products.

| Product | Use |
|---|---|
| Tannin | |
| Resin | |
| Wax | |
| Rubber | |
| Dyes | |
| Cork | |

Plants depend on the animals too. Here are some ways by which plants benefit from the animals.

### Animals help in pollination and seed dispersal

A number of insects, birds, and bats help in pollination. Butterflies, bees, wasps, and hummingbirds are important agents of pollination. Animals are also the agents of seed dispersal as they keep on moving from one place to another and in the process carry the seeds of plants to various places.

Now you know that all the plants and animals are interdependent on one another. There is a very delicate balance operating in nature. If for any reason the plants or animal numbers are disturbed, it will have an adverse effect on the environment.

*Fig 18.8 Hummingbird—an agent of pollination*

## Deforestation

Forests are being cleared at a very rapid rate. The clearing of the forests is referred to as *deforestation*. The growing human population has been a primary cause of forest destruction. More people need land to live on and wood products to consume.

- Large areas of forests are destroyed for logging wood. The heavy machinery used to penetrate the forests and build roads cause extensive damage.
- The felling of one 'selected' tree, tears down with it the climbers, creepers, and other plants growing nearby. Removing a felled tree from the forest causes even further destruction, especially when it is carried out carelessly.

*Fig 18.9 Deforestation*

- The forests are cut down to make way for vast plantations where products such as bananas, palm oil, sugarcane, tea, and coffee are grown.
- Trees are cut down for fuel wood that is used for cooking and heating.
- Hundreds of thousands of hectares of forests have been destroyed for building of hydroelectric dams.

## Consequences of deforestation

We have till now studied how useful the forests are for us and other animals. Let us look at what will happen if the forests disappear.

- Felling of trees in large numbers will disturb the oxygen cycle leading to the increase in the amount of greenhouse gases like carbon dioxide in the air. This will lead to global warming as these gases absorb heat and increase the temperature of the surroundings.
- We will not be able to obtain the plant products.
- It causes soil erosion in large quantities making the soil barren. The Sahara Desert once used to be a lush green forest which became a desert as a result of extensive deforestation.
- Trees hold the soil firmly, thus felling of trees makes the area prone to landslides and floods.
- Felling of trees also affects the rainfall that may lead to droughts in severe circumstances.
- Animals that live in the forests will lose their habitat.

We can thus conclude that the forest is a dynamic system full of all kinds of life like plants, animals, and microorganisms. It is everybody's duty to conserve this natural resource.

What do you think will be the consequences of man's destruction of forests at this alarming rate? Write down and put up a chart in class.

**Infobit**

**Delhi launches ambulance for trees!**

An ambulance for trees set out on 5 February 2010 to protect the green cover in parts of the national capital. The ambulance is equipped with water tanks, chain saws, tree pruners, sprayer, and ladders.

## Go Green

If all the forests are cleared and the water as well as air get polluted, the balance of nature would be destroyed and the Earth would no longer be able to support any life. This would make humans as well as other living animals extinct. Therefore, it is in our own interest that we care for the environment and protect it. So, grow more trees, reduce pollution, and conserve the natural resources.


**Crown:** this includes the branches, leaves, and reproductive structures extending from the trunk or the main stem

**Emergent layer:** the layer of tallest trees in a forest

**Canopy:** the green roof formed by tall trees over the plants lying below

**Producers:** green plants that produce their own food

**Consumers:** all the animals that depend on plants for food

**Decomposers:** organisms which break down the dead leaves, plants, and animals and convert them into humus

**Food chain:** a chain that tells how the energy is transferred from producers to primary, secondary, and tertiary consumers

**Food web:** a network of interconnecting food chains

**Deforestation:** clearing of forests in large numbers

**Soil erosion:** the removal of the top fertile layer of the soil due to extensive rain or wind


- The forest is made up of plants, animals, and microorganisms.
- The forest consists of emergent, canopy, understorey, and forest floor layers.
- There are a number of plants and animals that occupy each layer.
- A food chain tells us about who eats whom in nature.
- Several food chains interconnected to each other make a food web.
- Plants and animals are dependent on each other for their survival.
- Forests provide habitat, useful products, help in exchange of gases, regulate the climate, reduce pollution, and prevent soil erosion.
- Forests are being destroyed for logging, for growing crops, for fuel wood, and for building residential places and dams.
- Deforestation results in global warming, soil erosion, pollution, and the loss of animal habitat.

## Put on your THINKING CAP!

***1. Mark the correct answer from the options given for each question.***

a) Which of the combinations is the correct order of layers of a forest starting from the top?

i) canopy, understory, emergent, forest floor
ii) forest floor, canopy, emergent, understorey
iii) emergent, canopy, understorey, forest floor
iv) understorey, canopy, forest floor, emergent

b) In which forest layer do palms and shrubs grow?

i) emergent ii) canopy
iii) understorey iv) forest floor

c) Which of the following is not a producer?

i) mushroom ii) grass
iii) green herb iv) green shrub

d) Which of the following constitutes a food chain?

i) grass, wheat, and mango ii) grass, goat, and human
iii) goat, cow, and elephant iv) grass, fish, and goat

e) Which of the following is not a forest product?

i) gum ii) iron
iii) resin iv) rubber

f) Which of the following products do we get from plants?

i) rubber ii) silk
iii) honey iv) iron

g) In which forest layer, mosses and ferns are found?

i) emergent ii) canopy
iii) understorey iv) forest floor

h) Several food chains interconnected to each other and make a

i) food pyramid ii) food cycle
iii) food web iv) both (i) and (ii)

***2. The table below contains words that have been chopped in two pieces. Find the pieces that fit together and write them in the blanks given below.***

| | | | |
|---|---|---|---|
| her | dec | scav | can |
| om | unde | cr | hab |
| engers | nivore | opy | omposers |
| itat | pr | eme | rstorey |
| own | rgent | bivore | oducer |

_____ _____ _____

_____ _____ _____

_____ _____ _____

3. ***Place the animals given below in the layer of the forest they would be found in.***

| | | | | | |
|---|---|---|---|---|---|
| Snakes | Bugs | Gorillas | Frogs | Leopards | Birds |
| Elephants | Small monkeys | Tigers | Lizards | Butterflies | Earthworms |

| Emergent layer | Canopy layer | Understorey layer | Forest floor |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

4. ***Arrange the organisms in the correct order in the following food chains.***

a) Tiger, grass, zebra

b) Grass, snake, grasshopper, hawk, mouse

c) Sea grass, bear, snail, fish, seal

5. ***Fill in the blanks in the following paragraphs with the words in the respective boxes.***

**The bottom of the food chain**

| bottom | trees | Sun | grass | chain |
|---|---|---|---|---|

Plants such as _____ and _____ are at the _____ of the food _____. Plants get their energy from the _____.

**The middle of the food chain**

| deer | herbivores | rabbits | carnivores |
|---|---|---|---|

Animals such as _____ and _____ get their energy by eating plants. They are called _____, which means plant eaters. There are many more herbivores on our planet than the _____, which are the animals that eat meat.

**The top of the food chain**

| predators | hunt | prey | top | lions |
|---|---|---|---|---|

_____ such as wolves and _____ are at the _____ of the food chain. Predators are animals that _____ on other animals. The animals that they hunt are called _____. Some animals are both predators and preys.

**The food web**

| connected | energy | web | more |
|---|---|---|---|

Most animals belong to _____ than one food chain, which means many food chains are _____ together. Many food chains together form a food _____. The food web shows how the Sun's _____ moves from plants to animals.

**6. *Match the columns.***

| | |
|---|---|
| a) food chain | i) microorganisms that break down dead plants and animals |
| b) consumers | ii) preservation or restoration from loss, damage, or neglect |
| c) vegetation | iii) a layer of trees that forms a roof over the lower layers |
| d) producer | iv) the relationship between the animals in a habitat and the food they eat |
| e) conservation | v) organisms which make their own food |
| f) canopy | vi) network of interconnecting food chains |
| g) forest floor | vii) the clearing of forests |
| h) food web | viiii) organisms which do not make their own food |
| i) deforestation | ix) the plants of an area or a region |
| j) decomposers | x) the lowest layer of a forest |

**7. *Write short answers.***

a) Name the decomposers present in a forest? What is their function in the food chain?
b) What is passed on along a food chain from one organism to another?
c) How is a kite different from an earthworm in the function that it performs to keep the environment clean?
d) Name some useful products plants provide to humans.
e) What is the understorey layer of a forest? Give examples of animals and plants found there.
f) What will happen if forests on Earth disappear?

**8. *Answer in details.***

a) What are primary and secondary consumers? Give examples.
b) Explain how soil erosion and floods are prevented by forests.
c) Why are forests being destroyed by human beings? What are the consequences?

## Extended learning

S 1. Make a forest in a jar!

a) Take a big glass jar and place approximately 5 cm of soil and 7.5 cm of water in it.
b) Place the jar near a window, without a lid and leave it overnight (this will let the contents settle).
c) Plant an aquatic plant in the jar. Do not replace the water that evaporates from the jar.
d) Once or twice a week, add three to four birdseeds to the jar. While there is water in the jar, the seeds will germinate and then rot.
e) Continue adding seeds even after the water evaporates.

f) As the water evaporates from the soil, the aquatic plant will die. The birdseeds will now find the environment suitable for successful growth.

g) Sunflower seeds, which grow large, can be added to represent forest trees.

h) Add water, as a substitute for rainfall, to keep the soil damp to keep things growing.

2. Find out about forest fires and how they are caused.

S 3. As a concerned citizen find out how you can help in saving the forests.

HIGHER ORDER THINKING SKILLS
**HOTS**

1. An elephant is a huge animal in comparison to a squirrel. Yet it is said that both of them occupy the same level in a food chain. Can you guess why?
2. The forests are usually referred to as the lungs of the Earth. Why?
3. What would happen if all the bacteria and fungi and other decomposers were killed in a forest?


For more information

http://www.museum.state.il.us/muslink/forest/htmls/intro_imp.html

http://environment.nationalgeographic.com/environment/global-warming/deforestation-overview.html

http://science.howstuffworks.com/environmental/green-science/deforestation.htm

http://library.thinkquest.org/CR0215471/global_warming.htm

# 19 Journey of Wastewater

**You will learn about**

- Wastewater and its sources
- Treatment of polluted water
- Wastewater management
- Sanitation and diseases

We have already learnt that water is a basic necessity for life. It is essential for the existence of not only the human beings but also plants and animals. Without water, plants, animals, and microbes, everything will perish. Our body is composed of about 75 per cent of water. It allows our blood to flow through the blood vessels and also allows the waste matter to be eliminated from our body. All biochemical reactions in our body require water as a medium.

Our country is rich in water resources; there is a network of almost 113 rivers and vast river basins to hold plenty of groundwater.

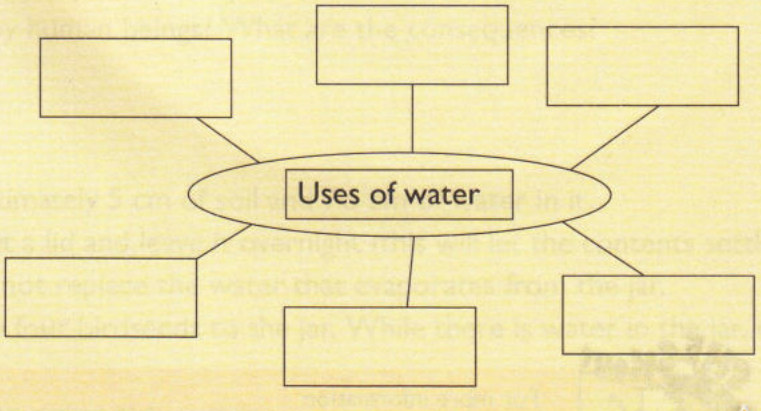
However, with the rapid increase in the population and the rising demands of water the available water resources in many parts of the country are getting depleted. The quality of water is also deteriorating.

## Wastewater and its sources

Water is discharged during many of our daily chores—bathing, washing clothes, flushing toilets, preparing meals, and washing dishes. The water which gets discharged after use is called

**ACTIVITY 1**

Think of the innumerable uses of water and prepare a webchart based on it.



*wastewater.* Can the wastewater be reused? The answer is yes. The wastewater undergoes a treatment to make it clean and suitable for reuse. This process is called *sewage treatment.* The treated water is safe to use. It can be disposed of readily into the water bodies like the fresh water and thus it again becomes a part of the water cycle. Treatment of wastewater is also an indirect method of water conservation.

*Fig 19.1 Wastewater sources at homes*

Commercial establishments like hotels, restaurants, industry, hospitals, agricultural land, etc., are also the sources of wastewater. A wide range of soluble and suspended impurities are present in such water. They are called *contaminants.* The discharged water becomes rich in lather and gets mixed with oil and other impurities. Let us see what the wastewater from different sources contains.

- Household wastewater carries body waste, dirt, soap and detergents from toilet, washing machines, and showers, food, and grease from sinks.
- Agricultural wastewater contains pesticides, insecticides, husk, plant, animal waste, etc.
- Hospitals generate wastewater that contains disease-causing bacteria, virus, and other microbes.
- Industrial wastewater consists of harmful chemicals like chromium and lead that are present in paints and dyes. Wastewater from construction sites also contains huge amounts of impurities.

The wastewater from our houses flows down the drain. It gets accumulated and forms sewage. Nutrients such as nitrogen, phosphorous, and organic material promote the growth of weeds which lower oxygen levels of water, and badly affect aquatic life and recreational use of rivers and lakes.

## What is sewage?

Sewage is the accumulated wastewater which includes domestic or industrial liquid waste. It goes through a system of pipes, called sewers, which are linked to each other to form a network called *sewerage system.* They help in collecting, treating, and disposing of sewage. Sewage from individual buildings flows into collecting sewers, which carry the waste to a central plant for treatment and disposal. The stream of sewage which enters the treatment plant is called *influent.* Sewers that only carry domestic sewage are called *sanitary sewers.* Storm sewers help in carrying run-off from rain and melted snow. In many systems, both domestic sewage and run-off water are carried in combined sewers. This is undesirable, because they start overflowing during heavy rains and

then discharge untreated sewage from the sewage treatment plant. Sewers are usually made of clay, concrete, or plastic.

You might have come across several openings on the road surface. These are called *manholes*. These are covered with heavy cemented or metallic lids which help to reach the underground sewerage for cleaning and maintenance. Manholes are located at the junction of two or more sewers or at places where the direction of the pipes are changed. Sewer lines carry the waste to the *Sewage Treatment Plant*. The water which comes out of the treatment plant is called *effluent*.

**ACTIVITY 2**

Study the sewage route present in your colony. How many manholes do you find? Bring uncovered manholes to the notice of the Municipal Corporation officials. Note down the risks that can occur due to uncovered manholes.

Of all the domestic waste generated, the organic matter like vegetable and fruit peels decompose easily whereas plastic products are harmful as they do not decompose. Polythene packets may lead to blockage of the sewers which results in overflowing sewerage especially during heavy rainfall.

## Treatment of polluted water

It is said that 'the solution to pollution is dilution'. When small amounts of sewage are discharged into a flowing water body, purification occurs as a natural process. When cities generate such large quantities of sewage, then dilution alone cannot prevent pollution. This makes it necessary to purify wastewater before disposal. The disposal of untreated or partly treated sewage directly into a stream or body of water can result in serious water pollution. Various chemicals may poison the water, killing fish and other wildlife, which makes the water unfit for use. As wastes decompose, they can deplete the oxygen supply in the water, making it unfit for all forms of aquatic life. The collection and treatment of sewage is one of the most important municipal services. Name the organization which provides this service in your locality. The sewage is treated to destroy germs and reduce the level of contaminants before it is returned to a water body.

Water treatment plants clean and maintain the quality of drinking water by taking it through the following processes.

***Aeration*** Here, wastewater is exposed to circulating air. This adds oxygen to the wastewater and allows gases trapped in it to escape.

***Coagulation*** In this process, dirt and other floating particles get stuck together to form scum which floats over the water surface.

***Sedimentation*** This process helps heavy particles to settle at the bottom of the tank to form sludge.

***Disinfection*** In this process, chemicals like chlorine and ozone are used to kill harmful microorganisms in the water.

***Filtration*** Through this process, wastewater is passed through a porous substance which acts like a filter (filter paper, membrane, sand).

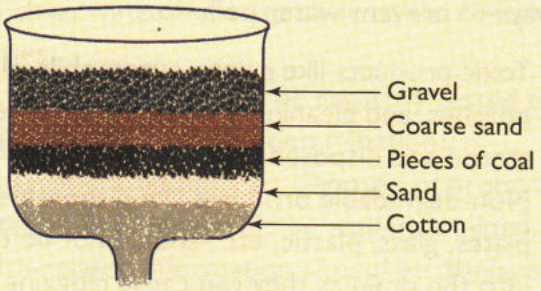
## Wastewater management

Water is an essential commodity which is needed in every walk of life. Similarly, generation of wastewater is also an inevitable part of human life. Thus, we have to raise awareness among people to realize their responsibility in the effective management of wastewater. How would you feel if you have to wade through the dirty

## ACTIVITY 3

**To demonstrate the working of a wastewater treatment plant**

1. First prepare a filter by using a 2 litre bottle with its bottom cut. Turn the bottle upside down. Loosely put a cotton plug in the neck of the bottle. Pour fine sand over the cotton plug followed by activated charcoal, coarse sand, fine gravel, and coarse gravel. This acts as a filter. Clean the filter by slowly pouring 4–8 litres of clean tap water.



*Wastewater treatment (filtration)*

2. Prepare some dirty water by adding 1 cup of soil or mud to two litres of water in a bottle.
3. Shake the bottle, this helps in aeration. Collect a small amount of the dirty water and label it as *water before treatment.*
   Continue the aeration process by pouring the water back and forth between two bottles 10 times. Do you find any change in the colour? Collect a portion of this aerated water and label it as *water after aeration.*
4. Add two table spoons of alum (*phitkari*) to this. Stir the mixture slowly for 5 minutes. After sometime you will observe some precipitate like substance (*coagulation*) in the water.
5. Allow the water to stand undisturbed for 20 minutes. Observe the water at 5 minute intervals. You will find the precipitate formed starts settling down (*sedimentation*).
6. Without disturbing the sediment, pour the top clear portion of water through the filter model prepared earlier (*filtration*).
7. After you have collected more than half of the water poured through the filter, add two chlorine tablets to the filtered water (*chlorination*).

Compare the treated and untreated water. What was the effect of adding chlorine on the colour and odour of the filtered water?

drain water? Usually we ourselves are responsible for this situation. If we had been more careful and not thrown garbage down the drain, then our drains would not have gotten clogged. So, if we want to stay healthy, it is our utmost responsibility to reduce the generation of sewage and make sure that the sewage does not make our surroundings dirty.

Sewage treatment depends a lot on the quantity and quality of the contaminants present in the sewage. With the rapidly increasing population, urbanization, and industrialization, the sewage is becoming more and more contaminated. The government should make sure that there are adequate treatment plants to treat sewage.

**Infobit** Although the practice of sewage disposal has been around since early Roman times, it assumed increased importance in the early 1970s due to rising concerns about environmental pollution.

There are many things that we can do individually to prevent water pollution. *Reduce*, *recycle*, and *reuse* are known as the three Rs of the waste-reduction movement. Given below are a few ways to prevent water pollution:

- Toxic products like paints, automobile oil, polishes, and cleaning products should be stored and disposed of properly.
- Non-degradable products like disposable plates, glass, plastic, etc., should not be thrown into the drain as they can cause clogging of the pipes. Make use of reusable articles.
- Avoid throwing flowers, plastic bottles, etc., into streams, lakes, rivers, or seas as they litter the water bodies.
- Farmers should try using natural fertilizers and pesticides. They should not overuse them or over-water gardens and lawns as chemicals can get into water systems due to run-offs.
- Cooking oil, ghee, mayonnaise, and fats should not be poured down the drains as they may block the pipes and grease present in the sewage will reduce the flow of water.
- Vegetable waste should be collected for composting.

## Sanitation and diseases

Sanitation is one of the major problems of our country. Our country has a rural background and most of the villages lack proper sewage systems. Almost 700 million people have no toilets in their homes. In India, 60 per cent of the population defecate in the open—in the fields, dry river bed or the bushes, on the roadside, beside railway lines and canals, on any vacant land. This lack of sanitation facilities in many areas also presents a major health risk. Every year, 700,000 children die due to diarrhoea and dehydration caused by poor hygiene. Untreated human faeces causes water and soil pollution. Human faeces of persons suffering from diseases like cholera, typhoid, and jaundice contain several microbes which may contaminate the underground and surface water. Water supply, sanitation, and health are closely related. Contaminated water that is consumed may result in waterborne diseases including hepatitis, typhoid, cholera, and dysentery. Without adequate quantities of water for personal hygiene, skin and eye infections (trachoma) spread easily. Stagnant water in the drains becomes a breeding ground for mosquitoes which spread malaria, filaria, dengue, etc.

**Infobit** The simple act of washing hands with soap and water can reduce the occurrence of diarrhoea by one-third. Providing adequate sanitation facilities is the key to prevent waterborne diseases.

### Economical methods of sewage disposal

Constructing a sewerage system is an expensive process because it involves the laying down of several sewers, aeration and sedimentation tanks, and their maintenance. But there is another economical alternative for sewage disposal known as *on-site sewage disposal system*. In this, wastewater systems are designed to treat and dispose of effluents on the same property that produces the wastewater. It is a cost-effective, practical, and sometimes beneficial way of dealing with sewage.

*The modern septic tank system* is an on-site disposal method, which uses 'standard' flushing. The septic tank acts as sedimentation-cum-digestion tank. Anaerobic (in the absence of air) digestion of the settled sludge occurs in its bottom zone, and the remaining liquid has to undergo treatment in a soak pit/filter bed. This can be done in areas where the water table is very low and the rainwater from the surface also does not interfere with their functioning.

*The composting toilet* is an aerobic processing system that treats excreta, typically with no water or small volumes of flush water, by aerobic

decomposition. This is usually a faster process than the anaerobic decomposition in the septic tanks. They help to reduce the need for water to flush toilets.

**Infobit**

*Sulabh International Social Service Organisation* is an organization which has brought about a revolution in sewage disposal technology. It is maintaining over 5500 public toilet complexes spread all over India, out of which 104 are linked with biogas plants. They are made effluent-free from odour, colour, and pathogens, by filtration of effluents through activated charcoal, followed by ultraviolet (UV) rays. The filtration unit makes it colourless, odourless, and free from organic particles and UV eliminates bacteria, so that it could be safely used for agricultural purposes, gardening, or discharged into any water body. Biogas from human excreta is being used for different purposes, e.g., cooking, lighting, electricity generation, and body warming.

### Sanitation at public places

There are several basic rules for sanitation in public places.

- There should be sufficient toilet facilities for the maximum number of people using the area during the day.
- There must be a wash basin for cleaning hands, with clean water and soap close to the toilet facilities.
- The water supply should be regularly tested to ensure that there is no contamination.
- Waste generated must be disposed of properly.
- Sanitation facilities should be well maintained.
- Health-related information should be displayed in public places with eye catching, simple, and accurate signs.
- Health and hygiene messages like handwashing, use of garbage bins, care of toilet facilities may be passed on to the public by audio-visual aids and colourful posters.

Effective sewage disposal and waste management is the key to have a healthy and prosperous country. We all play a role in making our environment healthy and clean. We should also try to make the best out of waste. Wastewater should be used in agriculture as it contains water, minerals, nutrients, and its disposal is often expensive. Wastewater management is thus another way of water conservation.

**Go Green**

You might have heard of *carbon footprint*. It is the amount of carbon dioxide released as a result of human activities. It is a mark we make upon the planet Earth. The smaller the carbon footprint, the better it is. We can reduce our carbon footprint by following the steps given below.

1. Walking or cycling short distances instead of using automobiles.
2. Using public transport in place of private vehicles.
3. Growing as many trees as possible.
4. Following the principle of reduce, reuse, recycle.


**Wastewater:** the water which gets discharged after use

**Effluent:** treated wastewater which flows out of a treatment plant

**Influent:** the sewage that enters the sewage treatment plant

**Sewage:** liquid discharge containing impurities from residential and industrial areas

**Contaminants:** soluble and suspended impurities present in water

**Sewer:** pipes which carry sewage from different places

**Sewerage system:** a network of pipes which carry sewage from its source to the treatment plant

**Aeration:** to expose water to circulating air

**Sedimentation:** the process when heavy particles settle at the bottom of the tank.

**Composting:** decomposition of organic matter by the action of bacteria

**Chlorination:** a method of disinfecting water by adding chlorine


- Sewage is the mixture of water and waste products carried off through a drainage system.
- The process of treating wastewater is called sewage treatment.
- It helps to destroy germs and reduce the level of contaminants in wastewater.
- Treatment of wastewater is also an indirect method of water conservation and prevents water pollution.
- Sewage is carried through a system of pipes called the sewer which are linked with each other to form a network called the sewerage system.
- Chemicals like chlorine, bleach, and ozone help in disinfecting water.
- Vegetable waste should be collected for composting.
- Septic tank, composting pit, and chemical toilets are examples of on-site method of sewage disposal.

## Put on your THINKING CAP!

***1. Choose the correct option.***

a) Why should cooking oil, ghee, and fats not be poured down the drains?

i) These will block the pipes and reduce the flow of water.

ii) These will burst the pipes.

iii) These will add harmful chemicals in drains.

iv) These will add microbes in the drains.

b) What is the full form of WWTP?

i) Waste Water Treatment Plant

ii) Well Water Treatment Plant

iii) Waste Treatment Plant

iv) Wind Water Treatment Plant

c) Which statement defines aeration?

i) to expose air to circulating water
ii) to expose water to circulating air
iii) a method of disinfecting water
iv) a method of disinfecting air

d) This is a by-product of sewage treatment and can be decomposed to produce biogas.

i) sewage
ii) sludge
iii) sewer
iv) scum

e) The chemical which is used to kill the harmful microorganisms present in water is

i) fluorine
ii) ozone
iii) chlorine
iv) both (ii) and (iii)

f) The process in which alum is added to water that causes dirt and other particles to stick together is known as

i) sedimentation
ii) chlorination
iii) coagulation
iv) decantation

g) Which of the following is not a water-borne disease?

i) typhoid
ii) cholera
iii) dysentery
iv) hepatitis

h) Our body is composed of about 75% of

i) water
ii) food
iii) wastewater
iv) both (ii) and (iii)

**2. *Match the terms with their meanings.***

| | |
|---|---|
| a) coagulation | i) impurities percolate through layers of sand, charcoal, and gravel |
| b) sedimentation | ii) substance that is left behind after wastewater is treated |
| c) filtration | iii) chlorine is added to the water before it goes to your home |
| d) aeration | iv) alum is added to the water causing dirt and other particles to stick together |
| e) sludge | v) water is sprayed into the air where it mixes with oxygen |
| f) primary treatment | vi) impurities settle to the bottom of the tank |
| g) chlorination | vii) stage at which solids are separated from liquids in wastewater treatment by using screens |

**3. *Arrange the following process in the correct order.***

a) Air is mixed into the tanks with wastewater effluent
b) Chlorine or bleach is added to the effluent
c) Sand and grit are removed
d) Bacteria are removed from the effluent
e) Oils and grease float to the surface



**4. *Give the full form of the following:***

a) UV
b) WHO
c) WWTP

**5. *Tick the correct option.***

a) Aeration adds *oxygen/nitrogen* to water.
b) *Cholera/chicken pox* is a waterborne disease.

c) *Aerobic/anaerobic* bacteria grow in the absence of air.
d) Suspended floating particles form *sludge/scum* on the surface of sewage.
e) *Aeration/septic* tank system is an on-site disposal method.

**6. *Name them.***

a) Two waterborne diseases _____ _____
b) Two substances used to disinfect water _____ _____
c) A biogas _____
d) Two nutrients carried by agricultural wastewater _____ _____

**7. *Write short answers.***

a) What is sewage? Why is it necessary to treat the water before discharge?
b) Why should oil and ghee not be poured into the drains?
c) What does wastewater contain?
d) Suggest any four methods to control water pollution.

**8. *Answer in details.***

a) Explain the wastewater treatment process.
b) What can be done to improve sanitation in public places? Give four methods.
c) How do water treatment plants maintain the quality of drinking water?
d) Describe two on-site sewage disposal systems.

**9. *Define the given terms.***

a) Aeration
b) Coagulation
c) Sludge
d) Contaminants
e) Influent
f) Effluent

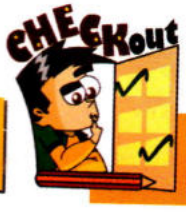
## Extended learning

S 1. Prepare the model of a kitchen drainage system by joining several pieces of plastic pipes to form a network of pipes. Pour a glass of water from one end; add a pinch of colour to it. Add a few pieces of paper along with straw and other objects which can float in water and can pass through the pipes easily. Observe the colour of the water which comes out at the other end. Do you get back the paper, straw, etc.?

S 2. Make a field trip to your local waste treatment plant. Investigate how sludge from waste treatment is stored or recycled. Is it put in a landfill or used as fertilizer or is it simply burnt off? If this is not possible, ask a representative from the water utility to visit the class.

HIGHER ORDER THINKING SKILLS
**HOTS**

Give reasons for the following:
1. Chlorine is added to clarified water.
2. We must not throw polythene packets in the drains.
3. Human excreta should be disposed of properly.






For more information
http://www.buzzle.com/articles/sewage-water-pollution.html

# Summative Assessment 1

(Maximum Marks: 50)

**1. *Fill in the blanks.*** ***(5×1 marks)***

a) The organisms which depend on other organisms for their food are called _____.

b) _____ is a sticky colourless film on the teeth which is created by bacteria.

c) _____ is the art of growing silkworms for silk.

d) Light colours are _____ reflectors and _____ absorbers of heat.

e) Litmus is _____ indicator which is commonly used in laboratories.

**2. *Match the columns.*** ***(5×1 marks)***

| | |
|---|---|
| a) meteorologist | i) a device to monitor wind speed |
| b) weathering | ii) burning of any substance in presence of air |
| c) anemometer | iii) a person who studies the weather |
| d) combustion | iv) solutions conducting electricity |
| e) electrolytes | v) gradual physical and chemical wearing off of rocks |

**3. *State the following as true or false.*** ***(10×1 marks)***

a) Lichen is an example of a symbiotic relationship. ☐

b) Premolars and molars are used to tear the food. ☐

c) Large difference in air pressure and high-speed winds give rise to cyclones. ☐

d) Shearing is the process in which the wool is washed in detergents to remove impurities. ☐

e) The range of a clinical thermometer is from –10°C to 100°C. ☐

f) Bases are bitter in taste and soapy to touch. ☐

g) Dissolving salt in water is a chemical change. ☐

h) Migration is the seasonal movement of animals from one place to another. ☐

i) The dark-coloured layer below the O horizon is called subsoil. ☐

j) Physical change is a permanent change and cannot be reversed. ☐

**4. *Select the correct option.*** ***(10×1 marks)***

a) Lichen is an example of a symbiotic relationship between

i) alga and fungus ii) tree and fungus

iii) alga and plant iv) bacteria and tree

b) Which type of animals have sharp pointed and curved teeth for tearing the flesh?

i) herbivores ii) carnivores

iii) omnivores iv) all of these

c) The process that involves the removal of fleece and a thin layer of skin from the body of sheep is called

i) scouring ii) reeling

iii) carding iv) shearing

d) Metal vessels are generally provided with wooden handles because wood

i) is a good conductor of heat ii) is a poor conductor of heat

iii) reacts quickly to changes in temperature iv) is cheaper and easily available

e) Which acid is found in soft drinks?

i) ascorbic acid ii) boric acid

iii) carbonic acid iv) tartaric acid

f) Which of the following is not an example of chemical change?

i) cooking of food ii) burning of paper

iii) melting of ice iv) ripening of fruits

g) Why do most monkeys have a prehensile tail?

i) to grasp the branches of trees or hold objects

ii) to communicate with each other

iii) to warn their enemies that they are dangerous

iv) to feed the young ones

h) All are the main causes of soil erosion except

i) overgrazing ii) flood

iii) deforestation iv) afforestation

i) The process of deposition of a layer of zinc on an object is called

i) galvanization ii) crystallization

iii) combustion iv) corrosion

j) Why do rail tracks have gaps where two sections are joined?

i) the tracks are made of iron which expands on heating

ii) the tracks are made of iron which contracts on heating

iii) the tracks are made of iron which is a poor reflector of heat

iv) the tracks are made of iron which is a poor absorber of heat

**5. *Answer the following questions.*** ***(10×2 marks)***

a) What is nutrition? Distinguish between autotrophic and heterotrophic modes of nutrition.

b) Why does a thick glass tumbler break when hot liquid is poured into it?

c) How can we get rid of indigestion or acidity?

d) Explain the process of digestion in human beings.

e) With the help of a diagram describe how silk is produced.

f) Define universal indicators. Which flower is used as a natural indicator?

g) Explain briefly how a camel survives in the hot and dry desert climate.

h) Mention the six precautions a person should take when there is a thunderstorm.

i) How is soil formed? Explain the three types of weathering.

j) Show the locations of four different types of taste buds on human tongue.

# Summative Assessment 2

(Maximum Marks: 50)

**1. *Fill in the blanks.*** ***(5×1 marks)***

a) The _____ is a sheet of muscles that separates the chest cavity from other internal organs.

b) The device which gives us the instantaneous speed of the vehicle is called _____.

c) _____ is a device used to prevent the flow of excess current in the circuit.

d) _____ flowers have both the pistil and the stamens.

e) The pulmonary vein carries _____ blood from lungs to the heart.

**2. *Match the columns.*** ***(5×1 marks)***

| | |
|---|---|
| a) the thin coiled wire inside a bulb | i) concave mirror |
| b) helps in disinfecting water | ii) glacier |
| c) network of interconnecting food chains | iii) filament |
| d) used by dentists | iv) ozone |
| e) moving mass of ice | v) food web |

**3. *State the following as true or false.*** ***(10×1 marks)***

a) Deforestation results in global warming, soil erosion, pollution, and loss of animal habitat. ☐

b) Respiration without oxygen is called aerobic respiration. ☐

c) The petals in plants are responsible for sexual reproduction. ☐

d) The act of disposing of urine is called micturition. ☐

e) When a body covers equal distances in equal intervals of time, it is said to describe non-uniform motion. ☐

f) A lens which is thicker in the middle and thinner at the edges is called a concave lens. ☐

g) The water table is the topmost level of underground water. ☐

h) A collection of two or more cells is called circuit. ☐

i) Suspended floating particles form sludge on the surface of sewage. ☐

j) *Spirogyra* is a unicellular alga found in freshwater ponds and in slow streams. ☐

**4. *Select the correct option.*** ***(10×1 marks)***

a) This provides nourishment to the growing embryo.

i) endosperm ii) ovary

iii) ovule iv) zygote

b) The safety device that is used in household circuits to protect the appliances is the

i) bulb ii) fuse

iii) switch iv) battery

c) The part of the respiratory system which is shared with the digestive system is the

i) larynx ii) trachea

iii) bronchus iv) pharynx

d) It is used in headlights of cars.

i) concave mirror ii) convex mirror

iii) concave lens iv) convex lens

e) Which of the following types of blood cells provide immunity to the body against diseases and infections?

i) RBCs ii) WBCs

iii) platelets iv) all of these

f) It measures time by the position of the sun.

i) water clock ii) sand clock

iii) candle clock iv) sundial

g) The seeping down of water into the inner layers of the soil is called

i) infiltration. ii) depletion.

iii) flood. iv) drought.

h) The by-product of sewage treatment which can be decomposed to produce biogas is

i) sludge. ii) scum.

iii) alum. iv) bleach.

i) The organisms that break down the dead leaves, plants, and animals and convert them into humus are called

i) producers. ii) consumers.

iii) decomposers. iv) none of these

j) All of these are pollinated by insects except

i) rose. ii) orchid.

iii) lily. iv) grass.

**5. *Answer the following questions.***

a) What is pollination? With the help of a diagram explain self-pollination and cross-pollination.

b) Distinguish between producers, consumers, and decomposers.

c) Describe briefly the mechanism of breathing in human beings.

d) Define the terms:

i) Uniform motion ii) Non-uniform motion

e) Differentiate between concave and convex lenses.

f) How does transportation of water take place in plants?

g) With the help of a diagram explain the working of an electric bell.

h) Describe the major factors causing the depletion of the water table.

i) How can we improve sanitation in public places?

j) Explain any four uses of the forests.