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.....John Lubbock

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BIOLOGY

CLASS 9

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Don't hide her behind the sky scrapers storeys
Warmth of breez has to be sought
Don't let it to be bought
Don't gift the breath lessness of green house gases
to the blossing buds of generation next
let them see the snow fed mountains
and feel the green bedded plains instead of
reading about them in their text
Daisies, daffodils, Each one is a wonder in itself
do not end them just to please yourself
Be ready to guard you with a plan of prevention
from the attacks of test tube aterrors
and each thoughtless inventions
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BIOLOGY

CLASS IX

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Chapter 1

Cell its structure and functions

In the previous class you have already learnt about cells and their structure. You have also learnt about discovery of the cell, its sizes and shapes, unicellular and multicellular organisms.

Let us recall some of the activities related to these aspects. For example

- Onion cells were nearly rectangular while the cheek cells were circular in shape.

Add other examples as the one given above.

1) _____
2) _____
3) _____

Primarily, cells are studied under the optical microscope. When we observe the cell under a compound microscope, we can see following organelles: cell wall, cytoplasm, nucleus, chloroplast and the mitochondria. However, when the same cells are observed under the electron microscope, a few other structures become visible.

To study various cells scientists have been trying to observe cells from different parts of plants and animals, draw their structures, take photograph of them and make of them. These have given valuable information about the typical plant and animal cells. Here we will try to study the diagram of models of the cell.

Typical Cell

All the organelles shown in the typical plant or animal cell will not exist in every cell. For example, chloroplasts are always shown in the typical plant cell, yet all plant cells do not have chloroplasts. chloroplasts only in the cells of green plant parts like the leaf, tender stem etc. The organelles that feature in most of the cells are included in this model. The typical cell provides a way to study cells. Once we arrive at such a model, we can compare any cell with it. Observe the given diagrams of typical plant and animal cells (Fig-1 & 2).

1. What common features do you see in both the cells?
2. What cell organelles are found exclusively in plant cell?
3. Compare the vacuoles of plant and animal cells, note down the differences.

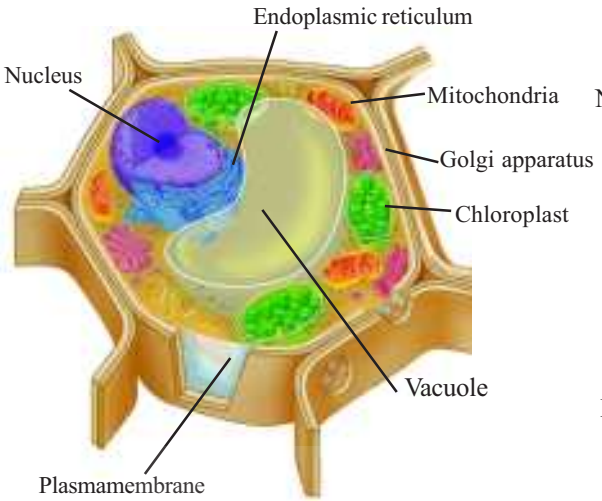


Fig-1 Typical Plant cell

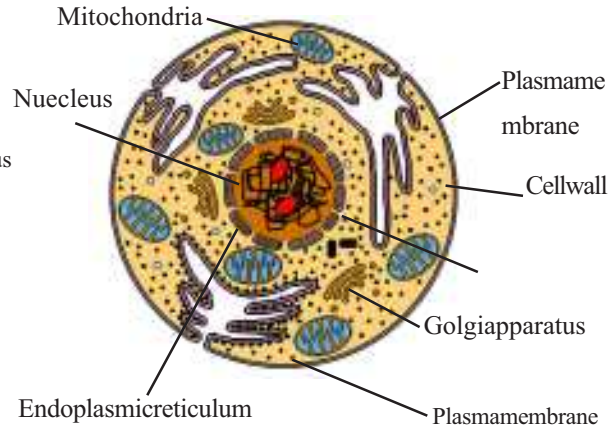


Fig-2 Tipical Animal cell

Let us study the different parts of plant and animal cell.

Cell membrane or Plasma membrane

In your earlier class you have already studied that cell membrane is the covering of the animal cell. In plant cell there is another layer present over the cell membrane known as the cell wall. With the help of the given activity you will be able to see a cell membrane.

Activity-1

Observing cell membrane

Take Rheo leaf, tear the leaf in single stroke. Observe it against the light. Take a small piece of leaf peal with light coloured (transparent) portion. Put it on slide and put a drop of water on it. Cover it with cover slip and observe the light portion of leaf under the microscope.

Draw the diagram of what you have seen?

Now put 1-2 drops of dilute salt solution on the membrane and leave it for 5 to 10 minutes.

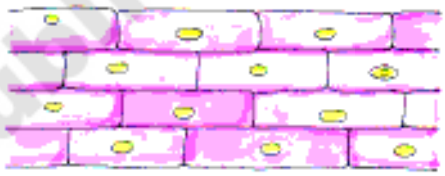


Fig-3(a) Rheo leaf peel cells with membrane

(For preparing salt solution take 50 ml of water and dissolve one tea spoon of salt in it. Stir it well.)

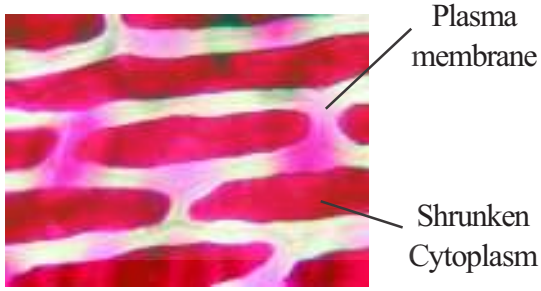


Fig-3(b) Cell membrane

- Observe it under microscope. Draw your observation in your note book.
- Compare the observations of both activities or fig-3(a) and 3(b) and note down the differences?
- Can you guess the reason of the differences?

When we put salt solution over the peel of rheo leaf, water present inside the rheo leaf cells come out. It results in the shrinking of the cytoplasm along with cell membrane. The outer boundary of coloured area is actually the **cell membrane** (fig-3(b)) which became separated from the cell wall.

However we can observe the structure of cell membrane only through an electron microscope. Cell membrane is flexible and is made up of mainly lipids and proteins.

The cell membrane is the outermost layer of the cell that separates cytoplasm from the external environment. This is also known as the **plasma membrane**. The cell membrane defines the shape and size of the cell, encloses the cytoplasm and protects it from the external environment. The internal environment of the cell is different from that of outside. Inside a cell, one finds a very specific composition of substances and balance of various substances is maintained. The cell membrane plays a crucial role in maintaining this balance.

Any substance entering or leaving the cell can do so only through this membrane. The uniqueness of this membrane lies in the fact that it does not allow every substance to pass through it. The exchange of substances through the cell membrane happens very selectively. Hence it is known as selectively permeable membrane. This characteristic of the membrane enables it to control the exchange of substances between the cell and its external environment. You will learn more about the function of cell membrane in the Chapter "Movement of material across the cell membrane".

Cell wall

This is a unique feature seen in plant cells. While the cell membrane acts as the outer layer in an animal cell, in a plant cell there is an extra layer (mainly of cellulose) outside the cell membrane which is known as the cell wall. This is considered to be one of the major differences between plant and animal cells.

The cell wall is a tough but flexible porous layer that lends a definite shape to the cell and it also provides protection. Earlier it was believed to be inactive, but it is now considered to be one of the most significant organs of the cell that continuously exchanges information with other cells during growth and development.

What is the role of cell wall in plant cells?

It exerts an inward wall pressure to resist the outward directed pressure exerted by cell sap hence; the plant cells can withstand much greater changes in surrounding medium than animal cells.

Nucleus

Lab Activity

Aim: To observe the nucleus in cheek cells.

Material required: A tooth pick or ice-cream spoon or spatula, glass slide, coverslip, watch glass, needle, blotting paper, 1% methylene blue, normal saline, glycerine, microscope, etc.

Procedure:

1. Wash your mouth and scrap a little of the internal lining of your mouth

with a clean tooth pick or spatula or ice-cream spoon.

2. Place the scrapping in a watch glass containing a very small quantity of normal saline.
3. After cleaning, transfer the material to a glass slide.
4. Put a drop of methylene blue and wait for a couple of minutes.
5. Wipe off the extra stain with a fine cloth or blotting paper.
6. Put a drop of glycerine over it.
7. Place a coverslip. Tap the coverslip with the blunt end of needle so as to spread the cells.

Precautions:

1. Do not scrap the cheek too hard as it may injure you (buccal mucosa).
2. Scrapped material should be spread uniformly on the slide.
3. Excess of stain should be drained off.
4. There should be no air-bubble under the cover slip

Observe the temporary mount under low and high power of microscope. Draw your observations in your notebook.

1. What was the shape of the cells that you have observed?
2. Were these cells structure similar to the structure in onion peel cell?
3. Was there any darkly coloured spherical or oval dot like structure near the centre of the cell?

You have already studied about this dark coloured dot in cells. This is the nucleus. It was named by Robert Brown in the year 1831. Brown had no idea about its function. This is one of the most important organelles of the cell. This is also known as the cell's control room. The nucleus is the largest and most distinct of all cell organelles. Schleiden, who was one of the proponents of cell theory, thought that new cells were created from the nucleus and he called it the cytoblast.

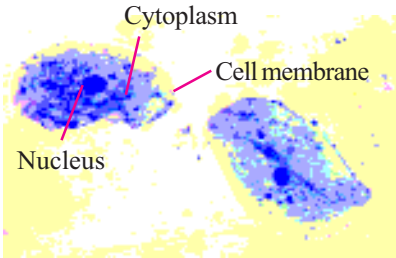


Fig-4 Nucleus cheek cells

Barring a few exceptions, almost all eukaryotic cells have a nucleus. Red blood cells in some mammals and phloem sieve tube in plants are examples of cells that do not have a nucleus. Even these cells do have nuclei in the beginning, but it is later thrown out of the cells and destroyed.

The nucleus regulates and controls all the functions of a cell and determines the characteristics of the organism. It consists of all genetic information. The nucleus is also closely involved in the process of cell division.

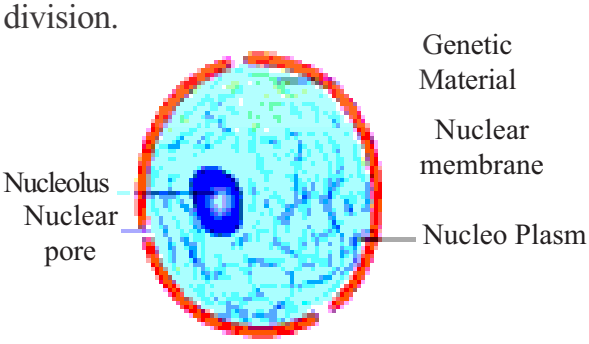


Fig-5 Nucleus
(view through Electron microscope)

The membrane that encloses the nucleus and separates it from contents of cytoplasm is known as the nuclear

membrane. This is very similar to the cell membrane. Almost the entire genetic material of the cells is found in the nucleus.

On the basis of the presence or absense of the organised nucleus cells are categorized into two types, i.e. Prokaryotic cells (without organised nucleus) and Eukaryotic cells (with organised nucleus).

The above description was primarily about eukaryotic cells that contained a membrane bound nucleus. Cells that do not have a nuclear membrane bound nuclear material are called prokaryotic cells. We have mentioned earlier that the bacterium is a prokaryotic cell. Cyanobacteria, blue-green algae also belong to this category.

Cytoplasm

When we look at the temporary mounts of onion peel, we can see a large region of each cell enclosed by the cell membrane. This region takes up very little stain. It is called the cytoplasm. The cytoplasm is the fluid content inside the plasma membrane. It also contains many specialised cell organelles. Each of these organelles performs specific function for the cell.

Cell organelles are enclosed by membranes. In prokaryotes, beside the absence of a defined membrane bound nucleus (or nuclear region), the membrane-bound cell organelles are also absent.

Protoplasm vs. cytoplasm

For a long time it was believed that the essence of life was stored in the fluid found inside the cell. Hence this was named protoplasm which means life fluid. But when it became clear that the fluid is basically a medium in which various particles and membranes float around and that the functions of the cell actually take place in these organelles, it began to be understood that life resided in this organization. In particular, the material inside and outside the nuclear membrane was differentiated after the discovery of nucleus. Hence, protoplasm was renamed as cytoplasm, that is, cell fluid. The fluid inside the nucleus came to be known as the nuclear fluid or nucleoplasm.

Cell organelles

Now let us discuss about some important cell organelles. 1. Mitochondria, 2. Plastids, 3. Ribosoms, 4. endoplasmic reticulum, 5.Glogi apparatus, 6.Lysosomes, 7. vacuoles.

They are important because they carry out very crucial functions in cells.

Endoplasmic reticulum (ER)

When the cell was observed under the electron microscope, a network of membranes was observed throughout the cytoplasm. This network creates passages

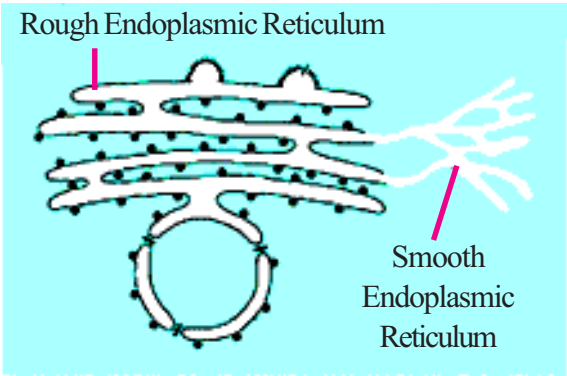


Fig-6 Endoplansmic Reticulum

within the cytoplasm for the transport of substances from one part of the cell to another. This network of membranes is known as the endoplasmic reticulum.

The endoplasmic reticulum (ER) is a large network of membrane-bound tubes and sheets. The ER membrane is similar in structure to the plasma membrane. Endoplasmic reticulum may have some granule like structure on there surface called as ribosomes, such parts are called as rough endoplasmic reticulum (RER). Areas/sections that do not have ribosomes on them are smooth endoplasmic reticulum (SER). Rough endoplasmic reticulum is sites of protein manufacture. The SER helps in the manufacture of fat molecules, or lipids, important for cell function. The manufactured proteins and lipids are then sent to various places in the cell depending on need, using the ER. Some of these proteins and lipids help in building the cell membrane.

Thus, one function of the ER is to serve as channels for the transport of materials (especially proteins) between various regions of the cytoplasm or between the cytoplasm and the nucleus. It also functions as a cytoplasmic framework providing a surface for some of the biochemical activities of the cell. In vertebrate liver cells SER plays a crucial role in detoxifying many poisons and drugs.

Golgi body or Golgi apparatus

Although Camillo Golgi had observed this organelle in the year 1898 using an optical microscope, its finer structure came to be observed only under an electron microscope.

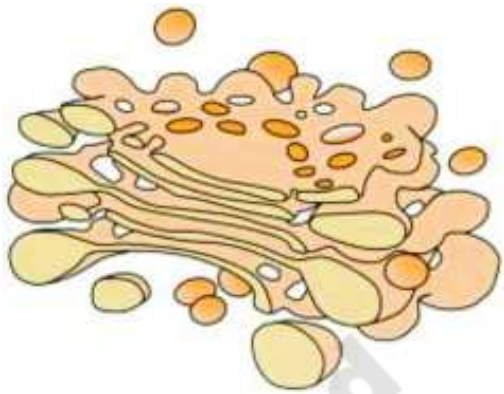


Fig-7 Golgi apparatus

This organelle is also made up of several membranes. These membranes create sac-like structures around which many fluid-filled vesicles abound. The proteins and other substances produced in the ribosome reaches the golgi body through these vesicles. Here, these substances are altered slightly. In one sense, the function of the golgi bodies is to package various substances before they are transported to other parts of the cell. From here these substances are either sent towards the cell membrane or to another organelle, the lysosome. After reaching the cell membrane these substances are secreted from the cell, and sometimes even used to regenerate or repair the membrane.

The number of golgi bodies varies from cell to cell. Their numbers are particularly large in those cells that secrete hormones and enzymes.

Lysosome

One of the facts that troubled the scientists for a long time was that, certain enzymes present in the cell that had the

ability to destroy almost all the structures in the cell didn't damage it. This puzzle was solved when lysosomes were discovered as tiny particles visible in the cytoplasm. It was found that they contained the destructive enzymes. Thus the enzymes normally do not come in contact with the rest of the cell. The materials that need to be destroyed are transported to the lysosomes. At times, the lysosomes burst and the enzymes are released to digest the cell. Hence, lysosomes are also known as the suicide bags of the cell.

Mitochondria

Activity -2

Observing Mitochondria

Let us do this activity with onion peel.

i) Make a fresh solution of Janus Green-B in a Beaker

ii) Mix 200mg Janus Green-B in 100ml of water

iii) Take a watch glass pour some solution. Put the onion peel in this solution and keep it for about half an hour.

iv) Keep a piece of onion peel on the slide and wash thoroughly with water.

v) Cover the slide with a cover slip and observe it under microscope at high magnification.

Observe and make a sketch of the same in your note book. Compare it with the given diagram.

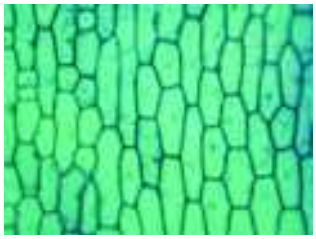


Fig-8(a) Mitochondria in onion peel cell

You can do this activity by taking other available material like leaves of Casiatora or Cheek cells.

You may have observed green oval (or) cylindrical grains scattered in the cytoplasm. These are the mitochondria

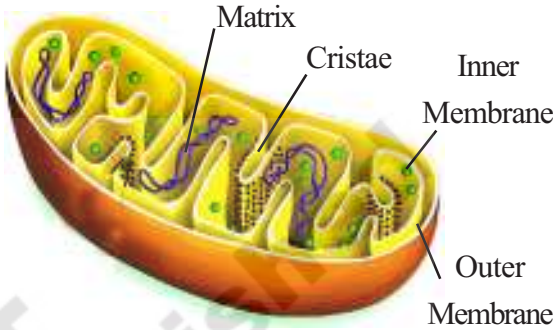


Fig-8(b) L.S. of Mitochondria

Mitochondria are small, spherical or cylindrical organelles. Generally a mitochondrion is 2-8 micron long and about 0.5 micron wide. It is about 150 times smaller than the nucleus. There are about 100-150 mitochondria in each cell. When seen under the optical microscope, the mitochondria appear as oval or cylindrical dots in the cell. Electron microscope reveals their unique internal structure in great detail.

Information derived from the electron microscope tells us that the mitochondria are made of a double-membrane wall. The inner membrane of the wall protrudes into the interior in folds and forms structures called cristae; the space between cristae is known as the matrix.

Mitochondria are responsible for cellular respiration, a process through which the cell derives its energy to do work. Because of this, mitochondria are also known as the cell's powerhouse of the cell.

Ribosomes

There are small granul like structures in the cytoplasm of the cell. They are called ribosomes. We can see ribosomes on the surface of rough endoplasmic reticulam.

Plastids

Activity - 3

Observation of chloroplast in rheo leaf

1. Take the peel of Rheo leaf and mount it in water on a slide.
2. Observe it under compund microscope.

Let us make a drawing of the observations.

You will observe small green granules called chloroplast. They mainly contain green substance called chlorophyll.

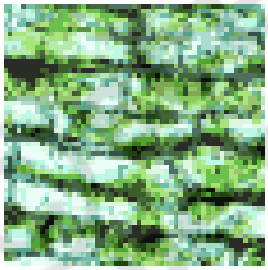


Fig-9(a)

Activity-4

Observing chloroplast in algae

Collect some algae from pond and separate out thin filaments of them. Place a few filaments on a slide. Observe it under the microscope. Take the help of given figure and draw the picture of chloroplast that you have observed under the microscope.

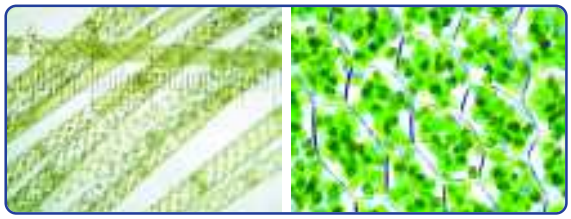


Fig-9(b) Chloroplasts in Algae

Chloroplast is a type of plastid. Plastids are present only in plant cells. Plastids are mainly of two types chromoplasts (coloured) and leucoplasts (colourless).

Chloroplasts are of different shapes

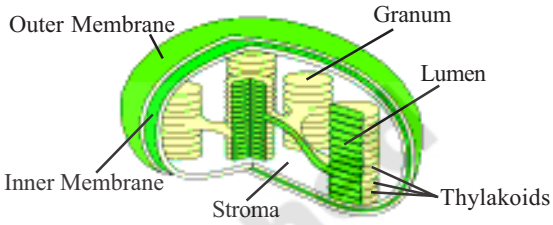


Fig-9(c)

disc, oval etc. In algae, these can be found as ladders, stars, spirals or reticulate. The diameter of chloroplasts in higher plants can vary between 4 to 10 micron. The primary function of chloroplasts is to trap the energy from sunlight and transform it to chemical energy, thus helping to carry out photosynthesis.

Vacuole

Activity-5

Observing vacuoles

1. Take the leaf or stem of any succulent plant (like the torch cactus).
2. Take thin cross section of stem of cactus in a watch glass containing water.
3. Stain it with dilute safranine solution.
4. Observe the section under low and high power microscope.

What do you observe?

The large empty spaces present in the cell are vacuoles. These are fluid-filled sac-like structures. In animal cells vacuoles are small in size while in plant cells they are large. In mature plant cells they might occupy almost the entire cell space.

Do you know?

Certain organelles are present in large number in the cell for example cells involved in photosynthesis may contain around 50 to 200 chloroplasts.

Are cells flat?

Usually when cells are seen under the microscope, the image appears as flat and two-dimensional. It seems that all the organelles in the cell are situated in one plane.

In reality, cells have length, breadth and thickness. We can easily see the length and breadth. Since we cannot see the thickness of the cells under the microscope, we tend to think that these are flat objects. However, there are a few easy ways to observe the thickness of the cells. The easiest method is to slightly change the focus while viewing plant cells on the slide and look at the cell wall. You'll find that you are able to see the thickness of the wall. This three-dimensional image becomes clear if you reduce the intensity of light as well.

Fig-10 Cell

Each cell thus acquires its structure and ability to function because of the organization of its membrane and organelles in a specific way.

Where do cells come from?

The observations so far made it clear that all living beings are made of cells and that each cell has a nucleus. Around 1838-39, two scientists expressed this in the form of a theory. The scientists were Matthias Jakob Schleiden (1804-1881) and Theodor Schwann (1810-1882). Schleiden was a botanist while Schwann was a zoologist. For the record, it should be mentioned that quite a few scientists had recognized by that time that cells were present in all living organisms and were expressing it in their own ways. However, Schleiden and Schwann were the first to claim that this fact was true for the entire plant and animal kingdom. In other words, they took the first bold step of generalizing from observations and coming up with a theory which was applicable to all living organisms. And because of this, the credit for propounding the cell theory goes to them. What is noteworthy is that there was a gap of about 200 years between Robert Hooke first observing cells and the formulation of the cell theory.

Schleiden and Schwann together formulated the cell theory. This theory however did not explain as to how the new cells were formed. Rudolf Von Virchow

(1855) first explained that cells divided and new cells can formed only by the division of the pre-existing cells. He modified the hypothesis of Schleiden and Schwann to give the cell theory a final shape. Cell theory as understood today is based on two cardinal principles.

(i) All living organisms are composed of cells and product of cell.

(ii) All cells arise from pre-existing cells.

Key words

Plasma membrane, Selectively Permeable membrane, Prokaryotic cell, Eukaryotic cell, Chromoplast, Leucoplast, Cisternae, Vesicles, Cristae, Matrix.

What we have learnt?

- The fundamental organizational unit of life is the cell.
- Cells are enclosed by a plasma membrane composed of lipids and proteins.
- Plasma membrane is a selectively permeable membrane.
- In plant cells, a cell wall composed of cellulose is located outside the cell membrane.
- In prokaryotes nuclear membrane is absent.
- The endoplasmic reticulum functions both as passageway for intra cellular transport and as manufacturing surface.
- Lysosomes are membrane bound sacs filled with digestive enzymes.
- The Golgi apparatus consists of stacks of membranes bound vesicles that function in the storage.
- Mitochondria are also known as powerhouse of the cell.
- Two types of plastids are present in cell; chromoplastids and leucoplastids.
- Vacuoles are the storage sacs for solids or liquid contents.
- All cells arise from pre-existing cells.

Improve your learning

1. Differentiate between (A.S 1)
   (a) Plant cell and animal cell
   (b) Prokaryotic and eukaryotic cells

2. What happens if plasma membrane ruptures or breaks? (AS 2)
3. Prepare a model of plant cell or animal cell. (AS 5)
4. What would happen to the life of cell if there was no golgi complex? (AS 2)
5. What happen to cell if nucleus is removed? Give reasons to support your answer? (AS 1)
6. Lysosomes are known as suicidal bags of the cell? Why? (AS 1)
7. Why do plant cell posses large sized vacuole? (AS1)
8. Prepare a temporary mount of any leaf peel observe the stomata draw their picture? Write a short note on the same. (AS 5)
9. "Cell is the basic unit of life", explain the statement.(AS 1)
10. How do you appreciate about the organization of cell in the living body?(AS 6)
11. If the organization of cell is destroyed due to physical and chemical influence what will happen? (AS 6)
12. Read the chapter carefully collect the information about the functions of different cell organelles and make a table which contains serial number. Cell organelle, function. Don't forget write your specific findings below the table? (AS 4)
13. How could you appreciate function of tiny cell in a large body of an organism (AS 6)
14. Look at the following cartoon of a cell. Find out the functions of cell organelles (AS 5)

15. Who and when proposed cell theory. What are salient features of it? (AS 1)

Chapter 2

Plant tissues

You have already learnt about different cell organelles and their functions in the chapter ***"Cell its structure and functions"***. In unicellular organisms, a single cell performs all the functions. But in multi-cellular organisms there are numerous cells, performing various functions.

Plants that we observe around us are usually multi-cellular. They perform several life processes such as growth, respiration, excretion, etc, similar to those performed by animals. In addition to these they can perform photosynthesis and prepare food not only for themselves but also for all the other living organisms dependent on them, either directly or indirectly.

Let us recall the information about different parts of the plants and the functions they are associated with.

Activity-1

Parts of the plants and their functions.

We have studied about the functions of plant parts in earlier classes. Read the functions given below and write the name of the parts involved in performing the respective function.

S.No	Function	Name of the parts
1	Absorption of water from soil	
2	Exchange of gases (air)	
3	Photosynthesis	
4	Transpiration	
5	Reproduction	

- How can the plants perform all the life processes?
- Is there any specific arrangement of the cells in plants that help in carrying out these processes?

Let us try to find out more about arrangements of cells in plants and their functions by the following activities.

Do the following activities with the help of your teacher.

Activity-2

Cells in onion peel

- Take a piece of an onion peel.
- Now place it on the slide.
- Put a drop of water and then a drop of glycerin on it.

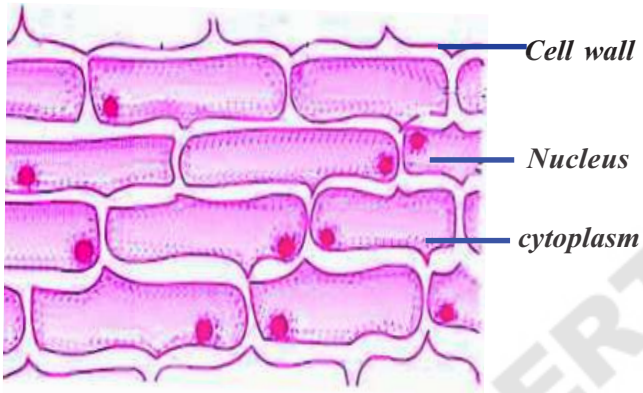


Fig-1 Onion peel

- Gently cover it with a cover -slip.
- Observe it under the microscope.
- Draw and label the diagram, what you have observed under the microscope.

Compare your drawing with the figure-1 to find out labeled parts.

- Are all the cells similar?
- How are the cells arranged?

Activity-3

Cells in a leaf peel.

- Take a betel leaf or a Tradescantia leaf.
- Tear it with a single stroke. So that a thin edge be seen at torn end.
- Observe the thin edge where the leaf

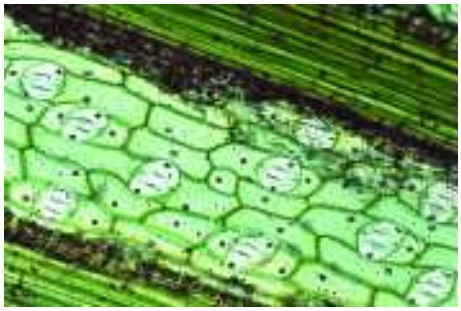


Fig-2 Betel leaf peel

has been torn under the microscope in the same manner as you had observed the onion peel.

Draw a diagram of what you observed and compare with the following.

- Are all the cells similar?
- Is there any difference in their arrangement?
- What can we infer from the above activities?
- Do you find cells in groups in both the activities?
- Compare and write a note on the arrangements of the cells as you see in both the activities.

You may have observed that the cells are present in groups with certain arrangement. With the help of following activities we shall try to find out whether these arrangements have special roles to play in the plant body.

Activity-4

(a) Cells in root tip

- Are the cells in the root similar to that in a leaf. Let us find out how the cells are arranged in the root. For this we need onion root tips.

- Take a transparent (plastic/glass) bottle fill with water. Take an onion bulb slightly larger than the mouth of the bottle.
- Put the onion bulb on the mouth of the bottle as shown in the fig-3.

Fig-3 Onion root

- Observe the growth of roots for a few days till they grow to nearly an inch.
- Take the onion out and cut some of the root tips.
- Take an onion root tip.
- Place it on the slide.
- Put a drop of water and then a drop of glycerin on it.
- Cover with cover-slip.
- Put the 2-3 layer of filter paper on the cover slip,
- Tap the cover-slip gently press with the blunt end of the needle or brush to spread the material.
- Observe the structure and arrangement of the cells.
- Draw diagram that you observed under microscope.

· Are all the cells similar?

· What is the arrangement of cells?

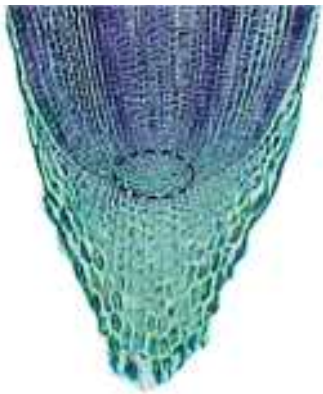


Fig-4 Onion Root Tip

Activity-5

(b) Growing roots

- Take the onion used in the previous activity and mark the cut end of the roots with a permanent marker.
- Put it in the same set up as used in the previous activity.
- Leave the set up aside for at least four to five days. Take care that there is enough water in the glass so that the roots are submerged.

- Did all the roots grow in a same manner?
- What happened to the roots which had been cut off?
- Write down your findings, regarding the cut roots and those that were not?

We observe that by removing the tip of the onion root, having a particular arrangement of cells, the growth of the root in length is stopped.

You have observed that cells are present in groups. Cells in groups which are nearly similar in structure perform similar functions. Such groups of cells are called tissues.

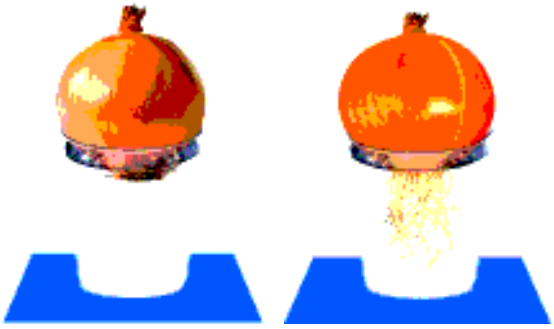


Fig-5 Growth of roots in onion bulb

One day Haritha went to a park with Latha. There she saw a gardener had been cutting the tips of the plants with cutter. She had a doubt and asked the gardener.

Let us read the conversation

"How do the plants grow if the tips have been cut off?"

He said "Branches will grow from the sides".

Later she saw another gardener, watering a stump. She went there and asked.

"Why are you watering the stump?"

"The stump will soon bear leaves" He said

Haritha had a question in her mind, "How will the leaves come?" Do you know the answer?

Now we will study about those tissues that bring about growth, repair and other functions in a plant body.

There are four basic types of tissues in the plants. They are

- Tissues that bring about overall growth and repair are called **Meristematic tissues**.
- Tissues that form outer coverings are called as **Dermal tissues.**
- Tissues that form the bulk of the plant body, helping in packing other tissues are called as **Ground tissue**s.
- Tissues that help in transport of materials are called as **Vascular tissues**.

You have already observed some types of tissues. To observe the various types of plant tissues we need to know some techniques for preparing slides and cutting sections. See annexure-1 for the same.

Meristematic tissues

Observe the given figure of a stained section of a shoot tip.

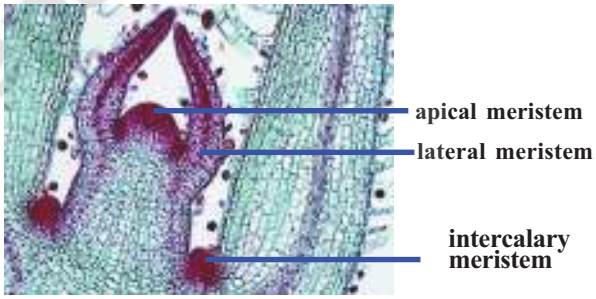


Fig-6 L.S. of a Shoot tip

From the above figure you can infer that meristematic tissues are present on the tip, sides and in between layers of other tissues. Meristematic tissues at the growing tip that bring about growth in length are called as **apical meristematic** tissues.

Tissues present around the edges in a lateral manner and giving rise to growth in girth of the stem are called **lateral meristematic** tissues.

Areas from which branching takes place or a leaf or a flower stalk grows, we find a kind of meristematic tissue called as **intercalary meristematic (also called as Cambium)** tissue.

Activity-5

We had already observed the tissues present in the root tip in earlier activities.

Table -2

Arrangement of the cells (Tissues)	Shoot tip	Root tip
At the tip		
At the lateral side		
At the point of branching		

From all this we can conclude that different types of meristematic tissues are present both in the root tip and shoot tip.

Cells in the meristematic tissues are

- Small and having thin cell wall.
- Living with prominent nucleus and abundant cytoplasm.
- Compactly arranged without intercellular spaces.
- Continuously dividing cells.

Let us learn about the other types of tissues.

Activity-7

Dicot Stem tissues

- Prepare a temporary mount of the TS of a dicot stem.

Can we find the above tissues in the root tip as well?

Activity-6

Comparing the shoot tip and the root tip – Meristamatic tissue

Carefully observe the figures of root tip and shoot tip. Do you find any similarities or differences between the two? Note down your observations in the following table-2

- Observe it under the microscope.
- Draw and label the diagram.
- Compare it with figure given below

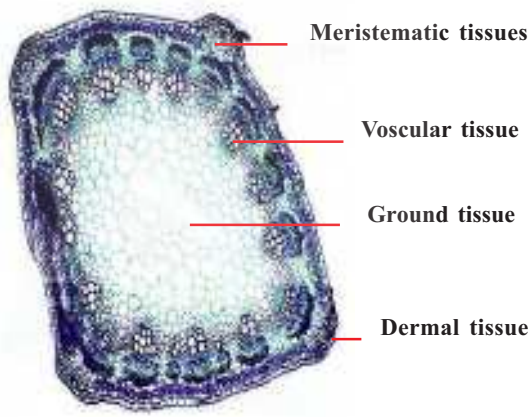


Fig-7 Dicot stem (TS) - Tissues

- What are the similarities between the shoot tip tissues and the tissues as shown in the above figure?
- Are all the cells similar in shape and structure?

- How many different types of arrangement of cells (in the form of tissues) could you see in the given figure?

You have already studied about the meristematic tissues. The other major groups that we shall study now are dermal tissue, ground tissue and vascular tissue. These develop from the cells of the meristematic tissues during the growth and repair of the plants parts.

Dermal Tissue

- What kind of arrangements do you observe in the outer layer of the TS of stem?

We can find the dermal tissue over the entire surface of the plant body.

We will do the following activity to observe the dermal tissue more closely.

Activity-8

Rheo leaf - Dermal tissue.

- Take a fresh leaf of Rheo or Betel plant
- Tear it with a single stroke, so that a thin whitish edge can be seen at torn end.
- Slowly remove it and observe that peel under the microscope (by preparing a temporary mount).

See the arrangement of cells .Are all cells similar? Are there any spaces between the cells?

This activity shows a part of the dermal tissue of plants.

Dermal tissue (Dermis) usually consists of a single layer of tissues showing variations in the types of cells. On the basis of their functions and location. This tissue is studied as three different types- epidermis (outer most layer), mesodermis (The middle layer) and endodermis (the innermost layer).

The walls of the cells of dermal tissue are thicker as compared to the cells of meristematic tissues. In desert plants it may be even more thick and waxy. Small pores are seen in the epidermis of the leaf, called stomata. They are enclosed by two kidney shaped cells, called guard cells. Cells of the roots have long-hair like parts, called root hairs.

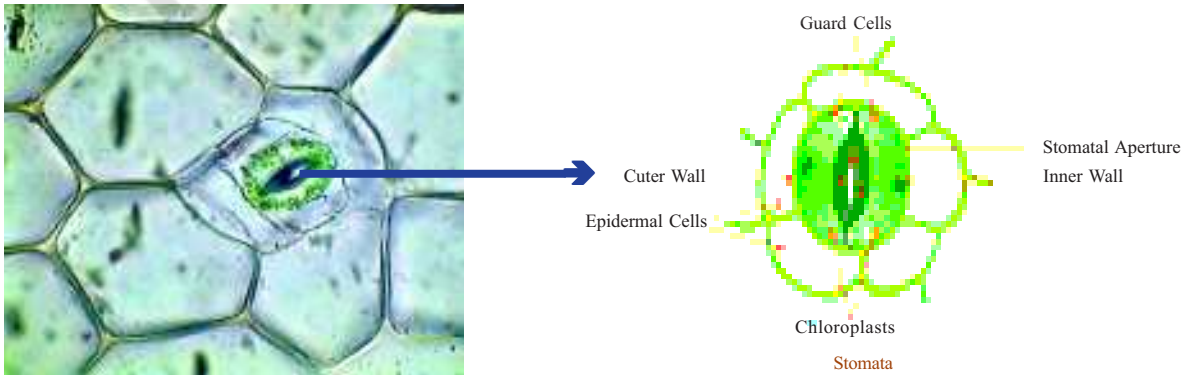


Fig-8 Peel of Rheo leaf – Dermal tissue

Do you ever saw sticky substance on the trunk or branches of tree like Acacia, Neem, etc,. What is it? Where is the gum secreted from?

Do you know?

Plants have the ability to store certain substances that are either their excretory products or accumulated food or some secretary substances in different ways. Gum is secreted from the dermal layer of gum tree.

The dermal layer protects the plants from loss of water, mechanical damage and invasion by parasitic and disease causing organisms. In big trees the dermal tissue forms several layers above the epidermis. It is called bark.

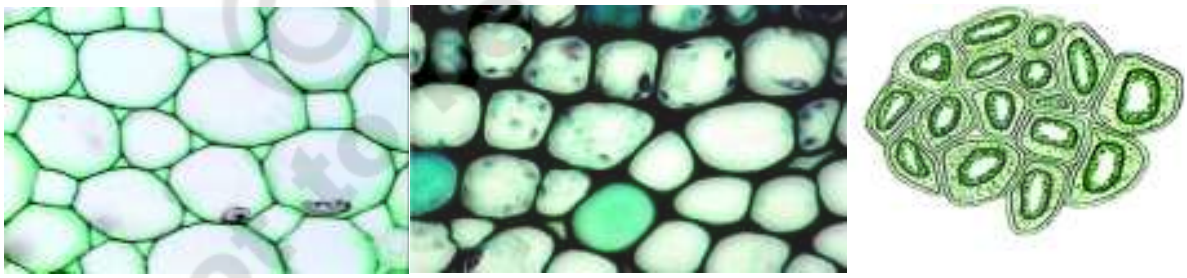
Stomata and root hair are also dermal tissues that are essential for gaseous exchange and transpiration as well as absorption of water and minerals respectively. Photosynthesis is also carried out by certain cells of this tissue.

Ground Tissue

You have seen the ground tissue in the T.S. of stem (Figure 7). Make a sketch of the arrangement of cells you had seen.

You can see that cells appear larger with prominent walls.

These cells form the ground tissue. It forms the bulk of the plant body. The ground tissue is useful for storing food and providing physical support to the plant body. There are mainly three types of ground tissues. They are parenchyma, collenchyma and sclerenchyma.



Parenchyma *Collenchyma* *Sclerenchyma*

Fig -9 Ground tissue- Types

The cells of the parenchyma are soft, thin walled and loosely packed. The Parenchyma which contains chloroplasts is called "Chlorenchyma". The Parenchyma which contains large air cavities or spaces is called "Aerenchyma". The Parenchyma which stores water or food or waste products is called "Storage Tissue".

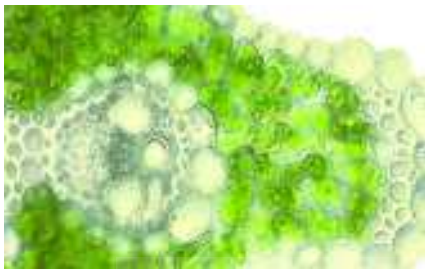
Collenchyma tissues have thicker walled, longer cells compared to parenchyma.

In the sclerenchyma the cells are thick walled and compactly arranged with nearly no spaces between them.

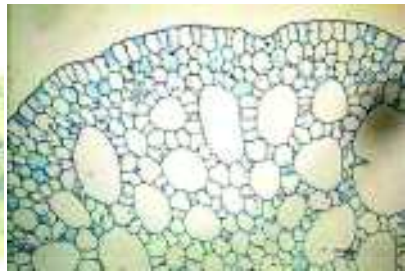
Let us observe the ground tissue of some other stems

Activity-9

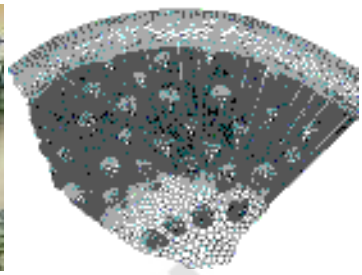
Take permanent slides of Chlorenchyma, Arenchyma, Storage Tissue in your laboratory observe under microscope find out the characters and differences write in your notebook.



Chlorenchyma



Arenchyma



Storage Tissue

Fig -10

Do you know?

Nehemiah Grew (1641-1712) was practicing physician and worked as the secretary of the Royal Society, London. He began his work on the study of internal structure of the plants in the year 1664.

Grew's fundamental inference was "Every plant organ consists of two types of organical parts. One is pithy and other is ligneous part".

Grew gave the term **"parenchyma"** for the pithy part. Grew initiated the study of tissues (Histology) in plant bodies and published his work as the book 'Anatomy of Plants' in the year 1682.

Nehemiah Grew (1641-1712)

Vascular Tissue

We know that roots can absorb water from the soil and send it to other parts of the plant. The leaves and other green parts prepare food and supply it to all the parts of the plant.

Let us study the tissues involved in transportation.

We had performed an experiment on transportation in class VII, in the chapter on plant nutrition. We had seen that if the plant is kept in red coloured water. Some of the parts of the plant turned red. Do the same experiment again by keeping a small plant (with roots) in red coloured water? Leave it for two hours. Now cut a T.S. of the stem and observe it under the microscope.

- Which portion of the plant is responsible for this transport?
- Draw a rough sketch of the portion and mark the portion that appeared red.

- What do you conclude from your observation?

The tissues involved in transportation are vascular tissues. They are composed of different types of cells and their specific arrangements.

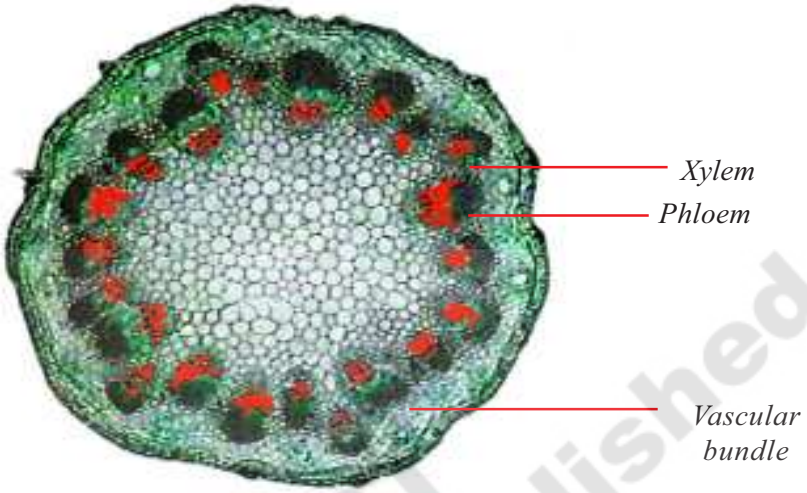


Fig-11 TS of stem

The part that appeared red is Xylem tissues, while the cells adjacent to these (As shown in the figure 12) are of phloem tissues. Xylem is responsible for transport of materials away from the root. Phloem helps in the transportation of the material away from the photosynthetic parts of the plants. Hence they are known as conducting or vascular tissues. xylem and phloem together form the vascular bundles.

The vascular tissue gives mechanical support to the plant as well.

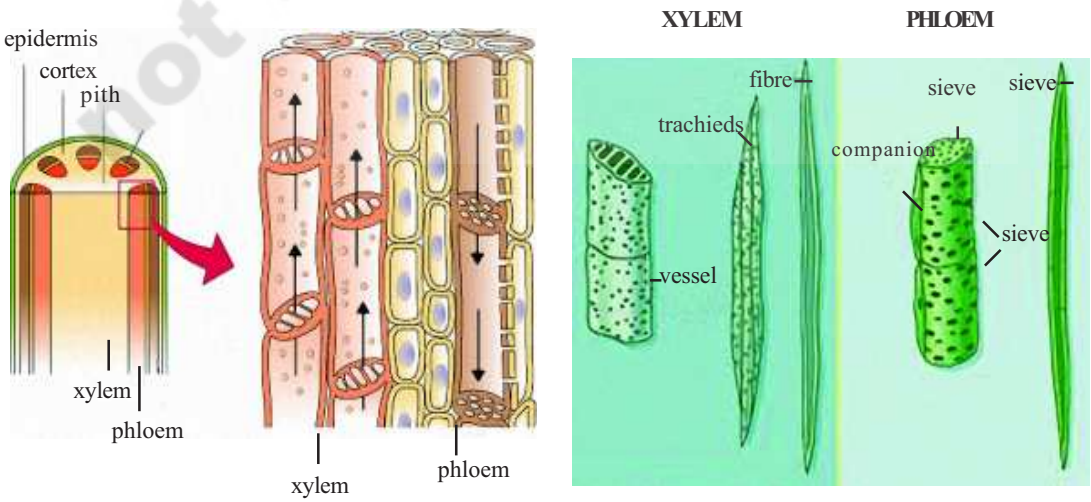


Fig-12 Different Cells of Xylem and Phloem

Xylem contains elongated tracheid cells, tubular vessels, fibres and parenchyma Phloem contains long sieve cells and sieve tubes, companion cells, fibres and parenchyma.

Do you know the vascular tissues carry water to great heights in the plant body. It is up to nearly 200 ft in Eucalyptus plants and up to nearly 330 ft in the red wood trees.

We have seen in this lesson that plants have different types of tissues which are arranged in specific manner to carry out different functions in the plant body.

Key words

Tissue, Meristematic tissue, Apical meristem. Later meristem, Inter calary meristem. Dermal tissue, Epidermis, Bark, Ground tissue, Parenchyma, Collenchyma, Sclerenchyma, Vascular tissue, Xylem, Phloem, Vacular bundles, Trachieds, Vessels, Fibres, Sieve cells, Sieve tubes, Companion cells.

What we have learnt?

- Tissue is a group of cells similar in structure, and performing similar functions.
- Meristematic tissue is the dividing tissue, present in the growing regions.
- Meristematic tissue is mainly of three types. They are Apical meistem, Lateral meristem and Intercalary meristem.
- Dermal tissue covers the plant body and gives protection.
- Ground tissue is bulk in all the parts of the plant and gives support and stores food. It is of three types. They are Parenchyma. Collenchyma and Sclerenchyma.
- Vascular tissue conducts transportation. It is mainly of two types. They are xylem and phloem.

Improve your learning

1. Define the terms (AS 1)
   - Tissue
   - Meristematic tissue
   - Dermal tissue

2. Differenciate in between the following (AS 1)
   - Meristematic tissue and Ground tissue
   - Apical meristem and lateral meristem
   - Parenchyma and collenchyma
   - Sclerenchyma and parenchyma
   - Xylem and phloem
   - Epidermis and bark
3. Name the following (AS 1)
   - Growing tissue, which cause growth in the length of the plant.
   - Growing tissue, which cause growth in the girth of the plant.
   - Large air cavities in the aquatic plants.
   - Food material in pharenchyma.
   - Pores essential for gaseous exchange and transpiration.
4. Compare and contrast the following (AS 1)
   - Xylem and phloem
   - Meristematic tissue and Dermal tissue.
5. Give reasons to the following (AS 1)
   - Xylem is a conductive tissue
   - Epidermis gives protection
6. "Bark cells are impervious to gases and water". What experiment you will perform to prove this? (AS 3)
7. Chlorenchyma, Arenchyma and storage tissue – Even though these three are parenchyma. Why do they have special names? (AS 1)
8. Draw and label the diagram of the T.S. of stem (AS 5)
9. Describe the functions of - Meristem, Xylem and phloem (AS 1)
10. While observing internal parts of plants, how do you feel about its structure and functions? (AS 6)
11. If you want to know more about tissues in plants what questions you are going to ask? (AS 2)
12. Collect information about dermal tissues of plants in what way they help to them. (AS 4)

ANEXURE

In this technique fine sections of the material are cut. Figures in next page will help you to understand this technique.

- To get section cuttings pith material is taken as the support. A slit is made in the pith material longitudinally.
- The specimen (root or stem or leaf or bud) is inserted in the slit for section cutting.
- To get longitudinal section (LS) the specimen should be inserted in the pith material transversely.
- To get transverse section (TS) the specimen should be inserted in the pith material longitudinally.
- Thin sections should be cut, using the blade as a tool.
- Collect the cuttings in a watch glass with water.
- Select one thin section and put it on a glass slide with the help of a small brush.
- Put a drop of glycerin on it.
- Stain with a drop of safranin.
- Gently cover with the cover-slip using needle.
- Use blotting paper to remove the excess water or glycerin or stain.
- Then observe under the microscope.

(a) Material

(b) Making the pith material

(c) Making slit in the pith material

(d) Cutting specimen to get TS

(e)Inserting the Specimen to get TS

(f) Section cutting with blade

(g) Taking the thin section with brush

(h) Keeping the section on the slide

(i) Putting a drop of water, Glycerin

(j) Staining with safranin

(k) Covering with cover-slip

(l) Obsere under Microscope

Chapter 3

Animal tissues

We had learned about plant tissues in the earlier chapter. Do animals also have the four major groups of tissues as in plants? To study about the animal tissue we can take examples of tissues present in some animals that we see around us. In the chapter on plant tissues we observed that different types of functions were carried out by different tissues. We will try to see whether this happens in animals also.

We know that different organ systems work to carry out different functions.

Enlist them:

1. .....
2. .....
3. .....

- Do some tissues help the organs to carry out their functions?
- How do they do so? Discuss with your friends and write.

There are different kinds of tissues in the animals to perform different functions like plant tissues. Some tissues cover and protect the body. Some tissues helps in the movement which is performed by muscles and bones and other types of tissues make connection between these two tissues. Some tissues carry information like responses.

We will try to learn more about the tissues by doing the following activities.

Lab Activity

Aim: Identification of tissue in collected sample.

Apparatus: Microscope, slide, dil Hcl, forceps, brush.

Procedure: Collect a small piece of chicken with bone from your nearby chicken centres or market.

For observing each type of tissue, you need to follow specific procedure. After completion of every activity, do not forget to draw the diagram and answer and discuss the questions.

- Put it in dilute HCl for two hours.
- Take the skin part of chicken peice.
- Place the material with forceps or brush on the slide.
- Then keep the another slide on it and press both gently.
- Observe under microscope
- Draw the diagram of what you observe under microscope in your

note book. Compare your diagram with the following picture.

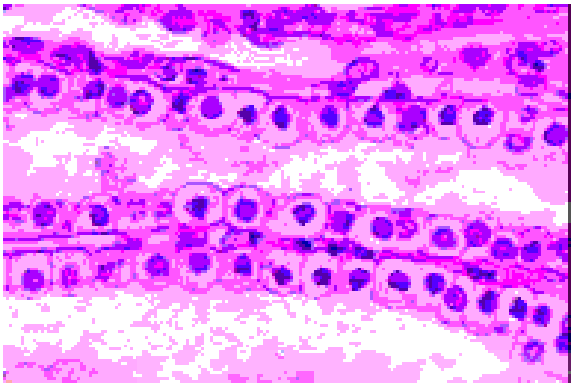


Fig-1 Epithelial Tissue

Now try to find out the answers.

- Are all the cells similar?
- How are they arranged.
- Are these cells tightly packed and formed as continuous sheath?
- Is there any inter cellular space?
- Think, why these cells look like continuous sheath?
- Does this tissue covering protect inside and outside of the animal body?

Procedure - 2

- Take a sterilized syringe needle.
- Collect one drop of blood from finger tip by pricking with syringe needle. (Under guidance of teacher)
- Take a slide. Keep the finger on the slide to collect one drop of blood
- Put another slide on it gently and press both sides.
- Observe under microscope
- Draw the diagram of what you observe under microscope in your note book. Compare your diagram with the following picture.

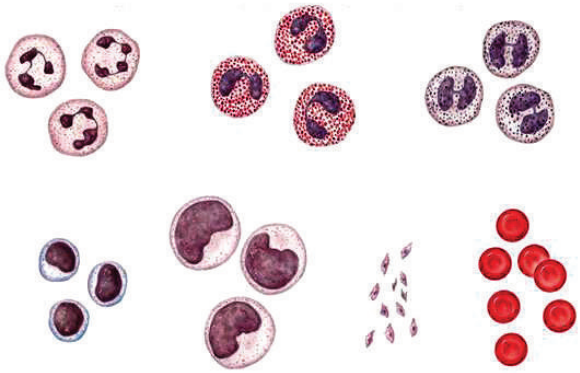


Fig-2 Blood

Now try to find out the answers.

- What you observe?
- Are all cells in your blood sample are same?
- Is there any fluid like substance?
- While making a blood slide, sometimes air bubbles also formed. It may confuse you. Do not be hurry to observe.
- Do you agree that blood is also a tissue?

Procedure - 3

- Take a piece of muscle of chicken which is collected for activity-1.
- Put in diluted HCl or vinegar and leave it for two hours.
- Next morning collect the piece of muscle on a slide with forceps.
- Put another slide on it and press both sides gently.
- Observe under microscope.
- Draw the diagram of what you observe under microscope in your note book. Compare your diagram with the following picture.

Fig-3 Muscle

Now try to find out the answers.

- How are the cells arranged?
- Do you find any difference between skin cells and muscle cells?
- If you want to observe the bone tissue in the chicken bone, settle it in vinegar or diluted Hcl over night. It is better to do this one day before your discussion in the class. Then only the bone becomes soft. Take a piece from it by using knife.
- Do you find any relation among these tissues?
- Is this tissue useful for movements in our body?

There are four types of tissues in the animals

- Covering or protecting tissue, inside or outside of animal body, is epithelial tissue.
- A loosely spaced and imbedded in intra cellular matrix whixh makes connection between organs is called Connective Tissue.
- The tissue which is responsible for movements in our body is known as muscular tissue.
- A specialized tissue that responds to internal, external stimuli, nerves tissue.
- Are the functions of all the above tissues the same?

Let us study about tissue in our body.

Epithelial Tissue:

(Epi means-Outer, Theliuam means-Tissue)

Epithelial tissues are present in the skin, lining of mouth, lining of blood vessels, lung alveoli and kidney tubules.

Activity-1

Collect the substance lining of mouth by using wooden spoon and observe this under microscope. Draw the diagram that you observed in the microscope, in your note book.

- How are the cells arranged
- Are there any inter cellular spaces?

The epithelial tissue, extremely thin and flat, form a delicate lining. This is called as squamous epithelium. We find this type of epithelium in oesophagus, lining of mouth, lining of blood vessels, lung alveoli where transportation of substances selectively occurs through permeable membrane (you will learn about permeability next chapter transportation substance through plasma membrane).

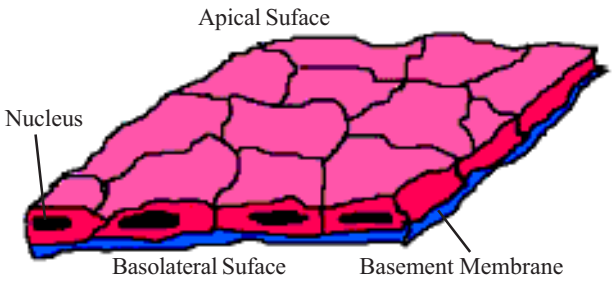


Fig-4 Squamous Epithelium

The epithelial cells in skin are arranged in the form of layers. This is called as stratified squamous epithelium.

- Think, why are the epithelial cells in skin arranged in the form of layers?
- If you drink hot tea or chilled cool drink, how would you feel?
- If your skin burns or wounded which tissue would effected.

Activity-2

Take a permanent slide of cuboidal epithelium from your laboratory slide box and observe under microscope. Draw the picture in your note book. How are the cells arranged?

Fig-5 Cuboidal Epithelium

These are the cuboidal epithelial cells form the lining of kidney tubules. The ducts of salivary glands were providing mechanical support.

Do you know?

Sometimes a portion of epithelial tissue folds inward and formed a multi cellular gland. Hence it is called as granular epithelium.

Activity-3

Take a permanent slide of columnar epithelium from the slide box and observe under microscope.

Fig-6 columnar epithelium

- Draw the figure that you observed under microscope
- How are the cells? Do you find any hair like projections on the outer surface of epithelial cells.

These types of cells are present where absorption and secretion occurs. Try to think where do this type of epithelial tissues present in your body?

Do you know?The skin is also a kind of epithelial tissue. Where does nails, and hair grow from. The scales of fishes, reptiles and feathers of birds also grow from epithelium. These are modified epithelial cells. You learn more about them in the chapter: Adoption in Ecosystem.

Connective tissue

If you tilt any part of your body, what will happen to internal organs? Is there any displacement? The internal organs located at specific places ,because there is no displacemet in organs due to connective tissues. They connect organs and muscles.

These tissues are called connective tissue.

Connective tissues help in binding the other tissues and organs together and provide a frame work and support to various organs in the body. These tissues also play a major role in the transport of material from one tissue to another. They also help in the body defence, body repair and storage of fat. There are different types of connective tissues, each performing a different function.

How do glass wear items carry for longer distance?

Areolar tissue is one type of connective tissue which joins different tissues. It helps in packing and helps to keep the organs in place. These cells are called fibroblasts. These are the major components in this type of connective tissue. These cells secrete fibrous material which holds the other tissue in position. These cells also help in repair of the tissues when they are injured.

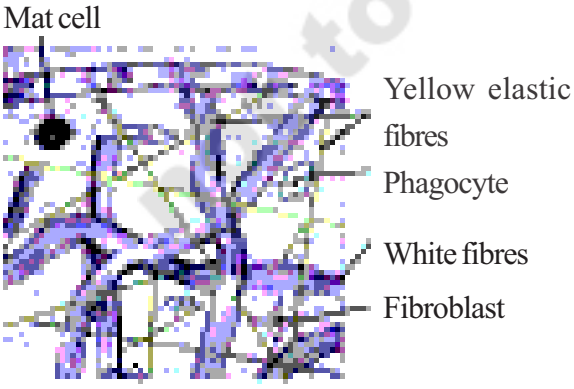


Fig-7 Areolar Tissue

The muscle in our body is attached to the skin and bone by this type of tissue. We can see this type of tissue around blood vessels and nerve.

Why do old people shiver in winter when compared to youngsters? Is there any insulator like substance to prevent the escape of heat energy during winter?

Fat storing adipose tissue is found below the skin and between internal organs. The cells of this tissue are filled with fat globules. Storage of fat also acts as insulator.

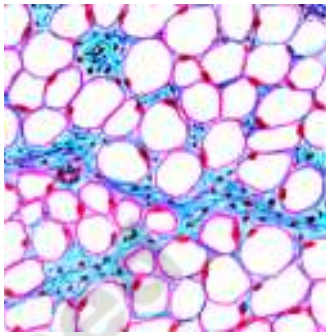


Fig-8 Adipose tissue

Are all tissues in our body smooth and soft?

Which tissue gives definite shape to body of vertebrae?

Bone is another type of connective tissue; it forms the frame work that supports the body. It is a major component of the skeletal system of several vertebrae (except some fishes like sharks).

Do you know?

Bone is made of calcium phosphate and calcium carbonate. These salts are secreted by cells called osteocytes. These cells are present in the central hollow portion of the bone called bone marrow.

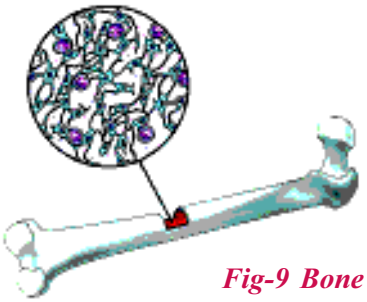


Fig-9 Bone

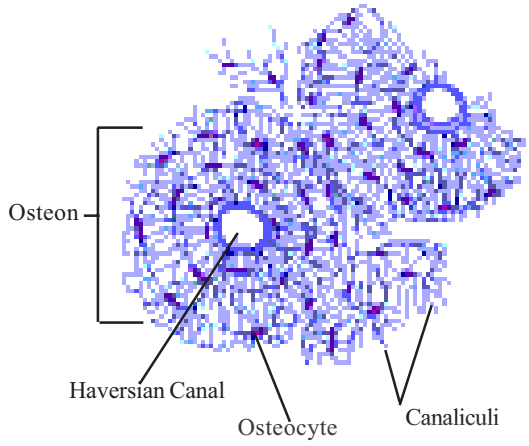


Fig-10 Osteocyte (bone cells)

Cartilage is a type of connective tissue found in the joints of bones, tip of ribs tip of the nose, external ears and in trachea. Embryos of several vertebrae do not have bone but have cartilage. The entire skeleton of fishes like sharks is made of cartilage. Cartilage is hard but not as hard as bone.

Fig-11 Cartilage

How two bones are connected at joints?

Ligament is yet another type of connective tissue that connects bones at the joints and holds then in position. It is made up of large number of fibres. These fibres are made of a protein called collagen. This is very elastic in nature.

You know that, body movement is because of muscles with the help of bones. How muscles are attached to bones?

Tendon is a type of connective tissue which is also made of fibres.

The tendon joins the muscle to the bone. It is also made of collagen.

Think and discuss

Blood is a type of connective tissue. Why would it be called connective tissue?

Activity-4

Invite a scientist or doctor to your place. Recrod an interview about blood structure and its functions. It is important to make a questionnaire inorder to conduct interview. After completion of interview, prepare a booklet about blood and display it on bulletin board or class room library.

It differs from other types of connective tissues. There are different types of cells in blood and each one has a different function. All the cells in the blood cells float freely in the plasma. Extra cellular space is filled with fluid called plasma. There are no fibres in blood.

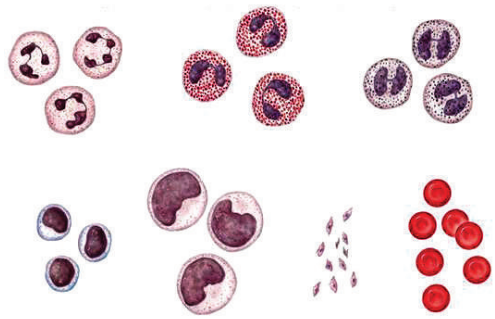


Fig-12 Blood cells

Story of blood

Recall the activity 2. Blood is also a tissue which is having different components. Let us know more about blood.

There is red stream that flows in closed canals in our body. Think what is it?

The red stream that flows in closed tubes in our body is blood. It is also a type of connective tissue. Blood explains many things about us. Blood is the source to identify our wellness or illness. It is very interesting to know about blood current in our body. There is highly sophisticated and well developed mechanism to circulate the blood to the entire body. Our heart pumps the blood 36 thousand liters of blood in the distance of 20 thousand kilometers in the time period of 24 hours. Blood is red in colour. Animals can not be our relatives. Do you agree with the statement that animals with red coloured blood. The blood is always not red in all animals. The cockroach has white blood where as there is blue coloured blood in snail. It is really a wonder that blood appears in different colours.

Normal adult human beings have about 5 litres of blood. A chief component in plasma is water.

Besides water, it also has several nutrients such as glucose, amino acids, proteins, vitamins and hormones etc. required for the body and excretory products such as lactic acid, urea, salts etc. Plasma also contains factors responsible for blood clotting. Herarine helps to prevent blood clotting in blood vessels.

Cells present in blood are corpuscles. They are three types 1. RBC 2. WBC 3. Blood platelets.

Red blood cells also known as erythrocytes are red in colour. They have red coloured protein called haemoglobin. Because of haemoglobine blood is red in colour, which helps in the transport of oxygen and carbon dioxide 1ml of human blood has about 5 millions of red blood cells which live for 120 days in blood.

We can make a chain of red blood cells around the earth at equator with 7 circles. When you are in mother's womb your RBC are formed in the liver and spleen. After your birth these RBC are generated from the bone marrow of long bone. All mammals except camel and Ulama have red blood cells without nucleus.

The second type of cells present in blood are white blood cells. These cells do not have haemoglobin, hence they are colourless cells or leucocytes. These cells are less in number when compared to the RBC. There are two types - granulocytes and agranulocytes.

There are three types of cells in the granulocytes - Neutrophils, Basophils and Esinophils. These cells attack and destroy the microorganisms that enter the blood.

Some white blood cells sacrify their life to fight against external enemy (micro organisms). These dead WBC come out of wound. This is generally called 'pus'.

There are two types of agranulocytes lymphocytes and monocytes. Lymphocytes secret anti - bodies to guard against foreign material that enter into blood. So they are

called microscopic policemen. Monocytes move like amoeba and along with granulocytes. They attack the foreign materials and engulf them. The foreign materials are destroyed inside these cells. They are called as 'scavengers'.

Blood platelets are a separate group of cells which do not have a nucleus. They are disk like projections. Whenever a blood vessel is injured, platelets accumulate at the site of injury and help in the formation of a blood clot. The clot seals the wound in blood vessels and prevents further blood loss.

"Your sisters and brothers are not your relatives". This shocks you! Land Steiner, a German doctor, found a new blood relation among us. He divided human beings in to four major groups. They are A, B, AB and O. The person who lives on another side of the globe is same with same your blood group is also blood relative. Do you agree this? AB group human beings can receive the blood from any other groups. Hence they are called as universal recipients. 'O' group people can donate the blood to any other group. So these people are known as universal donors.

Lab Activity

Find your blood relations:

Let us find out your blood relatives in your class. For this we need a kit (That is available in your school lab.) to find out your blood group.

Aim : Identification of Blood Group

Apparatus : Blood Identification Kit, Glass Slide, Wax Pencil, Disposal Needle.

Kit Components and Storage

All the reagents should be stored at 2-8°C when not in use.

Sl No	Components	Quantity (100 tests)
1	anti-A sera	5 ml
2	anti-B sera	5 ml
3	anti-RhD sera	5 ml
4	porciline white plate	2
5	Wax pencil	1
6	Needle (24G)	100
7	Instruction manual	1

Materials Required (not included in the kit):

Cotton, 70% alcohol, toothpicks.

Procedure:

1. Take one porciline plate, clean and dry it. The plate must be very clean so that it does not interfere with the reaction.
2. With a wax pencil, draw three circles on the plate to divide the surface into three parts and draw three circles, one in each part as shown in Figure1.

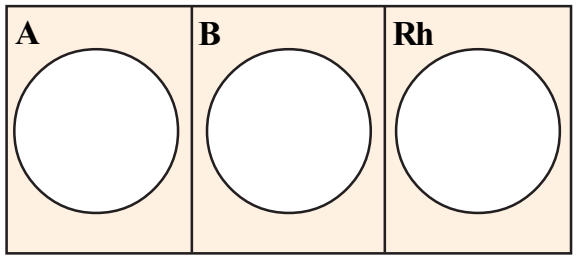


Fig-13 Template on a porciline plate for blood grouping.

3. Place one drop of the corresponding antiserum (at room temperature) near the edge but within each of the circles as shown in Figure 2.

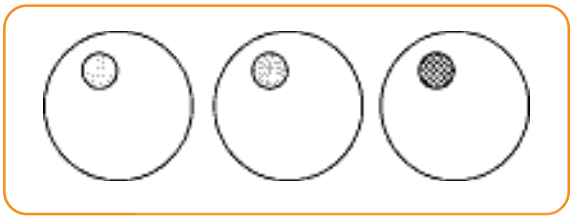


Fig-14 Addition of anti-sera on the glass slide.

4. Choose a finger (usually left ring finger). Clean this fingertip with an alcohol in a cotton ball and let it dry. Keep the cotton ball nearby, as it is needed again. Dangle the hand down to increase the amount of blood in the fingers.
5. Press on the bottom of the fingertip with the thumb of the same hand (to help hold blood in the fingertip) and quickly prick the fingertip with the help of a needle.

Note: The needle is sterile, so do not touch the tip with anything before using it.

6. Quickly, let one drop of blood get into each circle but not touching the anti-sera. Do not touch any of the anti-sera.
7. After putting three drops of blood, apply gentle pressure to the wound with cotton ball.

   Remember to properly dispose the used needle.
8. Use a toothpick to mix the blood and antiserum and stir gently. Do it for each of the circles using a fresh toothpick every time. The wax pencil circle will help to keep the sample isolated.
9. Watch to see if any of the samples show agglutination. The agglutination will appear as the grainy clumps of red blood cells (RBCs) suspended in a clear solution. Rh is slower to agglutinate, so do not give up too soon.

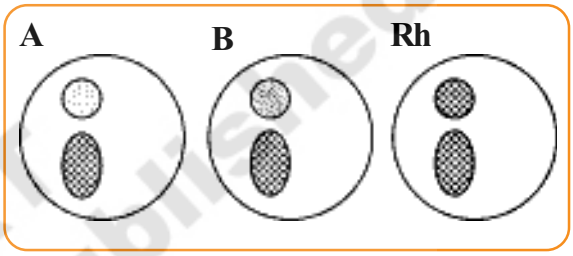


Fig-15 Blood added on the glass slide.

Result and inference :

Determine the blood type depending on the result. Following table can be used to determine the blood type:

Table: Determination of blood group (type).

Anti-A	Anti-B	Type
Yes	No	A
No	Yes	B
Yes	Yes	AB
No	No	O

Independent of whether agglutination occurs in anti-A and anti-B sera, clumping may or may not occur in anti-RhD serum. If agglutination occurs in anti-RhD serum, the Rh factor is positive; and if it does not, the Rh factor is negative.

Result should Note in the given table

Sl.No	Name	Blood Group

Note: *While taking blood samples don't use same needle for all. It is very dangerous. It spreads different diseases. You should use disposable needles for each pupil. It is better to conduct such kind of test only with the help of Health Inspector.*

Muscle Tissue:

If you are wounded deeply, a deep scar would form along with ditch? If we are wounded on skin, a lighter scar would form. Why? The skin cells have regenerating character. Think about the muscle cell. Will they get regenerated like epithelial cells?

Muscles are responsible for the movements of hands and legs and also of several internal organs such as intestine and heart. Small amounts of muscle tissues also present in blood vessels. These helps in increasing or decreasing the diameter of the blood vessel and thus the blood flows. Heart is made of only one type muscle cells and they help in pumping the blood.

How do muscles contract and relax?

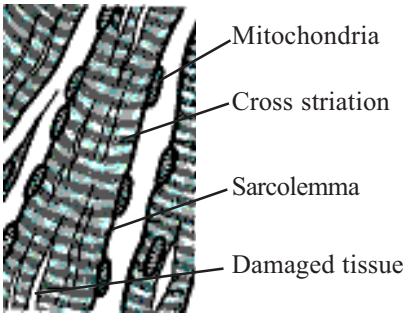
Muscular tissue consists of elongated cells called muscle fibres. This tissue is responsible for movement in our body. Muscles contain special protein called contractile proteins which contract and relax to cause movement.

During winter, body shivers. Why?

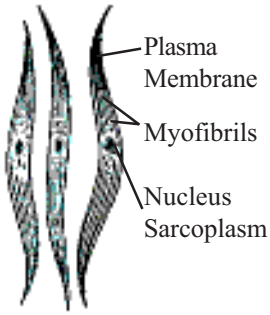
When the body is exposed to cold air, we shiver. During shivering muscles contract and relax producing large amount of heat. This keeps the body heat.

Based on their structure, location and function, muscles are three types. They are striated muscle, non-striated muscle, cardiac muscle.

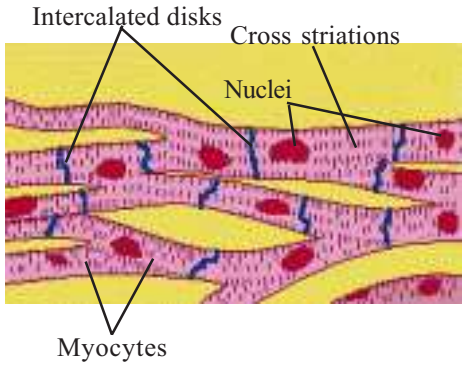
We can move some muscles by our conscious effort. For example the muscle present in inner limbs move when we want them to, and stop when so decide. Such muscles are called voluntary muscle. These muscles also called as skeletal muscles as they are mostly attached to bones and help body movement; these muscles show alternate light and dark bands or striations. As a result, they are also called striated muscle. The cells of this tissue are long, cylindrical, un branched and having many nuclei in the body (multi nucleated).



Striated muscles



Non-striated muscles



Cardiac muscles

Fig-16

Activity-5

Collect three types of muscle slides (Striated muscles, Non-striated muscles, Cardiac muscles) from slide box. Then observe these under microscope. Write your findings in the following table.

Sl.No	Striated muscles/ Characters	Non-striated muscles/ Characters	Cardiac muscles/ Characters

The movement of food in alimentary canal or the contraction and relaxation of blood vessels are involuntary. We can not really start them or stop them simply by wanting to do so. Smooth muscle or involuntary muscles control such movements. They are also found in the Iris of the eye, in uterus and in the bronchi of the lungs. The cells are long with pointed ends and having a single nucleus (uni nucleate). They are also called un striated muscle.

Can you tell why are they called as un striated muscle?

The muscles present in the heart are responsible for pumping of blood. The cells are long branched and have nuclei. Cells are joined to each other at their end. All the muscle cells in cardiac muscle have striations. Though it resembles the striated in its structure, it is an involuntary muscle.

Nervous cells

If you put your fingers in a glass of hot water, how do you feel?

How would you know the water is hot? Or cold? If you put your leg on a sharp edged stone while walking, how do you feel?

The feelings like the above situations is because of specialized mechanism in our body. It works like electric current passing through wires. Brain, spinal cord and nerves play active role in this mechanism.

Activity-6

Collect the slide of nerve cells from slide box. Then observe these under microscope. Write your findings

Nerve cells are the only cells in the body which do not have the ability of regeneration. These are very specialized cells. No two neurons or nerve cells in the nervous system have same appearance.

Cells of nervous system are highly specialized for transmitting the stimulus very rapidly from one place to another within the body. We can identify 3 distinct parts in nerve cells. They are 1. Cell body or cyton 2. Axon 3. Dentrites

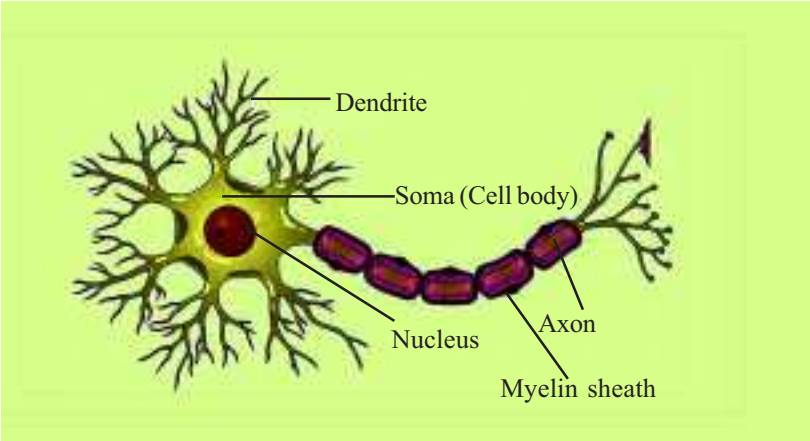


Fig-17 Nerve cell

Cell body or cyton has a large nucleus and cytoplasm. The cytoplasm contains granular structure called Nissal's granules.

There are some projections arising from cell body. These are called dentrite. They are sharp, branched more in number. One projection of the cyton is somewhat longer than remaining projects. This is called axon. Some nerve cells have axon covered with sheath like structure. This sheath called as myaline sheath. Nodes are called as Ranvier Nodes.

Axon of a nerve cell is connected with dentrites of a near by nerve cell to frame a web like structure throughout body.

Key words

Tissue, Epithelial tissue, Connective tissue, Insulator, Bone narrow, bone, cartilage, Connective tissue, Muscle tissue, Nerve tissue.

What we have learnt?

- Tissue is a group of cells similar in structure and functions.
- Animal tissues can be epithelial, connective, muscular and nervous tissue.
- Depending on shape and function, epithelial tissue is classified as squamous, cuboidal, columnar, ciliated and glandular.
- The blood consists plasma, RBC, WBC, Platelets.
- The different types of connective tissues in our body include areolar tissue, adipose tissue, bone, tendon, ligament, cartilage and blood.
- Striated, unstrained and cardiac are three types of muscle tissues.
- Nervous tissue is made of neurons that receive and conduct impulses.

Improve your learning

1. What do you understand by the term tissue? (AS1)
2. Show the difference between the three types of muscle fibres with diagrams. (AS3)
3. What is the specific function of the cardiac muscle? (AS1)
4. Differentiate between striated, unstriated and cardiac muscles on the basis of their structure and site / location in the body. (AS1)
5. Draw a labelled diagram of a neuron. (AS 3)
6. Name the following. (AS1)

   a) Tissue that forms the inner lining of our mouth.

   b) Tissue that connects muscle to bone in humans.

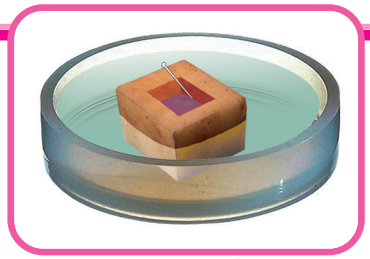
   c) Tissue that transports food in animals.

   d) Tissue that stores fat in our body.

   e) Connective tissue present in the brain.
7. Identify the type of tissue in the following: skin, bone, lining of kidney tubule, vascular bundle. (AS1)
8. If the platelets are not present in the blood what happens? (AS2)
9. If you touch at elbow, you get a shock like feeling. Why? (AS 7)
10. The blood is also a fluid connective tissue but in the fluid form. Justify the statement.
11. Identify your blood group with help of kit? (AS 3)
12. Ramu felt weak. Ramu's father took him to hospital. The doctor advised a blood test. The report says that he does not have the required levels of haemoglobin. What are it ill effects? (AS 6)
13. Blood group of Koushik is O^{+ve} and Pranavi is B^{+ve}. Whom can they donate blood and why? (AS 1)

Chapter 4

Movement of materials across the cell membrane



All the organisms in the world are made up of cells. You know that cell is the Basic unit of life. You have learnt about different parts of and their specific duties in the chapter "Structure and functions of cell". It is very interesting to know how substances pass through cells. There is a wonderful mechanism. Let us learn.

Activity-1

Get in-go out

Let us look at the substances in the table. Some are needed by the cells while some are discarded by the cells.

Substance	Should go into the cell	Should go out of the cell
Oxygen		
Glucose		
Proteins		
Fats		
Vitamins		
Minerals		
Carbon dioxide		
Wastes		

Identify and tick mark which substances should go in and which substances should go out of the cell.

- Which substances should enter into the cell? Why?
- Which substances should come out of the cell? Why?
- Can you name any other substances, which should enter into the cell?
- Which substances should enter into the cell and go out of the cell?

You know that cell performs different functions. For these different types of

substances are required by the cell. These are solids like glucose, liquids like water, and gases like oxygen. To understand the entry or exit of substances into and out of the cell, let us do the following activities.

For doing these activities, we have to prepare different solutions.

Preparing Solutions:

To prepare sugar solution we need sugar and water. In a sugar solution sugar is the solute and water is the solvent. Sugar dissolves in water forming sugar solution.

Preparation of saturated solution :

Take 100 ml of water in a beaker. Add sugar/salt. Stir till it is dissolved. Repeat it till little amount of it is left at the bottom of the beaker which will not dissolve. This is the saturated solution of sugar/salt (in cold water).

Which one is more concentrated solution?:

Take three beakers with one hundred ml. of water in each. Add half teaspoonful of sugar to the first beaker, one teaspoonful to the second and one and a half teaspoonful to the third.Compare the three solutions and answer the following. The solution of which beaker will be most sugary? What is the reason?Can we convert the solution of beaker I into solution of beaker III? How?How can we make the solution of the third beaker indicated to that of the first?How much water should we add to the solution in the third beaker to make it similar to solution of the first beaker? Solutions with different amount of solute dissolved in them are solutions of different concentrations.The amount of sugar present in the 100 ml of water is the concentration of the sugar.Which beaker has the most concentrated solution?

Lab Activity

Aim : Observation of material in different solutions

Material: 1. Two beakers 2. Tap water 3. Sugar 4. Dry grapes or kishmish

Procedure: Take 100 ml of water in a beaker. Keep dry raisin (kishmish) in it.

Fig-1 Kishmish kept in tap water

Leave it for one hour Observe what has happened. Take it out and compare it with the dry raisin. Is there any change in the size of kishmish. (You may try the same activity with slightly dried carrots and other such vegetables) Do you ever observe that your mother dipped witted vegetables in water. Can you identify the reason.

Then take 100 ml of saturated solution of sugar in a beaker, which was already prepared.

Fig-2 Swollen kishmish keep in tap water

Chapter 5

Diversity in Living Organism

There are so many plants and animals around us. We know very little about them. Most of them belong to a world not visible to the unaided eye, as you have already studied in the chapter on, 'Microbial World'. The types of organisms that we have studied so far are also in lakhs! Existing from mountain peaks to deserts and to the deep oceans, from extreme cold conditions to extreme hot ones and many more, such diversity is the symbol of nature.

Studying about diversity as it is, would be a very chaotic and difficult task. Moreover describing and naming each organism individually without knowing the organisms that might be sharing common characteristics would be insignificant. Thus people who have tried to study diverse organisms in nature have tried to make groups of them on the basis of differences and similarities found among them. This helped to identify largely varied and closely related groups of organisms.

Thus our knowledge of the entire living world depends on first making meaningful groups to carry out our study in a systematic manner.

In this lesson we will try to study the diversity present among several living organisms, classify and appreciate natures' miracle.

Diversity in plants

Activity-1

Observation of plants

Collect leaves from different plants. Observe them carefully and fill the table.

S.No.	Name of the plant (the leaf of which is taken)	Length of the leaf	Width of the leaf	Colour of the leaf	Shape/Size of the leaf	Margin of the leaf	Venation of the leaf

- Could you find any two leaves which are similar with respect to any of the characters, size, shape, colour or any other as mentioned in the table?
- Note down the differences you observed in the sample of leaves collected by you. Write two such characters that differed most.
- To study more about such characters let us do another activity.

Activity-2

Observation of external characters of plants (monocot and dicot)

Collect at least five different plants (at least two must be either grass, maize, paddy etc. plants) with flowers from your surroundings. Observe their external characters carefully. Draw the following table in your notebook and note down your findings. You can also do this with as many flowering plants as possible.

S. No.	Name of the plant	Length of the Stem	Length between nodes	Leaf venation	Flower Single/ born in group	No. of petals	No. of sepals	Taproot/ fibrous root

- Which characters given above varied most?
- Select a character mentioned above which shows minimum diversity.
- Did you find any similarities? What were they?
- Did you find patterns like –plants with fibrous roots had flowers borne in groups? Note some other patterns that you may have observed.
- Carefully observe the plants collected by you and note down some other characters not mentioned in the table.
- Did you notice any two plants which were alike with regard to the above characteristics? If not, note down what differences you found?
- Note down some similar characters that you have observed.

We can see that there are several characters that we can choose to make groups of plants, some groups would have

many plants taken in our sample, while some would have just a few.

So far we have discussed about plants and their leaves but what about their seeds?

You know that seeds look different. But if we open them would they show similar structural make up or completely different ones?

To find out more about this let us do the following activity.

Activity-3

Observation of seeds

Collect some seeds from the plants of green gram, red gram, Bengal gram, wheat, paddy, groundnut, maize. Soak them for a day and observe them carefully. Take a maize seed and press it between your fingers . Does a small whitish structure come out? Actually maize seeds from fresh soft corn cobs would easily let this structure out. Observe it carefully. It is the baby plant /embryo. The portion left in your hand within the seed coat has a single cotyledon(or seed leaf). Repeat the activity with soaked whole grains of wheat and rice and the other seeds as well.

Use a hand lense for your careful and close observations. Make a table like the one given below in your copy and note down your observations in the table.

S. No.	Name	Colour	Shape/size	No. of cotyledons(seed leaves)	Others
1.					
2.					
3.					
4.					
5.					

- In case you do not know names write a number or give name on your own.

Note down what differences that you observed.

Name any character as mentioned in the table that helped you to roughly divide the sample of seeds into two groups.

The following activity leads us into the systematic way of grouping. You will again need the soaked and softened seeds for this purpose.

Open the given seeds. When you try to do this with peanut seeds, two thick portions come out which are its cotyledons. See if you find such structures in other seeds taken by you. If needed, you can take help of hand lens as well.

Activity-4

Observation of different characters in monocot and dicot plants

Collect the plants or pictures of the whole plants to complete the following table(you can take the help of annexure to this chapter as well)

S. No.	Name of the plant	Leaf venation	No.of cotyledons / seed leaves	Tap root system or fibrous root system
1.	Maize			
2.	Paddy			
3.	Grass			
4.	Beans			
5.	Green gram			
6.	Ground nut			

Here as we finish our activity we would have established some common characteristics of land plants- those having two seed leaves are called dicotyledons, while those having single seed leaf are called monocotyledons.

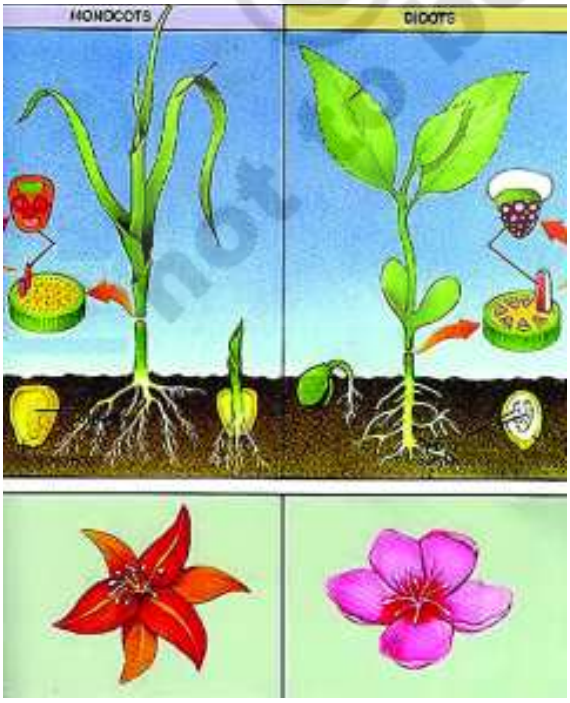


Fig-1

They share some common characteristics like venation (dicots have reticulate/branched, while monocots have parallel venation).

By doing the above activity we can understand how grouping is done in biology by observing the similarities and differences among diverse groups in the sample under study. We will do some similar exercises with animals now.

Diversity in animals

Activity-5

Observation of external characters of insects

Collect housefly, mosquito, ant, dung beetle, butterfly, moth and cockroach from your surroundings. Observe them carefully. Take the help of a magnifying glass to get a closer view.

- Are all insects of the same size or shape?

S. No.	Name of the Insect	No. of Legs	No. of Wings	Colour	Shape/Size	body parts (Segmentation)	Other characters

- What differences did you observe with regard to legs?
- What differences did you observe with regard to wings?
- Is there any relationship between the number of wings and legs?

Did you find any two insects with same characters? If yes, display in the class. If no, note down the differences in your note book.

Even though all these are insects and you see that they show several differences. Can you find at least one character that is similar to the whole group, what is it?

How would you group insects? Would it be based on number of body segments or number of legs they have?

The examples of insects given above are of different species. Hence they show a lot of difference and we say they are diverse. If we were to compare insects of the same type that is to say two houseflies we would perhaps still find some differences(try it out yourself) and these would be variations.

Let us see some variations that are present in human populations

Variations in humans

Activity-6

Variation in animals (external characters)

Do this activity in a group of atleast 10 children. Draw the table in your notebook and fill it.

S. No.	Name of the Student	Height	Weight	Lenth of fore finger	Thumb Impression	Palm	
						Length	Width

After observing the table try to answer the following questions.

Which character helps you to make the maximum number of groups?

Which character helps you to have just a single individual in a group?

Compare your group table with that of other groups and note down the differences you found.

Did you find same observations of any two students in your class?

You might have observed that no two thumb impressions are alike. It is a very specific character of an individual.

Is there any other structure in the human body that is as unique as the thumb impression? What is it?

We have seen variations in animals let us see how we could study the same in plants.

Variations in plants

Activity-7

Variation in two different neem plants

Collect two small almost equal sized neem plants from your surroundings observe them carefully and fill the table.

S. No.	Name of the Plant	Length of the stem	No. of Leaves	Size / Shape of the Leaves	Colour of the Leaves	Margin	Venation
1.	Neemplant -1						
2.	Neemplant -2						

- What differences could you find in the similar looking neem plants?
- Why do you think such differences are present in nature?

So far we have done some activities to study, appreciate and group living organisms on the basis of the diversity and variations present in nature. Several exercises have been done to select characters to group organisms on the basis of similarities and differences between them. The presence of differences between organisms of the same species is called variation.

Variation between different species is always greater than the variation within a species. As we have observed so far, variation forms a basis for selection of characters to group organisms. Grouping organisms on the basis of certain characters which vary over populations indicating some common lineage of each varied group , or the way in which the organism may have evolved is classification. Thus classification in biology is the systematic study of organisms present in nature with respect to their evolution.

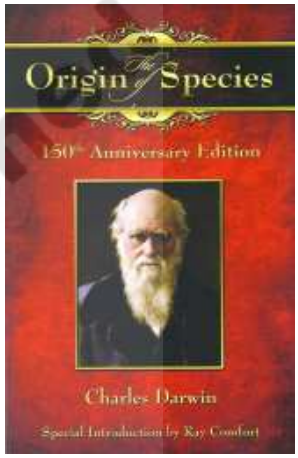
What is the need of classification?

- It gives better knowledge and better understanding of organisms that are studied.
- It helps to study the organisms in a proper and systematic manner.
- It helps to make comparison in an easier way.
- It helps in understanding the relationship among the organisms and their interdependence.
- Classification makes our study more focused and helps us to handle huge population of organisms.
- It gives us an idea of evolution (How organisms have evolved in nature?).

Classification and evolution

All living things are identified and categorized on the basis of their their structure and function. Some characteristics are likely to make more wide-ranging changes in body design than others. There is a role of time in this as well. So, once a certain body design comes into existence, it will shape the effects of all other subsequent design changes, simply because it already exists. In other words, characteristics that came into existence earlier are likely to be more basic than characteristics that have come into existence later.

This means that the classification of life forms are closely related to their evolution. Evolution is the process of acquiring change. Most life forms that we see today had variations that accumulated over years to allow the organism possessing them to survive better. Charles Darwin first wrote about this in his book, "The Origin of Species"in 1859. When we connect the idea of evolution to classification we find in some groups of organisms, the body designs have not changed over the years while several organisms have acquired body designs relatively recently. Since complexity of design has increased over the years and is yet to increase, we may say that older organisms are simpler as compared to the younger.



Charless Darwin

History of classification

In India, classification had been the basis of studies in medicines and dates back to first and second century A.D. Charak and Sushrut had classified the plants on the basis of their medical importance. There after Parasar in his book 'Vrikshyurveda' (The science of life of trees) documented the classification system for several land plants for the first time. This classification mainly deals with the structure of the flowers

Let us study how biologist from 16th century have been trying to classify diverse organisms so far.

Classification done by biologists till date:

The following table shows how different biologists have gone about forming the first category in classification..

Linnaeus 1735	Haeckel 1866	Chatton 1925	Copeland 1938	Whittaker 1969	Woese et al. 1990	Cavalier-Smith 1998
2 kingdoms	3kingdoms	2empires	4 kingdoms	5 kingdoms	3 domains	6 kingdoms
(not treated)	Protista	Prokaryota	Monera	Monera	Bacteria	Bacteria
					Archaea	
		Eukaryota	Protoctista	Protista	Eukarya	Protozoa
						Chromista
			Plantae	Plantae		Plantae
Vegetabilia	Plantae			Fungi		Fungi
Animalia	Animalia		Animalia	Animalia		Animalia

Although biologists in the 16th and seventeenth centuries did not recognize that the similarities and differences among organisms were consequences of evolutionary mechanisms, they still sought a means to organize biological diversity. In 1758 Carl Linneaus proposed a system that has dominated classification for centuries. Linnaeus gave each organism two names, denoting genus and species such as Homo sapiens(the former representing genus while the latter representing species). He then grouped genera(several genus) into families, families into orders, orders into classes, classes into phyla, and phyla into kingdoms. Linnaeus identified two kingdoms: Animalia (animals) and Plantae (plants). All the terms like species, genus, family, order, class, phyla etc were defined by Linneaus on the basis of the similarities and differences studied by him in groups of organisms.

Carl VanLinneaus

The first major break from the Linnaean model came from Thomas Whittaker. In 1969 Whittaker proposed a "five kingdom" system in which three kingdoms were added to the animals and plants: Monera (bacteria), Protista, and Fungi. Whittaker defined the kingdoms by a number of special characteristics. First, he specified whether the organisms possessed a true

nucleus (eukaryotic) or not (prokaryotic). The eukaryotic unicellular organisms were placed into the kingdom Protista. The rest were three multicellular eukaryotic kingdoms that distinguish themselves by the general manner in which they acquire food. Plants are generally autotrophs and use photosynthetic systems to capture energy from sunlight. Animals are heterotrophs and acquire nutrients by ingesting plants or other animals, and then digesting those materials. Fungi are also heterotrophs but, unlike animals, they generally break down large organic molecules in their environment and live on them.

The five kingdom system was certainly an advance over the previous system because it captured the diversity of life in a better way. Three groups bacteria, fungi, and protists - did not fit well into either the animal or plant category. Moreover, each of these three groups appeared to possess diversity comparable to that of animals or plants. Thus, the designation of each as a kingdom seemed fitting.

In the years since Whittaker's system was developed, however, new evidence and new methods have shown that the five-kingdom system also fails to adequately capture what we now know about the diversity of life. Microbial biologists became aware of these limitations as they discovered unicellular organisms that appeared to be prokaryotic, but were extremely distinct in their internal structure and other characteristics from the traditional bacteria. Some of these unusual prokaryotes lived in hot springs and other places where the temperatures were near or even above the boiling point of water (the thermophiles). Others, the extreme halophiles, were able to tolerate very high salt concentrations. Other techniques like DNA (the chemical of design of life) sequence data also increasingly suggested that these prokaryotes were most unlike the traditional bacteria. Thus other modifications in the classification scheme came into existence.

Do you know?

There are various hypotheses as to the origin of prokaryotic and eukaryotic cells. Because all cells are similar in nature, it is generally thought that all cells came from a common ancestor cell termed the Last Universal Common Ancestor (LUCA). These LUCA eventually evolved into three different cell types, each representing a domain. The three domains are the Archaea, the Bacteria, and the Eukarya (a classification as suggested by Woese).

Archaea and bacteria are prokaryotic cells that is they do not have a membrane bound nucleus, the nuclear material is present dispersed in cytoplasm.

The cell walls of bacteria unlike the archaea contain a fat like chemical peptidoglycan..

Eukarya have eukaryotic cells or cells having a membrane bound nucleus.

The hierarchy of classification

Classification is done starting from grouping living organisms into domains for

example prokaryota, eukaryota, archaea which form the largest categories with several dissimilar and few similar characters to species forming the smallest category with several similar and few dissimilar characters. Broadly, a species includes all organisms that are similar enough to interbreed and perpetuate or even individually reproduce

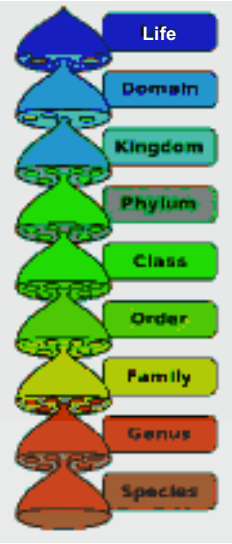


Fig-2 Heirarchy

- Why do you think classification system has undergone changes over the years?
- If you were asked to classify organisms what would be your basis of classification?

Now let us study some of the characters that have been considered to classify organisms under the five kingdoms of classification.

Monera

Observe the given slides carefully and say

- How many cells are found in the organism?
- Do you find any nucleus in the middle of the cell?
- Are there any other cell organelles found in the cell?

By observing the above characteristics we conclude that Monerans are

A. One-celled organisms
B. Cells have no membrane bound nucleus
C. Reproduce by splitting in two
D. Absorb nutrients from outside their bodies
E. They move with the help of locomotory organs like flagella, cilia or hair like structures present on them.
F. Some monerans cause diseases, but others are helpful to people.
G. Examples: bacteria

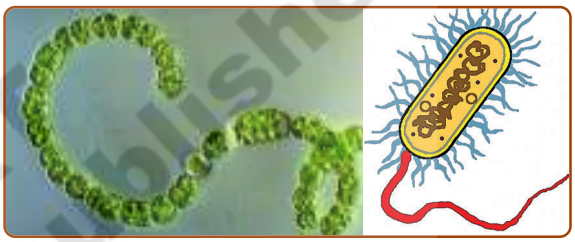


Fig-3 Bacteria

Three major groups of organisms come under this group. They are archaebacteria (ancient bacteria present till date, some species found in hot springs come under this), eubacteria (streptococcus, rhizobium, e.coli etc) and cyanobacteria which are also called blue green bacteria as they appear similar to blue green algae externally but internally are more like bacteria(but they are not bacteria).

Protista (protoctista)

Observe the given slides carefully and say

- How many cells are found in the organism?
- Do you find any nucleus in the middle of the cell?
- Are there any other cell organelles found in the cell?

- Are there any locomotory organs in them?

Characteristics of protists

A. Most are one-celled (unicellular), but some have many cells.
B. Cells have a membrane around the nucleus.
C. Some get nutrients and energy by eating other organisms.
D. Some get energy from the sun, and nutrients from the water around them.
E. These live either solitary or in a colony.
F. Some of the cell organelles are present inside the cell.
G. Most reproduce by splitting in two.
H. Examples are paramecium, amoeba, algae, kelp etc.

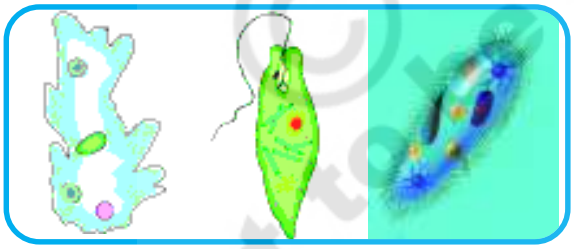


Fig-4 Aemoeba, Euglena, Paramecium

Fungi

Observe the specimen and diagrams given below and answer the following questions.

- What is the colour? Can they prepare their own food as green plants?

Make a sketch of the main parts of the body.

- Do you find root like structures? Guess why?

Characteristics of fungi

A. Most are many-celled(multicellular) and some are one-celled organisms.
B. Eukaryotes with well defined prominent head (you usually see them propping out from the ground or on barks of trees during rainy season).
C. Get nutrients and energy by absorbing/ digesting the surface they live on through root like structures which are fine thread like parts of their body.
D. Most of these reproduce by spores.
E. Examples are yeast, mushrooms, bread moulds, and lichens.

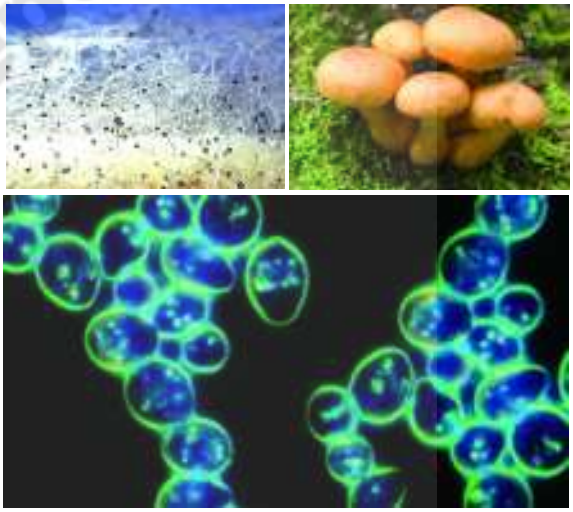


Fig-5 Bread mould, Mashroom, Yeast

Plantae

- Several plants grow around you. Do all of them produce seeds?
- Think if grass produces seeds(hint:compare with rice plants and think).
- Name some plants that produce seeds.

- Which part of the plant produces seeds? Where is it located?(recall structure of plant parts studied in earlier classes)
- Do all plants have a definite structure to produce seeds?

Plants are diverse in nature. The basis of classifying them is the way they acquire their food, the type of reproductive structures they have and the way they reproduce. They are multicellular, eukaryotic with cell walls. They are usually autotrophs and use mainly chlorophyll for photosynthesis.

The first level of classification among plants depends on whether the plant body has well differentiated, distinct parts.

The next level of classification is based on whether the differentiated plant body has special tissues (vascular tissues) for the transport of water and other substances within it. Further classification looks at the ability to bear seeds and whether the seeds are enclosed within fruits.

Lets look at some plants like moss and ferns more closely.

Activity-8

Observation of moss plants through hand lens.

You can collect mosses from the greenish velvety growth on bricks during the rainy season. Scrap a bit of this greenish growth over a slide and observe with a hand lens or under a dissection microscope. You may find structures like that shown in the fig-5.

Fig-6 Mass

These are not exactly flowers but structures that contain seed like structures called spores. Spores contain very little food while the seed stores a lot of it. Moreover where seeds are produced from ovule of flower, spores are produced within structures called as sporangium in a different manner.

If you get a fern to observe, try to see the brownish or blackish dot like structures. These are the spore bearing bodies.

Fig-7 Sporangium

Plants like moss and fern which do not produce flowers and have sporangium as reproductive structures are called non-flowering plants or cryptogams, those that

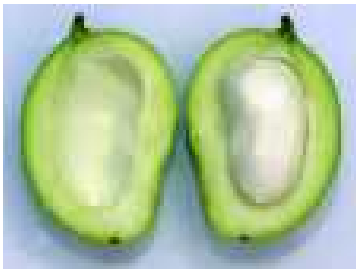


Fig-8 Mango seed

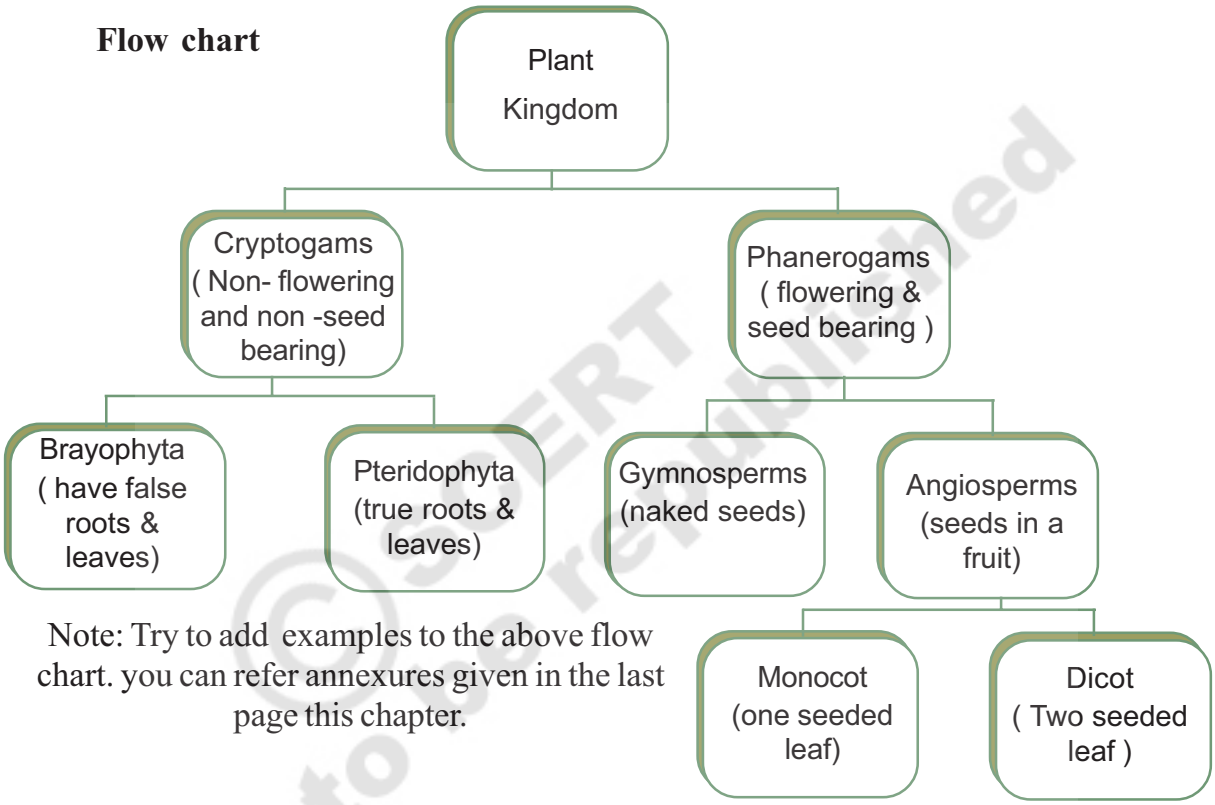
produce flowers are phanerogams like pine, cycas, neem, mango etc.

Among flowering plants those having seeds enclosed within fruits are angiosperms (e.g. mango) and those without it are gymnosperms (e.g. pine).The following pictures will help you see this.

Fig-9 Pine

- Write down the characteristic features of dicot and monocot plants that you have studied in earlier sections of this chapter.

Flow chart



Note: Try to add examples to the above flow chart. you can refer annexures given in the last page this chapter.

Classification of Animals

These are organisms which are eukaryotic, multicellular and heterotrophic. Their cells do not have cell-walls. Most animals are mobile. They are further classified based on the extent and type of the body design differentiation found.

Major groups are:

Porifera

The word Porifera means organisms with holes. These are non-motile animals attached to some solid support. There are holes or 'pores', all over the body. These lead to a canal system that helps in circulating water throughout the body to bring in food and oxygen. These animals are covered with a hard outside layer or skeleton. The body design involves very minimal differentiation and division into tissues. They are commonly called sponges, and are

Fig-10 Sycon

mainly found in marine habitats. Some examples are Euplectelea, Sycon, spongilla etc.

Coelenterata/Cnidarians

These are aquatic forms showing more body design differentiation as compared to poriferans. There is a cavity in the body. The body is made up of two layers of cells: one forming the outer layers while the other forming the inner layers. Some live in colonies ,like the corals that are tiny (nearly 3 to 56 mm) but their colonies where we may find several types of them are as huge as say an island (1800 sqkm), while others like hydra, jellyfish and sea anemones are common examples.

Fig-11 Hydra

Platyhelminthes

The body of animals in this group is far more complexly designed than in the two other groups we have considered so far. The body is bilaterally symmetrical, meaning that the left and the right halves of the body have the same design. There are three layers of cells from which differentiated tissues can be made, which is why such animals are called triploblastic. This allows outside and inside body linings as well as some organs to be made. There is thus some degree of tissue formation. However, there is no true internal body cavity or coelom, in which welldeveloped organs can be accommodated. The body is flattened dorsoventrally, meaning from top to bottom, that is why these animals are called flatworms. They are either freeliving or parasitic. Some examples of freeliving animals like planarians, or parasitic animals like liverflukes and tapeworms.

Fig-12 Tape worm

Nematoda

The nematode body is also bilaterally symmetrical and triploblastic. However, the body is cylindrical rather than flattened. There are tissues, but no real organs, although a sort of body cavity or a pseudocoelom is present. These are very familiar as parasitic worms causing diseases, such as the worms causing elephantiasis (filarial worms) or the worms in the intestines(roundworm or pinworms).

Fig-13 Round worm

Annelida

Annelid animals are also bilaterally symmetrical and triploblastic, but in addition they have a true body cavity. This allows true organs to be protected in the body structure.

There is, thus, extensive organ differentiation.This differentiation occurs in a segmental fashion, with the segments lined up one after the other from head to tail. These animals are found in a variety of habitats– fresh water,marine water as well as land. Earthworms and leeches are familiar examples (see Fig.16)

Fig-14 Earthworm

Arthropoda

This is probably the largest group of animals. These animals are bilaterally symmetrical and segmented. There is an open circulatory system, and so the blood does not flow in well defined blood vessels. The coelomic cavity is blood-filled. They have jointed legs (the word 'arthropod' means 'jointed legs'). Some familiar examples are prawns, butterflies, cockroaches, houseflies, spiders, scorpions and crabs (see Fig-17).

Fig-15

Mollusca

In the animals of this group, there is bilateral symmetry. The coelomic cavity is reduced. There is little segmentation. They have an open circulatory system and kidney-like organs for excretion. There is a foot that is used for moving around. Examples are snails and mussels.

Fig-16 Snail

Echinodermata

In Greek, echinos means hedgehog, and derma means skin. Thus, these are spiny skinned organisms. These are exclusively free-living marine animals. They are triploblastic and have a coelomic cavity. They also have a peculiar water-driven tube system that they use for moving around. They have hard calcium carbonate structures that they use as a skeleton. Examples are starfish and sea urchins.

Fig-17 Sea star

Protochordata

These animals are bilaterally symmetrical, triploblastic and have a coelom. In addition, they show a new feature of body design, namely a notochord, at least at some stages during their lives. The notochord is a long rod-like support structure (chord=string) that runs

along the back of the animal separating the nervous tissue from the gut. It provides a place for muscles to attach for ease of movement. Protochordates may not have a proper notochord present at all stages in their lives or for the entire length of the animal.

Protochordates are marine animals.

Examples are Balanoglossus, Herdmania and Amphioxus

Fig-18 Herdmania and Amphioxus

Vertebrata

These animals have a true vertebral column and internal skeleton, allowing a completely different distribution of muscle attachment points to be used for movement. Vertebrates are bilaterally symmetrical, triploblastic, coelomic and segmented, with complex differentiation of body tissues and organs. All chordates possess the following features:

(i) have a notochord
(ii) have a dorsal nerve cord
(iii) are triploblastic
(iv) have paired gill pouches
(v) are coelomate.

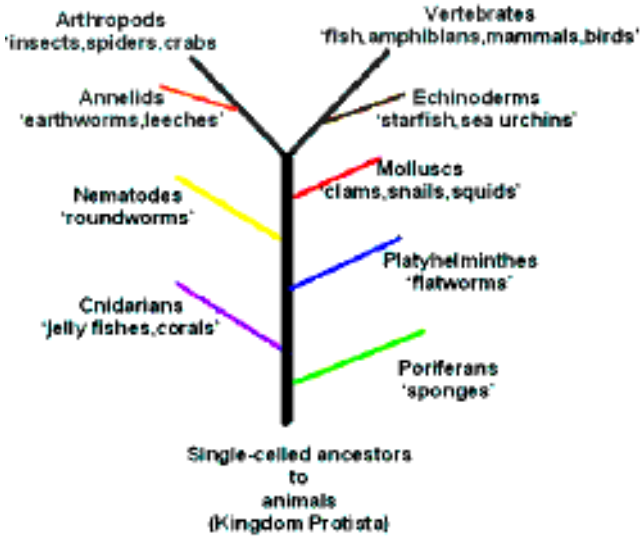
Vertebrates are grouped into five classes.

1. Pisces 2. Amphibians
3. Reptiles 4. Birds / Aves
5. Mammals

Do you know?

Fishes are cold blooded animals. They can change their body temperature according to their surroundings. Most of the fishes are oviparous but some give birth to young ones. We do not call them fishes which give birth to young ones. We call them aquatic mammals. e.g.Dolphin and whales. Hippocampus (Seahorse) is another fish like animal in which males carry babies as our mothers do. Sea horses are used in Chinese medicine. Seahorse population are thought to have been endangered in recent year by overfishing and habitat destruction.

Hippocampus



Vertebrates

Animals with Notochord (Notochord replaced by vertebral column in adults)

5					4	3	2	1
Mammals Suckle young (feed babies with milk, skin covered by hair/fur breathe air give birth to fully formed young once)					**Birds (Aves)** feathers, tow wings, claws, lay eggs. Warm blooded animals, four chambered hearts.	**Reptiles** have dry skin and scales, lay eggs, breath air, Cold blooded animals, most of them have a three chambered heart, but crocodiles have four heart	**Amphibia** young live in water, but adults live on land, smooth slimy skin, lay eggs. First vertebrates, can live both in water and land, Poikilothermic, hibernate during winter, aestivate during summer, Heart is three chambered.	**Fish (Pisces)** have fins and tails, breath underwater using gills, Cold blooded animals and hearts have only two chambers.
Land Mammals Mammalia Outer ears four limbs (arms / legs)			**Marines Mammals** Animals which grow and live in the water, some only have sparse covering of hair.	**Flying Mammals** use echolocation, nocturnal, roots in trees or caves, under roots.				
Marsupials Care for and feed their young in their sacks.	**Primates** Well developed hands / feet with fingers / toes, can judge distance, very intelligent social animals/ form bonds with family friends.	**Rodents** Gnawing animal, large incisor teeth (two parts) use like chisels to gnaw on hard foods.						

Lab Activity

Observe in your School Lab the Slide of a hydra (whole mount)/ picture of a hydra

- Is the body made of a single cell or a group of cells?
- Did you find any hollow structure inside the body?
- Did you find any other characters in it?

If you find any characters note down in your note book. Also draw a diagram of the given specimen.

The hollow structure found inside the body is called Coelom or body cavity.

Observe in your school Lab Specimen of a tape worm

Carefully observe the given specimen and note, the external characters you found, in your note book.

- How does the body look like?
- Did you see a body cavity in it?
- How does the head and tail look like?

The organisms which have flat body are called as flat worms, (platy-flat, Hilmenthes- worms), hence they are included in the name Platyhelminthes.

Observe in your School Lab the Specimen of a round worm (Ascaris)

Observe the given specimen and note down the characters what you found / observed in it.

- Does the body look same as in the Platyhelminthes?
- What are the differences you observed between tape worm and round worm?
- How does the head and tail look like in the specimen?

These animals are round shaped and depend on others for food (parasites). You cannot find true body cavity in these animals (pseudo coelomates).

Both platy and nematy helminthes are together called Helminthes.

Observe in your School Lab the Specimen of Earthworm

Collect a big earth worm from your surroundings without causing any harm to it.

- Touch the skin of the earthworm and say how do you feel?
- What is the colour ?
- Are there any differences you observed in its body colour and among the body parts?
- How does it move?
- Are there any ring like structures seen in its body?
- Draw a diagram of an earth worm in your note book and show all the characters you observed in it.

The body of earthworm is made of several ring-like structures. (annulus: rings, edios: form)

Hence they are included under Anneldians. Body cavity is clearly visible in it.

Observe in your School Lab the Specimen of a Cockroach.

Collect a cockroach or any insect and observe it carefully.

- How does the skin look like?
- Did you observe any hard layer on the skin?
- How many parts is the body divided into?
- Observe the legs and says how does it look like?
- Name some more animals whose legs are jointed as seen in the cockroach?

These are included in Arthropoda (Arthro-jointed, pod-legs) as they have jointed legs. Most of the animals in this group are the insects. Body is divided into three parts. Head, thorax and abdomen.

Observe in your School Lab the Specimen of Snail.

Observe a snail collected from a pond and keep inside a glass beaker.

Observe against sunlight.

Note down its characters you observed in your note book.

- How does the outer body look like?
- Keep the snail unmoved for some time and when it starts moving observe its body.
- Is the body soft or hard?
- Did you find any antennae like structure in it?

These animals whose body is soft and enclosed in a hard shell is called Molluscs.

Pearls are produced from a mollusc called oyster.

Observe in your School Lab the Specimen of starfish.

Collect a star fish when you visit a nearby sea beach. And observe its external characters carefully. If not possible, go to your school lab and observe the specimen of star fish. Note down your observations in your note book.

- What do you find on the skin of the star fish?
- Are there any arms and ray shaped structure in it?
- Did you find a small hole in the middle of the star fish?

These are exclusively marine living and spine skinned animals. (echino: spines, derm: skin)

All echinoderms are marine; they cannot live in freshwater or on land.

They are bottom dwellers and benthic.

Most are pentamemal, it means that they have fivefold symmetry with rays of arms in fives or multiples of five.

Ask your teacher and write five examples of echinoderms and draw diagrams in your note book.

Observe fish in your school lab.

Collect a fish from a fish monger and observe its external characters. You might have seen a long spine inside the body of a fish. This is the back bone of the fish. From fishonwards, all animals possess back bones and they are termed as Vertebrates (animals that have ventebral columns).

- Observe the skin of the fish. How does it look like?
- Write the body parts of the fish where scales are not present?
- Open the mouth of the fish. What is seen in it?
- Open side part of the fish where usually ears are located. What did you see there?

Cut open the fish and observe its heart. How many chambers are seen in its heart?

What will happen if you keep a small fish out of water for some time? Think, why?

Fishes are the first organisms possessing back bones. Body is covered with scales. Heart is two chambered. These are aquatic animals and cannot survive on land. There are specialized organs called Gills useful for its respiration.

(You need not complete all the activities in a single Lab period. You must be catious while observing the specimens to find out its characters.)

Nomenclature

- Why do we need to give universally accepted names to organisms?

Think , discuss with your friends and write on this.

Let us see what happens when we go about using local names.

- Do you know the common names of potato in different languages?
- Suppose you used the name batata where people knew only English, would you get your potatoes?

We see that local names may create a lot of confusion. This would hinder study about an organism as talking about it in one place would not match with the other.

Common Name	Telugu Name	Hindi Name	Tamil Name	Marathi Name	Odia Name
Potato	Bangala Dumpa	Aloo	Urulakkiz Hangu	Batata	Bilati Aloo

This problem was resolved by scientists by agreeing upon a scientific name for organisms in the same manner that chemical symbols and formulae for various substances are used over the world. Naming of organisms with a distinctive scientific name is called Nomenclature. It is unique and can be used to identify organisms anywhere in the world.

Certain norms are followed while writing scientific names. They are-

- Genus should begin with a capital letter.
- Species should begin with a small letter.
- When printed, the scientific name should be in italics.
- When written by hand, the genus name and the species name have to be underlined separately.

For example, the scientific name of a Mango tree is Mangifera indica and a Human being is Homo sapiens.

Activity-9

Try to find out the scientific names of at least 10 organisms that you see around you.

To classify just keep the following points in mind

Procedure

- Observe, make a labeled sketch of the organism (use dissecting microscope as necessary)
- Write a brief description of the organism, focusing on the characteristics that distinguish it as a member of its group.
- Select a criteria for classification for example "body structure".
- Research the classification of the organism as done by other scientists
- Try to findout answers for these questions

1. Is the organism prokaryotic or eukaryotic?
2. Is the organism unicellular, multicellular, or colonial?
3. How does the organism reproduce?
4. What are the sources of energy and carbon for the organism?

Key words

Flora, fauna, diversity, variation, classification, evolution, kingdom, domain, phylum, class, order, family, genus, species, nomenclature

What we have learnt?

- Diversity is the hallmark of nature. Variation among the organisms leads to evolution and growth of diversity.
- Scientists started classification of organisms depending upon the similarities and differences in them (sample under study).
- Differences that are observed in very closely related populations are called variation.
- In nature no two organisms are identical.
- Classification helps us in exploring the diversity of life forms.
- Classification is the systematic study of organisms present in nature.
- Classification of life forms is closely related to their evolution.
- The major characteristics considered for classifying all organisms into five major kingdom are:

  i. Whether they are made of prokaryotic or eukaryotic cells.

  ii. Whether the cells live solitarily or in colonies.

  iii. Whether the cells have a cell wall and whether they prepare their own food.

  According to Whittaker, all living organisms are divided into five kingdoms, namely:

  1. Monera 2. Protista

  3. Fungi 4. Plantae 5. Animalia

- Plantae and animalia are further divided into subdivisions on the basis of increasing complexity of body design of organisms.
- Recently Cavalier-Smith classified the organisms into six kingdoms as
  1. Bacteria, 2. Protozoa 3. Chromista 4. Plantae 5.Fungi
  6. Animalia.
- Naming of organisms with a distinctive scientific name is called Nomenclature.
- Nomenclature provides a uniform way of identification of the vast diversity of life around us.
- Carolus Linnaeus introduced Binomial nomenclature by which an organism is named by two words- a generic name and a specific name.

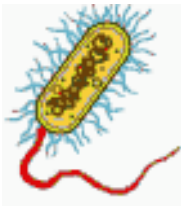
Improve your learning

1. Variations in organisms lead to diversity in living organisms? State reasons (AS1)
2. What was the basis of early classifications? (AS1)
3. What are the advantages of classifying organisms? (AS1)
4. What is the need of classification? What questions you will ask for this? (AS 2)
5. How do monocots differ from dicots? (AS1)
6. One day Kavitha soaked seeds of green grams, wheat, maize, peas and tamarind. After they became tender, she tried to split the seed. Name which would split, which would not and identify them according to the characters. (AS 4)

Sl. NO.	Name of the seed	Split into half (y)/ does not Split (N)	Monocot (M)	Dicot (D)
1				
2				
3				
4				

7. Make a flow chart of invertebrates in the kingdom Animalia, based upon their characteristic features. (AS 5)
8. Write some common characters of Pisces, Reptilia and Aves. (AS 1)
9. Name the kingdom to which these organisms belong according to Whittaker.(AS1)

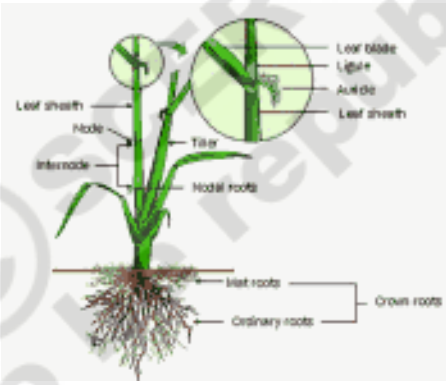


10. Explain how animals in vertebrata are classified into further subgroups.(AS1)
11. Platypus or Echidna is a group that forms a link between reptiles and mammals. Think and write about some characteristic features that these would have. (AS 4)
12. Sujata says Bat is not a bird but a mammal. How can you support Sujata's statement?
13. Which phylum do I belong to (AS1)
    a) My body is made of pores. I live in water. I do not have back bone also .....
    b) I am an insect. I have jointed legs . .....
    c) I am a marine living animal with spiny skin. My body is radially symmetrical .....
14. How can you appreciate the effort of scientists in classifying a wide range of organisms? (AS 6)

ANNEXURE-1

Maize plant



Rice plant

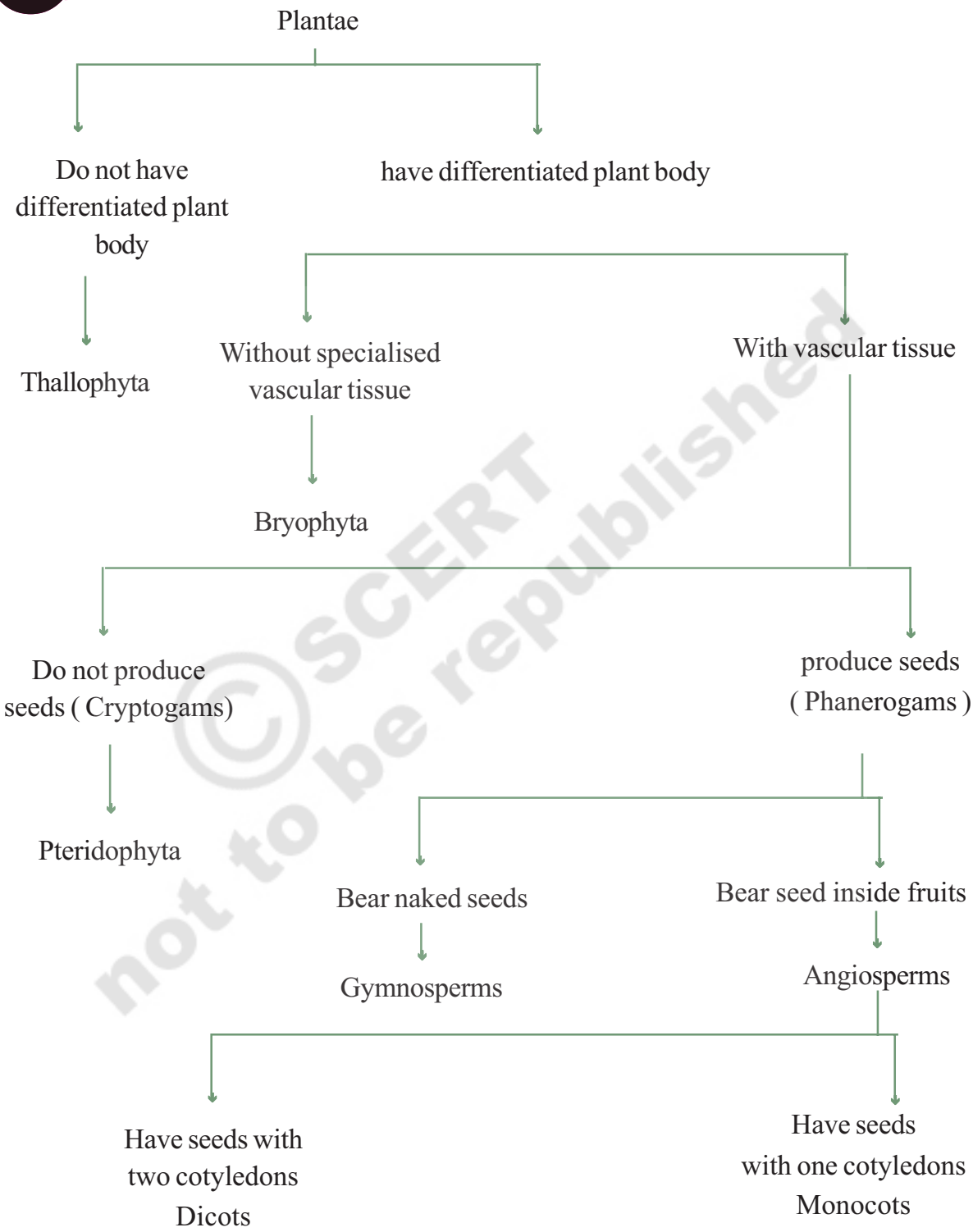
Grass plant

Bean Plant

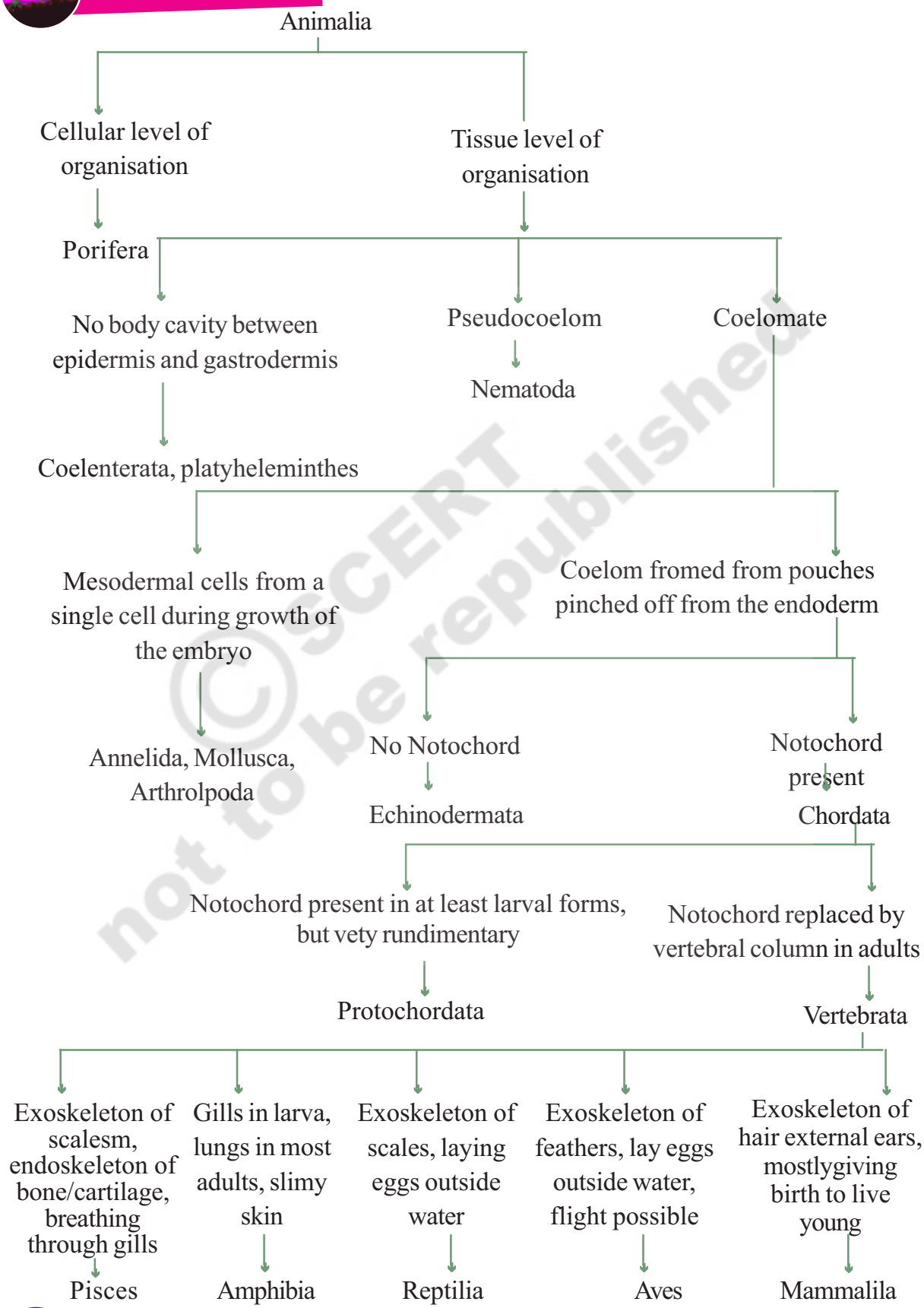
Green gram plant

ground nut plant

ANNEXURE-2

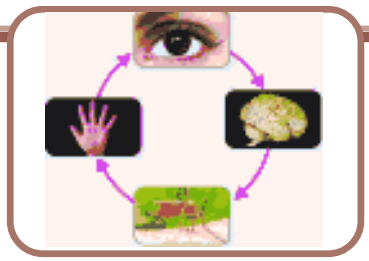


ANNEXURE-3



Chapter 6

Sense Organs



We enjoy the beauty of nature with our eyes, the melodious music with our ears, the fragrance of flowers with our nose, the taste of food with our tongue and feel the cool breeze on our skin. What do we do when suddenly bright light falls on our eyes or a hot utensil is touched by chance? All these situations show just how our senses pick up informations and react to them.

Our senses aren't just a part of us, they define us. This is because nothing that we experience in our life, from the most important to the most boring, would be possible without the intricate power of our senses.

Nothing in the entire universe of scientific exploration can even come close to matching the ability of our brain to use information sensed by our eyes, ears, skin, tongue, and nose to produce a rich sensory experience in a matter of milliseconds!

- But how much do we know about our senses?

What do our senses do?

Our senses have several roles to play. They aid our survival by directing us toward certain informations of our environment that are important for us and influence some activity (called as stimuli). As for example tasty foods draw us towards them and our mouth starts watering. Our senses also help us locate mates, seek shelter, and recognize our friends. Incidentally, our senses also give us the opportunity to find pleasure in music, art, athletics, etc.

There are yet other things that our senses do. You may have experienced feeling hurt to see someone in pain. Usually when we have strong emotional ties to someone and when he or she experiences pain, so do we(not just emotional ties we could be influenced by situations not directly related to us and yet feel the pain e.g. sympathising and feeling pain of drought affected people).

How do our senses accomplish all this? The complete answer is complex, but it involves one elegantly simple idea that applies across the sensory system. Our sensory impressions of the world involve nerve signals. These play a very important role in the way we react or respond to various stimuli or even to same stimuli in different situations.

For example generation of flavor preferences by our brain is usually based on what our body needs. Like cooked fish

may not smell good to some people. But if the person is very hungry and has no other option and particularly if the body has a need for protein, fish may suddenly smell good!

Stimuli from the environment around are received by our body through some sense organs. As we already know, they are the eyes, ears, nose, tongue and skin. Let's try to understand the path of receiving a stimulus to expressing a response (sensation).

Stimulation to Sensation

There are certain conditions, substances etc in nature that trigger the process of sensing them by our body. These are stimulants. Information carried by these stimulants are picked up by certain organs called as receptors present in our sense organs and converted into nerve signals. These are carried to the brain and processed to create a sensation. For example when reflected light (stimulus) from the surface of a green leaf and its surroundings reaches receptors in our eyes, it is converted into nerve signals. These signals reach the brain and are interpreted as green coloured shape against a background. We see this as the leaf.

Brain is the centre for all the sensitive activities. It receives information through sensory nerves that bring nerve signals from the sense organs and after interpretation sends off signals through another type of nerves called as motor nerves to parts that are to show the response. For example, you see a mosquito biting you on your leg through your eyes. The response works through motor nerves from the brain to your hands to strike and kill it.

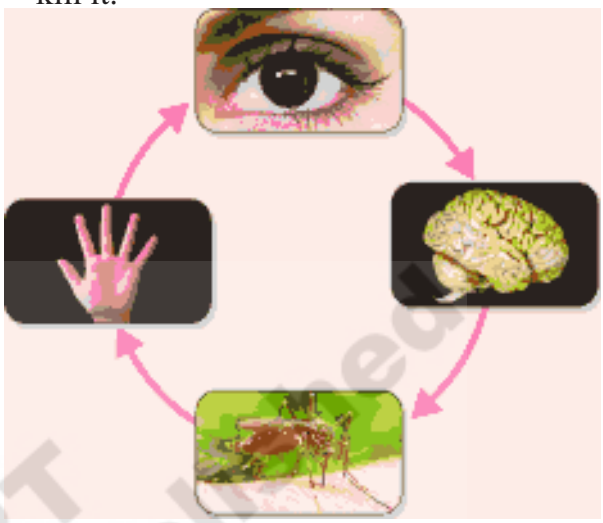


Fig-1 schematic representation of nerve stimulation to response.

Activity-1

Note down a few lines of any text in your book.

Write about the stimuli and responses and the sensory and motor functions with respect to the sense organs involved.

- Do you think our sense organs work together? Why, why not?

All stimuli may not lead to responses. Only a particular level of stimulus will give rise to a response. Moreover changes in stimulus also go unnoticed if they are not of a particular level.

Activity-2

Dissolve a pinch of sugar in a glass of water. Drink a little of this. Does it taste sugary? Why?

You could try this for different concentrations of sugar ,adding by proper

quantification, that is, weighing and preparing solutions to find out how much sugar in solution starts off your sensation. (you could take 1/4th teaspoonful sugar each time which would be nearly 2grams, for your convenience)

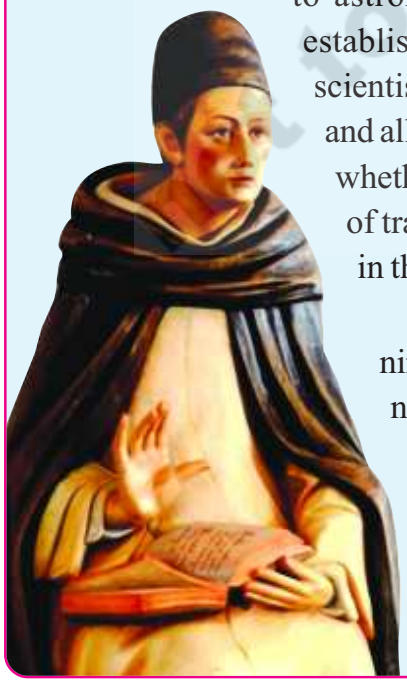
You may have often noticed while drinking tea or coffee that if you eat a very sweet substance in between, your tea or coffee appears to be less sweet as compared to the sips taken before eating the sweet (Thus, salty snacks go with tea or coffee!).

Looking back in History

Scientists from ancient times have wondered about the senses. Nearly 2300 years back Plato and then Aristotle mentioned the five senses of humans among which the sense of touch was considered the most important. In ancient Indian and Chinese medical documents also, mention of senses have been found. Thereafter for over a thousand years no documents regarding the role of senses had been found till Albertus Magnus' contributions (around 1220 AD).

He was a bishop in a church in Italy, a keen observer of nature and a lover of science who followed Aristotelian ideas, but commented on them for the first time making them accessible for wider academic debate. He mentioned the role of nerves for the first time in the sensation of touch.

Physiology of sensation could be studied in great detail only from the 17th century as this was the prime time when several instruments were being invented to aid the unaided eye to observe more closely. Johannes Kepler (1600 AD), well known for his contributions to astronomy regarding the rotation and revolution of earth, established the role of eye as a sense organ. In recent years, scientists have uncovered new insights into how our senses work and all the amazingly complex and fascinating things they can do, whether we are aware of them or not. The electrochemical basis of transmission of nerve signals and functions of specific areas in the brain involved in sensations are also better understood.



The number of senses from Aristotelian era to the nineteenth century stands at five, while in the modern era this number signifies the sense organs in our body.

Though it is classically considered that humans have five senses, but in fact, we may have many more. We have one sense of touch dedicated to pressure, another for heat and cold, and yet another for vibration and texture and that's just one of our traditional sense of touch!

This usually happens because a higher level of the same stimulus masks that of the lower level. Remember the poem "Tinaga Tinaga Vemu Thiyyanundu".

We should consider our sense organs to be change detectors. If you have ever jumped into a cool pool on a hot day, you know that sensation is critically influenced by change. In fact, a main role of our stimulus detectors is to announce changes in the external world—a flash of light, a splash of water, a clap of thunder, the prick of a pin etc. The receptors present in our sense organs specialize in gathering information about new and changing events.

Though our senses are change detectors, usually small changes or unchanging stimuli often go unnoticed. Our senses accommodate to unchanging stimulation and we become less and less aware of constant stimulation. For example the sounds in a printing press may be very uncomfortable for a worker landing there for the first time. Eventually as time passes, the person would not find the sounds so uncomfortable.

What does all this mean for our understanding of human sensation? The general principle is this: We are built to detect changes in stimulation and relationships among stimuli and often adapt to certain stimuli.

Our Sense Organs

As we all know, we have five main sense organs, the eyes, ears, skin, nose and tongue. These sense organs have sensory receptors. Each type of receptor is highly sensitive to specific stimulus types.

1. Eye

Vision helps us detect desired targets, threats, and changes in our physical environment and to adapt accordingly. So, how does the visual system accomplish this? We shall do a few activities and read the following section to find out about this.

Activity-3

1. Observe the external structure of your friend's eye, draw the diagram and label it (you can take the help of diagram given in this section).
2. Observe the eye ball of your friend in normal light. Then throw a beam of torchlight on your friend's eye.

- What is his or her reaction? Why is it so?

Fig-2(a) The Human Eye

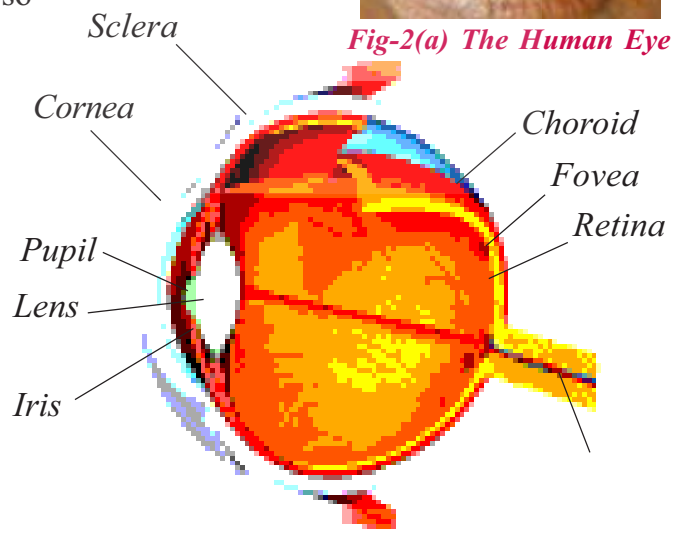


Fig 2(b) Human eye: schematic cross sectional view

Now ask your friend to keep the eye closed for around two minutes. Now let her/him open the eye. Observe the size of the small black portion in the centre. Ask your friend to keep her/his eye open forcibly as you throw the beam of torch light this time. Observe what happens to the small dark portion.

- What happened to the small dark portion called the pupil? Guess why.

Structure of the eye

Our eye contains eye lids, eye lashes, eyebrows and lachrymal glands. A thin layer, called conjunctiva covers the front portion of the eye. The eye ball is located in the eye socket. Only 1/6 portion of the eye ball is visible to us.

Eye has three main layers. They are sclerotic layer or sclera, choroid layer and retina. The outer most thick, tough, fibrous, non-elastic and white coloured layer is sclera. The sclera bulges and forms cornea. The end of sclera connects to the optic nerve. The second layer is choroid layer. This layer is black in colour and contains a lot of blood vessels. It encloses the eye except the part pupil. The part formed by the choroid layer around the pupil is iris. Radial and circular muscles are present in the iris. Biconvex Lens is present immediately behind the pupil is attached to the ciliary muscles and suspensory ligaments.

The lens divides the inner eye ball as aqueous chamber and Vitreous chamber. Aqueous chamber is filled with water like fluid whereas vitreous chamber is filled with jelly like fluid.

Retina contains the cells, called rods and cones. The area of no vision, called blind spot and the area of the best vision, called yellow spot are present in the retina. The yellow spot is also called Macula or Fovea.

Functioning of the eye:

The Visual Sensation

You might think of the eye as a sort of "video camera" that the brain uses to make motion pictures of the world. Like a camera, the eye gathers light through a convex lens, focuses it, and forms an image in the retina at the back of the eye. The lens, turns the image left to right and upside down (you may have studied in the chapter on light that we get an inverted /upside down image through a convex lens). This visual reversal may have influenced the very structure of the brain, which tends to maintain this reversal in its sensory processing regions. Thus, most information from the sense organs crosses over to the opposite side of the brain. Likewise, "maps" of the body in the brain's sensory areas are typically reversed and inverted. But while a digital camera simply forms an electronic image, the eye forms an image that gets extensive further processing in the brain.

The unique characteristic of the eye that makes it different from other sense organs, lies in its ability to take the information from light waves then transform the characteristics of light into neural signals that the brain can process.

This happens in the retina, the light-sensitive layer of cells at the back of the eye that acts much like the light-sensitive chip in a digital camera. As with a camera, things can go wrong. For example, the lenses of those who are "nearsighted" focus images short of (in front of) the retina; in those who are "farsighted,"the focal point extends behind the retina. Either way, images are not sharp without corrective lenses.

The real work in the retina is performed by light-sensitive cells known as photoreceptors. These photoreceptors consist of two different types of specialized cells the rods and cones that absorb light energy and respond by creating nerve impulses.

But why are there two sorts of photoreceptors? Our eyes function sometimes in near darkness and sometimes in bright light. These two types of processors involving distinct receptor cell types named for their shapes have evolved for this purpose.

Fig 5 a Fig 5 b Schematic Representation Rods and cones in the human retina

Nearly 125 million tiny rods containing the pigment rhodopsin "see in the dark" that is, they detect low intensities of light at night, though they cannot make the fine distinctions that give rise to our sensations of color.

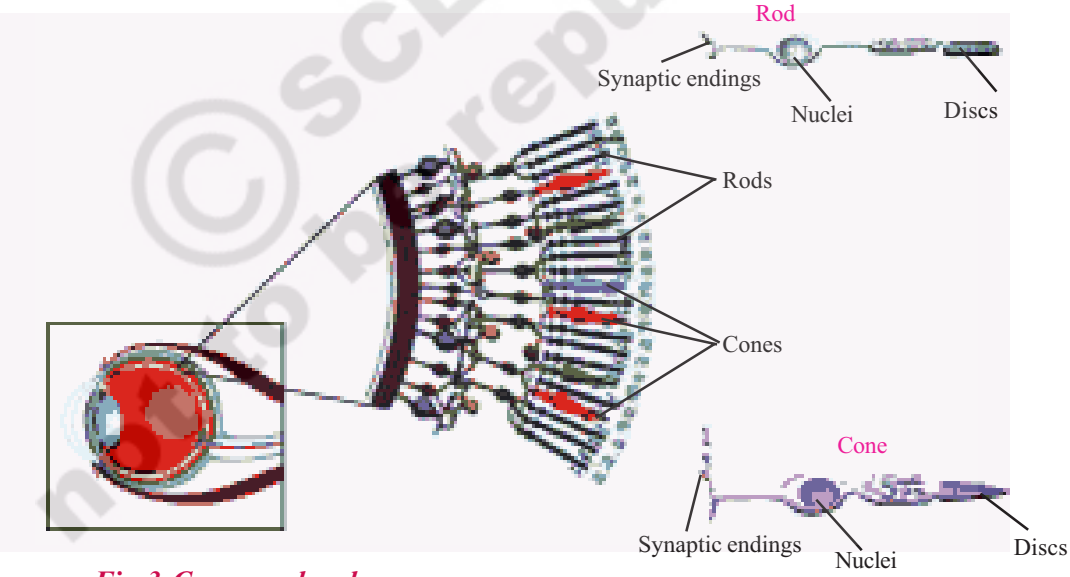


Fig-3 Cones and rods

Cells and tissues in the eye

Making the fine distinctions necessary for color vision is the job of the nearly seven million cones containing the pigment iodopsin that come into play in brighter light. Each cone is specialized to detect the light waves we sense either as blue, red, or yellow and the array of colours formed by their combinations. Thus the yellow field, the bright red morning sun, the blue sky and all other colours in nature are sensed. Let us observed the figure 5a, 5b.

The cones concentrate most in the very center of the retina, in a small region called

the fovea, which gives us our sharpest vision. With movements of our eyeballs, we use the fovea to scan whatever interests us visually, the features of a face or, perhaps, a flower.

There are other types of cells in the retina that do not respond directly to light. These handle the job of collecting impulses from many photoreceptors (rods and cones) and shuttling them on to the nerve cells. Presence of some other receptor cells sensitive to edges and boundaries of objects and those that respond to light and shadow and motion in the retina have also been reported recently.

Bundled together, the nerve cells make up the optic nerve, which transport visual information from the eye to the brain.

Again, it is important to understand that the optic nerve carries no light. Only patterns of nerve impulses conveying information derived from the incoming light is carried. Each of the eyes collects slightly different view of an object. The brain puts the two views together and a three dimensional picture is formed.

Just as strangely, there is a small area of the retina in each eye where everyone is blind, because that part of the retina has no photoreceptors. This blind spot is located at the point where the optic nerve exits each eye, and the result is a gap in the visual field. You do not experience blindness there because what one eye misses is registered by the other eye, and the brain "fills in" the spot with information that matches the background.

Activity-4

Hold the text at arm's length, close your right eye, and fix your left eye straight on the fig-4. Keep your right eye closed and bring the book slowly closer. When it is about 8 to 10 inches away the gap disappears as it is on the blind spot of your left eye. But you will not see a "hole" in your visual field. Instead, your visual system "fills in" the missing area with information from the blue line on either side.

Fig-4

Eye protection

Each eye is protected by eyelids, eye lashes, eye brows and lachrymal or tear glands. A thin membrane covers the front part of the eye. This membrane is called conjunctiva. The conjunctiva is made up of transparent epithelium. It is also a protective cover to the eye. Whenever unwanted substances come in contact with this layer the lachrymal glands are stimulated to wash the substance out of the eye. The fluids that are filled in the eyeball (vitreous and aqueous chambers) protect the lens and other parts of the eye from mechanical shocks. Cornea is the clean window in the sclera in front of the Iris. It protects the eye from direct exposure to light.

Think and Discuss

- What will happen if we have no eye lashes?
- Is tears good for us?

Eye: Some structures that bring about adjustments

The Iris is a muscular structure which adjusts the size of the pupil which is nothing but a gap between the iris in front of the lens. Adjustments are made depending on light intensity.

Cilliary muscles and suspensor ligaments are capable of adjusting the focal length of the eye lens.

Activity-5

1. Observe the Iris and its surroundings of your friend's eye. Can you find the pupil?
2. Observe the colours and patterns in the iris of your friend' s eyes.

Is there any difference from one another? Select a minimum of ten members and note the result. Use a hand lens for close observation. Record your observations in your notebook.

Do you know?

While issuing identity cards like AADHAR. They take photographs of your eyes. Do you know why did they take photo of your eye? Iris patterns are individual specific and can be used for identification just as our finger prints.

The lenses in our eyes are very special. They are biconvex and crystalline in nature. Their shape is adjustable to some extent that is their focal length can be changed with the help of cilliary muscles and suspensory ligaments. They can change the shape of the lens from a moderately to more convex form.

Activity-6

1. Enter into a dark room from a very bright place. What happens?
2. Sit in a dark room for some time. Then go into a bright light room. What happens?

Do you know the impression of an image stays in the retina for about 1/16 of a second. If the still images of an object are flashed at the rate faster than 16 per second. The eye receives it as moving. This is how we see movies.

Eye and Illusions

Activity-7

Take two pieces of white papers with same size. Draw the picture of a cage on one paper and the parrot on the other. Then insert a stick and attach the blank sides of the papers with gum see the adjacent figure. Let it dry then twist the stick rapidly.

What do you notice? Guess why.Let us observe the following figures.

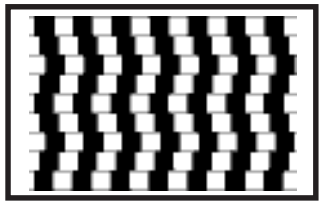
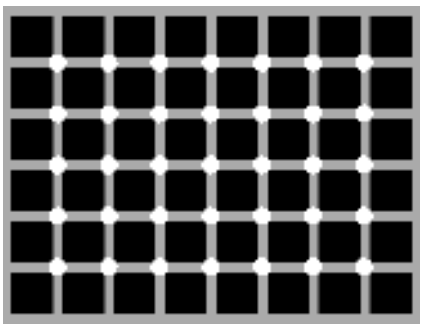


Fig-5(a)

Fig-5(b)

fig-5a :are these lines straight or not

fig-5b: wich one is having big circle in the centre



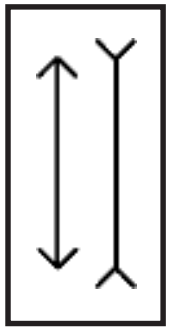


Fig-5(c) *Fig-5(d)*

fig-5c: Why do the dots, gray painted as appearing at the intersections of the grid?

fig-5d: which line is smaller

What illusions tell us about Sensation

When your mind deceives you by interpreting a stimulus pattern incorrectly,

you are experiencing an illusion. Such illusions can help us understand some fundamental properties of sensation and particularly the discrepancy between what we see and external reality.

Let's first examine the black-and-white grid. As you stare at the center of the grid, note how dark, fuzzy spots appear at the intersections of the white bars. But when you focus on an intersection, the spot vanishes. Why? The answer lies in the way receptor cells in your visual pathways interact with each other. The functioning of certain cells that are sensitive to light–dark boundaries inhibits the activity of adjacent cells that would otherwise detect the white grid lines. This makes you see the grayish regions, even though you know that the squares are black and the lines are white, this knowledge cannot overcome the illusion.

Diseases and defects of the eye

The main diseases and defects of the eye are - Night blindness, Xeropthalmia, myopia (near sightedness), Hypermetropoia (far sightedness), glucoma, cataract and colour blindness. Some persons may have eye defects by birth due to various reasons. Ask your teacher about these eye defects and write one or two sentences for each in your notebook.

Taking care of our eyes

You know the saying Sarvendriyanam Nayanam Pradhanam. How you take care of your eyes? Let us observe the following check list as your teacher how to get points.

Wash eyes with fresh water atleast thrice or four times per day.	Yes/No
Keep the distance between the book and eyes about 25 cm while reading.	Yes/No
Don't give continuous stress and strain to the eyes. Stop the work for some time when ever your eyes feel stressed.	Yes/No
Eat food materials like green leafy vegetables carrots etc rich in Vitamin A.	Yes/No

Work under good lighting.	Yes/No
Don't rub your eyes if anything falls in them, just wash the eyes immediately.	Yes/No
Remove dust in eye by using tongue, ring, blowing air etc.	Yes/No
Consult the eye specialist immediately whenever you face any vision related problems.	Yes/No
Avoid to see lightening gas welding sporks, eclipse.	Yes/No

- How many points you got?
- Are you aware of your eyes?

Ear

Apart from hearing ear helps in maintaining the equilibrium of our body. Do you know by which bone your ears made of? Observe the following picture how inside your ear is?

1. *Auditory canal*
2. *Ear drum*
3,4,5. *Semicircular canals*
6. *Cochlea*
7. *Vestibular nerve*
8. *Cochlear nerve*
9. *Eustacian tube*
10. *Ear Asslcles*
11. *Outer ear (Pinna)*

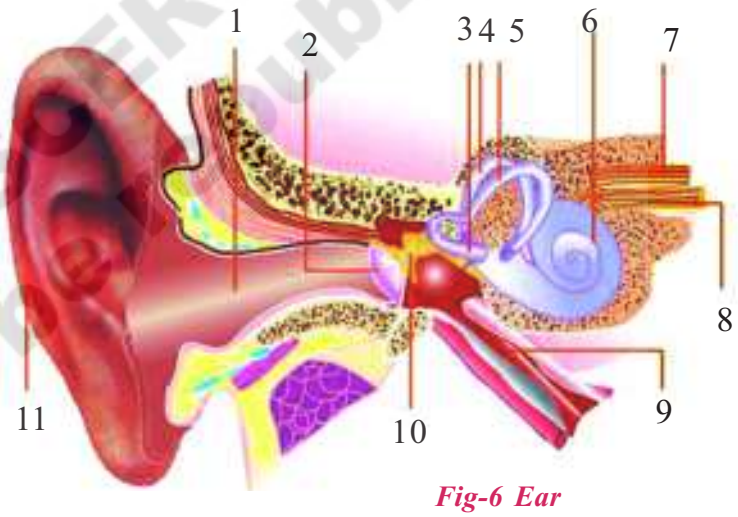


Fig-6 Ear

External ear:

It is the visible part of the ear on either side of our head. It is a flap like structure, called the Pinna. It leads to the ear canal. The pinna is crumpled and made up of cartilage.

- Have you ever observed wax like substance in your ear? Do you know where does it comes from.?

  Pinna has ceruminous (wax producing) and sebaceous glands (oil producing). These help to keep the ear cannal lubricated prevent the dust and other particles from entering into the ear canal. The ear canal is also called Auditory Meatus. A thin layer, called tympanum or ear drum is present at the end of the auditory meatus. It is present in between the external and middle ear. It is in the shape of a cone. Its narrow area connects to the first bone malleus of the middle ear.

- If we have not our external ear what will happen to us?

Middle ear:

Middle ear plays an important role in amplifying the vibrations received on the tympanum membrane. The chain of three bones, malleus, incus and stapes helps to do the same. Oval window is a membrane, covered ending of the middle year it opens into the inner ear through round window.

Internal ear or Inner ear:

Internal ear consist of bony labyrinth enclosing the membranous labyrinth. The membranous labyrinth consists of vestibule, three semicircular canals and cochlea. The anterior part of the vestibule is sacculus and the posterior part is utriculus. Nerve fibers from them form vestibular nerve.

The semicircular canals are connected to the vestibule and filled with endolymph. Vestibule and semilunar circles together form vestibular apparatus. If maintains the equilibrium of the body, pertaining to the posture and balance of the body.

Cochlea is a spiral shaped structure. It has three parallel tubes called scala vestibuli, scala media and scala tympani.

The first two are separated by the vestibular membrane. The second and third are separated by the basilar membrane. Scala vestibli and scala tympani are filled with perilymph. Scala media is filled with endolymph. It contains organ of conrti and tiny cells called primary sensory cells. Cochlear nerve fibres form cochlear nerve. The vestibular and cochlear nerves join together and form auditory nerve.

The Hearing/Auditory Sensation

External ear collects the sound waves. They enter into the auditorymeatus. Then they strike the tympanum. The vibrations from the tympanum reach the malleus, incus and stapes. They magnify the intensity of the sound vibrations. The stapes transmits the vibrations to the membrane of oval window. Then they transmit to the cochlea. The bacillary membrane is moved then the vibrations reach to the organ of carti. The impulses are sent to the brain through the auditory nerve. The hearing can be done according to the responses given by the brain.

Activity-8

- Take a plastic or Iron funnel. Stretch a piece of rubber balloon and cover the wide part of the funnel with it. Tie it with rubber band. Put four or five rice grains on the sheet. Ask your friend to shout 'Oh' at the narrow opening of the funnel.

Observe the movements of the rubber sheet while he is shouting. Observe the rice grains also. What happens to the rice grains? Why?

- Later remove the grains. Keep the wide part with balloon sheet on the chest of your friend. Put the narrow end at the opening of your ear. Could you hear any sound? What is it?

Functions of the ear:

- To collect and transform vibrations produced by sound to nerve impulses to be carried to the brain for processing.
- To maintain balance or equilibrium:
- Ask your teacher in what way ear maintain balance.

Caring for the ears

- Don't insert any sharp edged thing in the ears to clean the ear cannal.
- If any blockage occurs due to ear wax, use the ear drops, or a few drops of coconut oil to loosen it.
- A specialist may be consulted whenever needed.
- It is very danger to pore boiled oils, leafy juices in the ear. Sometimes it may cause deafness.

Ear – diseases:

Common ear-diseases like formation of pus, infection of ear drum etc may be caused by bacterial and fungal infections. If any infection occurs, one must consult the qualified doctors and use prescribed medicines.

Nose

Structure of the nose

Our external nose has two nostrils. They lead to the nasal cavity. Nasal septum divides the nasal cavity into two halves. The nasal cavity is lined with mucus membrane and small hairs. Olfactory receptors are present in the mucus membrane.

Smell and our Nose

Smell serves a protective function by sensing the odur of possibly dangerous food or, for some animals, the scent of a predator. We humans seem to use the sense of smell primarily in conjunction with taste to locate and identify foods, avoid spoiled foods etc. Humans use the sense of smell in much limited manner as compared to other animals.

Fig-7 Nose

The Smell or Olfactory sensation

Smell from flower like Artabotrys (Sampenga) and fruits like Jack fruit (Panasa) is good for some people but not for others. How we get smell either it is good or bad?

Biologically, the sense of smell, or olfaction, begins with chemical events in the nose. There, odurs (in the form of airborne chemical molecules) interact with receptor proteins associated with specialized nerve cells. These cells, incidentally, are the body's only nerve cells that come in direct contact with the outside environment. Receptors present at the base of the skin lining the inner walls of the

nose, are highly sensitive to odor chemicals. These odor chemicals can be complex and varied. For example, freshly brewed coffee owes its scent to as many as 600 volatile compounds (substances that reach gaseous state quickly as they have low boiling points.)

- List out how many odors did you able to smell?

More broadly, scientists have cataloged at least 1,500 different odor-producing chemicals. Exactly how the nose makes sense of so many odors is not completely understood, but we do know that nasal receptors sense the shape of odor molecules.

We also know that the nose's receptor cells (see figure11) transform information about the stimulus into nerve signals and convey it to the brain's smell centers located on the underside of the brain. There, our sensations of smell are initially processed and then passed on to many other parts of the brain. Unlike all the other senses, smell signals are not relayed through the hypothalamus an important part of brain that coordinates our nervous systems and endocrine or hormone secreting system.

- If you are suffering from cold did you smell things in the natural way?
- Do you find any relation between smell and taste?

The hairs and mucous in the nasal cavity keep dust, germs and other unwanted materials away from gaining entry into our bodies through the nose.

Activity-9

Blindfold your friend and ask him/her to identify different things by smell like lemon, tea, coffee, potato, tomato, tamarind, spinach, curd, brinjal, etc. Keep as many things but be careful in choosing them. They should not be in powdered form. Don't allow your friend to touch them.

How does the sense of smell work in identifying some substances mentioned above?

Taking care

Take proper care of your nose by washing it with water as you take bath and during nasal infection by washing them with lukewarm saltwater.

Tongue

Structure of the tongue

Our tongue is made up of voluntary muscles. It contains about 10 thousand taste buds. The taste buds are located in the walls of the papillae.

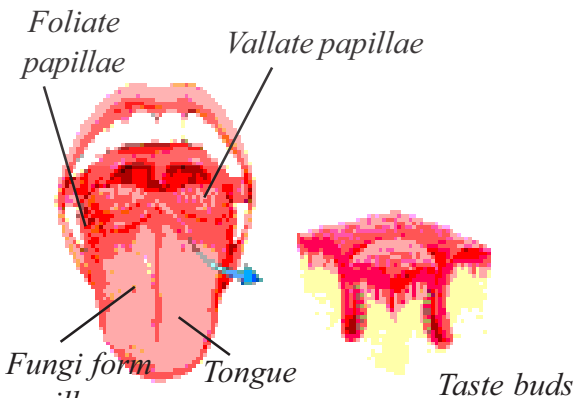


Fig-8 Tongue

Taste and our tongue

Like smell, taste is also a sense based on identifying chemicals in food and the

texture of it. But the similarity doesn't end there: The senses of taste and smell have a close and cooperative working relationship. So many of the subtle distinctions you may think of as flavors really come from odors. (Much of the "taste" of an onion is odor, not flavor. And when you have a cold, you'll notice that food seems tasteless because your nasal passages are blocked.)

Most people know that our sense of taste, or gustation, involves four primary qualities or dimensions: sweet, sour, bitter, and salty. Generally our Telugu people consider six types of tastes (Shadruchulu) which includes spicyness, Vagaru but actually they are tastes.

Less well known, however, is a fifth taste called umami . Umami is the savory flavor found in protein-rich foods, such as meat, seafood, and cheese. It is also associated with monosodium glutamate (MSG) also called as "huching", often used in Asian cuisine.

Metallic taste is the taste of some artificial processed food material.

The taste receptor cells, located in the taste buds on the top and side of the tongue, sample flavors from food and drink as they pass by on the way to the stomach. These taste receptors cluster in small mucous-membrane projections called papillae. Each is especially sensitive to molecules of a particular shape.

Moving beyond the receptors on the tongue, a specialized nerve "hotline" carries nothing but taste messages to specialized regions of the brain.

Developmental Changes in Taste

Infants have heightened taste sensitivity, which is why babies try to sense everything by taste. This super sensitivity, however, decreases with age. As a result, many elderly people complain that food has lost its taste.

Activity-9

Close the eyes of your friend with a piece of cloth. Give her/him a piece of ginger, garlic, tamarind, banana and jaggery one by one. Ask her/him to taste by just taking these one at a time on the tongue. Remember that your friend needs to rinse his /her mouth between each test.

Could your friend tell the taste by just putting the substances on the tongue?

Now repeat the above experiment by asking your friend to take a bite and press the food on the palate. What difference does he or she feel now?

As food enters our mouth, we bite and chew it and press it against the palate with our tongue. This releases the chemicals in food that trigger off our taste buds to act and carry stimulus to the brain to be processed for recognition of taste. The same taste bud is capable of producing different signals corresponding to the different chemicals in food.

Activity-10

Observe your tongue by standing in front of the mirror by sticking your tongue out.

See how many different kinds of structures you can see on your tongue.

Compare with the given diagram.

You can clearly see flake like structures that are the filiform papillae.

The roundish structures are fungiform papillae.

There are large roundish ones at the back of the tongue which are circumvallate papillae. On the sides of the tongue the bump like structures are foliate papillae.

Taste buds are present on all of these except the filiform papillae that are not the sites of taste sensation.

Do you know?

Each taste bud has a cavity with a pore. The pore is called taste pore. The epithelial cells, surrounding the taste buds form taste cells or the receptors. The receptor cells and the cells supporting them are situated in the cavity. Each receptor cell connects to a nerve fibre. All the nerve fibres connect to main nerves that carry messages to the brain and spinal cord for further processing.

Activity-11

Blindfold your friend and ask him/her to close his or her nose as well. Give a few cumin seeds to your friend and ask him/her to chew. Ask your friend to identify what you gave. You could try this with a small piece of potato as well.

- What do you observe? Why?

Taking care about the tongue

- Clean and wash the tongue before going to bed at night and after rising up in the morning.
- Wash the mouth cavity, after eating the food.
- If any problem arises consult the doctor immediately.

Think and Discuss

- Why we are suggested not to take too cool or too hot food material.
- If you are suffering from fever that time to your not able to enjoy the taste of food why?

Skin

The sense of touch had received supreme importance in the sphere of senses from ancient time. The organ involved is our skin.

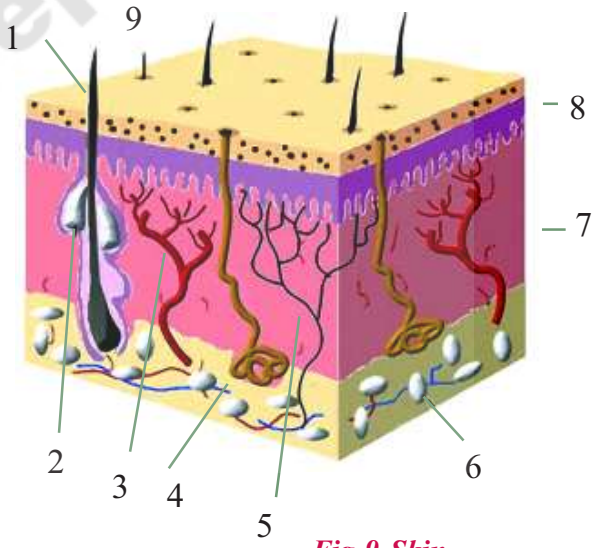


Fig-9 Skin

Structure of the skin

1. hair
2. Oil gland
3. blood vessel
4. sweat gland
5. nerve
6. fat lobules
7. endodermis
8. epidermis
9. pore

Our skin is the sense organ for touch. It contains cutaneous receptors for touch. The skin consists of two main layers, called epidermis and dermis.

Epidermis is the layer for protection. It has sweat pores and small hairs. It contains three layers. They are outer stratum corneum or cornified layer containing dead cells, middle granular layer containing living cells and inner malpighian layer containing the cells dividing constantly. Dermis lies below the epidermis. It is made up of elastic connective tissue. It contains sweat glands, sebaceous glands hair follicles, blood vessels and fats.

Skin and touch:

Skin is the outer most covering of our body. It regulates the body temperature and eliminates certain waste material through sweat. It is the sense organ of touch. The sense of touch is done by the cutaneous receptos. It is the largest organ of all. It provides the first level of protection to the body.

- How sensitive is our skin?

Activity-12

Make bundles of three toothpicks. See to it that their pointed ends are at the same level. Now ask your friend to make an outline of one of her/his palm. Ask you friend to close her/his eyes. Now starting from the tip of the thumb keep pricking lightly with your toothpick bundle all over the plam and keep asking your friend how many points she/he could identify each time. Remember to record with w cross if there is no sensation and with numbers depending on the number of points identified.

Repeat this with some of your friends.

- Where on the palm do you find maximum sensation?
- Where did you find minimum sensation?
- Are palm sense patterns same for all your friends?

The colour of the skin is due to the presence of the pigment, called "melanin". This pigment gets stimulation, when exposed to sun light. The skin becomes dark to protect other layers of the skin from harmful effects of light. Skin is sensitive to touch, temperature and pressure. It contains the separate receptors such as tactile receptors for touch, pacinian corpuscles for pressure, nociceptors for temperature etc.

Activity-13

Press your thumb gently on the tip of a sharpened pencil. Later press it on the blunt end of the pencil.

- How do you feel? Why?
- Do you know?

In Braille script, the letters are written in the form of elevations and depressions. So, the visually impaired students can read the script merely by touching.

Taking care about skin:

We should take bath regularly

- Use soap to clean the body
- If any redness, itching, decolouration and rashes appear on the skin immediately consult the doctor.

Some of the diseases, affecting the skin are.

- Viral diseases such as measles, chicken pox etc.
- Bacterial diseases such as leprosy
- Leucoderma, the disease due to the deficiency of melanin.
- Pellagra the disease due to the deficiency of vitamines.
- Fungal diseases such as ring worm.

Sense organs are the gate way of knowledge. We see, hear and feel the nature by these sense organs. Taking care of sense organs provide good health which leads to better lively hood.

Key words

Sensory receptors, lacrinal glands, conjunctiva, sclera, cornea, iris, pupil, choroid layer, suspensory ligaments, vitreous chamber, aqueous chamber, retina, blind spot, fovea, optic nerve, night blindness, myopia, hypermetropia, cataract colour blindness. pinna, ceruminous glands, sebaceous glands, auditory meatus, malleus, incus, stapes, tympanum, vestibule, semilnar canals, cochlea, basilar membrane, auditory nerve, chemoreceptors, olfactory sense fungiform papillae, filiform papillae, vallate papillae, foliate papillae. Melanin, ceruminous glands, sebaceous glands, cutaneous receptors, tactile receptors, leucoderma

What we have learnt

- Sense organs are five, sense organs work together for particular sensations.
- There is a particular level at which the process of sensation is triggered.
- Stronger sensation masks weaker ones.
- The lens in the eye is adjustable.
- Lachrnmal glands secrete lubricant for the eye aiding in movements of the eye.
- Retina contains mainly Rods for near dark (dim light) vision while Cones help in bright light colour vision.
- Blind spot is the area of "No vision" where the optic nerve leaves the eye.
- Fovea is the area of distinct vision.
- Each eye gets a slightly different view of an object.
- The image forms on retina.
- Our ear has three main parts. They are external ear, middle ear and internal ear.
- Ceruminous glands and sebaceons glands are present in the ear.
- Tympanum or ear drum is present at the end of the auditory meatus or ear cannal.Vibrations of this due to sound travelling through ear cannal, starts the process of hearing

- The middle ear contains three bones, called malleus, incus and stapes that amptify sound.
- Tongue contains nearly 10000 taste buds present on the papillae.
- Skin has cutaneous receptors. It is the sense organ of touch.
- Sense organs send messages through sensory pathways to the brain where they are processed and sent to required sense organs to function through motor pathways.

Improve your learning

I. Give reasons for: (AS 1)

1. We usually do not see bright colours in dim light
2. Removal of wax layer too often will raise incidence of ear infection
3. During severe cough and cold we lose taste of food.
4. While cutting onions our tears start flowing.

II.Find out the false statements and rewrite them as correct ones. (AS 1)

1. The rationale behind seeing is just the impression of the image in the retina.
2. Ear functions only to hear.
3. Iris patterns are like finger prints used in identifying individuals.
4. Saliva helps the taste buds in taste sensation.
5. We are not able to adapt to sensations.

III.State the difference between the two (AS 1)

1. Rods and cones
2. Iris and Pupil
3. Pinna and Tympanum
4. Nasal cavity and ear canal

IV. How do the following processes occur? (AS 1)

1. When we see an object, a real inverted image is formed on the retina.
2. The sound waves, collected by the pinna are changed as vibrations.
3. We move our hand away from a hot object.
4. A pungent odour, makes us close our nose.

V. Fill in the blanks with suitable words. Then give reasons why the words are suitable. (AS 1)

1. Chroid layer provides ..... to the eye.
2. The relationship between the tongue and ..... is more.

3. Iris pattern is used for individual ……
4. Area where optic nerve leaves the eye is called the ……
5. The ear drum is the …….

VI Choose the correct option (AS 1)

1. This vitamin is essential for the health of eye.
   a) Vitamin 'A' b) Vitamin 'B' c) Vitamin 'C' d) Vitamin 'D'
2. Sensation is a complex pathway involving -
   a) Sense organs b) Sense organs and nerve impulses
   c) Sense organs,nerve impulses, brain
   d)Brain and nerve impulses
3. The sound waves if not focused by external pinna and ear cannal will result in
   a) Hearing several types of sound loudly b) Not hearing anything
   c) Slight hearing d) Not being able to make out the type and origin of sound
4. The muscles of the eyeball of a person becomes non functional, the invariable effect would be-
   a) The person fails to close eyes
   b) Fails to move eye and see colours clearly
   c) Feels pain in the eye
   d) The nerves reaching the muscles become nonfunctional.
5. The tongue of a person is exposed to a high salty taste then:
   a) The person learns to taste salty things better
   b) Loves tasting salty things
   c) Hates tasting salty things
   d) Fails to taste a less salty thing just after the exposure.

VII Draw and label the diagrams, showing the structure of the (AS 5)

1. Eye 2. Ear 3. Tongue

VIII How would you pay concern towards disabled people who is lacking sensory organs?

IX How do you appreciate the functions of sensory organs which helps us to enjoy the beauty of nature? (AS 6)

X Form a group with five students in your class and collect eye diseases and its characteristics by talking with ophthalmic assistant. (AS 4)

XI What happens if our skin loss its sensory nature? (AS 2)

XII Sagar is not able to listen things properly. Guess what would happen to him. What suggestions you would like give to him? (AS 7)

Chapter 7

Animal behaviour

Fig-1 (a) Butterfly on a flower (b) Gorilla at rest (c) A bird making a nest

Observe the above figures. You must have observed all these things in your surroundings. While observing them you might have got questions like these.

- Why fish do not need to learn how to swim?
- How can butterfly get to know about nectar?
- How ants search their food and give information to each other about this?
- Who does teach a bird to make a nest?

In this lesson we will try to understand about why animals behave in a specific way. Is there any pattern in their behaviour? What are the factors that affects their behaviour?

What do we mean by Animal Behaviour?

Animal Behavior is the scientific study of the wild and wonderful ways in which animals interact with each other, with other living beings, and with the environment. It explores how animals relate to their physical environment as well as to other organisms, and includes topics such as how animals find and defend resources, avoid predators, choose mates, reproduce, and care for their young.

Fig-2 Weaver bird

The study of animal behavior begins with understanding how an animal's physiology and anatomy are integrated with its behavior. Both external and internal stimuli prompt behaviors external information (For example threats from other animals, sounds, smells) or weather and internal information (For Example hunger, fear). Scientists are drawn to the study of animal behavior for varied reasons and the field is extremely broad, ranging from research on feeding behavior and habitat selection to mating behavior and social organizations.

Different types of Animal Behaviour

There are several types of behaviours in humans and other animals that have been described and investigated by researches. The following types have been studied so far

- Instinct
- Imprinting
- Conditioning
- Imitation

Instinct

Instinctual behaviours are behaviours that need not be learned. They can be complex like making nest by birds, choose mates and forming into groups for protection, etc.

Fig-3 A Spider spinning its web

- What is going on in the figure?
- Will you consider spinning the web by spider as an instinct behaviour? Why or why not?

If your hand touches something hot or sharpened are accidentally it automatically moves away. This is because of reflex action. Reflexes are also a type of instinct behaviour. We do not have to learn this.

- Give two examples of reflexes?

Imprinting

You might have observed this type of situations. Chickens and ducklings are able to walk almost immediately after hatching from the egg. Duckling can even swim after a few days. They recognise their mother because of a behaviour type called imprinting.

Fig-4 Hen with ducklings

Ducklings will follow the first moving object they meet after hatching. They become socially attached to this object and treat it as their mother. Imprinting lets young animals recognise their mother from a young age. They can follow her for food and protection.

Imprinting is useful if the first moving object they see really is their mother. But ducklings will imprint on people, balls and even cardboard boxes if these happen to be the first things they see.

- Try to find out more examples of imprinting from your surrounding.

Do you know?

Konrad Lorenz (1903 to 1989) was an Austrian scientist who studied animal behaviour. He discovered that if he reared geese (give local name of this) since they hatched; they became imprinted on him. They followed him around and preferred to be near him even when they had grown into adult geese.

Conditioning

Conditioning is a type of behaviour involving a response to a stimulus that is different from the natural one. It is a type of learned behaviour.

If we take ringing of school bell as an example, student shows different types of conditioning to a school bell as per the time.

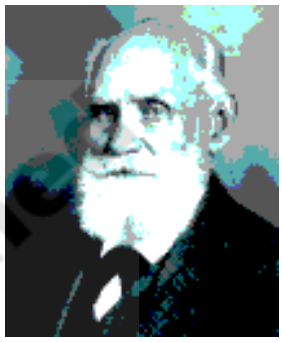
When the school bell rings in the morning, students gather for assembly.

When school bell rings at the end of break time, the students leave the playground and go to their classrooms.

When school bell rings at the last period students rush to leave their classroom.

There is one stimulus of ringing the school bell, but students show different responses to it. It is only because by their experiences they had learnt when to perform which function. They would be wrong sometimes.

Ivan Pavlov (1849 to 1936) was a Russian scientist who has investigated conditioning. He discovered that dogs produced extra saliva when they were offered food. This is a natural response to a stimulus - food makes a dog's mouth water. The saliva produced is needed to start digesting food and to make swallowing food easier.



Ivan Pavlov

Pavlov noticed that they also did the same when the person who fed them came into the room, even if the person had not brought any food. Pavlov went on to ring a bell at the start of feeding time, and eventually the dogs produced extra saliva when they heard the bell, before any food was brought in.

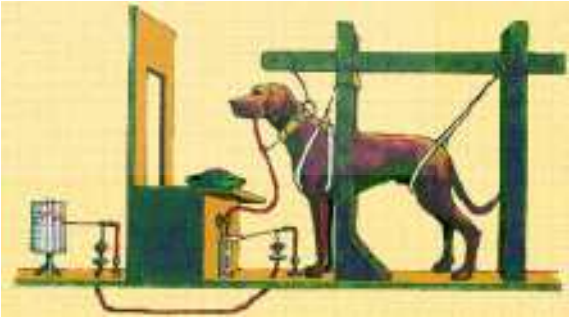


Fig-5 Dog Experiment

A dog salivating when it hears a bell is not a natural response. They would not do this without being conditioned to do so. The behaviour has been learned. It's called a conditioned response.

Fig-6 Electric fences stop grazing animals straying

People and animals can be conditioned to avoid certain things. For example, grazing animals get an unpleasant electric shock when they touch an electric fence.

They eventually avoid the fence, even when it is turned off.

Can you recall some other examples of conditioning? try to enlist at least five of them.

Imitation

Imitation is a type of behaviour where one animal copies another animal. Humans often imitate each other, often without realising it. When people talk to each other, they may stand or sit in a similar way, and copy each other's movements. Scientists think that this happens so that the speakers feel more at ease with other.

Some scientists think that humans are the only animals that copy each other. Other scientists have observed chimpanzees and other primates imitating each other. For example, chimpanzees can use sticks to spear juicy grubs to eat. Other chimpanzees copy this behaviour. In this way they learn new skills. Do you ever heard monkey imitate us. Read and discuss about the story 'Monkey and Hat marchant'

Fig-7 Behaviour of Chimpanzee

Human behaviour

Humans show many of the same types of behaviour as other animals. But human behaviour is often more complex because we are more intelligent and aware of ourselves.

Instinct

Humans have instincts, but it is possible for us to overcome natural urges to follow certain behaviour. For example, hungry persons might want to start eating immediately when they sit down at the dinning table, but they have learned that good manners mean they should wait until

everyone is seated and ready to eat.

Imitation

People often imitate each other. This can help them learn something new and useful, such as new skill in lessons, sport or at work. It can also leads them to show less useful or harmful behaviour. For example, young people may start smoking, drinking alcohol or taking drugs as a result of copying each other to 'fit in'. But it is very dangerous for our health.

Conditioning

Conditioning can be used to change the behaviour of people. Advertisers are very skilled at this. They use pictures of their products which make them look glamorous or exciting, often by using famous actors or sports people. By associating the product with attractive images the advertisers are trying to set up a conditioned response to their product. People will respond positively and buy the product.

Investigating behaviour

Behaviour can be investigated in the 'field' or in the laboratory. It can be observed and measured, and experiments can be designed to test how it works. Human behaviour is affected by many variables. It can be more difficult to study than the behaviour of other animals.

Investigations in the field

Some scientists spend many hours watching and studying the behaviour of animals. They may be interested in how the animals live alone, group into families or form large groups such as herds.

Animals can signal to each other. For example, they may call to each other to warn of danger. Some scientists are interested in such signals. They record and study them to work out what the signals mean.

Tagging

You have studied about bird migration in the chapter biodiversity and its conservation. Like birds some other animals also migrate over large distances to find food or nesting sites. Animals can be 'tagged' by attaching tracking devices to them. Tagging lets scientists follow the journeys the animals make.

Lab Activity

The work of Lorenz and Pavlov has been mentioned in the earlier sections. These scientists studied animal behaviour under controlled conditions.

You can also study the behaviour of cockroach. For this you will need a choice box. You can make a choice box by following the given steps-

- Take a box, and divide it into four chambers with the help of a cardboard as shown in figure.
- Make tiny holes in any two chambers of one side so that light can pass through these holes into the chambers. Let other two chambers as it is (Dark).
- Now create humid environment with help of moist cotton wool in one of the lightened and one of the dark chambers.

- So the box has been divided into four chambers with different conditions i.e. light and dry, light and humid, dark and dry, dark and humid. Preparations are over. Make four groups in your class. Each group will put several cockroaches into a choice of chamber with four different conditions:
- light and dry
- light and humid
- dark and dry
- dark and humid
- Cover the box and leave the setup for 15-20 minutes.
- Count the number of cockroaches in each chamber.
- In which chamber the number of cockroaches is highest?
- Compare your observations with other groups. Write down the differences if any.
- From your experiment try to write down a short note about behaviour of cockroaches regarding their living conditions.

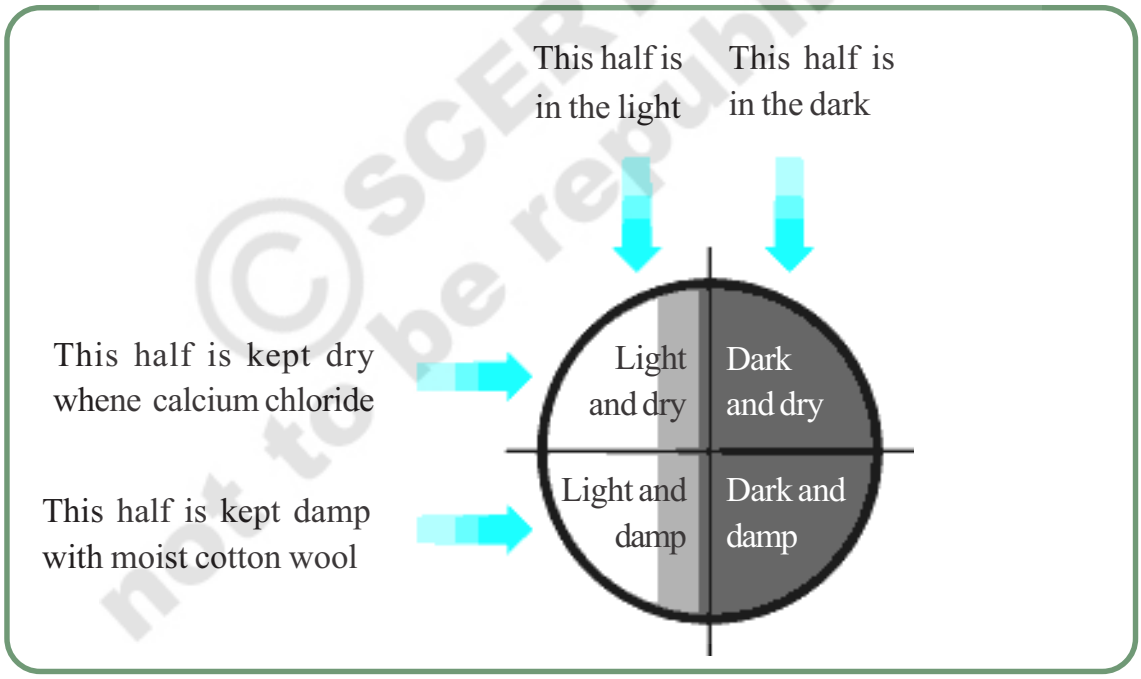


Fig-8 Choice box showing different conditions

Cockroaches prefer dark and damp conditions.

The quarter of the choice chamber with these conditions contains most or all of the cockroaches.

Activity-1

Let us observe the following behaviours of different animals. Identify their imprinting, instinct, conditioning or imitation.

- Our pet dog barks only on

strangers. If you do not stop dogs into kitchen, how would they behave?

- Ants which usually go in a line reach sweet kept in tin. How do they know the way to reach the tin?
- Mosquitoes, cockroaches come out of their places only when it is dark. How do they know the difference between light and dark?
- Bats and owl move and search for food during night only. How could they know what is a day what is a night?
- When you untie the neck of your bull at the time of plouging, it moves towards plough without any instructions. In the same way, it moves towards tub at the time of feeding. How does the bull respond differently?
- Birds collect material which is soft, strong to build its nest. How do they know the quality of material.
- Puppies, kitten fight each other when they saw a piece of cloth. They try to tare it off why?
- In a particular season, some birds in our surroundings migrate from long distances. How do they know their way?

Offsprings (kids) of different animals, either they live on land or in water perform activities by instinct, imprinting, imitation or conditioning. Animal behaviour is based on different bio chemical reactions. Identifying or smelling ability of dogs and searching and communicating nature of ants is because of pheromones. (ask your teacher about pheromones)

Let us know some interesting behaviour which reflects their intellectual abilities in animals. It is very interesting to watch making of nest. It varies from species to species. Birds build their nests in different ways. Weaver bird selects three broad leaves one for bottom, two for top and sides and collect threads to make their nest by stitching these three leaves. Some of the birds build its nest only with leaflets.

Fig-9 Nesting Birds

- Observe different birds building their nests in your sorroundings.
- Collect material and try to build same type of nest on your own. Try to understand how the birds are so intelligent.

Beaver, a mammal, which lives in North America builds dams across water streams. Beaver cut big trees by its sharp teeth to

Fig-10 Beaver carrying log

fell the trees across the stream.Then the beaver constructed nearly four feet wall by using twigs, stones and mud. Stagnated water is the living home for beavers family.

Wasp is an intelligent bee which builds its home keeping in view its future needs. Wasp builds its hive on the walls by using mud.

Fig-11 Wasp making nest

They select suitable mud for constructing its hive. If it is dry the wasp makes it wet by adding drops of water. If it is wet airs it for some time to make balls to build its hive. Then they search for food. They collect food material by injecting its venom (usually other larvae) and kept in it its hive. Wasp lay its eggs on the food material, which is used as food for larvae of wasps.

Some experiments towards animal intelligence

Let people believe or not, cheating / bluffing, hiding are also characteristic features of self consciousness. In other words,we can say that you know what others think of you and vice versa. So, in order to make them confused, you do something that others can not guess your plans. Not only humans, but there are some other animals

also that show the same behaviour.

Fig-12 Scrubjay bird

A bird called scrubjay hides its food. But unfortunately when it searches back its own food, it finds that another scrubje had already stolen. An experiment proved that a scrubjay had hidden its food in presence of another bird. After some time it was found that the other bird had stolen it by fixing a plan.

Fig-13 Squirrell

Squirrells too hide their food in a fascinating way. They always behave in such a manner that somebody is trying to steal their food. In order to misguide others they dig holes in many places and heap leaves, starch etc to cover them. Sometimes, most of the holes does not contain any food. In this way, they cheat others to make believe that these holes contain food.

If we think of logic, we must remember Dolphins. Dolphins have great logical thinking power.

It was proven by Hermon. Hermon studied four bottle nose Dolphins at Kavalo Basin mammal labarotory of Hawai islands. He named them Akkikomoi, Phoenix, Allen and Hippo.

Fig-14 Dolphins playing

He could understand by his study that Dolphins can remember their names and understand a code language if they are trained by practice. Even they could reply to complex code language. For example, the closed fist shows a tub, raised arms show a ball and one hand raised tells 'bring here'. The altogether actions are understood by the Dolphins. If we show the above actions in a sequence, the Dolphins would bring the ball from the tub. If we reverse the actions they throw the ball into the tub.

They remember their names by short and long whistles.Variety of whistles are recognised by them. If a Dolphin of particular whistle is called, all the dolphins stare at ,while the particular one comes to you.

Another wonder behaviour is remarked with Alex, an African grey parrot. In 1977, Evirin Pepperberg bought a parrot and trained it. Slowly he made it learn more than 100 words. He then arranged the words in such a way that Alex can frame its own sentences. After some days, he showed Alex one yellow bowl and another yellow dish. The dialogues between them are:

Pepperburg: What is the similarity?
Alex: Colour?
Pepperburg: What is the difference?
Alex: Shape?

Fig-15 African Grey parrot

Likewise Alex could recognise even minute similarities and differences between any two objects irrespective of colour, site, shape etc. it even tried to teach other parrots of its group. When they utter wrongly it instructed them to say 'clear'.

Besides, wonderful thing is that it calls an apple as 'Bannery' because it tastes like a banana and look, like a big cherry. Naming in this way is a sign of creativity in language. Before Alex's death it could even learnt upto 7th table.

Activity-2

Every species in animal kingdom has its own standards of intelligence which reflects through their behaviour. Animals also express feelings like happiness, threat, fear, anger, sadness etc. Your pet dog is a best example to observe different types of feelings. After returning from fields in the evening cow licks its calf. It reflects its affection towards its baby. You also see this types of behaviour in other animals.

Hissing of snakes, barking of dogs, stiffing of nailed hair of hedgehog (Mulla Pandi), bad flavour from skin of Tasmanian Devil etc, are all the expression to protect themselves from predators.

Do you know?

Some animals spray bad smell through their body to protect from predators. Tasmanian Devil is the worst smelling animal in animal kingdom. We are also familiar with a beetle with foul smell called Bombardier Beetle.

Fig-16(a)
Tasmanian Devil

Fig-16(b)
Bombardier Beetle

It has two chemicals hydroquinone and hydrogen peroxide stored in its body. Whenever the beetle feels threatened, these chemicals mix with some special enzymes and that heat up the liquids, which gives out bad smell from its body.

- Select any one of the animals in your surroundings.Observe how it behaves in the following situations.
  1. Name of the animal:
  2. Place where it lives
  3. How it builds its place:
  4. Way of collecting food / prey:
  5. External characters:
  6. Expressions:
     Happiness, Sadness, Fear, Threat, Quarrel, Caring self / young ones
  7. Group behaviour

Display your observations in the classroom

Animals also behave like us in most of the situations. It is very interesting and important to understand animal behaviour to conserve bio-diversity. Ethology is the scientific and objective study of animal behaviour and a sub- topic of zoology. The focus of Ethology is on animal behaviour under natural conditions. This is the combination of laboratory and field science with a strong relation to certain other disciplines such as Neuro anatomy, Ecology and Evolution. Ethology began during 1930 with the works of Duch Biologist NIKOLAS TINBERGEN and by Austrian biologist KONRAD LORENZ and KARLVON FRISCH. They got Nobel prize for their works on animal behaviour in 1973.

Key words

Instinct, Reflex, Imprinting, Conditioning, Imitation.

What we have learnt

- Animal shows different types of behaviour.
- Animal behaviour is the scientific study of the ways in which animals interact with each other, with other living beings, and with the environment.
- Finding of resources and defending them, avoiding predators, choosing mates, reproduction, and taking care of their young etc are examples of some of animal behaviour.
- Scientists categorize animal behaviour into different categories like, Instinct, Imprinting, Conditioning, Imitation.
- Human behaviour is more complex because we can control our behaviour and aware of ourselves.
- Animal behaviour can be investigated in controlled conditions as well as in the field.

Improve your learning

1. What is advantage of reflex action? (AS 1)
   (a) It has to be learned (b) It happens differently each time
   (c) It does not have to be learned (d) None of them
2. If a rat is given a mild electric shock when it goes to a certain part of its cage, it eventually avoids going there. This is because of- (AS 1)
   (a) Imitation (b) Conditioning
   (c) Instinct (d) Imprinting
3. Describe all four types of behaviour discussed in the lesson with appropriate examples. (AS 1)
4. Differentiate between (AS 1)
   (a) Imitation and Imprinting
   (b) Instinct and Conditioning
5. How behaviour of human is different from behaviour of other animals? Explain with an example. (AS 1)
6. Observe ants going on a line. Meanwhile two talk each other to communicate infectives ask you teach how they communicate and write a note on this. (AS 4)
7. "Understanding of animal behavour creates positive attitude towards animals." how you suppot this statement? Explain with suitable examples. (AS 6)
8. Look at this picture. How do you feel about sibbiling care nature of animals. Do you ever see such kind of situations in your soroundings? Expalin in your own words. (AS 7)

Chapter 8

Challenges in improving agricultural products

From the chapter 'Our food' in Class 6 you came to know that we require different kinds of foods. They include various kinds of seeds like wheat, rice, dal, different types of leaves like spinach, menthi and many other things. In addition, non-vegetarians eat meat, fish, eggs etc. While discussing food chains in the chapter 'Ecosystem' we also learned that our diet as well as that of several of our domestic animals is eventually linked to plants.

- Try to estimate how much grain your family consumes in a month.
- Also, try to guess how much land is required to grow this amount of grain?

A family consisting of four members requires 50kgs of grains per month or 600kg per year. The area of land required for the same is around 1.4 square kilometers .Can you estimate how much area of land would be required to grow the quantity of grain needed for your family in a year? You know if the members of a family increase, food requirement also increases accordingly. If the requirement cannot be met it leads to food crisis. We know that population of our country increases every year. Is the food production able to meet the need of increasing population? Does the rate of food production increase proportionately to population growth? We shall try to find out the answers to some of such questions by doing the following exercise.

Given below is the tabulated data of population growth and production of food grain of the concerned decade. Read the table carefully and find out answers for the given questions.

Table:1 Rate of growth of population and food grain production

Decade	Population Growth(PG)	Food grain production(FP)	Ratio FP/PG
1961-1971	2.4	2.83	1.18
1971-1981	2.23	1.8	0.80
1981-1991	2.16	3.13	1.45
1991-2001	1.95	1.1	0.56
2001-2011	1.65	1.03	0.62

- In which decade population growth is higher?
- In which decade food grain production is higher?
- What major differences did you find in the table?
- Is food grain production increasing according to population growth?
- In which decades production of food grains not satisfied the needs of population? What will happen if the production is not sufficient?
- The decade 1991-2001 shows that rate of food production was nearly half as compared to population. What can you infer from the decade when population growth was highest?

Increasing food production in proportion to compensate the needs of increasing population is a big challenge for our country. Our farmers are constantly trying to meet the challenge against all odds.

Write your suggestions to improve food production.

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- Share your ideas with classmates. What are the common suggestions in your list?

Apart from human beings, other living creatures also need food to survive. Many of these animals have been domesticated and live with us. So we need to provide them fodder, grain etc.

In this chapter, we shall discuss what methods are used to increase the production of the crops we grow for food. There is one thing that needs to be stressed when we talk about increasing production. It can be explained more easily through an example. Suppose we plant a crop of wheat. Suppose the plants grow nice and healthy but they do not produce any grain. Would you call this a good wheat crop? So when we talk about increasing production, what we mean is increasing that part of the crop that is useful for us.

Let us now begin our discussion on increasing production.

The production of a crop does not increase because of any one factor alone. Only when there is a proper combination of several factors, the production can increase. Some of these factors include the kind of seeds planted, the properties of the soil, the availability and proper application of irrigation and fertilizers, the weather, controlling insect attacks, the growth of weeds and so on.

Fig-1 Paddy

Experiments done with corn have shown the impact of some of these factors on crop production. Some results of these experiments are given in Table 1.

Table-2

Method	Production (kg/he)	Gain (kg/he)
Time of planting		
A month after the onset of rains	3,400	
Immediately after the onset of rains	5,830	2,430
Density of planting		
plants per hectare 39,600	4,100	
plants per hectare 19,800	5,130	……..
Weeding		
Once	4,040	
Twice	5,200	……..
Nutrient application		
Without phosphorus	4,570	
56 kg of phosphorus	4,660	……..
Without nitrogen	4,320	
78 kg of nitrogen	4,900	……..

The table shows us the gains achieved in production by using different methods. For example, planting the seed at the correct time resulted in a production gain of 5,830 - 3,400 = 2,430 kg per hectare.

Calculate the exact gain from each method mentioned in the table and note the results in the table.

You now have some idea about some of the factors that affect the production of various crops.

Let us now discuss the various factors that affect the production of crops in more detail.

How to increase the food production?

We know that the cultivated land is very limited. If we make use of plenty of land for cultivation some forests may be destroyed. So we need to think of another solution. Observe the following solutions.

1. Increasing the area of cultivated land.
2. Increasing production in the existing land.
3. Developing high yielding varieties.
4. Alternating crops.
5. Mixed crops.
6. Cultivating short term crops like Rabi.

- Which of the above option do you think is more meaningful?

You have already learnt about long term and short term crops or Kharif and Rabi crops. Short term varieties produce grains more than long term varieties.

Alternating of crops preserve the soil fertility. Mixed crops system helps the farmers to produce variety of crops as well as increase production.

To get high yield 3 types of methods are being used.

1. Improving high yielding varieties.
2. Using high yield management methods. (Crop production management)
3. Crop protection management.

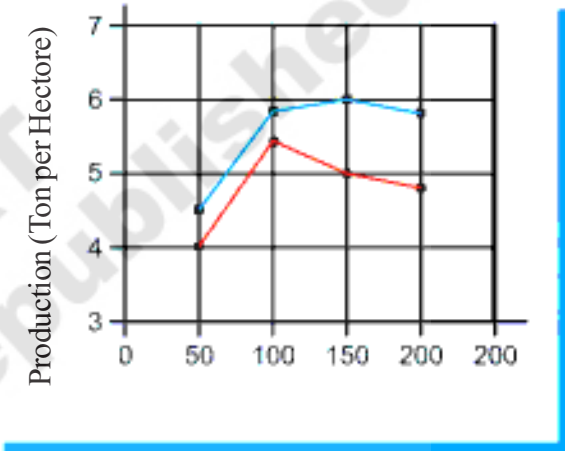
Improving high yielding varieties

Observe the size and colour of maize in your kitchen. (if not, ask your mother why she doesnot purchase maize as a food material) Some seeds are small with yellow colour and some are large with white colour. The white coloured large ones are hybrid variety. They give high yielding.

Fig-2(a) HybridVariety

Fig-2(b) Local Variety

An experiment was conducted to find out how irrigation affected the production of a crop. In the experiment, crops were grown in two fields. One field was irrigated while the other wasn't. The same amount of nutrients, like nitrogen, was applied to both the fields. However, the amount of nitrogen was increased by the same quantity for successive crops in both the irrigated and unirrigated fields. The results of the experiment are illustrated in Graph-1.



Supply of Nitrogen (Kg. Per Hectore)

Sufficient supply of water

Less supply of water

Graph-1

On the basis of Graph 1, explain the importance of irrigation in increasing crop production.

What difference is there in crop production when the same quantity of nitrogen is applied to both the irrigated and unirrigated field?

What does a plant do with water?

We learned in the chapter 'Nutrition in plants' in Class 7 that a plant absorbs water

from the soil. What does it do with this water? We saw that the plant combines water and carbon dioxide with the help of sunlight to produce carbohydrates. Starch is one such carbohydrate. Different types of sugar and cellulose are also carbohydrates. A chemical analysis will show that 100 grams of water react with 260 grams of carbon dioxide to form 180 grams of carbohydrate.

But the plant does not use all the water it absorbs through its roots to produce carbohydrates. Actually, most of this water evaporates into the air.

Activity-1

Take a polythene bag. Cover the bag on leaves and tie it. Keep it 4-5 hours. You observe it. What did you find in the polythene bag? Where did they come from? Do this experiment during day time and night time separately. Note the differences in your note book.

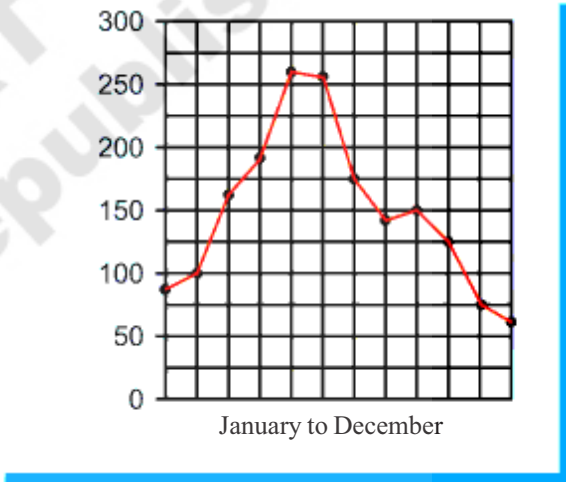
Fig-3 Transpiration

If you tie a plastic bag over a leaf, you will be able to see how much water a plant releases in the air. It is estimated that a plant uses only 0.1 percent of the water it absorbs to form carbohydrate.

That means, if a plant absorbs one litre of water, only one millilitre will be used to produce carbohydrate. The remaining 999 millilitres evaporate from the leaf.

The relationship between water and crop yields

You may have wondered what difference it would make if water is scarce when only 0.1 percent is used to produce carbohydrate. Let's investigate the matter a little more in depth. Graph 2 below tells us how much water evaporates from plants in different seasons.



Water evaporates from plants(in m.m)

Graph-2

- Find out from the graph the months in which the most water evaporates from plants.
- Are these the same months in monsoon season when the rainfall is heavy?
- So how does the availability of more water effect the plant?

Let us now look at an interesting fact. Most of the water released by plants evaporate from the leaves. The leaves have tiny, microscopic holes called stomata.

Water evaporates through these stomata. We know that more water evaporates when the weather is hot. In such a situation, the stomata begin to close. This lessens the amount of water that evaporates from the leaves.

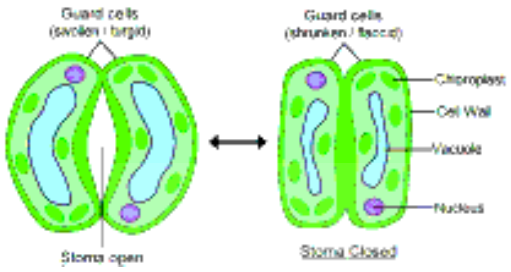


Fig-4 Stomata in the leaf

We learned in the chapter 'Nutrition in plants' that plants absorb carbon dioxide. The carbon dioxide also enters the leaves through the stomata.

- When the weather is hot and the stomata close, what effect would this have on the absorption of carbon dioxide by the plant?
- What effect would a change in the amount of carbon dioxide absorbed have on the growth of the plant?
- If the plant does not get water at this time, what effect would this have on its growth? Discuss in your class and findout reasons.

Plants cannot absorb nutrients directly from soil. Only the nutrient that dissolves in water is absorbed by the roots of the plant. We discussed about transportation of substance in the chapter "Transportation of substances through plasma membrane" and in the chapter "Plant Cell". Try to think of how xylem and phloem are useful in transportation.

- What are the main water sources in your village for agriculture? How farmers utilize them?

Paddy require more quantity of water.

Can you give such examples? Cultivation of paddy, wheat and sugar cane are suitable where places have rich water resources. If we cultivate such crops under wells and bore wells what will happen?

Most of the farmers of our state cultivate crops like paddy, sugar cane irrespective of proper availability of water, only because of supporting price and marketing facility. So farmers invest more on irrigation of water, electricity bills, pesticides and fertilizers. Agriculture Officers advise to cultivate dry land crops (Aruthadi Pantalu) in less water areas. And also to practice different water management practices.

- Make a list of crops which require less amount of water.

Drip irrigation is a good practice in agriculture to prevent water wastage. In drip irrigation, water is supplied through small pipes. These pipes have small holes through which water passes drop by drop.

Think and discuss

- In what way this kind of water supply is useful to the crop as well as the farmer?
- Water Shed is a process to improve ground water level. In what way it is related to irrigation? Support with your answer.

Activity-2

- Make a block diagram of irrigation of water from major water resources in your village?
- Draw the route map of Jawahar and Lal Bahadoor Canals of Nagarjuna Sagar in Andhra Pradesh map.

Plant nutrients

Just as we need different kinds of nutritious food, plants also require different kinds of nutrients. You know that a plant absorbs carbon dioxide from the air and water from the soil and produces carbohydrates with the help of sunlight.

Plants also absorb different kinds of mineral salts from the soil, in addition to water. Among these are the salts that plants require in larger quantities. For example, plants need nitrogen, phosphorus and potassium salts in larger quantities. These are called Macro Nutrients. Some nutrients are necessary for plants in small quantities. These are called Micro Nutrients. Ex: Iron, Manganese, Boron, Zink, Copper, Molybdenum, Chlorine etc.

These salts are obtained from the soil. When we grow a crop, the plants absorb some salts from the soil. Table-3 shows the amounts of nitrogen, phosphorus and potassium salts absorbed from the soil by different crops.

Table-3: Absorption of salts by different crops

Crop	Yield per hectare	Nitrogen	Phosphorus	Potassium
Rice	2,240	34	22	67
Wheat	1,568	56	22	67
Millet	1,792	56	15	146
Corn	2,016	36	20	39
Sugarcane	67,200	90	17	202
Groundnut	1,904	78	22	45

Every time, any of these crops sown in a field, absorb these amounts of nutrients.

Soil Nutrients

- If a field is cultivated for many years, what would happen to the nutrient content of the soil?
- How does the soil get back or replenish these nutrients?

Let us examine this question in more detail.

Nutrients present in the soil are consumed by plants and are replenished or returned to the soil in many different ways. In nature the continuous process of death and decay add nutrients to the soil and the process is too slow to be commercially useful. Rotating crops, adding organic

manure or chemical fertilizers etc. are man made processes.

Crop rotation

Usually, farmers do not grow only one crop in a field. Different crops are grown in different seasons. It has been seen that cereal crops take lot of nutrients from the soil. Legumes are different. While they do take nutrients from the soil, they also provide some nutrients to it. Growing leguminous crops result in an increase in the quantity of nitrogenous salts in the soil. Thus to grow a leguminous crop between cereal crops is beneficial either by alternating cropping system or by mixed cropping.

Nitrogen, Phosphorus and Potassium are the important nutrients.

Let us observe the following table.

Table-4:

Nutrient	Uses
Nitrogen	New leaves, flowers arise fast.
Phosphorus	Penetrates roots deep in to the soil to absorb nutrients quickly
Potassium	Resistance towards pests, increases the quality of smell, colour, and taste of fruits.

To avoid nutrient deficiency in the soil, farmers cultivate alternate crops.

- A farmer cultivated sugar cane in his land for the last five years. Another farmer cultivated sugarcane in the first year and soya bean in the second year and sugarcane in third year.
- In which case do you think has the land lost most of its nutrients?

Crop rotation is the process in which one crop is followed by another crop on an agricultural field. Some best combinations for crop rotation are given below.

- After cultivation of paddy, blackgram/ groundnut has to be grown, followed by paddy again for cycle to continue.
- After cultivation of tobacco, mirchi has to be grown for the cycle to go on.
- After cultivation of redgram, maize/ paddy has to be grown for the cycle to go on.

What is the benefit of crop rotation?

When cereals are cultivated more nutrients are utilized. If legumes are grown in the soil, less nutrients are utilized. Not only this, they synthesise some nutrients into the soil. Do you find any crop rotation methods in your village? What are they? Ask your village elders and collect the information about it.

Cultivating mixed crops

- Have you ever seen two types of crops in the same field?
- Which crops are grown in this way?
- What are the uses of cultivating mixed crops?

Discuss in groups and display your writings in your classroom.

If more than one crop is cultivated in the same field then it called mixed crop. Because of mixed crop cultivation the soil becomes fertile. The nutrients which are

used by one crop will be regained by cultivating another crop.

Which crops can be cultivated as mixed crops? Observe the following...

Soya grown along with Pea

Pea grown along with Green gram

Corn grown along with Black gram

Groundnut grown along withsunflower

Maize grown along with Red gram

Sorghum grown along withPea

Cotton grown along with Groundnut

Fig-5 Red gram in Haldhi

Fig-6 Cabbage in ground nut

Generally pulses and cereals are grown as mixed crops. Short term crops are grown in Long term crop fields. In the fruit growing fields like Lemon, Pomegranate, Papaya, etc., pulses like Red gram, Black gram, Green gram, etc., are cultivated as mixed crops.

Fig-7 Betel Leaf

- Is betel (Tamalapaku) a mixed crop? How can you justify your answer?

Can you name some leguminous crops? Leguminous crops usually have many small nodules on their roots. Several different kinds of bacteria live in these nodules. These bacteria absorb nitrogen from the air and convert it into a form that can be used by the plant.

- Ask your teacher about names of the nitrogen fixing bacteria.

You could uproot a soya bean plant or a Bengal gram plant to see the nodules on their roots.

Root nodules in legume plants

The microorganisms in the nodules use some of the nitrogen for their own purpose. Some nitrogen is used by the leguminous plant itself. But after the crop is harvested, the roots remain in the soil. So the soil gets some nitrogen in this way.

Experiments have shown that a leguminous crop gives about 50 kg to 150 kg of nitrogen per hectare. The crop grown after the leguminous crop can take advantage of the availability of more nitrogen in the soil.

Fig-8 Rood Nodules

Nowadays a bacterial culture is also available. This is mixed with the seeds. When the seeds are sown, the plants are able to produce more nodules on their roots.

Apart from this, there are various kinds of blue-green algae that add nitrogen to the soil. Blue-green algae culture is also available. It is applied in rice fields.

So if a leguminous crop is rotated with a cereal crop, the leguminous crop replenishes, to some extent, the nitrogen taken from the soil by the cereal crop. But potassium, phosphorus and other nutrient elements cannot be replenished in this way.

Organic manure

Do you ever saw a herd of goats in a vacant field? Why shepherds make arrangements to stay their goats and sheeps in the fields?

The organic (natural) manure is produced by decaying the plant and animal wastes! The manure produced from decomposed plant and animal products has more organic material. This gives good nutrients to the soil. It makes the soil fertile. Because of humus, the natural manure, water holding capacity of soil is increased.

Natural organic manures are generally divided into two types. One is concentrated organic manures and the other is Macro organic manure.

Groundnut, Gingili, Castor, Coconut, Neem, Jetropa Seed powders are the examples of Concentrated organic manures. These are also used as fodder for cattle and poultry.

Animal excreta, compost, deep litter are the examples of Macro organic manure. Nutrients are rich in the concentrated organic manures than in macro organic manure.

By organic manure we normally mean the plant and animal residues in the field, such as stalks and roots, cow-dung, urine etc. The percentage of various nutrient elements in one tonne of organic manure is given in Table 5.

Table-5: Percentage of nutrient elements in organic manure (kg/tone)

Manure	Nitrogen	Phosphorus	Potassium
Goat manure	5-7	4-7	3-4
Dry compost	5-10	4-8	6-12
Dry organic manure	4-15	3-9	3-10
Neem powder	5-6	1-2	1-2
Vermi compost	1-3	1-2	1-2

(Dry organic manure is made by mixing cow-dung, hay, urine etc)

Suppose a paddy crop is grown in a field and five tonnes of rice are harvested.

Calculate from Table 3, how much nutrient elements this crop must have taken from the soil. To replenish this quantity of nutrient elements in the soil, how much of dry compost needs to be added?

Green Manure crops

Do you know that some crops are grown so that they can be ploughed back into the soil? Some examples are berseem, kulthi, sunhemp, lobia, green gram etc. Details of these crops and the nitrogen they provide per hectare are given in Table 6.

Fig-9 Green manure crops

Table-6: Percentage of nitrogen in different green manure crops

Name of crop	Nitrogen (kg /tonne)
Lobia, beans	7.1
Dhaincha	6.2
Kulthi	3.3
Green gram	7.2
Sanhemp	7.5
Horsegram	8.5

If the total weight of the green manure crop in a field is 8 to 25 tonnes per hectare, the amount of nitrogen it provides on being ploughed back into the soil is 70 kg to 90 kg per hectare.

Farmers, who have no sufficient time for making Green manure, are suggested to use green leaf manure. Any plant leaves are used as green leaf manure.

Find out whether all the green manure crops mentioned in Table 6 are leguminous crops.

On the basis of Table 6, explain the reason for growing green manure crops.

Soil testing

How do farmers know what type of crop needs to be cultivated? What types of crops are suitable for the soil in their fields? Farmers, who are experienced, are able to make out from the colour and texture of the soil.

- You had also studied about the same in your earlier class. Ask a farmer to find out about crops that can be grown in different types of soil.

Nowadays, Agricultural officer and the Soil Testing Technologist are available in every area. They observe the field and suggest what to do.

Have you ever heard about *'Bhusara Pariksha Kendra'* (Soil Testing Centre)? At these centers the soil technologist collects soil samples from fields and tests the fertility levels of soil. They give us knowledge about the soil. The testing centers are situated in division and district

levels. If you send the sample of soil from your field, they send you a report after testing it. By the report you will be able to know that which nutrient is lesser and which is more. This helps the farmer to select the type of crop, manure, fertilizer etc and its quantity. This prevents wastage and minimizes investment.

Vermi Compost

To replenish soil nutrients, adding of natural manure is a good practice. Vermi compost is one of the techniques in soil nutrient management. Let us read the following case study to know about vermi compost.

The farmers are Bomma Raju Cheruvu of Vinjamur Mandal faced many problems in using of chemical fertilizers. They searched for alternate practices. Farmers understand the importance of soil health. They formed a group to grow vermi compost with the help of Agriculture Field Officers of DOT centre.

They constructed 10x1x1/2 *meters vermi compost beds in sheds which protect these beds from direct sunlight and rain. They collected coconut, banana and sugarcane leaves, coconut coir and dry black gram plants. They made them into 3 to 4 inches layer. This inner layer was wet with water. They collected house hold waste of dry cattle dung from the village to fill the bed. They did not use, wet dung. They were careful to avoid glass, polythene, rubber and metal objects in the bed.*

After two weeks of making bed, they kept thousand earth worms per square meter and covered the bed with Gunny bags to maintain 30 to 40% of moisture. After 60 days they collected their first manure. Second time they, got the manure within 40 to 45 days. Every year they got the manure 6 times from these beds. They got one ton of compost from three tons of organic wastes. They said that after using this organic manure, investment on chemical fertilizers and other pesticides became reduced and the quality their agricultural products increased.

Fig-10 Vermi compost culturing

Fig-11 Vermi compost beds

Think and discuss

In what way vermy compost is better than chemical fertilizer.

Panchgavya

This is also a natural manure. The main ingredients of Panchgavya are milk, curd, ghee, dung and urine of cow. Mix cow dung and cow ghee. Settle it for four days. On the fifth day, add urine, milk and curd of cow. Also add kallu, coconut water and sugarcane juice to the mixture. And then add banana paste. Settle it for ten days. Stir the material morning and evening. Then you will get Panchagavya the only sprayer type of manure. 3% of Panchgavya is helpful to grow crop with higher yielding. It is also used as food for hens and fish in ponds.

Fig-12 Panchagavya

Organic farming

By using chemical fertilizers, we can get high yielding for only 20 to 30 years. After that soil becomes reluctant to plant growth. These chemicals damage soil fertility. If the soil health is proper, then only the soil responds to fertilizers. Otherwise, using of fertilizers become mere waste.

Long term high yielding capacity of soil (soil productivity) depends on both availability of nutrients in the soil (soil fertility) and suitable physical, chemical and biological characters of soil (soil health).

To maintain soil productivity organic farming comes into existence. In this type of farming, farmers use natural manures and natural pest controlling methods and they also practice crop rotation and mixed crop systems.

In organic farming farmers use bio fertilizers, instead of using chemical fertilizers and synthetic pyrithroids, to get higher yielding.

Some micro-organisms which are useful to synthesise nutrients from the environment or from soil to plants. These are called microbial cultures or bio-fertilizers.

Bio fertilizers

Bacteria		Algae	Fungi	
Nitrogen Fixers: Ex: Rhyzobium Azotobacter Azospyrillum	Phosphorus Solubulisers: Ex:Bacillus Pseudomonas	Nitrogen fixer: Ex: Bluegreen algae	Phosphorus moralizers: Ex:Micoryza	phosphorus solubuliser: Ex: Pencillium

Generally bio fertilizers are two types. One is nitrogen fixers and the other is Phosphorus moralizers, solublelisers. Observe the flow chart of different bio-fertilizers.

- What do you find from the flow chart
- What are the major nutrients synthesized by this.

Bio fertilizers are useful to maintain soil health and productivity. These do not have nutrients in them like organic manures. They synthesize nutrients from environment and soil. These are also called farmer (eco) friendly fertilizers.

Fig-13 Bio fertilizers

Chemical Fertilizers

You may have heard names like urea, NPK and superphosphate. These are chemical nutrients. These are partially or completely synthetic in origin.

We have already seen that plants get many of their nutrients from the soil. The quantity of nutrients in the soil decreases if plants continue to absorb them. We have also seen some ways in which soils replenish their nutrient content. There is one other way in which soils can receive nutrients by adding chemical fertilizers.

The percentage of nutrients differs in various chemical fertilizers. So a farmer, who uses a chemical fertilizer, first checks how much of which nutrient he gets from that fertilizer before applying it in his fields.

Table 5: Percentage of nutrients in different chemical fertilizers

Name of fertilizer	N (%)	P (%)	K %)
Urea	46	0	0
Superphosphate	0	8-9	0
Ammonium sulphate	21	0	0
Potassium nitrate	13	0	44

If we use 50 kg of urea, then according to Table 5, 23 kg of nitrogen (46 percent) will be added to the soil.

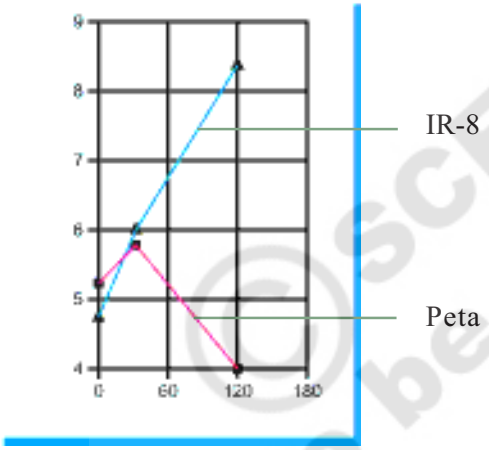
- To get the same quantity of nitrogen, how much ammonium sulphate should we add?
- If 50 kg of superphosphate is added to the soil, how much phosphorus would the soil get?

But whether we use organic manure or compost or chemical fertilizers, it is not enough to know the percentage of nutrient elements they contain. It is important to know how much of this nutrient is finally available to the plant. It is also necessary to know which is the best time to provide the nutrients so that the plant can make the fullest use of them. We must also examine which is the best way to add the nutrients to the soil. For example, would it be better

to sprinkle them in the field or to dissolve them in the irrigation water or to place them under the soil.

The Method Determines The Effect

It is not necessary that the production of all crops increases equally if an equal amount of nutrients is applied. The type of crop determines the effect of the nutrients. For example,the effect of applying nitrogen fertilizers on an indigenous rice variety (Peta) and a hybrid rice variety (IR-8) is shown in Graph-3.



Graph-3

- What is the difference in effect of nitrogen fertilizer on Peta and IR-8?

Normally, a farmer uses chemical fertilizer to increase the crop production from his fields. The question is, how much fertilizer should he add?

Graph 3 shows the resultant increase in crop production for different quantities of chemical fertilizers.

- Look at the graph and say whether crop production will continue to increase as we add more and more quantities of nitrogenous fertilizers?

Suppose 120 kg of nitrogen per hectare are added to a crop of Sonora-64 wheat. A total of 5.3 tons of wheat will be produced.

On the basis of Table 2, calculate how much of phosphorus and potassium will be absorbed from the field by this wheat crop. Is it advisable to add only nitrogenous fertilizer to increase production? What effect will this have on other nutrients in the soil? Explain with reasons. Now let us consider the last factor relating to crop production.

Crop protection

Suppose we take best variety of seeds, sow them at the correct time, apply fertilizers properly at proper intervals and irrigate a crop well. Will there be any obstacle in getting a good crop?

There are many other factors that affect a crop production. Let's look at some of them.

Weeds

Often, other plants grow in a field along with the crop. These plants are called weeds. Do you know any names of weeds in paddy field?

What effect do weeds have on a crop? Before trying to answer this question, discuss the following points in your class:

1. How would weeds affect the supply of nutrients to the crop?
2. How would they affect the sunshine available to the crop?
3. What effect will there be on the water available for the crop?

- Will these factors affect crop production? Look at the crop figures

relating to weeding in Table 1 and explain what effect there would be on crop production if a field is not weeded. What do you think should be done to rid a field of weeds?

Activity-3

Make a list of the major weeds in your area. Find out which weeds grow with which crops. If possible, collect these weeds and make display. Find out what farmers do to get rid of these weeds.

Insects and plant Diseases

Apart from weeds, plants are affected by insect attacks. Some insects eat the stems of plants, some nibble at the leaves, while others destroy the roots. But there are also insects that are useful for plants. For example, many insects help in the pollination of plants.

There are several microorganisms that destroy plants. We cannot see them, but we can see the destruction they cause in plants. These include shriveling and discolouration of leaves, rusting of the stem and leaves, fungal growths etc. There are, however, some useful microorganisms that make nitrogen available for plants.

The diseases caused by insects and microorganisms affect crop production. The question is, how should we deal with this problem? Nowadays, farmers use insecticides, fungicides and other chemicals. However, there are other ways to solve the problem. For example, weeding could rid a field of weeds. Or insects can be captured and removed from the fields.

Insecticides are actually chemicals. They are used to kill insects.

Ask your teacher about whether insects can develop immunity to the insecticides used to destroy them? Immunity means the insecticide no longer has any effect on the insect it targets.

There is another problem when we use insecticides to kill pests or weedicides/ herbicides to destroy weeds. A large percentage of these chemicals remain in the soil. From the soil, these chemicals find their way into water sources. Do you think that a chemical used to kill insects will have no effect on humans?

People who spray these chemicals in the fields are exposed to them and some of the chemicals enter their body. What effect do you think these chemicals will have on their health? discuss in yourclass.

Fig-14 Diseases in plants

Another problem is that these chemicals destroy all insects. We have seen earlier that some of these insects are useful and helpful to plants. In our state, Prakasham and Guntur districts are the places where pesticides and insecticides are used in large quantities.

Look at the pictures

- If insects that pollinate crops are killed, what effect will this have on crop production?
- In recent times, why farmers touch the flowers with handkerchiefs in sunflower fields?

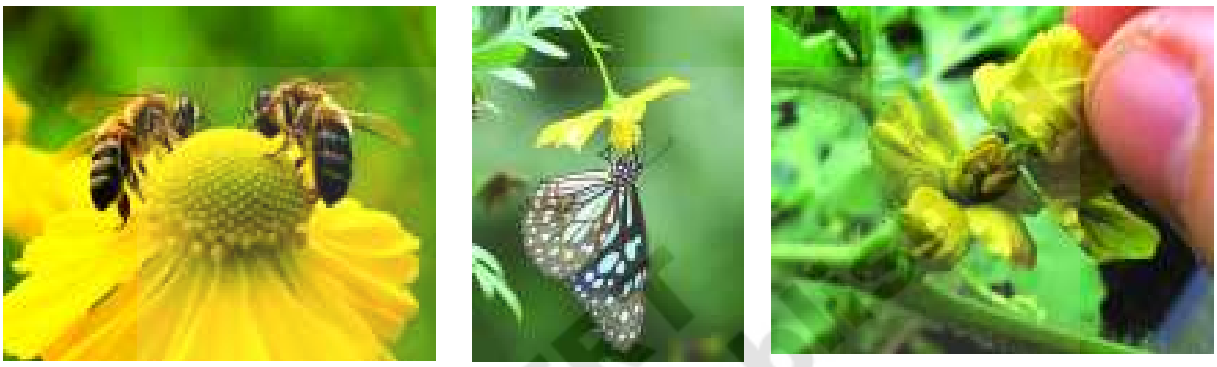


Fig-15 I nsects and birds helping in pollination Pollination with hands

- Some people ask this question: If we don't use these chemicals, how can we get a good crop? How can we increase production? Is there an answer to this question? What could it be?

Suppose we can use some other methods that do not give rise to these problems. For example, they say we can make use of the natural food chains to control pests. Remember, we had discussed food chains in the chapter 'Different Ecosystems'. There are many insects that eat other insects. They are called predatory insects. We can make use of these insects. There are also birds that eat insects. We can use these birds to get rid of insects.

Similarly, people say we can capture harmful insects and kill them. The problem is that this method is both slow and time consuming. However, supporters of this method say the process can be speeded up. For example, if a lighted bulb (Deepapu Teralu) is placed in a field, insects would cluster around it.

- Discuss with your friends and try to find out some other alternates for pesticides.

Natural pest controlling methods

Generally farmers use synthetic pyrithroids like pesticides, insecticides to control pests on crops. There are so many natural pest controlling techniques.

- Which are followed by our farmers?

Some insects control the harmful insects and they are called friendly insects. Spiders, dragon fly, Krisopa, mirids, lady bird beetle, etc., are the insects that eat worms like jasids, trips, and stem borers. Trycoderma bacterium lives in the eggs of

stem borer, tobacco cater pillar, gram cater pillar and destroy these pests at the egg stage. Some bacteria like Bacillus Turengenisis destroy some pests.

Fig-16 Biological control by natural enemies (Predatory Insects)

Some mixed crops also control some pests and diseases. After paddy, cultivating black gram, groundnut etc. prevents Tungro virus disease on paddy. After cotton, cultivating maize and gingili prevent gram cater pillar. After Red gram, cultivating maize and corn prevents spotted bole worm and dried disease. These are called Akarshaka Pantalu.

- Do you know why Jetropa in cotton fields, marigold in Mirchi fields cultivated?

Improvement in food production and sustaining soil health, environmental protection are the both sides of agriculture practices. Farmers should be aware of quality, innovative practices in agriculture.

Key words

Weeds, insecticides, fertilizers, fungicides, irrigated farming, unirrigated farming, predatory insects, bacteria, immunity, stomata, carbohydrate, bacterial culture, crop rotation, mixed crop, organic farming, vermi compost.

What we have learnt

- Food production is not increasing in accordance with increase in population.
- Factors for the increase of food production are quality and variety of seed planted, properties of the soil, availability and proper application of irrigation and fertilizers, weather, controlling insect attacks, controlling the weeds etc.
- Mixed crops system helps the farmers to produce varieties of crops as well as increasing production also.
- Alternative of crops preserve the soil fertility.

- Seeds with the desired characters were developed by using the Hybridization methods and Genetic Engineering techniques.
- Plants utilize 0.1% of water which it absorbs to form carbohydrates during photosynthesis process.
- Absorption of CO_2 and evaporation of water occurs through Stomata.
- Dry land crops (Aruthadi pantalu) are suitable for less water available areas.
- Plants need Nitrogen, Phosphorous and Potassium salts in large quantities, these are called Macro nutrients.
- Plants need some nutrients like Boron, Iron, Copper etc., in small quantities. These are called Micro nutrients.
- Nutrients are replenished to the soil by rotating crops, adding organic manure or chemical fertilizers.
- Mixed crop cultivation makes soil fertile. The nutrients which are used by one crop will be regained cultivating another crop.
- Humus and water holing capacity are increased in the soil by applying the natural manure.
- Any plants leaves can be used as green manure.
- Vermi compost is far better than chemical fertilizers.
- Over usage of pesticides leads to Soil pollution, water pollution and hazard to Bio- diversity.

Improve your learning

1. Suggest some ways in which our country could increase the production of rice to meat atleast global limits. (AS1)
2. How are biofertilizers more beneficial as compared to chemical fertilizers? (AS1)
3. (a) Find out the adverse effects of chemical fertilizers needed for growing the high yielding varieties of crops? (AS1)

   (b) Can high yielding varieties be grown without them as well? How? (AS1)
4. What threats to nature do chemical fertilizers, pesticides, insecticides and herbicides pose? (AS 6)

5. What are the adverse effects of using high yielding varieties of seeds? (AS1)

6. What are the essential measures that a farmer needs to take before sowing the seeds of a crop? (AS1)

7. Suppose you had a farm in a drought striken area of your state what crops would you grow and how? (AS1)

8. What measures will you take to save your field from seasonal outburst of insects?

9. What basis would you adopt to explain to a farmer using chemical fertilizers switch over to organic fertilizers? (AS 4)

10. A farmer had been using a particular insecticide for a long time. What consequences will it have on- a) insect population b) soil ecosystem? (AS 2)

11. Venkatapuram village is in drought prone area. Somaiah wants to cultivate sugar cane in his fields. Is it beneficial or not? You want to convey him-which questions will you ask him? (AS 7)

12. Draw a block diagram of water resources in your village? (AS 5)

13. Ramaiah has soil testing done in his field. The percentages of nutrients are 34-20-45. Is it suitable for cultivating sugar cane crop? Which crops can be cultivate without using pesticides in Ramaiah's field? (AS 2)

14. Organic manure is helpful to Bio diversity. How do you support this statement? (AS6)

15. Make a list of the major weeds in your area (you have already conducted the project). Find out the weeds which are grown in different crops? (AS 4)

Name of the Crop	Weeds that grown on crop

16. Spraying high dose of pesticides is hazardous to bio diversity and crop yielding. How can you support this statement? (AS 6)

17. Natural pest controlling methods are useful to Bio diversity. Comment it? (AS 7)

ANEXURE

a) Hybridization

In recent times the biotechnologists have developed high yielding varieties of different crops particularly food grains and vegetables. By using hybridization methods and genetic engineering techniques the seeds with desired characters are developed. You will learn more about this in future courses.

Tomatoes are soft and fleshy but they are not suitable to preserve for more than week days. If the tomato is somewhat harder and fleshy it would be suitable to preserve. So biotechnologists select the desirable characters and develop hybrid varieties. Seedless fruits like grapes and papaya are hybrid ones.

Think, why we need hybrid variety of paddy, millets and cereals?

Lab Activity

Take one example from each of millets, cereals, vegetables and fruits. First you have to list out the known characters of the above and then list out the characters that you want to change or modify in them. But you need to give your own reasons- why do you want to make such changes in them?

Hybrid tomato

S. No.	Type	Example	Known characters	To be changed characters	Reasons
1	Fruits				
2	Vegetables				
3	Millets				
4	Cereals				
5					

b) Hybrid Varieties:

Biotechnologists develop hybrid varieties by crossing between two plants which have genetically different characters and thus developing new variety with useful characters.

Hybridization as a process to yield high yielding variety of rice in India for commercial production was started in 1911. It was started by Dr. G. P. Hector, the erstwhile Economic Botanist during 1911 in undivided Bengal with headquarters at Dacca (now in Bangladesh). Subsequently, in 1912, a crop specialist was appointed exclusively for rice in Madras Province. Prior to the establishment of the Indian Council of Agricultural Research (ICAR) in 1929, Bengal and Madras were the only provinces which had specialist exclusively for rice crop. Later several other research stations were opened which released 445 improved varieties of rice by 1950. These varieties were of various characters such as-giving produce early, deep water and flood resistant, drought resistant, disease resistant etc

Pomato

The hybrid varieties that are produced by hybridization techniques are high yielding, disease resistant, can thrive on less rainfall and will grow in acidic soils also.

You people also can develop your own hybrid varieties. It's very interesting to do.

Let us do the following Experiment and record your observations carefully.

Red and yellow equal to rellow

If you want to make your own hybrid flower you need to do the following. But it is time consuming process and patient job too. For this you need red and yellow colour Chandrakantha plants.

- Select 5 or 6 red flowers on a plant.
- Remove all the other flowers of that plant.
- Take each flower, remove stamens carefully.
- Take yellow flower and rub with that flower gently on the stigma of selected red flower for pollination (You need to do this process in evening only. Because these flowers bloom in the evenings and fall down in the next morning).
- Tie a tag with a thread loosely to the pollinated flowers to avoid confusion in identifying these flowers for seeds in the next few days.
- Within a week days you will get black seeds.
- Keep them another two weeks to dry and sow them in a pot.
- Take care to grow the plants until they flower.

- Observe the colour of the flowers. How are they?
- Record your findings at every step and discuss with your teacher.
- You know that it is a time consuming and patiently job. Think- how the scientists work for?

Do you know? You know Tomato and potato. Do you Know Pomato? Look at this photo.

Scientists developed pomato plant by the hybridization of Tomato and Potato plants. It produces tomatoes on the top and potatoes under the ground. How wonderful it is!

Is it beneficial or not?

c) Genetic engineering:

Another method of improving crop production is genetic engineering. The substances which carry desired characters are introduced into the plants and produced new varieties. These varieties are otherwise called as genetically modified seeds (GMS).

- Ask your teacher as to why some people fight against GMS.

The seeds thus produced are of good quality and grow in areas with different climatic conditions and different soils. This type of seeds is necessary for farmers. These are useful for them to improve crops in their areas.

Think- in what way less yielding time and cultivation of dwarf varieties are also good characters. Discuss in groups and write your findings in your notebooks.

Other side of the coin

Increase in production of crops is not at all a questionable task. To maintain balance between population growth and food requirement, there should be a need to implement more productive practices. Genetically modified seeds are solving the problem. But they the whole diversity of the food grains. Traditional and local varieties become extinct.Such mono-cultural practicesleadto increasing uncontrollable pests and diseases on plants. For this farmers use pesticides beyond limits. This causes undesirable damage to the eco system. For example cultivation of B.T. Cotton and Brinjal seed varieties resulted in committing suicides of farmers. Multinational companies impose the countries throughout globe to cultivate those seeds only. Think- how people like us raise our voice against this issue.

Comparison chart

	Chemical Fertilizer	Organic fertilizer (compost / biofertilizer)
Example:	Ammonium sulphate, ammonium phosphate, ammonium nitrate, urea, ammonium chloride etc.	Cottonseed meal, blood meal, fish emulsion, and manure and sewage sludge, etc.
Advantages:	Chemical fertilizers are rich equally in three essential nutrients i.e. Nitrogen, Phosphorus and Potassium that are needed for crops and always ready for immediate supply of nutrients to plants if situation demands.	Add natural nutrients to soil, increases soil organic matter, improves soil structure , improves water holding capacity, reduces soil crusting problems, reduces erosion from wind and water, Slow and consistent release of nutrients,
Disadvantages:	Several chemical fertilizers have high acid content. They have the ability to burn the skin. Changes soil fertility.	Have slow release capability; distribution of nutrients in organic fertilizers is not equal
Rate of production:	High, because of immediate supply of nutrients.	Moderate, because of slow release of nutrients.
Nature:	Chemical fertilizers are manufactured from synthetic material	Organic fertilizers are made from materials derived from living things.
Preparation:	Artificially prepared.	Prepared naturally. One can prepare organic fertilizers, themselves or can also buy.
Cost:	Costly	Cheap
NPK Ratio:	20 to 60%	About 14%
Nutrients:	Have equal distribution of three essential nutrients: phosphorous, nitrogen, potassium.	Have unequal distribution of essential nutrients.

A progressive farmer

Now a days, farmers - the back bone of our country- believe that agriculture is a non profitable occupation. In this scenario Gudivada Nagaratnam Naidu, a progressive farmer started revolution in agriculture and proved that it is one and only profitable occupation.

He got many National and International awards for his innovative practices in his fields. Scientists, intellectuals and presidents of different nations visited his field where glories of agriculture products practiced.

To overcome the challenges in the field of agriculture, farmers should attain knowledge of modern technologies in agriculture and marketing. It is direly essential for getting more profits. Let us look at his experience in his words.

"I am Gudivada Nagaratnam Naidu. I am a peasant; still I did not take any loan from any bank till today. Besides, I never lent any money from others. I feed my family with what I grow in my field. I grow oilseeds, uncontaminated fruits, flowers in my field for me and for others.

The root of my success lies in growing mixed crops. I started cultivation in one acre out of 17 acres of land which is situated in outskirts of Hyderabad of Hayathnagar mandal at Taramathi pet. But later i started cultivating the remaining 16 acares I used to grow food grains like paddy, groundnut, redgrams, and green grams, and black grams etc., vegetables like tomato, brinjals etc, flowers and also fruits. I never consulted any agriculturists for this purpose ever before. Having known my efforts, agriculturists are approaching me.

My efforts taught me that plants indeed get 95% of nutrients from nature and sunlight. Remaining 5% are supplemented by micro organisms present in the soil. So I realized that I have to take care of growing micro organisms in the soil. A healthy soil only nourishes the plants with the fertilizers we use.

A plant uses the nutrients that it requires and leaves the remaining for other plants. This is what I think as Biodiversity.

For example some plants maximum sunlight while others are exposed to limited sunlight. This is possible only because of

biodiversity. Drumstick plants are grown under coconut and Hellconia flowers can be grown under drum sticks. Aspergillus can be grown under coffee plants. This is the way of growing more plants with less investment in a limited area. This becomes success and beneficial when you implement the right pattern.

Usually it is difficult to yield 30 bags of paddy from an acre, but I yield 92 bags just by adapting some techniques. Most of the farmers are in wrong notion that SRI vari is a special type of seed. Actually, SRI vari is a system of cultivation in which we require less water and seeds. The real meaning of SRI is System of Rice Intensification. You can select any seed for this purpose. In this pattern of cultivation to get one kilo of paddy, we require only 2500 to 3000 litres of water. Where as in traditional system, for the production of same quantity of paddy, we require 5000 litres of water.

We should not prefer to cultivate a single crop, rather we should practice mixed crop for yielding. We should not blindly follow the ways and means what other farmers do."

Chapter 9

Adaptations in Dirrerent Ecosystems

Let us discuss these questions

What is a habitat?

Is a tree habitat only for a crow?

In what way an ecosystem is different from habitat?

We found that there were differences between the ecosystems of land and water and different ecosystems on land and water as well. We can see differences within ecosystems in very small areas as well.

We have studied in class VI in the chapter 'habitat' about the variations in the living communities, as well as organisms present at different levels, in the pond ecosystem and the tree. In this chapter we will see how organisms have started inhabiting certain areas, what needs they have and how they acquire different conditions from their surroundings to meet them.

To adjust themselves to diverse and distinct changes in ecosystems, organisms have to adopt different means for better survival. For example, some trees such as mangrooves and cypress have evolved a curious way to deal with the problems of growing in a wet and salty place. They have evolved to have curious looking projections from their roots called pneumatophores, or "knees".

Fig-1 Mangrooves

These "knees" develop from the lateral roots that are growing near the surface, and protrude up to 12 inches out of the soil or sediment. The precise function of these "knees" is not known, but there is general agreement that they aid the plants in maintaining adequate root respiration in a watery environment. We do not find such structures in plants growing around us.

All such ways and means that organisms adopt or develop over a certain period of time in different conditions for better survival are adaptations of organisms. We may also say that adaptation is a feature that

is common in any population because it provides some improvements for better survival.

Let us try to know more about adaptations in different ecosystems.

Activity-1

Take a kalabanda (aloevera) and a balsam plant in two separate pots. Water each of them with two tablespoons of water. Do not water them for a week. Observe the condition of the plants after a week.

- Which plant showed growth?
- Which plant dried first? Why?

Activity-2

Collect an aquatic plant out of a water body(Eg. duck weed, hydrilla, vallisneria etc. either floating at the surface or propping out of it). Carry it back home and plant it in a pot and water it.

- What do you observe? Compare your observation with that of activity1 and write a note on what you find.

From the above activity we see that some plants dry up without water very quickly, while others can grow even with very little water. Each of these plants are adapted to the conditions in their surroundings on the basis of need of water.

Organisms in nature create adaptable situations around them on the basis of their needs. They also adapt to situations specifically. For example in kalabanda the leaves are reduced to spines so that there is little transpiration loss and water is stored in the tissues of the stem (succulent stems). This helps the plant to live in conditions of water scarcity as we come across, in deserts. Kalabanda are found in our surroundings these days as well but you may have heard that they are generally called as desert plants (xerophytes).

Fig-2 Aloevera

Think and Discuss

- Can you give some examples of fleshy leaved plants?
- Why xerophytic plants do not have broad leaves?
- You may see Kittanara, a xeric plant, grown as fence around crop fields in some areas in our state. Actually those places are not desert. How can they grow there?

Opuntia, cactus are some desert plants.

Do you know about Boabab the tree. Its trunk is swollen. What do you think it

Fig-3 Desert plants

contains? It stores water in its trunk and survives the scorching heat of dry seasons.

Do you know though these are called ***Living stones*** they are not stones. The swollen leaves are adapted to desert conditions, minimizing water loss and storing water. These are also called pebble plants . Each pebble is actually a leaf with a cut window that lets in light. The stone like appearance deceives the animals and saves it from being eaten.

Fig-4 pebble plant

Now a days, many xerophytes are grown as ornamental plants in pots at homes. Some plants as a whole seem to be flowers. Some with thorns, some have flowers with bright colour petals. Now a days these kind of plants are used as gifts for Birthdays and other occasions also.

Like plants, adaptations can be seen in animals also. What adaptations can we see in Camel? How do they help? Hump - stores fat for later use. Long eye lashes - Protects eye from sand. Nostrils - closes voluntarily to protect from blowing sand. Long legs - keeps the body away from hot ground.

Fig-5 Cactus

Fig-6 Camel

Think and discuss

- Do all animals living in desert conditions show adaptations?
- Why some animals have scales on their body?
- Why the animals that lives in burrows usually wander during night time only?

Adaptations in some more desert animals

The side-winder adder snake crawls sideways with only a small amount of its body pressed against the hot sand. This technique helps it to keep itself cool. The golden mole escapes the heat of the sun by swimming through the sand just below the surface. It rarely emerges out as it finds all the needs below the ground.

Fig-7 Side winder sanke, Rat, Golden mole, Sand grouse

Some animals show extraordinary ability to survive in the desert. The *kangaroo rat* of western North American desert can live without drinking water through out its life. Because its body synthesizes little water in the process of digestion. The desert bird the *Sand grouse* flies long distances to an oasis in search of water, which it carries back in its crop for its nestlings.

The furry soles of fennec fox helps it walk on hot sand and loses heat through its ears. When the sand becomes too hot the sand diving lizard holds its feet in the air to cool down.

Do you know?

Animals which are active during night and sleep during the day are called Nocturnals. These creatures generally have highly developed senses of hearing and smell. They have specially adopted eye sight to see well in dark. Animals like bats, emit a high pitched sound which bounses off objects to find prey or protect from predators.

Cats, Rats, Bats, Owls are the Nocturnals generally seen in our suroundings. Some insects like crickets, firefly and fishes like cuttle fish are active during night only. Some desert animals become nocturnals inorder to escape extreme day time heat.

We know that organisms need shelter, food, light, air and many other things for their survival. Organisms often show adaptation according to these requirements.

Adaptations in Aquatic ecosystems

We shall study two different types of ecosystems in water (aquatic ecosystems) and some conditions in the environment that influence adaptations.

Aquatic ecosystems are mainly classified into two different types as Fresh water and Marine ecosystems.

Ponds, Lakes, Rivers are the examples of Fresh water Ecosystems

Seas, Oceans are the examples of Marine Ecosystems

As the living conditions are different we come across various adaptations in several organisms living in these ecosystems.

- You may know animals that live in water. You see some of them every day. Do you find in them any suitable characters adopted to live in water. Write a note on them in your notebook.

General aquatic adaptation as can be seen structurally (in body structure) are like presence of some special air spaces inside bodies or presence of such substances that help organisms to swim and float in water to inhabit different levels in the water body, or bear specialized structures to swim like flippers as in turtles and fins in fishes. Fishes, dolphins etc have floaters in their body (special structures of their digestive canals) to be able to inhabit particular levels in the water body. Microscopic photosynthetic organisms like planktons have droplets of oil in their cells that keeps them float. Larger plants

have long tough leaves and flexible stems.

- In what way flexible stem is useful to the aquatic plants. Ask your teacher or collect information from your school library and write a note on it.

Marine ecosystem

Over the last 2,000 million years, plant and animal life on earth has continuously evolved from its simple beginnings in the oceans to the complex existence on land today. It is no accident that protoplasm, a substance found in every living cell, strongly resembles seawater. Although some animals emerged from the sea millions of years ago to fill all available places on land, some remained in the ocean and evolved and adapted to life beneath the surface.

The ocean covers a larger part of the planet, yet it remains a little understood place as scientists have limited scope for the study of habitats that lack physical boundaries with a span of thousands of miles.

Each form of marine life has become adapted to a specific area with a relatively narrow variation in salinity, temperature, and light. The high salt content found in the ocean can support the large bodies of giant squids and whales, which has allowed them to evolve without the use of strong limbs for support. Nevertheless, salt water exerts enormous pressure on the air spaces of marine animals at depth (fluids like blood are practically incompressible). For every 10 meters pressure increases by one atmosphere (10^5 Newton/metre^2). You studied about in the chapter 'Force and Pressure' in VIII class and let us recall them.

Which limits our depths significantly unless we use diving craft specifically designed to maintain one atmosphere.

Secrets of swimming

Swimming is the fundamental characteristic feature of aquatic animals. Their bodies have certain adaptation to fight with pressure of underwater current. Let try to find out these secretes.

Yet, all sorts of other organisms thrive at high pressure. Some of them are even air-breathing surface dwellers like us. Some seals can dive up to a mile, and sperm whales can go much deeper than that (these are mammals like us). All these animals seem to share the same secret: instead of fighting the pressure, they let it collapse their lungs completely. Some oxygen remains in their lungs, but they mostly store it in their muscles, where it is needed; their muscle tissue contains much higher concentrations of oxygen-binding chemical than ours.

Moreover, collapsed lungs give deep-diving mammals another big advantage, once a seal's lungs have collapsed, it becomes heavier than water, and so it sinks. Thus it doesn't have to flap flippers all the way down; it reaches great depths mostly by gliding effortlessly, saving its oxygen stores, for the strenuous climb back to the surface.

The deep seafloor itself, well beyond the range of diving mammals, is inhabited

by an incredible diversity of animals. Some of the fish even have lunglike swim bladders to control their buoyancy (ability to float in a medium). They move up in the water column by secreting gas into the bladder and inflating it, and down by reabsorbing gas into their blood. Researchers have observed that such fishes hang motionless a few feet above the seafloor. A swim bladder does not collapse at depth because the gas inside is at the same pressure as the water outside which means if that external pressure suddenly decreases, the bladder will swell greatly, when such a fish is brought up from depth, its swim bladder sticks out of its mouth.

Marine animals must also regulate the interaction of freshwater and saltwater in their bodies. Specially developed kidneys, gills, and body functions help to maintain salt concentrations across membranes through osmosis. Marine animals must also be able to absorb dissolved gases like oxygen from the water needed to release the energy from food. Simple animals, such as anemones or worms, absorb the gases through their skin. Mobile animals use gills, or even lungs to absorb oxygen from the water and air. All animals in the ocean release carbon dioxide into the water as waste, which is then used by plants to produce energy.

Temperatures vary dramatically between the surface and the ocean floor. Marine life has developed many adaptations to the variations in temperature. Many marine mammals have blubber for insulation from the cold, and some fish have an antifreeze-like substance in their blood to keep it flowing. It is interesting to study the dramatically different adaptations in marine life on a vertical scale in the water. Animals and plants living in surface waters have access to high nutrient levels, increased temperatures, reduced pressure, and more light and therefore lack the adaptations of deep sea creatures that must live in highly pressurized, cold, dark waters with scarce nutrients.

Marine life has adapted to an incredible variety of conditions and habitats. Barnacles and mussels have developed mechanisms that allow them to cling to rocks in environments where they might otherwise be easily washed out by strong waves. Brightly-colored clownfish have adapted symbiotic relationships with anemones to protect both the clownfish and the anemone from predators. Sperm whales and herring gulls have adapted the ability to travel long distances and the ability to survive in a variety of environments.

Marine adaptations also include symbiosis, camouflage, defensive behavior, reproductive strategies, contact and communication like most other ecosystems on earth and adaptations to environmental conditions like pressure, temperature, light and salinity.

- Ask your teacher about symbiosis, camouflage, go for internet to find out some more details to prepare your paper to submit in your school symposium.

Now lets study light related adaptations of marine life forms.

The following diagram shows how certain zones in a marine ecosystem on the basis of availability of light at different depths are demarcated.

Fig-8 shows different Zones in the Marine Ecosystem

You can see different types of organisms at different depths in marine ecosystem. (this is only a representative figure showing only a few types of organisms).

Fig-8 Different zones in marine ecosystem

The following table shows some more abiotic characteristics and some types of organisms present at different depths in a marine ecosystem.

Table-1

Oceanic Zones	Light	Temperature	Depth	Plants / Animals
Euphotic zone (sunlit zone)	Brightly lit	Upto 30^0c	0-200m	Planktons, physalia, dolphins, flying fish, green turtles, sea anemones.
Bathyal zone (twilight zone)	Dimly lit	4^0c - 39^0C	200m-2000m	Whales, lantern fish, red, brown kelps. sea cucumbers, fish, squids, octopus, sponges, corals etc.
Abyssal zone (dark zone)	Dark	2^0- 3^0C	2000m-6000m	Brittle star, angler fish, tripod fish etc.

- How many zones can you see in the figure on the basis of light penetration? Name them.
- What types of abiotic conditions do you find as per the given table?
- What will affect adaptation to marine life other than the conditions shown in the table and figure?
- What happens to the temperature and pressure as depth increases?
- Which zone has more animals? Guess why?

The above analysis shows that there are different oceanic zones with variations in temperature, pressure, light etc. These abiotic factors give rise to various adaptations in organisms in the different zones.

Adaptations on the basis of light penetration

Euphotic zone

The organisms living in this zone are mostly floaters and swimmers. Animals in this zone usually have shiny bodies reflecting light away to merge with shiny water surface are transparent. These usually have very sharp vision. Plants are mostly green and photosynthetic activity is maximum in this zone. Some flora and fauna of this zone are trouts, herrings, dolphins, jelly fishes, different type of coral colonies which are extremely colourful, different types of algae & sea grasses (emergent plant species: rooted to the sides, in marine ecosystems these are rooted in the continental shelf area) diatoms etc. Nearly 80% of marine flora and fauna are found in this zone.

Fig-9 Coral colonies

Bathyal zone

Most of the plants found in this zone are the red and brown kelps, sponges, corals even animals with tubular bodies like squids and large animals like whales etc. Some of these have a flat body like the ray fishes. You may have big eyes sensitive to very dim light.

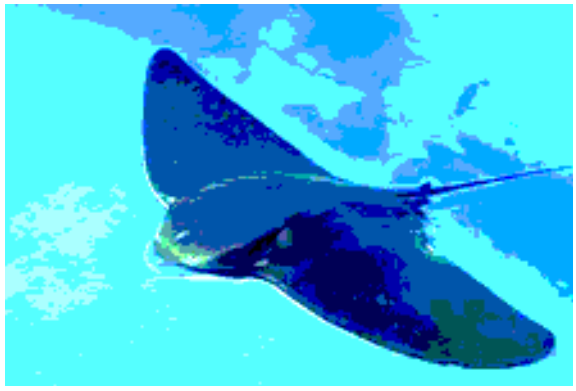


Fig-10 Ray fish

Abyssal zone

These zones are dark and cold throughout the year. Photosynthetic activity is absent. Deep sea animals are mostly predators and scavengers. The larger forms have wide mouths and huge curved teeth which prevent escape of any prey. Absence of skeleton, flattened bodies are some other characteristics observed. Some also have special structures that produce light on their bellies, around their eyes(which are usually nonfunctional that is, the organisms are blind) and at the sides of their bodies, some animals glow (shows bio luminiscence) in the dark waters.

Fig-11(a) Angluar fish

Fig-11(b) Brittle star

Do you know?

Electric Eel is an electric fish. It is capable of generating power electric shocks of upto 600 Volts, when it uses for hunting self defence. It is an apex predator. Despite its name, it is not an eel, but rather a knife fish.

Think and discuss

- Which organism among the two shown above do you think is present in euphotic zone?
- What kinds of adaptations can be seen in the organisms of the euphotic zone?
- What kind of adaptations can be seen in the organisms of abyssal zone ?
- What differences can you find in the animals of bathyal zone when compared to animals of euphotic (sunlit zone) and abyssal (dark zones)?
- How organisms of different zones of marine ecosystem are adapted.

Freshwater Ecosystems:

Fresh water ecosystems are stagnant water types as well as running water types. They may vary in size from as small as a puddle and pond to a large lake, river etc.

Osman sagar, Durgam cheruvu, Shamirpet lakes of Hyderabad and Vaddepalli cheruvu of Warangal, Paleru Cheruvu of Khammam, Kolleru lake of Krishna District are some fresh water lakes of our state.

- Does Pulikat lake of Nellore come under fresh water ecosystem or not. Why?

Just like the marine ecosystems, to study environmental conditions in lakes, some zones are marked. The littoral zone, limnetic zone and profundal zones on the basis of light penetration. Based on availability of light different kinds of organisms are found in these zones. Different factors like light, salt content, food, oxygen effect the organisms and their populations in different ways.

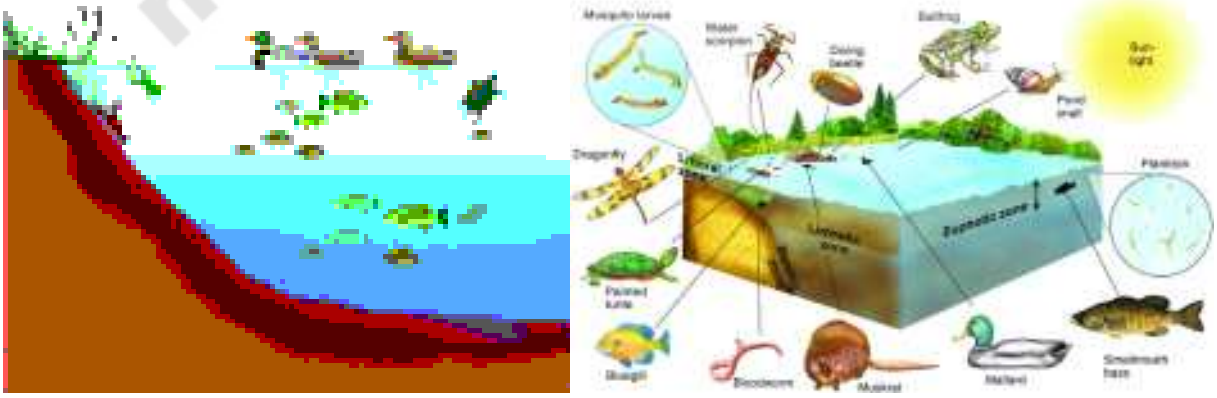


Fig-12 Zones in Lake Ecosystem and Types of Organisms present

Littoral zone: The shallow zone near the shore is also called as littoral zone. The water near the shore is usually muddy or turbid. This topmost and warmest zone at the edge of a water body is home to snails, clams, insects, several crustaceans, fishes and amphibians and the eggs and larvae of dragonflies etc.

Several organisms in this zone have well developed sight, usually have dull and greyish bodies and are fast swimmers. Plants like mosses, water lily, vallisneria, hydrilla etc are found here along with several types of algae. High photosynthetic activity occurs in this zone. Predators of this zone are tortoise, snakes and ducks.

The **limnetic zone** is the open water zone at the top of the water body and consequently receives a good deal of light. This zone contains a variety of freshwater fish with bright shiny, greyish or silver black scales that help them to merge with the surroundings. Transparent or whitish bodied crustaceans like daphnia, cyclops, small shrimps are also found in this zone. There are different types of floating plants like water hyacinth, wolffia, pistia along with a variety of algae. Photosynthetic activity is highest.

Both littoral and limnetic zones are photic zones.

The **profundal zone** is dimly lit and cold. Mostly heterotrophs (animals that eat dead organisms) are found in this region. Most of the animals, the so called bottom dwellers, that live here are mostly scavengers and predators, for example crustaceans, crabs, fishes like eels and glossogobius(isika dondu) , snails, turtles etc. They adapt themselves by feeding on dead animals that settle down. Many kinds of bacteria (detritus) thrive here that help in decomposing the dead organisms. Mud of the bottom floor, tiny particles of dead and decaying matter of plants and animal bodies make the water very turbid. Hence the bottom dwellers , rely mostly on smell and auditory (related to hearing) senses rather than vision to aquire their food.

The surface layers in the lake ecosystem gets heated while the deeper layers remain cool during day time. Often some organisms migrate to deeper layers during the day and reach the surface layers during night time when it cools down.

Other organisms found are like-

Mammals (like badgers, otters) live near water and are capable of swimming to catch their main food source, particularly fish.

Amphibians and reptiles like toads, frogs, alligators, crocodiles, salamanders start life underwater as eggs and tadpoles, and then move to ground as adults.

Insects such as skaters, water beetles, mosquitoes and dragonflies can skim over the surface of ponds, playing a critical role in the food supply for other animals.

Many species of ducks, geese and swans also reside in and around the lake ecosystem feeding on a number of different items including fish.

- Think, why birds live in and around ponds have webbed feet?
- Why cranes have long legs and long beaks?

Activity-3

You know some of the animals that reside in and around lake or pond. Make a list of those animals and the characteristics of their body.

Webbed feet of these help them to adapt to conditions on land as well as in water. Webbed feet and streamlined bodies have enabled them to be good swimmers. Wading birds such as herons and egrets which have long thin legs wander through the mud shallows searching for insects.

Water salinity and fish adaptation

Different fish species have very different tolerances for water salinity. All marine and freshwater fish maintain a constant internal salt concentration, which is midway between that of fresh water and sea water. Several marine species have a lower internal salt concentration than that of the water they swim in, so they tend to dehydrate as water is lost by osmosis. To compensate, they drink large amounts of water, and excrete the salts both via their kidneys and through highly specialised cells in the gills.

In contrast, freshwater fish have a higher internal salt content than their medium, and they tend to bloat, because osmosis leads to excess water entering the body through the permeable membranes in the mouth and gills. The water can be excreted in the form of urine, but to maintain a suitable salt balance freshwater fish need to reabsorb salt through the kidneys, and collect additional salts through salt-collecting cells in the gills.

It is the ability to regulate this salt absorption that determines the tolerance of a freshwater fish for saline water. When the water salinity level exceeds the fish's ability to adjust its salt regulation mechanisms, the delicate salt and fluid balance is upset and the fish dies.

Think and discuss

- Organisms of the oceans have a lesser salt content in their bodies than the sea water (around 3.5%).The fluid could drain out of the body of the organism into the sea. This could be dangerous and fatal to the organism. How do they survive under such conditions?
- Can fish in estuarine ecosystem survive in river as well as sea?

During summer the water in the lakes gets heated up and evaporates. Other requirements necessary to the organisms, like oxygen and nutrients gets decreased. This leads to the death and decomposing of organisms which makes living conditions unsuitable. In cold regions, the extreme low temperatures, the water in the lakes and ponds gets frozen, killing all the organisms.

- How are marine ecosystems different from fresh water ones?
- Write two types of adaptations you find in marine ecosystems, different from freshwater ecosystems.
- What are the similarities in adaptation on the basis of light

penetration in the two aquatic ecosystems?

- Which zone do you think,when compared to marine ecosystem, is absent in freshwater ecosystem?
- What would be a major factor leading to different types of adaptations in marine, freshwater ecosystems?

Adaptations in some aquatic plants

Fig-13(a) water hyacinth (floating) hydrilla (submerged)

Fig-13(b) Water lily (emergent)

Partially submerged plants have numerous air spaces inside the stems ,leaves ,roots that aid in gaseous exchange and buoyancy. Leaf bases of water hyacinth(Eichhornia crassipes) form air filled structures to keep them afloat. In water lilies leaves are flat, have an oily surface with stomata present on the upper surface of the leaf, while incompletely submerged plants like hydrilla, stomata are absent, leaves are thin, stems are highly flexible. The main adaptations that give hydrilla an advantage over other native plants are: it can grow at low light intensities, it is better at absorbing carbon dioxide from the water (diffuses into leaves), it is able to store nutrients for later use, it can tolerate a wide range of water quality conditions for example salinity(can grow in saline waters as well), and it can propagate sexually and asexually.

Other adaptations

Adaptation to temperature in plants

The effect of temperature on plants terrestrial ecosystem can be seen in different ways.

- Do all plants shed their leaves at same time in a year throughout the world.

Fig-14 Fall season modified stem

Some plants in temperate regions shed their leaves before the winter starts. This is to minimize transpiration loss as well as reduce photosynthetic and other metabolic activities, as low temperature renders several chemicals inactive for some time. In tropical regions some plants shed their leaves before the start of summer. Plants growing in hot

climates, usually keep the stomata closed during the day to reduce transpiration loss. High temperatures also lead to adaptations like reduced leaf.

Let us recall why xerophytic plants have modified stems and leaves.

- Are thorny leaves also an adaptation to temperature?
- If the trees have broad leaves at the time of snow fall season what will happen?

Adaptation to temperature in animals

Heat changes occur due to increase or decrease in atmospheric temperatures. These changes greatly affect the life of organisms in different ecosystems.

Fig-15(a) Polar bear

Fig-15(b) Blue whale

In cold regions the upper layers of the lakes get frozen during winter and the lower layers does not. Hence organisms migrate to deeper layers of the lake which is warmer and survive.

- Why polar bear has thick for on its body?
- In what way thick skin helps the seal to protect from cold weather?

Fig-15(c) Seal

Animals living in these regions adapt themselves in different ways. They have a thick layer of fat deposited under their skins, or thick fur coat or hair covering their bodies. These act as insulators preventing heat loss from their bodies. The fat not only insulates the body but helps in producing heat and energy. Such adaptations can be seen in whales, seals, bears etc.

Adaptation as a response to adverse situations

Some adaptations, to cope with adverse situations, are quite peculiar and prominent and yet go unnoticed by us.

Observe these pictures .You may find many kinds of organisms living underground like this. Why did they choose such places?

Fig-16 Hibernation

Many organisms that live in the hot deserts or polar regions migrate to the deeper layers of the earth to protect themselves from the extreme conditions of heat and cold. For example seasonal adaptations can be seen in amphibians like frog .To protect themselves from the extremes of hot and cold conditions they burrow deep in the ground and remain motionless until the conditions are favourable. During this period the rate of metabolic activities slow down and the animal goes into a nearly unconscious sleepy condition called *Hibernation* (winter sleep) and *Aestivation* (summer sleep).

- Collect information about hibernation and aestivation and make news bulletin. For this your need to go for library or internet and also take your teachers help for more examples.

Lichens

You may have observed greenish areas on the bark turn into a greyish whitish mass and then to a peculiar flaky or greenish growth. What do you think it is? A flavouring agent in the name of 'patther phul' is used in preparing biryani. It is also a type of lichen.

Fig-17 Lichen

The above picture shows the successful adaptation of algae and fungi colonies. The fungus colony attacks an algal colony where most of the algal colony that fails to compete dies out. The more adaptive forms live on to form symbiotic relationship with the fungi in colonies called Lichens. The figure shows such a colony growing on a tree trunk. The fungus provides water and minerals to the alga, while the alga performs photosynthesis and supplies food in the form of sugars to the fungus. Due to such symbiotc adaptations lichens are able to survive even in extreme conditions.

Adaptation to environment is not a simple phenomena. If we keep our cow in a desert it will be modified like a camel. If a giraffee is kept in a forest with short trees or plants it would not convert like a goat. Adaptation takes place over a long period of duration.

Story of Darwin's Finches

Charles Darwin in the year 1885 landed from the famous ship H.M.S Beagle on one of the islands of around 120 small islands of the group of Galapogos islands. He studied about different organisms of the islands. His most remarkable observation had been about finches (our state bird is also a finch). He was amazed to see that 13 types of finches that differed with respect to beaks and the colour of feather were present in the small region of the Galapagos islands. He noted that some finches eat seeds,while some eat fruits and the others eat insects.

Adaptive Radiation in Galapagos Finches

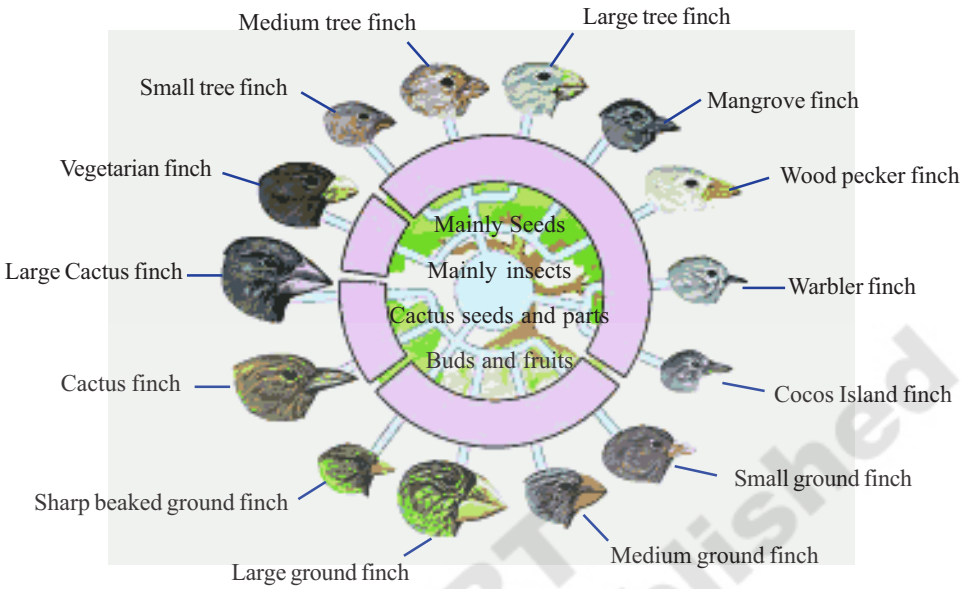


Fig-18

- Try to guess it there any relation between type of food taken and the structure of beak.
- The seed eaters had thick and heavy beaks.
- The fruit eaters had stubby beaks.
- The insect eaters had sharp and long beaks. .

Darwin observed that these birds had adapted to their immediate surroundings for food and shelter and showed a lot of variation even within the same species, especially with respect to the form of beaks. He made a sketch of the same as shown in the above figure. Thus he concluded that adaptation was something that an organism is undergoing continuously, even within very closely related forms in a particularly geographically separated area.

Key words

Adaptations, ecosystems, photosynthesis, transpiration, xerophytes, scavengers, euphotic zone, bathyal zone, Abyssal zone, littoral zone, limnetic zone, profundal zone, phytoplanktons, bio luminescence, amphibians, aestivation, hibernation.

What we have learnt?

- Organisms adjusting to diverse conditions of the ecosystem for better survival by adaptations.
- Different adaptations are found in organisms of marine and fresh water ecosystems.
- For their survival organisms have developed special characters to adapt themselves to temperature, water availability, pressure etc.
- Most of the xerophytic plants have fleshy, succulent and green coloured stem and reduced leaves.
- Marine ecosystem is divided as euphotic, bathyal and abyssal zones.
- Fresh water ecosystem of a lake has littoral, limnetic and profundal zones.
- In temperate regions, some plants shed their leaves before winter.
- Animals in cold regions have thick fur coat and a fat layer below their skin that act as insulators.
- The factors that affect the aquatic ecosystems are salt content, oxygen, food, light and pressure.
- Animals living in the bottom layers of the sea are usually blind.
- Hibernation and Aestivation seen in amphibians like frogs is an example of adaptation.

Improve your learning

1. What do you understand by adaptations in organisms and why do they adapt? (AS 1)
2. With the help of two examples, explain how these organisms have adapted themselves in the ecosystem? (AS1)
3. Collect some aquatic plants- cut the leaves and stems Observe them under microscope and record your observations like air presence /absence of air spaces etc., and answer the below. (AS 3)

   a) Why do they float on water?

   b) What make them float?

   c) Are there any other reasons for their floating?

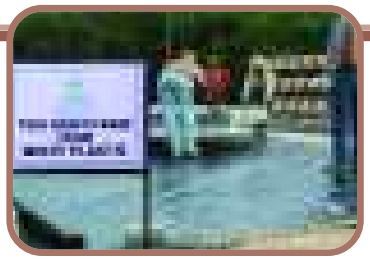
   d) Draw a diagram of what you have observed under microscope?
4. What special adaptations can be seen in the following organisms? (AS1)

   a) mangrove trees b) camel c)fish d) dolphins e)planktons.

5. If an animal of euphotic zone has to survive in abyssal zone, what adaptations are required to survive there? (AS1)
6. Marine water fishes drink more water than fresh water fishes. Do you agree? Justify.
7. Visit a nearby pond or a lake. Record the organisms you have observed and their adaptations? (A S 4)
8. Draw a lake showing different zones. Why are they called so? (AS 5)
9. Collect information of one lake from internet and prepare a table of organisms adapted at different zones? (AS 4)
10. Write the effect of temperature on the organisms adapted in a lake and pond in a tabular form. (AS1)
11. Amphibians are wonderful creatures on the earth. How do you appreciate their adaptation? (AS 6)
12. Some animals and plants survive only in certain conditions. Now a days, human activities cause damage to these conditions. What do you think about this? (AS7)
13. In the chapter on ecosystem, we had studied about the mangrove ecosystems. What kind of abiotic conditions did you study in them?(AS1)
14. How is the Coringa ecosystem different from the marine ecosystem you studied?
15. Are there any rivers meeting in the Bay of Bengal in the Coringa ecosystem collect information and make a note on them? (AS 4)
16. The aquatic ecosystem of Coringa mangrove region would be less saltier than the bay. Do you agree to this why? Why not? (AS1)
17. The Murrel (korramatta) and Rohu are fishes found in rivers. Will they be able to live in the Coringa ecosystem? Give reasons for your answer. (AS 2)
18. Crocodile, alligator are both the same? Actually they are not similar. Do you find any differences between them? What are they? (For this you need some references. Please go through your library.) (AS 4)

Chapter 10

Soil pollution



Our environment is composed of atmosphere, earth and water. The interaction of the atmosphere, lithosphere, hydrosphere and biosphere is continuing for years together. It was clean and enjoyable. But due to the various activities of man, the composition and complex nature of environment got changed. The activities include industrialization, construction, transportation, agriculture and deforestation. Such activities are though desirable for human development and welfare release unwanted materials into the environment causing it to be imbalanced rendering our life miserable.

We have learnt so far about soil formation and its properties in class VII, and also about air and water pollution in previous chapters. Here we will study about 'land pollution'. But before that, let us recall what we have learnt about soil.

We Indians worship **earth as mother**. We get everything for our living from soil. You have studied about structure of the soil in class VII. Let us recall, what you have learnt in class VII.

What is soil?

Soil is one of the th ree major natural resources, alongside air and water. It is one of the marvellous products of nature and without which there would be no life. It is a natural medium on the surface of the earth in which plants grow.

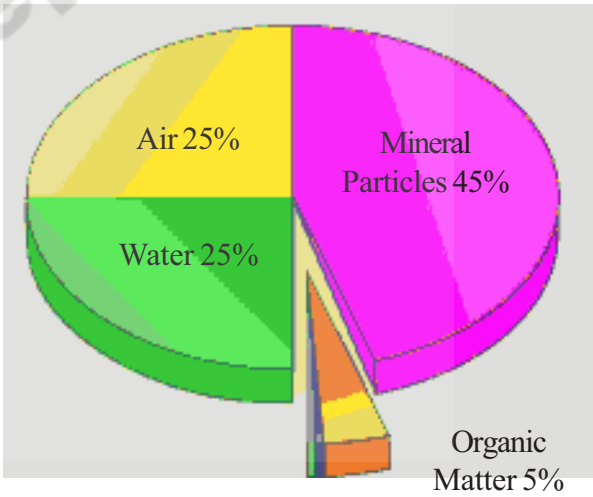


Fig-1 Components of soil

(Organic matter contains Organisms 10%, Roots 10%, Humus 80%)

Soil is made up of minerals and decomposed organic matter, along with air and water. Soil can create a habitat for fungi,

bacteria and related organisms, which in turn feed and support plant life.

Healthy soil is fundamental to the quality of food it produces and to the health of those who eat the food produced from it.

How is soil formed?

Soil formation is a long and complex process and it can take 100 to 10,000 years to create one inch of top soil! It is driven by many factors such as climate, topography, living organisms and the type of parent material. Parent materials come from break down of underlying rocks or from deposits by streams and rivers, seas and gulfs, hills, wind and glaciers or organic plant residues.

Over time, these materials are weathered by the effects of freezing, thawing, wetting, drying, heating, cooling, erosion, plants and animals and from chemical reactions. Eventually the parent material is divided into three horizontal layers, the top layer consists of mostly organic matter and biological activity, the middle layer is the zone of maximum material accumulation and the bottom layer bold is mainly the parent material, but slightly altered.

The top soil is important since it is the foundation for the life on the earth.

Do you know?

In one acre of land where the top soil is eight inches thick nearly five and half tons of Bacteria are present. 50,000 Earthworms are also present in it.

Soil properties

Crop quality directly depends on the quality of the agricultural soil in which it is grown. The higher the quality of the soil, the higher the quality of the crop produced. To determine how to obtain high quality soil, we must first understand the fundamental properties of soil. These can be divided into three major categories- physical, chemical and biological properties.

(i) Physical properties of soil

Soil comprises of minerals, organic matter, water and air. The composition and proportion of these components greatly influences soil physical properties including colour texture, structure and porosity. These properties regulate and affect air and water movement in the soil and thus, soil ability to function. Organic matter is the organic component of soil which includes the residues of dead plants, animals and organisms.

It consists of nutrients necessary for plants growth such as nitrogen, phosphorus and potassium. Soils which contain 30% or more organic matter are considered organic soil; all other soils are identified as mineral soils. Organic matter in soil improves water infiltration, decreases evaporation, and increases the water holding capacity. Also, where there is organic matter, there will be numerous organisms present helping to convert it back to nutrients and these organisms help to create crumb, ideal for cultivation. Thus, balancing a natural state of soil.

(ii) Chemical properties of soil

The term pH is used to indicate the level of acidity or alkalinity of a soil. The range of pH values of a good soil lies from 5.5 to 7.5. Below pH 7 the soils are termed as acidic and above pH 7 alkaline.

The pH of soil is important in determining the type of vegetation that will grow in the soil and the type of organisms that will live there. Also, presence of organic matter in soil has a close relationship with soil pH. Soil richer in organic matter is acidic in nature as a result of degradation of various substances produces various acids in soil. Availability of plants nutrients is strongly tied to the pH in soil.

The availability of N, K, Ca, Mg and S tends to decrease with decreasing pH since conditions which acidify the soil such as weathering and plant uptake also result in removal of these nutrients or in decreased microbial activity.

What will happen if there is increase in acidic or basic nature of soil?

(iii) Biological properties of Soil

Soil is not a dead mass but an abode of millions of organisms. It is the most abundant and diverse ecosystem on the earth. Soil organisms include both plants and animal forms ranging from sub microscopic viruses to earthworms, to large burrowing animals such as gophers and ground squirrels. Major microbial groups in soil are bacteria, fungi, algae and protozoa. These feed on plant residues burrow the soil and help in aeration and percolation of water.

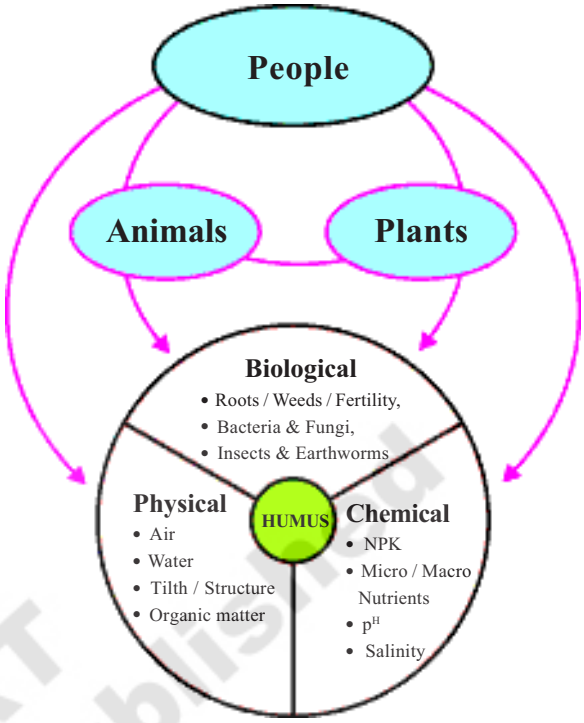


Fig-2 Biological properties of soil

Soil microbes also have influence in controlling the quantities and forms of various chemical elements found in soil. Most notable are the cycles of carbon, nitrogen, sulphur and phosphorus, all of which are elements important in soil fertility. Soil microbes convert organic forms of elements to their inorganic forms and liberate carbon dioxide, ammonia, sulphate, phosphate and inorganic forms of other elements. This process is known as 'mineralization'.

This is the basis of nutrient cycles in all major ecosystems of the world. Besides their role in controlling the rates of production of inorganic forms from various organic forms, soil microbes, particularly, soil bacteria also control the forms of ions in which these nutrients occurs. We shall study this in detail in the chapter of **'Biogeochemical cycles'.**

Thus, we can conclude that physical, chemical and biological properties of soils affect many processes in the soil that make it suitable for cultivation and other purposes.

SOIL FERTILITY

Fertility of soil is closely associated with the properties of soil and is defined by its capacity to hold water and nutrients and supply them to plants when they need them, independent of direct application of nutrients. Transfer of nutrients from the soil's organic matter to the mineral stage strongly depends on the soil organisms' activity and diversity. Soil organisms also contribute to buildup soil organic matter, including humus, the soil's most important nutrient reservoir.

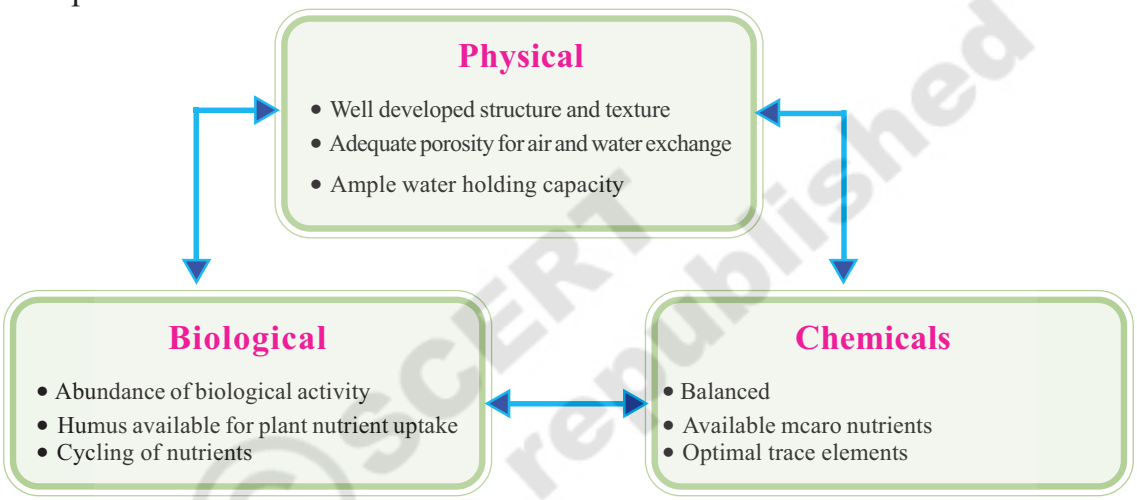


Fig-3 Properties of soil

When nutrients are bound in biological or organic form, they are neither lost nor bound to soil particles in a way which makes them unavailable to plants. Therefore, soil fertility can be described in terms of soil organic matter content of the soil, with good living conditions for soil organisms and growing conditions for the roots, which are closely linked to soil structure, the availability of nutrients, the soil's water holding capacity and its biological activity.

It is interesting to know that a major part of the soil microbial biomass is composed of fungi. Important representatives of the soil fungi, the mycorrhizae, grow in symbiosis with about 90% of all plant roots. The plant roots provide sugar for the growth of mycorrhiza. In reverse, the fungus explores the soil and brings back water as well nutrients such as phosphate, zinc and copper that are not easily available to plants. Mycorrhizae enlarge the rooting zone of plants and enter small soil pores, where plant roots cannot access. Iimproving soil structure, mycorrhizal action in soil and take plant carbon from the air and deposit into soil organic matter and stable soil aggregates.

In addition to the above, soil P^H, its acidity or alkalinity, is highly relevant to how readily nutrients become available in soil.

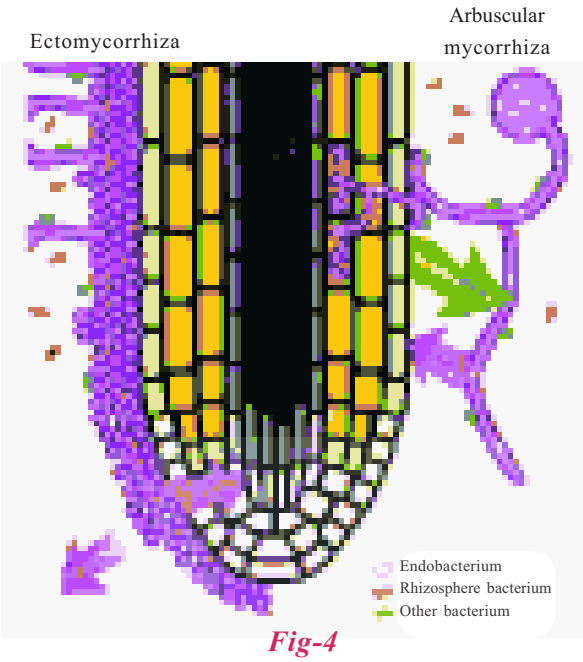


Fig-4

Proper soil fertility management is very important for successful crop production and farming. Organic farmers approach soil fertility management by protecting the soil and feeding it organic material, and then letting it feed the plants in a balanced way. When the soil is fertile in the organic sense, it can produce good crop yields for several years. You learned about organic forming in the chapter 'Challenges in improving agriculture.'

Soil pollution

"The Earth, the air, the land and the water are not an inheritance from our forefathers but on loan from our children. So we have to handover to them atleast as it was handed over to us." *- Mahatma Gandhi.*

As we discussed above, soil serves as the interface between earth, air and water; fulfilling a variety of complex, interdependent functions essential to life. Yet human activities alter its ability to perform its job. As compared to the other resources, it has taken a long time to become aware of the wealth, complexity, usefulness and fragility of the soil. When the quality of air and water deteriorates, the threat to public health is felt immediately. But as long as we can walk on the earth under our feet, where's the danger?

The impacts of various human activities for development and welfare are invisible and land pollution is a good example of that. We can't easily see the poisons that seep from underground mines, the garbage we have dip into landfills or from industrialization, agriculture and other mismanagement by human being. Land pollution, in short, is a much bigger and more subtle problem than it might appear. How does it occur? And what can we do about it? These are the questions to think about. But first let us understand up to what extent we are as human being, responsible for producing this waste.

Let us read the following conversation and prepare the list as per the instructions.

During interval time Venu was eating a fruit. He was about to throw the peel in corner of the varandah. His friend Ramu stopped her. Ramu said you should not throw waste in the varandah. Drop it in the litter given.

Now let us think, what will happen if you throw the wastes where ever you want?

Prepare a list of waste materials we throw out in a day from morning to evening classifying them as wet wastes and dry wastes with the help of the example given in the table below.

S. No.	Wet waste	Dry waste
1.	Vegetable peels	Biscuit wrapper
2.		
3.		
4.		
5.		

Can you imagine the quantity of waste we produce in a day and what happens to the waste materials we throw or dispose?

Activity-1

Weight the wet wastes, which you have listed in the table for one day. Divide the weight by number of people in your home. The result will be the per capita wet waste we are producing in one day.

$$\textit{Per capita wet Wastes produced at home} = \frac{\textit{Total weight of wet waste materials}}{\textit{No. of persons in your family}}$$

Multiply it by 30 = ... per month
Multiply it by 365 = ... per year

You will be surprised to note this astonishing figure of the waste we are producing in a day. Do you know what happens to the waste materials we produce?

Activity-2

Dumping and decomposing

We are producing tons of wastes in our daily activities. It is dumped at wherever the vacant place is available in Urban as well as Rural areas. Some of these wastes are decomposed but some are not. Let us do the following activity. For this you need to observe more than one month.

Take a polythene bag/plastic bucket / or any container. Fill half of it with soil. Keep wet wastes and other wastes in it. (Wastes should include vegetable peels, rubber, plastic etc). Add some more soil and sprinkle water regularly on it. Dig it and observe in 15 days intervals. Note your observations in the table.

Material	What has happened in the 1st fortnight	What has happened in the 2nd fortnight	What has happened in the 3rd fortnight
Vegetable peels			
Vegetable with removed peel			
Banana			
Plastic cup			
paper			
rubber			

Now think, why some of the waste materials are mixing with soil quickly while some do not?

The waste generated from various sources can be categorized into two types:

i) Biodegradable waste includes substances that can be degraded by microbes into harmless and non-toxic substances. Agricultural and animal wastes like leaves, twigs, hay, dung, etc. are biodegradable wastes.

ii) Non-biodegradable waste cannot be easily degraded. Aluminium cans, plastics, glass, DDT, etc. are examples of non-biodegradable wastes. Radioactive wastes produced during nuclear reactions take a long time to decay and are harmful to human beings. Now a dyas 'e-waste' (computer, mobile wastes) is also leads to soil pollution

Decomposition is the process of materials being digested and broken down into simpler substances, making nutrients

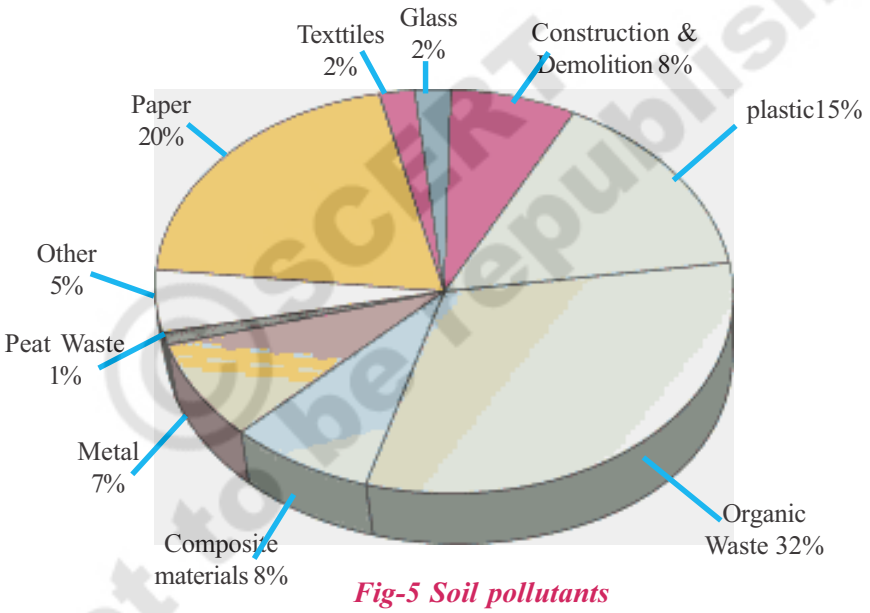


Fig-5 Soil pollutants

more available to plants. Thus, bio-degradable materials contribute directly to the fertility of the soil. But when the disposed amount of bio-degradable materials exceed it contributes the imbalance in the nature creating negative impacts. On the other hand, non-biodegradable materials directly contribute to land pollution due to the excessive amount and improper waste management. Thus, soil or land pollution can be understood as addition of substances which adversely affect the quality of soil or its fertility Generally polluted water also pollute soil. Solid waste is a mixture of plastics, cloth, glass, metal and organic matter, sewage, sewage sludge, building debris, generated from households, commercial and industries establishments add to soil pollution. Fly ash, iron and steel slag, medical and industrial wastes disposed on land are important sources of soil pollution. In addition, fertilizers and pesticides from agricultural use which

reach soil as run-off and land filling by municipal waste are growing cause of soil pollution. Acid rain and dry deposition of pollutants on land surface also contribute to soil pollution.

Think and discuss

- Today what are the pollutants produced from your school. How many of these are non-degradables.

Causes of land pollution

There are many different ways by which land pollution can occur. Soils are commonly used as dumps for household and industrial wastes. In many intensively farmed areas, leaching of nutrients from manure or inorganic fertilizers and effluents from processing plants may lead to high level of nitrate and other chemicals in ground water. Atmospheric deposition where soil gets contaminated when air pollution falls on to it, are much apparent still contributing to soil pollution. Thus, on the basis of sources of pollutants, soil pollution can be classified into the following categories:

- Agricultural Soil Pollution
- Soil pollution by industrial effluents and solid wastes
- Pollution due to urban activities

Soil pollution is caused by the presence of man-made chemicals or other alteration in the natural soil environment. This type of contamination typically arises from the rupture of underground storage links, application of pesticides, and percolation of contaminated surface water to subsurface strata, oil and fuel dumping, leaching of wastes from landfills or direct discharge of industrial wastes to the soil. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. The occurrence of this phenomenon is correlated with the degree of industrialization and intensities of chemical usage.

A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the soil or which disturbs the biological balance of the organisms in the soil. Pollution in soil has adverse effect on plant growth and living organisms in the soil.

Pollution in soil is associated with

- Indiscriminate use of fertilizers
- Indiscriminate use of pesticides, insecticides and herbicides
- Dumping of large quantities of solid waste
- Deforestation and soil erosion

Indiscriminate use of fertilizers

Soil nutrients are important for plant growth and development. Plants obtain carbon, hydrogen and oxygen from air and water. But other necessary nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulfur etc., must be obtained from the soil. Farmers generally use fertilizers to correct soil deficiencies.

Fertilizers contaminate the soil with impurities, which come from the raw materials used for their manufacture. Mixed fertilizers often contain nitrogen as

ammonium nitrate (NH_4NO_3), phosphorus as P_2O_5, and potassium as K_2O. For instance, As, Pb and Cd present in traces in rock phosphate mineral get transferred to super phosphate fertilizer. Since the metals are not degradable, their accumulation in the soil above their toxic levels due to excessive use of phosphate fertilizers becomes an indestructible poison for crops.

The over use of NPK fertilizers reduce quantity of vegetables and crops grown on soil over the years. It also reduces the protein content of wheat, maize, grams, etc., grown on that soil. The carbohydrate quality of such crops also gets degraded. Excess potassium content in soil decreases Vitamin C and carotene content in vegetables and fruits. The vegetables and fruits grown on over fertilized soil are more prone to attacks by insects and diseases.

Indiscriminate use of pesticides, insecticides and herbicides

Plants on which we depend for food are under attack from insects, fungi, bacteria, viruses, rodents and other animals, and must compete with weeds for nutrients. To kill unwanted populations living in or on their crops, farmers use pesticides.

The first widespread insecticide use began at the end of World War II that included DDT (dichloro diphenyl trichloro ethane) and gammaxene. Insects soon became resistant to DDT and as the chemical did not decompose readily, it persisted in the environment.

Since it was soluble in fat rather than water, it biomagnified up the food chain and disrupted calcium metabolism in birds, causing eggshells to be thin and fragile. As a result, large birds of prey such as the brown pelican, ospreys, falcons and eagles became endangered. DDT is now banned in the most of the western countries. Ironically many of them including USA still produce DDT for export to other developing nations whose needs outweigh the problems caused by it.

Besides DDT the most important pesticides are BHC, chlorinate dihydro carbons, organo phosphates, aldrin, malathion, dieldrin, furodan, etc. The remnants of such pesticides used on pests may get adsorbed by the soil particles, which then contaminate root crops grown in that soil. The consumption of such crops causes the pesticides remnants to enter human biological systems, affecting them adversely.

Pesticides not only have toxic effect on human and animals but also decrease the fertility of the soil. Some of the pesticides are quite stable and their bio- degradation may take weeks and even months.

Biomagnification

The nutrients necessary for plant growth (e.g., nitrogen and phosphorus) are found at very low concentrations in most natural waters. In order to obtain sufficient quantities for growth, phytoplankton must collect these chemical elements from a relatively large volume of water.

In the process of collecting nutrients, phytoplankton also collects certain human-made chemicals, such as some persistent

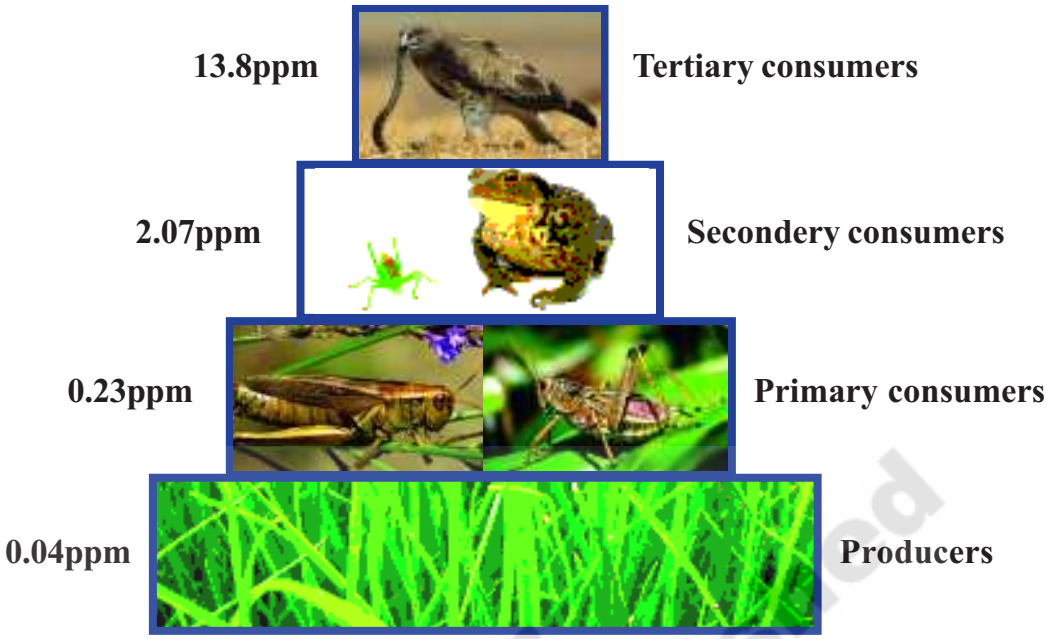


Fig-6 Bio magnification

The numbers are representative values of the concentration of DDT and its derivatives (in parts per million, ppm) in the tissues.

pesticides. These may be present in the water at a very low concentrations that they cannot be measured even with a very sensitive instruments. The chemicals, however, biologically accumulate (bioaccumulation) in the organism and become concentrated at levels that are much higher in the living cells than in the open water. This is especially true for persistent chemicals-substances that do not break down readily in the environment - like DDT and BHCs that are stored in fatty tissues.

The small fish and zooplankton eat vast quantities of phytoplankton. In doing so, any toxic chemicals accumulated by the phytoplankton are further concentrated in the bodies of the animals that eat them. This is repeated at each step in the food chain. This process of increasing concentration through the food chain is known as biomagnification.

Dumping of solid wastes

The sight of a dustbin overflowing and the stench rising from it are all too familiar sights and smells of a crowded city.

You look in some other direction and hold your nose as you cross it. Since the beginning, humankind has been generating waste, be it the bones and other parts of animals they slaughter for their food or the wood they cut to make their carts. With the progress of civilization, the waste generated became a more complex issue. At the end of the 19th century the industrial revolution saw the rise of the world of consumers. Not only did the air get more and more polluted but the earth itself became more polluted with the generation of non-biodegradable solid waste. The increase in population and urbanization are largely responsible for the increase in solid waste.

Solid waste means any garbage, trash, waste tire, sludge from a waste treatment plant, water supply treatment plant and other discarded materials, including solid, liquid, semisolid or contained gaseous materials arises from human and animal activities. In other words, solid waste may be defined as the organic and inorganic waste produced by various activities of the society which have lost their value to the first user.

Solid waste, on the basis of its sources of origin can be classified as:

1. Municipal Solid Waste: It consists of household waste; construction and demolition debris, sanitation residue.
2. Hazardous Solid Waste: industrial and hospital waste is considered to be hazardous waste as they contain toxic substances.
3. Infectious Solid Waste: Biomedical or hospital waste generated during diagnosis treatment etc. which include sharp, chemical wastes, discarded medicines and human excreta etc.

In general, solid waste includes garbage, domestic refuse and discarded solid materials such as those from commercial, industrial and agricultural operations. They contain increasing amounts of paper, cardboards, plastics, glass, old construction material, packaging material and toxic or otherwise hazardous substances. Since a significant amount of urban solid waste tends to be paper and food waste, the majority is recyclable or biodegradable in landfills. Similarly, most agricultural waste is recycled and mining waste is left on site.

The portion of solid waste that is hazardous such as oils, battery metals, heavy metals from smelting industries and organic solvents are the ones we have to pay particular attention to. These can in the long run, get deposited to the soils of the surrounding area and pollute them by altering their chemical and biological properties. They also contaminate drinking water aquifer sources. More than 90% of hazardous waste is produced by chemical, petroleum and metal-related industries and small businesses such as dry cleaners and gas stations contribute as well.

Toxic chemicals leached from oozing storage drums into the soil underneath homes, causing an unusually large number of birth defects, cancers and respiratory, nervous and kidney diseases.

Deforestation

Soil Erosion occurs when the weathered soil particles are dislodged and carried away by wind or water. Deforestation, agricultural development, temperature extremes, precipitation including acid rain, and human activities contribute to this erosion. Humans speed up this process by construction, mining, cutting of timber, over cropping and overgrazing. It results in floods and cause soil erosion.

Forests and grasslands are an excellent binding material that keeps the soil intact

Fig-7

and healthy. They support many habitats and ecosystems, which provide innumerable feeding pathways or food chains to all species. Their loss would threaten food chains and the survival of many species. During the past few years quite a lot of vast green land has been converted into deserts. Deforestation is slowly destroying the most productive flora and fauna areas in the world, which also form vast tracts of a very valuable sink for CO2.

Pollution due to urbanization

Pollution of surface soils

Urban activities generate large quantities of city wastes including several

Fig-8

Biodegradable materials (like vegetables, animal wastes, papers, wooden pieces, carcasses, plant twigs, leaves, cloth wastes as well as sweepings) and many non-biodegradable materials (such as plastic bags, plastic bottles, plastic wastes, glass bottles, glass pieces, stone / cement pieces). On a rough estimate Indian cities are producing solid city wastes to the tune of 50,000 - 80,000 metric tons every day. If left uncollected and decomposed, they are a cause of several problems such as:

- Clogging of drains: Causing serious drainage problems including the burst / leakage of drainage lines leading to health problems.
- Barrier to movement of water: Solid wastes have seriously damaged the normal movement of water thus creating problem of inundation, damage to foundation of buildings as well as public health hazards.
- Foul smell: Generated by dumping the wastes at a place.
- Increased microbial activities: Microbial decomposition of organic wastes generate large quantities of methane besides many chemicals to pollute the soil and water flowing on its surface
- When such solid wastes are hospital wastes they create many health problems: As they may have dangerous pathogen within them

besides dangerous medicines, injections.

Pollution of underground Soil

Underground soil in cities is likely to be polluted by

- Chemicals released by industrial wastes and industrial wastes.
- Decomposed and partially decomposed materials of sanitary wastes.

Many dangerous chemicals like cadmium, chromium, lead, arsenic, selenium products are likely to be deposited in underground soil. Similarly underground soil polluted by sanitary wastes generates many harmful chemicals. These can damage the normal activities and ecological balance in the underground soil.

Effects of soil pollution

With luck and the right atmospheric conditions, air and water pollution disperse and disappear. What makes land pollution such a problem is that land is static, so land pollution stays exactly where it is until and unless someone cleans it up. Land that's polluted stays polluted; land that's urbanized almost invariably stays urbanized.

As we know, plastics take hundreds of years to disappear while radiation can contaminate land for ten times longer. That means landfill sites and radioactive waste dumps remain that way pretty much indefinitely.

The simplest effect of land pollution is that it takes land out of circulation. The more land we use up, the less we have remaining. That might not sound a problem where there's plenty of land in rural areas, but it's certainly a concern where productive agricultural land is concerned, especially as the world's population continues to increase.

The biggest problem comes when contaminated land is returned to use, either as building or agricultural land. Houses might be built on brown field (former industrial) sites that haven't been cleaned up properly, putting future owners and their families at risk. Or people might get their water from rivers supplied by groundwater contaminated by landfill sites, mine workings, or otherwise polluted land some distance away.

Illnesses such as cancer develop over years or decades for a variety of reasons and it's extremely difficult to prove that they've been caused by something like local environmental pollution, especially when people move homes during their lifetime. No-one knows how much land is contaminated, how contamination varies from one place to another, or how land contaminants react with one another once they enter water resourses and become water pollution. So the scale of the problem and its ultimate effects are impossible to determine.

However, we do know what effect individual pollutants have. We know, for example, that lead is a toxic heavy metal that has all kinds of unpleasant effects on human health; it's been implicated in developmental deficits (such as reductions in intelligence) in children. We know that

some chemicals are carcinogenic (cancer-causing) while others cause congenital defects such as heart disease.

Thus, effects of soil pollution are vast and these can be summarized into three broad categories as follows:

1. Hazardous chemical entered into the food chain from soil, causes disruption of biochemical process.
2. Soil becomes infertile because of water logging and salinity.
3. Toxic chemicals affect plant growth and animal life.

Agricultural

- Reduced soil fertility
- Reduced nitrogen fixation
- Increased erodibility
- Larger loss of soil and nutrients
- Deposition of silt in tanks and reservoirs
- Reduced crop yield
- Imbalance in soil fauna and flora

Industrial

- Dangerous chemicals entering underground water
- Ecological imbalance
- Release of pollutant gases
- Release of radioactive rays causing health problems
- Increased salinity
- Reduced vegetation

Urban

- Clogging of drains
- Inundation of areas
- Public health problems
- Pollution of drinking water sources
- Foul smell and release of gases
- Waste management problems

Environmental long term effects of soil pollution

When it comes to the environment itself, the toll of contaminated soil is even more dire. Soil that has been contaminated should no longer be used to grow food, because the chemicals can leech into the food and harm people who eat it.

If contaminated soil is used to grow food, the land will usually produce lower yields than it would if it were not contaminated. This, in turn, can cause even more harm because lack of plants on the soil will cause more erosion, spreading the contaminants onto land that might not have been tainted before.

In addition, the pollutants will change the makeup of the soil and the types of microorganisms that live in it. If certain organisms die off in the area, the larger predator animals will also have to move away or die because they've lost their food supply. Thus it's possible for soil pollution to change whole ecosystems.

Control of soil pollution

The following steps have been suggested to control soil pollution. To help prevent soil pollution, we can limit construction in sensitive area. In general we would need less fertilizer and fewer pesticides if we could all adopt the three R's: Reduce, Reuse, and Recycle. This

would give us less solid waste.

Reducing chemical fertilizer and pesticide use

Applying bio-fertilizers and manures can reduce chemical fertilizer and pesticide use. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution.

Reusing of materials

Materials such as glass containers, plastic bags, paper, cloth etc. can be reused at domestic levels rather than being disposed, reducing solid waste pollution.

Recycling and recovery of materials

This is a reasonable solution for reducing soil pollution. Materials such as paper, some kinds of plastics and glass can and are being recycled. This decreases the volume of refuse and helps in the conservation of natural resources. For example, recycling of one tonne of paper can save 17 trees.

Reforesting

Control of land loss and soil erosion can be attempted through restoring forest and grass cover to check wastelands, soil erosion and floods. Crop rotation or mixed cropping can improve the fertility of the land.

Solid waste management

The solid wastes which are accumulated on the soil will pose a great problem to us. Throwing the wastes in dump yards is not the solution to the problem. For throwing wastes we need enormous land area.

For example in the state of Andhra Pradesh 32 large towns and cities are there. The average per capita solid wastes produced per day is 364 grams. To dispose all the wastes we need an area equal to the size of Hyderabad city(590 sq km) by the year 2012.

Thus, Proper methods should be adopted for management of solid waste disposal. Solid waste management involves activities including collection, transfer and transport to suitable sites, and safe disposal of wastes by methods which are environmentally compatible.

Fig-9 Water recycling

Industrial wastes can be treated physically, chemically and biologically until they are less hazardous. Acidic and alkaline wastes should be first neutralized; the insoluble material if biodegradable should be allowed to degrade under controlled conditions before being disposed.

As a last resort, new areas for storage of hazardous waste should be investigated such as deep well injection and more secure landfills. Burying the waste in

locations situated away from residential areas is the simplest and most widely used technique of solid waste management. Environmental and aesthetic considerations must be taken into consideration before selecting the dumping sites. Incineration of other wastes is expensive and leaves a huge residue and adds to air pollution.

Pyrolysis is a process of combustion in absence of oxygen or the material burnt under controlled atmosphere of oxygen. It is an alternative to incineration. The gas and liquid thus obtained can be used as fuels. Pyrolysis of carbonaceous wastes like firewood, coconut, palm waste, corn combs, cashew shell, rice husk paddy straw and saw dust, yields charcoal along with products like tar, methyl alcohol, acetic acid, acetone and a fuel gas, may reduce soil pollution.

Anaerobic/aerobic decomposition of biodegradable municipal and domestic waste is also being done and gives organic manure. Cow dung which releases methane into the atmosphere, should be processed further in 'gobar gas plants' to produce 'gobar gas' and good manure.

Bioremediation

Bioremediation means to use a biological remedy to abate or clean up contamination. This makes it different from remedies where contaminated soil or water is removed for chemical treatment or decontamination, incineration, or burial in a landfill. Microbes are often used to remedy environmental problems found in

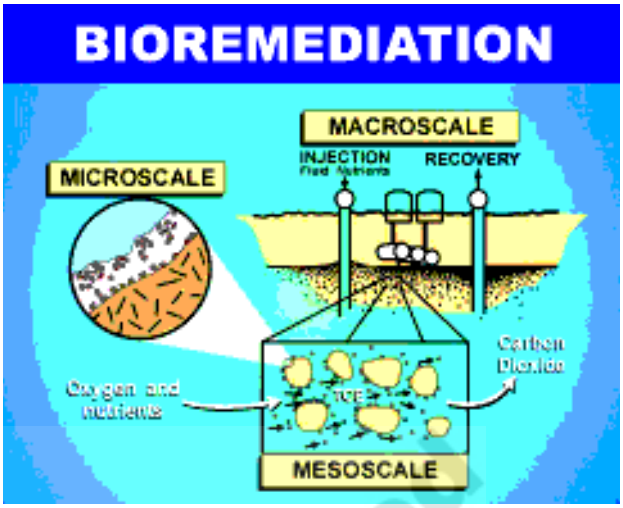


Fig-10 Bio remediation

soil, water, and sediments. Plants have also been used to assist bioremediation processes. This is called phytoremediation. Biological processes have been used for some inorganic materials, like metals, to lower radioactivity and to remediate organic contaminants. With metal contamination the usual challenge is to accumulate the metal into harvestable plant parts, which must then be disposed of in a hazardous waste landfill before or after incineration to reduce the plant to ash. Two exceptions are mercury and selenium, which can be released as volatile elements directly from plants to atmosphere.

Natural land pollution

Land pollution occurs massively during earth quakes, landslides, hurricanes and floods. All cause hard to clean mess, which is expensive to clean, and may sometimes take years to restore the affected area. These kinds of natural disasters are not only a problem in that they cause pollution but also because they leave many victims homeless.

Soil conservation

Soil is one of the most important natural resources. The importance of soil conservation is relatively less talked about as compared to the conservation of water and other natural resources. The almost-omnipresent soil is mostly taken for granted. Its omnipresence is ironically the reason behind us, human beings, taking it for a ride. We rarely even think of it as a natural resource that needs to be conserved, a part of the natural wealth that needs to be preserved. There are several ways possible for soil conservation that can be achieved through agricultural practices and measures that can be taken at home.

Plant trees

We all know that the roots of trees firmly hold on to the soil. As trees grow tall, they also keep rooting deeper into the soil. As the roots of the trees spread deep into the layers of soil, they contribute to the prevention of soil erosion. Soil that is under a vegetative cover has hardly any chance of getting eroded as the vegetative cover acts as a wind barrier as well.

Terraces

Terracing is one of the very good methods of soil conservation. A terrace is a leveled section of a hilly cultivated area. Owing to its unique structure, it prevents the rapid surface runoff of water. Terracing gives the landmass a stepped appearance thus slowing the easy washing down of the soil. Dry stonewalling is a method used to create terraces in which stone structures are created without using mortar for binding.

No-till farming

When soil is prepared for farming by ploughing it, the process is known as tiling. No-till farming is a way of growing crops without disturbing it through tillage. The process of tilling is beneficial in mixing fertilizers in the soil, shaping it into rows and preparing a surface for sowing. But the tilling activity can lead to compaction of soil, loss of organic matter in soil and the death of the organisms in soil. No-till farming is a way to prevent the soil from being affected by these adversities.

Contour ploughing

This practice of farming across the slopes takes into account the slope gradient and the elevation of soil across the slope. It is the method of ploughing across the contour lines of a slope. This method helps in slowing the water runoff and prevents the soil from being washed away along the slope. Contour ploughing also helps in the percolation of water into the soil.

Crop rotation

Some pathogens tend to build up in soil if the same crops are cultivated consecutively. Continuous cultivation of the same crop also leads to an imbalance in the fertility demands of the soil. To prevent these adverse effects from taking place, crop rotation is practiced. It is a method of growing a series of dissimilar crops in an area sequentially. Crop rotation also helps in the improvement of soil structure and fertility.

Soil pH

The contamination of soil by addition of acidic or basic pollutants and acid rains

has an adverse effect on the pH of soil. Soil pH is one of the determinants of the availability of nutrients in soil. The uptake of nutrients in plants is also governed to a certain extent, by the soil pH. The maintenance of the most suitable value of pH, is thus, essential for the conservation of soil.

Water the soil

We water plants, we water the crops, but do we water the soil? If the answer is negative, it is high time we adopt the method of watering soil as a measure of conserving soil. Watering the soil along with the plants is a way to prevent soil erosion caused by wind.

Salinity management

The salinity of soil that is caused by the excessive accumulation of salts has a negative effect on the metabolism of the crops in soil. Salinity of soil is detrimental to the vegetative life in the soil. The death of vegetation is bound to cause soil erosion. Hence, salinity management is one of the indirect ways to conserve soil.

Soil organisms

Organisms like earthworms and others benefiting the soil should be promoted. Earthworms, through aeration of soil, enhance the availability of macronutrients in soil. They also enhance the porosity of soil. The helpful organisms of soil promote its fertility and form an element in the conservation of soil.

Indigenous Crops

Planting of native crops is known to be beneficial for soil conservation. If non-native plants are grown, the fields should be bordered by indigenous crops to prevent soil erosion and achieve soil conservation.

Key words

Parent Material, soil fertility, mycorrhizal, minaralisation, bio degradable waste, non bio degradable waste, soil errosion, bio magnification, bio remediation.

What we have learnt

- Our environment is composed of atmosphere, earth, water and space and the interaction of the atmosphere, lithosphere, hydrosphere and biosphere is continuing for years together.
- Human and animal activities has interfered the composition and complex nature of environment and hence the problem of pollution raised.
- Soil is one of the three major natural resources alongside air and water composed of minerals and organic matter along with air and water. Soil is the most abundant and diverse ecosystem on the earth

- Soil formation is a long and complex process that takes from 100 to 10,000 years and driven by many factors including climate, topography, living organisms and types of parent material.
- Soil properties are classified into three groups, i.e., Physical, chemical and biological properties of the soil.
- Soil fertility is closely associated with soil properties and it is defined as its capacity to hold water and nutrients and supply them to plants when they need them, independent of direct application of nutrients.
- Soil or land pollution can be defined as Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.
- Wastes generated from various sources are categorized into biodegradable and non-biodegradable waste.
- Biodegradable material is any organic material that can be broken down by microorganisms into simpler more stable compounds. Most organic wastes like-wood, paper, are biodegradable.
- Materials that cannot be degraded by microbial action are said to be non-biodegradable materials.
- Land pollution is broadly caused by agricultural practices, Industrial wastes, urban activities.
- Biomagnification is the sequence of processes in an ecosystem by which higher concentrations of a particular chemical, such as the pesticide DDT, are reached in organisms higher up the food chain, generally through a series of prey-predator relationships.
- Soil erosion is a natural process. It became a problem due to various human activities causing it to occur much faster than under natural conditions.
- Deforestation, agriculture development, temperature extremes, precipitation including acid rain and human activities contributed to this faster soil erosion.
- Soil pollution leads to an imbalance in ecosystem and is closely associated with air and water pollution. The harmful effects are not seen clearly but reduced crop yield due to reduced soil fertility and loss of soil and nutrients, groundwater pollution, foul smell and public health problems are some of the effects that attract human being to think of this problem.
- There are many ways to control soil pollution which includes, three R's principles: Reduce, Reuse and Recycle, reforesting, proper solid waste management and bioremediation.
- Conservation of soil can be achieved through agricultural practices and measures that can be taken at home.

Improve your learning

1. Define soil pollution. (AS1)
2. Why are plastic bags a big environmental nuisance? (AS 6)
3. Describe an environmental friendly method to profitably dispose off human waste and cattle waste. (AS1)
4. Chemical fertilizers are useful to crops. In which way they cause environmental pollution? (AS1)
5. What steps can be taken to reduce pollution due to particulate matter from industries?
6. What is a medical waste? Why it is called hazardous waste? What is the safe way to dispose medical waste? (AS1)
7. Prepare flow chart to describe soil pollution, causes and methods of control.(AS 5)
8. What soil problems do you find in your area? Prepare a list of those problems and suggest a method for each of them to control those problems.(AS 7)
9. What farm practices impact soil? Do they impact soil in a positive or a negative way?
10. Rank the negative impact practices in your area in the order in which you think they should be eliminated. (AS1)
11. Rank the positive impact practices in order in which you think they should be used for the most benefit on your farm. (AS1)
12. Ravi said soil health is important? How can you support him? (AS 7)
13. How would soil texture affect the nutrients in soil? What would be its impact on crop production? (AS 2)
14. What are the three main physical properties of soil? What effects do this have on the plants? (AS1)
15. What is pH? What is its range? What are the negative impacts if the pH of soil is too low or too high?(AS1)
16. What is soil fertility? What are the sources of soil fertility? (AS1)
17. Name 10 living things that live in soil. What do these things do to affect the soil? (4)
18. What is organic matter? Why it is important to plants? (AS1)
19. What are the factors affecting organic matter levels in soil? How this level of organic matter can be increased? (AS1)
20. What is solid waste? Explain best practices for solid waste management. (AS1)
21. What is bioremediation? How it helps in controlling soil pollution? (AS1)
22. Why soil conservation is important to us? What will happen if no preventive measures would be taken? (AS 2)
23. Look at the following symbol what does its mean.

ANNEXURE

Earthworm

Most farmers are well aware that the presence of earthworms is a sign of fertile soil. But what makes them so valuable? Earthworms fulfill several crucial functions. First, they accelerate the decomposition of plant material on the soil surface by removing dead plant material from the soil surface. During the digestion of organic material, they mix organic and mineral soil particles and build stable crumbs in their excrements, which help improve the soil structure.

Earthworm excrements contain 5 times more nitrogen, 7 times more phosphate, 11 times more potash and 2 times more magnesia and calcium than normal earth. The tunnels created by earthworms promote infiltration and drainage of rainwater and thus contribute to prevention of soil erosion and water-logging.

Dung beetle:

Have you noticed one or two small black, insects rolling a large ball of dung which is larger than their size? There are called dung beetles (Scrab Beatle) Shiny metallic coloured. What do they do with that ball of dung? Dung is their food. They collect the dung makes it a ball and rolls it to a safety place and bury it in soft soil. (Fifty times its own weight)

During breeding season the female lays eggs in dung. The larvae grow by eating dung. They play remarkable role in agriculture. By burying and consuming dung they improve nutrient recycling and soil structure. They also protect the live stock, such as cattle, by removing the dung which, if left could provide habitat for pests/such as flies.

Many countries introduced dung beetle in their country for the benefit of animal husbandry. In Northern Thailand, it is taken as food. Chinese use dried beetles in medicine. The Dung beetles help in reducing green house gas emission from agricultural sector. In Ancient Egypt it is worshipped.

They are found on every continent except Antarctica. These live in habitat that range from forests to deserts. Most prefer the dung of Herbivores. Some eat excreta of omnivores.

They help new trees to grow for us. The seeds which the animals eat pan out undigested. The seeds are buried along with dung. Soon a new tree sprouts.

On a busy might the Dung beetle can bury 250 times its own weight of dung.

The plastic nightmare?

Plastic with its exclusive qualities of being light yet strong and economical has invaded every aspect of our day-to-day life. It has many advantages: it is durable, light, and easy to mould, and can be adapted to different user requirements. Once hailed

as a 'wonder material', plastic is now a serious worldwide environmental and health concern, essentially due to its non-biodegradable nature.

In India, the plastic industry is growing phenomenally. Plastics have use in all sectors of the economy – infrastructure, construction, agriculture, consumer goods, telecommunications, and packaging. But the good news is that along with a growth in the use, a country-wide network for collection of plastic waste through rag pickers, waste collectors and waste dealers and recycling enterprises has sprung all over the country over the last decade or so. More than 50% of the plastic waste generated in the country is recycled and used in the manufacture of various plastic products.

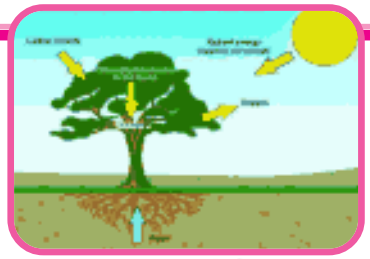
Conventional plastics have been associated with reproductive problems in both wildlife and humans. Studies have shown a decline in human sperm count and quality, genital abnormalities and a rise in the incidence of breast cancer. Dioxin a highly carcinogenic and toxic by-product of the manufacturing process of plastics is one of the chemicals believed to be passed on through breast milk to the nursing infant. Burning of plastics, especially PVC releases this dioxin and also furan into the atmosphere. Thus, conventional plastics, right from their manufacture to their disposal are a major problem to the environment.

Plastics are so versatile in use that their impact on the environment are extremely wide ranging. Careless disposal of plastic bags chokes drains, blocks the porosity of the soil and causes problems for groundwater recharge. Plastic disturbs the soil microbe activity, and once ingested, can kill animals. Plastic bags can also contaminate foodstuffs due to leaching of toxic dyes and transfer of pathogens. In fact, a major portion of the plastic bags i.e. approximately 60-80% of the plastic waste generated in India is collected and segregated to be recycled. The rest remains strewn on the ground, littered around in open drains, or in unmanaged garbage dumps. Though only a small percentage lies strewn, it is this portion that is of concern as it causes extensive damage to the environment.

The plastic industry in the developed world has realized the need of environmentally acceptable modes for recycling plastics wastes and has set out targets and missions. Prominent among such missions are the Plastic Waste Management Institute in Japan, the European Centre for Plastics in Environment, the Plastic Waste Management Task Force in Malaysia. Manufacturers, civic authorities, environmentalists and the public have begun to acknowledge the need for plastics to conform to certain guidelines/standards and code of conduct for its use. Designing eco-friendly, biodegradable plastics are the need of the hour. Though partially biodegradable plastics have been developed and used, completely biodegradable plastics based on renewable starch rather than petrochemicals have only recently been developed and are in the early stages of commercialization.

Chapter 11

Bio geo chemical cycles



We have learnt about environmental pollution and ecosystem in the previous chapter. Living things within an ecosystem interact with each other and also with their non-living environment to form an ecological unit that is largely self-contained. Sometimes this renewal process is gradual and gentle. Sometimes it is violent and destructive. Nevertheless, ecosystems contain resources within themselves which can regenerate.

There is usually a physical state, chemical form, and location in the cycle in which nature stores the bulk of the various chemical elements. Pollution occurs when the cycle is sufficiently disturbed either by accumulation of any element at some point in the cycle in inappropriate physical state or chemical form or amount disrupting environmental balance.

Thus, this is important to understand how nature is maintaining itself and what are the impacts of human activities on this self contained ecological unit. To understand these, we would need to know atleast some of the cycles of nature in which nutrients are exchanged and passed on from one level to the other as well as from one state to the other. The cycles that involve the flow of nutrients in on earth (elements essential for the living cell) from environment to organisms and back through certain pathways are known as biogeochemical cycles.

Biogeochemical cycles

A constant interaction, between the biotic and abiotic components of the biosphere, makes it a dynamic, but stable system. These interactions consist of transfer of matter and energy between the different components of the biosphere. Biogeochemical pathways determine the path of transfer of matter on earth. Let us look at some of the major biogeochemical cycles.

Biogeochemical cycles as we may see from the name itself includes both biological , geological and chemical or physicochemical pathways. This means the reservoir or pool of nutrients on earth may contain some chemicals of biological origin while others may be purely inorganic in nature also may be geochemical (obtained from rocks and soil) in origin.

Water though not considered as a biogeochemical cycle by most ecologists actually is the precursor of the major elements hydrogen and oxygen as some living organisms use them for making the basic food molecules for several organisms in nature.

Water is also a universal solvent and essential for various reations to take place within a living cell. Thus we shall also take up water cycle briefly in this chapter. Though the nutrient pool involves several elements of nature but, we shall study just the cycling of some major elements like oxygen, nitrogen and carbon.

The water cycle

All of the water that is on the earth has always been here. Earth never gets water added to it nor does water disappear from the earth. Water is constantly recycled in a process known as the hydrological or water cycle.

Fresh water is more scarce than you might think.Nearly 97% of all the water on the earth is in the oceans, and so only about 3% is fresh water. About 2% of this fresh water is permanently frozen in glaciers and at the polar ice caps.

Thus only about 1% is available fresh water. Again about 1/4 of this 1% is present as groundwater. Only about 0.009% of water on earth is in the rivers and lakes. Rest is present in the bodies of living organisms, as soil moisture, as humidity of atmosphere etc. Water is the most essential, abundant substance in living things.

The human body for example, is composed of about 70% water (remember all living organisms together constitute only 0.005% of water on earth). Water participates in many biochemical mechanisms, including photosynthesis, digestion and cellular respiration. It is also the habitat for many species of plants, animals and microorganisms, and it participates in the cycling of the materials used by living things. So, it is important that we protect our water resources.

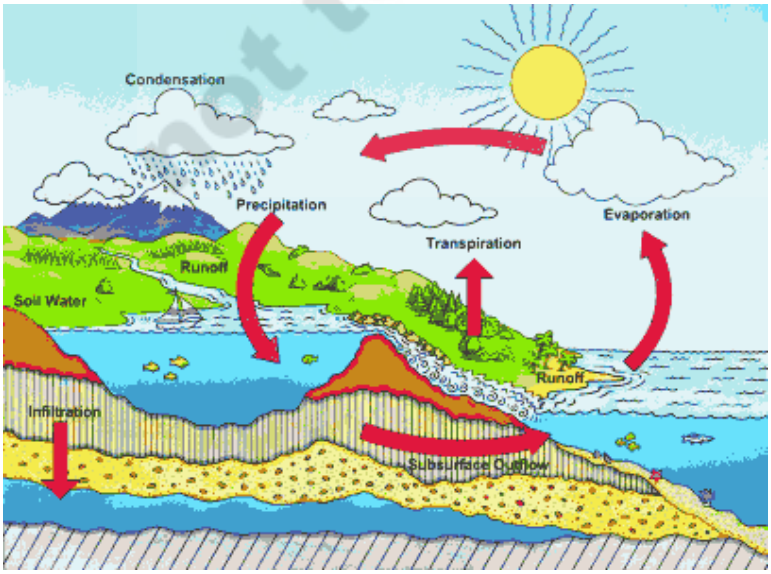


Fig-1 Water cycle

You have seen how water evaporates from the water bodies in the form of water vapour and the subsequent condensation of this water vapour leads to rain.

The whole process in which water evaporates and falls back on the surface of the earth as rain and other forms of precipitation including its flow from land into the sea/

oceans via several routes like rivers, ground water channels etc is known as the water-cycle.

This cycle is not as straight-forward and simple as this statement seems to imply. All of the water that falls on the land does not immediately flow back into the sea. Some of it seeps into the soil and becomes part of the underground reservoir of fresh-water.

Some of this underground water finds its way to the surface through springs. Or we bring it to the surface for our use through wells or tube wells. Water is also used by terrestrial animals and plants for various life-processes. Water provides hydrogen and oxygen that form integral part of basic organic compounds of life.

Let us look at another aspect of what happens to water during the water-cycle. As you know, water is capable of dissolving a large number of substances. Thus, it cleans the environment as it rains and water soluble pollutants are transported to different water bodies like lakes and oceans.

This dilutes the intensity of pollutants Also, as water flows through or over rocks containing soluble minerals, some of them get dissolved in the water. Thus rivers carry many nutrients from the land to the sea, and some of these are used by the marine organisms and rest of these get deposited which takes a longer time to cycle completely through the system.

On the other hand, it creates troubles as well. Dissolution of some harmful substances, like gases like SO_2 and oxides of nitrogen in rain water leads to 'acid rain'.

The nitrogen cycle

Nitrogen is both the most abundant element in the atmosphere and, a building block of proteins and nucleic acids. The nitrogen cycle is a complex biogeochemical cycle in which nitrogen is converted from its inert atmospheric molecular form (N_2) into a form that is useful in biological processes.

The element Nitrogen is constantly moving in a giant circle from the air, through the soil, into the bodies of plants and animals, and eventually back to the air by the process of nitrogen cycle. All living things need nitrogen mainly for growth, repair and development (nitrogen being essential for protein formation). Even though the earth's atmosphere is made up of 78% nitrogen, plants and animals cannot use it in this form.

The atmospheric nitrogen is thus converted into certain compounds that plants may take up from the soil by some biochemical (caused by certain bacteria like Rhizobium, Nitrosomonas etc) and physicochemical (caused by lightning) processes. Animals get the required amount of nitrogen from plants either directly (herbivores) or indirectly (carnivores).

The nitrogen cycle contains several stages:

1. Nitrogen fixation

Atmospheric nitrogen occurs primarily in inert form (N_2) or non reactive form that few organisms can use; therefore it must

be converted into a compound - or fixed - form in a process called nitrogen fixation. Most atmospheric nitrogen is 'fixed' through biological processes. A number of bacteria and blue green algae are known to be able to fix atmospheric nitrogen into compounds in their own body. These may be symbiotic (Rhizobium) or freeliving (Nitrosomonas) respectively. These organisms convert atmospheric nitrogen into the organic nitrogen for their own cells. As they die rapidly(they grow rapidly as well), this nitrogen, now present in the soil as compounds become available to plants. In leguminous plants like pea, beans etc there is a symbiotic relationship of the nitrogen fixing bacteria with the plant, thus nitrogenenous compounds are added to the soil after a leguminous crop is grown.

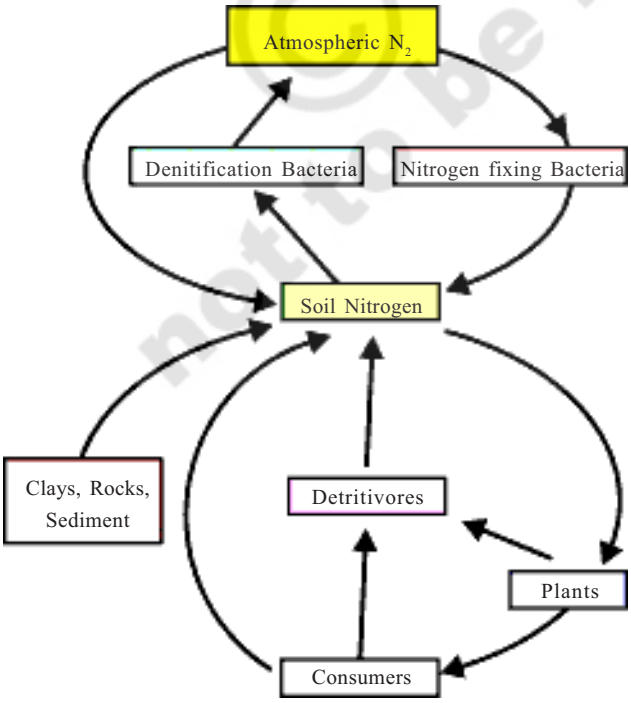


Fig-2 Nitrogen fixation

Nitrogen can also be fixed as nitrates by lightning. This reaches soil and water through precipitation that follows. Nitrates are taken up by plants to form proteins and nucleic acids.

2. Nitrification

Nitrates can also be converted to ammonia by the denitrifying bacteria in the soil (especially in waterlogged soils). The nitrifying bacteria may then use this ammonia to synthesize compounds for their own cell and eventually convert to proteins, nucleic acids, nitrites and nitrates. Nitrites are produced mainly by Nitrosomonas, while nitrates by Nitrobacters that are also capable of utilizing nitrites and converting them to nitrates. Death of these microorganisms add the nitrogenous compounds to the soil. Plants take up nitrate as well as ammonium ions from the soil to convert them to proteins and nucleic acids.

Nitrification can thus be summarized as:

Nitrates
↓ Denitrifying Bacteria
Ammonia
↓ Nitrosomonas
Nitrite
↓ Nitrobacter
Nitrate
↓
Plants

3. Assimilation

Nitrogen compounds mainly as nitrates or ammonium ions(NH_4^+) are taken up from soils by plants which are then used in

the formation of plant proteins and as animals eat these plants, animal proteins are synthesised.

4.Ammonification

Production of ammonia (NH_3) from nitrates and other nitrogenous compounds in called ammonification.

- Describe a path of ammonification discussed in the above section.

Ammonification also occurs when plants and animals die, or when animals emit wastes, the nitrogen in the organi c matter reenters the soil and water bodies where it is broken down by other microorganisms, known as decomposers. This decomposition produces ammonia which is then available for other biological processes.

Note: Processes 2-4 also contribute to nitrogen fixation.

5.Denitrification

Nitrogen makes its way back into the atmosphere through a process called denitrification, in which solid nitrate (NO_3) is converted back to gaseous nitrogen (N_2). Denitrification occurs primarily in wet soils where water makes it difficult for microorganisms to get oxygen. Under these conditions, certain organisms - known as denitrifiying bacteria - will process nitrate to gain oxygen, leaving free nitrogen gas as a byproduct.

Thus, the nitrogen content of the earth and its atmosphere remains in a perfect balance.

Human intervention and nitrogen cycle

Unfortunately, humans are interfering with the natural balance when they overuse artificially produced nitrates as agricultural fertilizers that are often washed into water bodies by rain as well as by releasing exponential amounts of untreated domestic sewage into water bodies. Before these nitrates can be converted into atmospheric nitrogen, they are often carried off by rain or irrigation to streams and rivers and even seep down to groundwater.

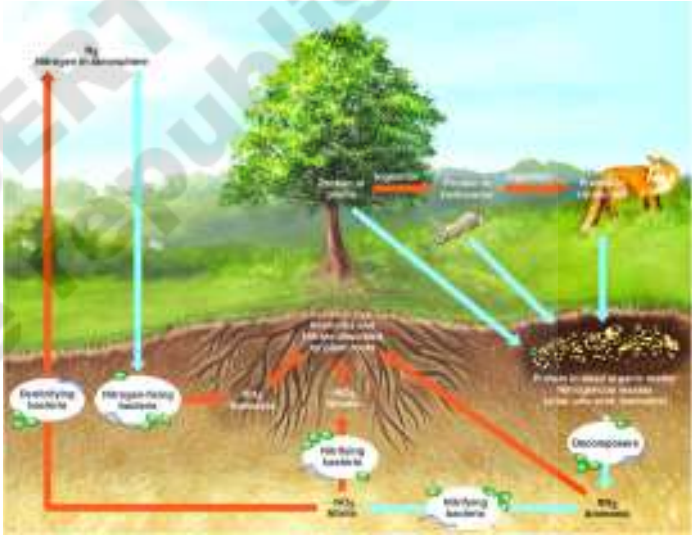


Fig-3

In some parts of the world, water for humans and animals contains such high concentrations of nitrates that it is unsafe for consumption. These excessive amount of nitrates and other nitrogenous compounds, when they reach rivers and lakes, cause too much algal growth. This over-abundance of algae uses up too much of the oxygen in the water. When oxygen level falls, other forms of life in the water bodies die off.

These were just a few examples of human intervention.

The carbon cycle

Carbon is found in various forms on the Earth. It occurs in the elemental form as say soot, diamond and graphite. In the combined state, it is found as gases, carbon dioxide and carbon monoxide in the atmosphere, as carbonate and hydrogen carbonate salts in various minerals, while all life-forms are composed of carbon containing molecules like proteins, carbohydrates, fats, nucleic acids and vitamins. The endoskeletons and exoskeletons of various animals are also formed from carbonate salts.

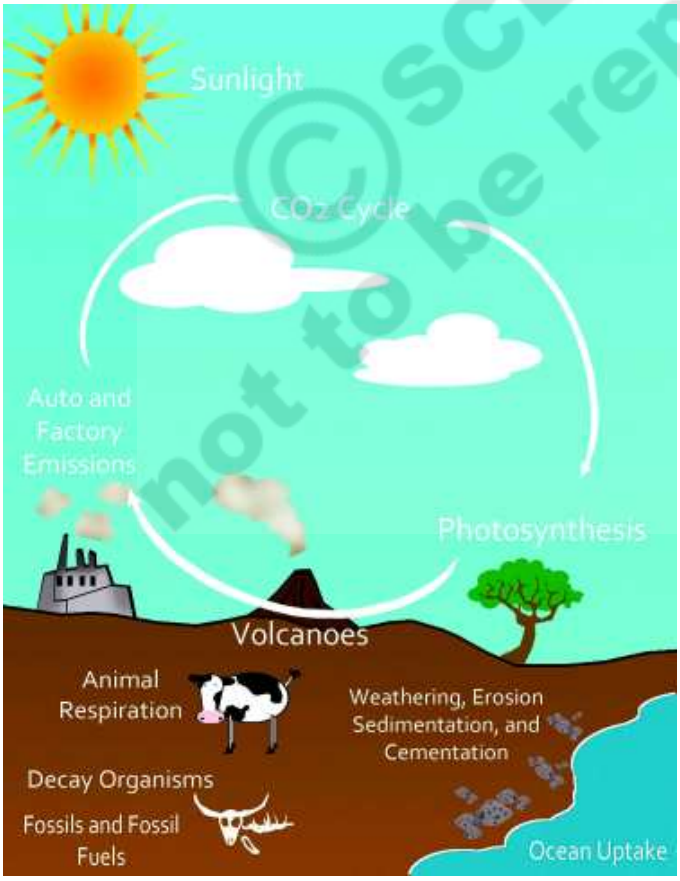


Fig-4 Carban cycle

Carbon dioxide is also responsible for maintaining the Earth as a greenhouse with temperature conditions suitable for life. Thus, carbon exists in the biosphere as the central element of life. Carbon Dioxide or CO_2, now makes up about 0.04% by volume of air.

Have you ever thought how this level of carbon is being maintained in the nature?

Carbon is incorporated into life through various processes. The main reservoirs of carbon are sedimentary rocks, fossilized organic carbon including the fossil fuels, the oceans, and the biosphere.

Photosynthesis

The first step in the biological carbon cycle is the conversion of inorganic atmospheric carbon into a biological form. This 'fixing' of carbon in biological form takes place within plants and other organisms - known as producers - in a process called photosynthesis, by which energy from sunlight is converted into chemical form.

In photosynthesis, light energy helps to combine carbon dioxide and water to create the simplest of sugars, the carbohydrate molecules known as glucose ($C_6H_{12}O_6$). In oceans, photosynthesis is carried out by microscopic aquatic plants called phytoplankton. The carbohydrates then become the source of chemical energy that fuel living cells in all plants and animals. In plants, some carbon remains as simple glucose for

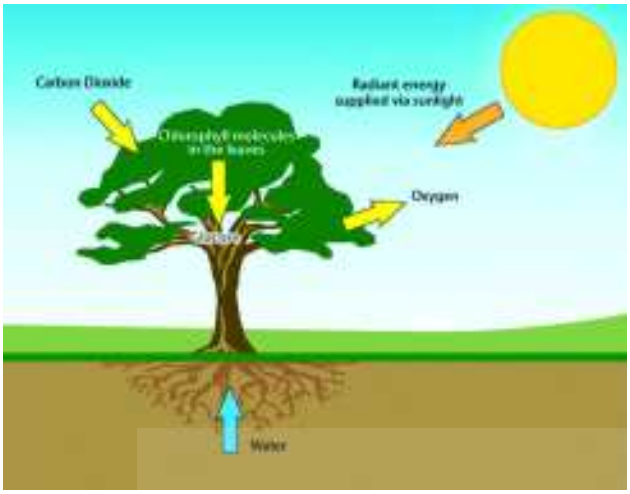


Fig-5

short-term energy use, while some are converted to large complex molecules such as starch for longer term energy storage.

Cycling and storage

The movement of carbondioxide takes place from the atmospheric reservoir of carbon dioxide directly as such to producers mainly the green plants, to consumers and from both of these groups to the microbial decomposer organisms. Fossil fuels, carbonate rocks and carbondioxide dissolved in the oceans are major additional reservoirs of carbon.

The first two of these additional reservoir are not directly available to plants for fixation. CO_2 from these resources becomes available when either fossil fuels are burnt or insoluble carbonates are converted to soluble bicarbonates. The return of carbondioxide to the atmospheric reservoir is accomplished in many ways.

Mainly through respiratory processes wherein food molecules are broken down for energy and CO_2 gas and other byproducts are emitted. Combustion of fossil fuels and other carbon containing substances, forest fires, volcanic emissions etc. also return carbondioxide to the atmospheric reservoir.

Other pathways are like- When a plant dies, it is broken down by microorganisms - called decomposers - that feed on the dead organic matter. As the microorganisms consume the plant matter, they release some of the plant's carbon into the atmosphere in the form of CO_2, although some is destined for longer-term storage in trunks and branches of trees and in the bodies of plant-eating animals or carnivorous animals that eat plant-eating animals.

Animals return more of the carbon to the atmosphere as CO_2 through respiration as we already know, although some will be stored within their bodies until they die and decompose in the soil. Carbon in the form of several compounds will remain stored in the soil as organic matter for example the fossil fuels that we use.

Carbon cycle and human intervention

Carbon buried under the ocean floor might take millions of years to return to the atmosphere, if it does at all. Throughout the Earth's history, the emission of CO_2 (and many other gases) from deep below the planet's surface happens as geological events, such as volcanic eruptions. A large part of the atmospheric carbon dioxide that we have today was

contributed by such geological events of the past.

Human beings tap into the geological carbon cycle by extracting oil and coal, which are both hydrocarbons(formed of carbon and hydrogen), for use in automobiles and power plants. A by product of combustion of these hydrocarbons is CO_2 and CO gases. Since the Industrial Revolution began, carbon dioxide levels in the atmosphere have increased measurably, mostly as a result of human use of fossil fuels.

Humans have also altered the biological carbon cycle, increasing atmospheric CO_2 levels, through forest clearing and land use. Trees store large amounts of carbon; when they die and decompose, much of this stored carbon is released as CO_2.

However, when humans clear large Places of forest, primarily through the use of fire, the levels of atmospheric carbon are affected in two ways. First, during combustion, stored carbon is released directly into the air as CO_2, and second, the clearing of land takes away a key mechanism for removing excess carbon dioxide from the atmosphere (via photosynthesis).

Since carbon dioxide is a primary greenhouse gas, the increase in atmospheric CO_2 due to human activities has resulted in an enhanced greenhouse effect resulting in higher global temperatures.

The green house effect

A greenhouse is a small house made of glass that is used to grow plants. It traps the sun's rays and keeps the heat from escaping. It is warm inside. In the same way that the glass traps heat in a greenhouse, some gases present in the atmosphere such as carbon dioxide, carbon monoxide, methane and water vapour trap heat from radiating back to the space. The natural greenhouse gases act like a big blanket around the earth, keeping it warm and

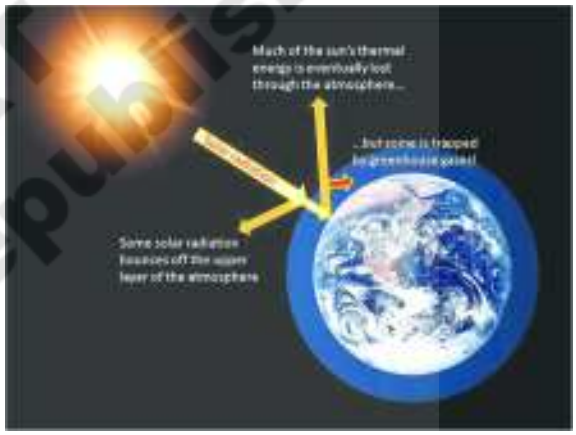


Fig-6 Green house effect

making life possible without which temperatures would have fallen to sub zero values.This phenomenon of naturally warming up is called "Greenhouse effect".

But the extent of this natural warming up process have been grossly affected now. Due to various human activities like burning of fossil fuels, deforestation and industrialization, an excessive amount of carbon dioxide and other green house gases has been emitted to the environment. As a result more heat gets trapped. This causes the temperature of the earth to rise, which results in Global Warming. Global

Fig-7 Green house gases

Warming is the recorded increase in the average temperatures of the earth's atmosphere and oceans. Global Warming affects the weather patterns on Earth and causes Climate Change. Climate change results in higher sea levels, more rainfall and severe droughts and floods.

What effect does climate change have on humans and animals? Discuss and write in your note book.

Lab Activity

Aim: Test the effect of a greenhouse on temperature

Materials required: Plastic bottle, nail, 2 thermometers, notebook and pencil.

Procedure: Make a hole near the top of the plastic bottle with the nail. Insert the first thermometer into the hole. Place the second thermometer next to the bottle. Make sure that the same amount of sunlight reaches both thermometers. After 10 minutes, note temperature values from both thermometers. Record the data in the notebook. Take the temperature records again after another 10 minutes and repeat it for 2-3 times more.

Now, answer the following questions:

Do both thermometers record the same temperature? If no, which one is higher?

Can you explain why these two temperature records are not the same?

Oxygen cycle

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

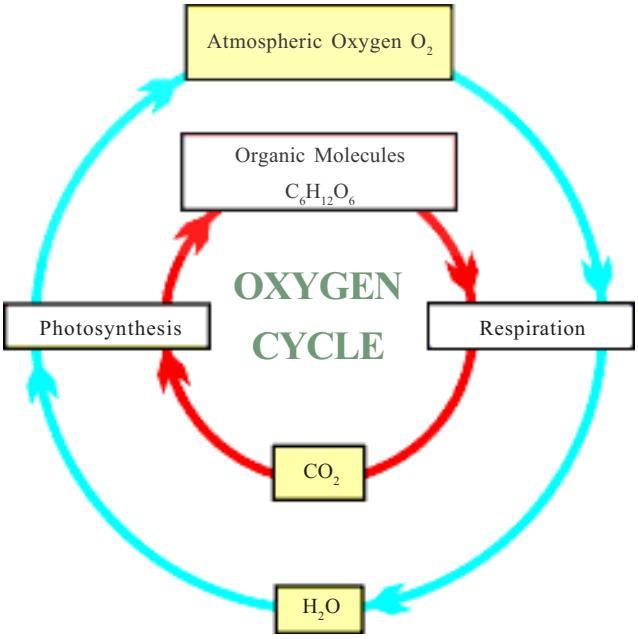


Fig-8 Oxygen cycle

Do you Know?

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

Oxygen is vital for life in many ways. Respiration utilizes oxygen releasing carbon dioxide to atmospheric pool maintaining a balance in nature. Dissolved oxygen supports aquatic life. Oxygen dissolves in water on the basis of different conditions. High temperatures do not support the process while a lot of turbulence in water usually at the surface helps greater amount of oxygen to dissolve.

Oxygen is needed for the decomposition of organic waste. Wastes from living organisms are "biodegradable" because there are aerobic bacteria that convert organic waste materials into stable inorganic materials. If enough oxygen is not available for these bacteria, for example, because of enormous quantities of wastes, they die and anaerobic bacteria that do not need oxygen take over. These bacteria change waste material into H_2S and other poisonous and foul-smelling substances.

The content of biodegradable substances in water is expressed by a special index called "biological oxygen demand" (BOD), representing the amount of oxygen needed by aerobic bacteria to decompose the waste. As the wastes get degraded and the dissolved oxygen is used up proportionately, the need or demand for oxygen increases i.e. the BOD increases. Thus BOD is a good indirect indicator for amount of biodegradable waste.

The cycle and storage

Oxygen from the atmosphere is used up mainly by the processes, combustion, respiration and in the formation of oxides of elements like nitrogen, iron etc. Oxygen is returned to the atmosphere in only one major process, that is, photosynthesis.

Ozone layer

The Earth's atmosphere is divided into several layers. The lowest region, the troposphere, extends from the Earth's surface up to about 10 kilometers (km) in altitude. Virtually all human activities occur in the troposphere. Mt. Everest, the tallest mountain on the planet, is only about 9 km

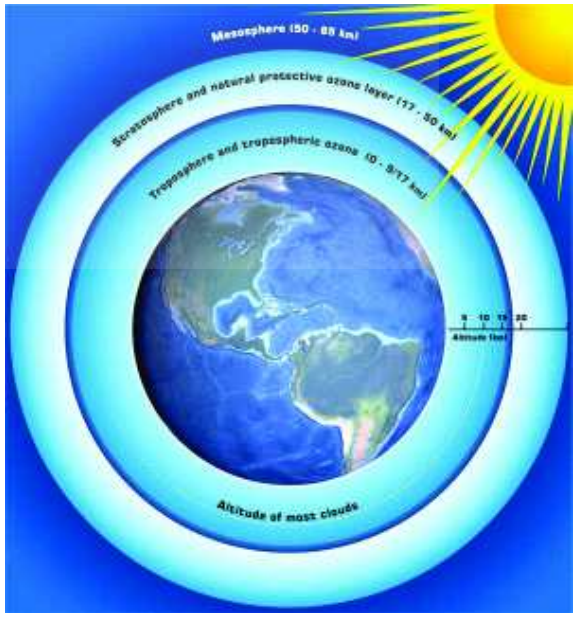


Fig-9 Ozone layer

high. The next layer, the stratosphere, continues from 10 km to about 50 km. Most commercial airline traffic occurs in the lower part of the stratosphere. most atmospheric ozone is concentrated in a layer in the stratosphere, about 15-30 kilometers above the Earth's surface. Ozone is a molecule containing three oxygen atoms. It is blue in color and has a strong odor.

Normal oxygen, which we breathe, has two oxygen atoms and is colorless and odorless. Ozone is much less common than normal oxygen. Out of each 10 million air molecules, about 2 million are normal oxygen, but only 3 out of 10 millions are ozone.

However, even the small amount of ozone plays a key role in the atmosphere. The ozone layer absorbs a portion of the radiation from the sun, preventing it from reaching the planet's surface.

Most important of all it absorbs the portion of ultraviolet light which causes many harmful effects, including various types of skin cancer and harm to some crops, certain materials, and some forms of marine life.

At any given time, ozone molecules constantly get formed and destroyed in the stratosphere. The total amount, however, remains relatively constant.

Ozone depletion

Certain industrial processes and consumer products result in the emission of ozone-depleting substances to the atmosphere. These gases bring chlorine and

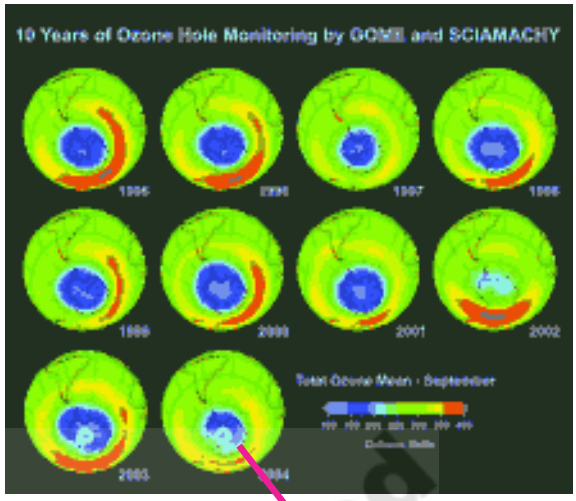
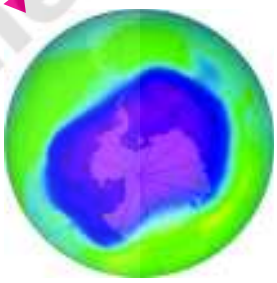


Fig-10 Ozone depletion



fluorine atoms to the stratosphere, where they destroy ozone in chemical reactions. Important examples are the chlorofluorocarbons (CFCs), used in almost all refrigeration and air conditioning systems. Most of these gases accumulate in the lower atmosphere because they are unreactive and do not dissolve readily in rain or snow. Natural air motions transport these accumulated gases to the stratosphere, where they are converted to more reactive gases. Some of these gases then participate in reactions that destroy ozone. The ozone hole is not really a hole, but it was observed that there is less ozone in Antarctica than in the arctic region.

Montreal protocol

The discovery of an ozone hole over Antarctica prompted action to control the use of gases which have a destructive effect on the *ozone layer*. From this concern emerged the Montreal Protocol on

substances that deplete the ozone layer, signed by 24 countries in 1987. It came into force in 1989 and has since been ratified by 120 countries. The original agreement was to control and phase out the production and supply of ozone depleting chemicals, specifically CFCs (*chlorofluorocarbons*) and their derivatives. A meeting in 1992 was held in Copenhagen to revise the Protocol. This meeting agreed to bring forward the phase out of *halons* to 1994, and CFCs and other *halocarbons* to 1996. These targets have since been met.

Key words

Water Cycle or hydrologic Cycle, Nitrogen Cycle, Nitrogen Fixation, Nitrification, Assimilation, Ammonification, Denitrification, Carbon Cycle, Greenhouse Effect, Global warming, Oxygen Cycle, Ozone Depletion.

What we have learnt?

- Representations of biological, geological and chemical processes that involve the movement of an element or compound about the surface of the earth are collectively known as 'Biogeochemical cycles'.
- Living things within an ecosystem interact with each other and also with their non-living environment to form an ecological unit that is largely self-contained.
- Ecosystems contain within themselves the resources to regenerate themselves and there is usually a physical state, chemical form and location in the cycle in which nature stores the bulk of various chemical elements.
- Biogeochemical cycles are complex in nature and consist of pools of several elements (like carbon, oxygen, nitrogen, phosphorous, calcium, potassium, sodium, iron etc) essential for life that circulate through living systems and are replenished in the pool. They include a variety of biological, geological and chemical processes.
- Water, oxygen, carbon and nitrogen are the key elements for life and are continuously recycled in the nature.
- Denitrification is the conversion, principally by bacteria, of compounds of nitrogen in soil and aquatic systems to the gases, nitrogen (N_2) and nitrous oxide (N_2O) and eventual release of these into the atmosphere.

- Biological oxygen demand is an indicator of amount of biodegradable waste in an ecosystem.
- The warming of the Earth's atmosphere and surface by the atmospheric greenhouse gases such as Carbon dioxide, methane and water vapors is called 'greenhouse effect'.
- Nitrification is the process of the conversion of ammonium to nitrite and nitrate by bacteria.
- Nitrogen fixation is the conversion of atmospheric nitrogen gas into ammonium and nitrates. Fixation may take place due to lightning and bacteria (into nitrates and into ammonium ions)
- A substance that supplies nutrition to a living organism, like carbohydrates, fats, proteins, vitamins, salts, iron, calcium, phosphorus etc are called nutrients.

Improve your learning

1. What is the importance of different biogeochemical cycles in the nature? (AS1)
2. What do you understand by Ozone layer? Write an essay to participate in elecution compitation on importance of ozone layer. (AS 6)
3. What emissions from human activities lead to ozone depletion? And what are the principal steps in stratospheric ozone depletion caused by human activities? (AS1)
4. Why could we say that biogeochemical cycles are in "balance"? (AS1)
5. What role does carbon dioxide play in plant life processes? (AS 7)
6. If all the vegetation in the pond died, what effects would it have on the animals? Why? (AS 2)
7. Burning of fossil fuels a concern for scientists and environmentalists, why? (AS 6)
8. How human activities caused an imbalance in biogeochemical cycles? (AS 7)
9. List three ways we, as humans, have affected the water cycle.(AS 7)
10. Describe interdependence of biotic and abiotic components by taking Nitrogen cycle as an example.Draw Nitrogen Cycle. (AS 5)
11. Go to a nearby pond observe organisms living in the pond and bio degradable substances mixing in water. How they effect on those organisms? write your observation.(AS4)
12. Prepare slogans on Green house Effect to announce in your school assembly (AS 7)