

*"Earth and sky, woods and fields, lakes and rivers, the mountain and the sea, are excellent schoolmasters, and teach some of us more than we can ever learn from books."*  
.....John Lubbock



State Council of Educational Research and Training  
Telangana, Hyderabad

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BIOLOGY

CLASS 9

# BIOLOGY

FREE

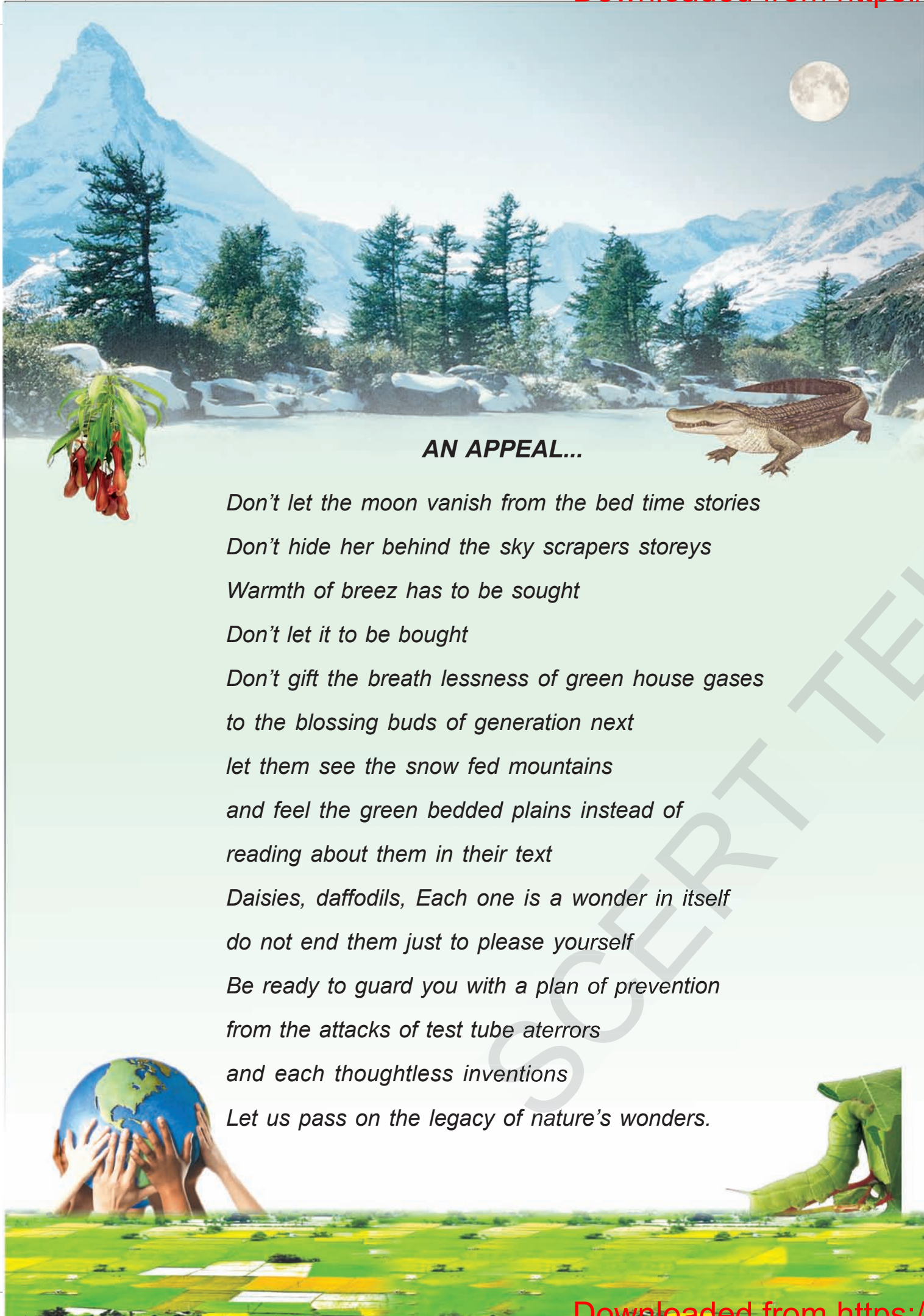
CLASS 9



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### AN APPEAL...

*Don't let the moon vanish from the bed time stories  
 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  
 Let us pass on the legacy of nature's wonders.*

### INSPIRE AWARDS

Inspire is a National level programme to strengthen the roots of our traditional and technological development. The major aims of Innovations in Science Pursuit for Inspired Research (INSPIRE) programme are...



- Attract intelligent students towards sciences
- Identifying intelligent students and encourage them to study science from early age
- Develop complex human resources to promote scientific, technological development and research

Inspire is a competitive examination. It is an innovative programme to make younger generation learn science interestingly. In 11<sup>th</sup> five year plan nearly Ten Lakhs of students were selected during 12<sup>th</sup> five year plan (2012-17) Twenty Lakhs of students will be selected under this programme.

Two students from each high school (One student from 6 - 8 classes and one from 9 - 10 classes) and one student from each upper primary school are selected for this award.

Each selected student is awarded with Rs. 5000/-. One should utilize 50% of amount for making project or model remaining for display at district level Inspire programme. Selected students will be sent to State level as well as National level.

Participate in Inspire programme - Develop our country.

Government of Telangana  
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When abused in or out of school. →

When the children are denied school and compelled to work. →

CHILD LINE 1098 NIGHT & DAY 24 HOUR NATIONAL HELPLINE

← To save the children from dangers and problems.

← When the family members or relatives misbehave.

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# BIOLOGY

## CLASS IX

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## Intro ...

Nature is the life source for all the living organisms. Rocks, water, hills and valleys, trees, animals etc. embedded in it... each of them are unique by themselves. Everything has its own prominence. Man is only part of nature.

The aspect which distinguishes man from nature and exclusive for himself is thinking power. Thinking transforms man as a unique power from rest of the nature. Though it, usually, appears simple and normal, the very nature often challenges us to untie the tough knots of its hidden secrets day in and day out.

Man intuitively contemplates and searches solutions for all the challenges forever. Curiously, the questions and answers are concealed in the nature itself. The role of science, in fact, is to find them out. For this sake, some questions, some more thoughts, and some other investigations are quite necessary.

Scientific study is to move on systematically in different ways, until finding concrete solutions. The essence of investigations lies in inquiring *i.e.* identifying questions, asking them and thus deriving adequate answers. That is why, Galileo said that scientific learning is nothing but improving the ability of questioning.

The classroom teaching of science must be in such a way that it encourages children to think and work scientifically. Also, it must enhance love towards nature. Even it should enable to comprehend and appreciate the laws governing the nature in constructing so much diversity all around. Scientific learning is not just disclosing new things.

It is also necessary to step forward without interrupting the interrelationship and interdependency along with understanding of the nature's intrinsic principles. High School children possess cognitive capacity of comprehending the nature and characteristics of the transforming world surrounding them. And they are able to analyze abstract concepts.

At this level, we cannot quench their sharp thinking capability with the dryteaching of mere equations and theoretic principles. For that, we should create a learning environment in the classroom which provides an opportunity for them to apply the scientific knowledge, explore multiple alternatives in solving problems and establish new relations.



Scientific learning is not just confined to the four walls of classroom. It has a definite connection to lab and field as well. Therefore, there is a lot of importance to field experience/ experiments in science teaching.

There is a great need for compulsory implementation of instructions of the National Curriculum Framework- 2005 which emphasizes linking of the science teaching with local environment. The Right to Education Act- 2009 also suggested that priority should be given to the achievement of learning competencies among children. Likewise, science teaching should be in such a way that it would help cultivate a new generation with scientific thinking.

The key aspect of science teaching is to make the children understand the thinking process of scientists and their efforts behind each discovery. The State Curriculum Framework- 2011 stated that children should be able to express their own ideas and opinions on various aspects. These Science Text Books are prepared to meet the set standards of the SCF and thus assist children in becoming self-reliant researchers capable of thinking intensely in scientific terms.

New textbooks are developed to achieve desired academic standards. So teachers should develop various teaching learning strategies to make their students to achieve class based academic standards. We should avoid rote learning methods for successful implementation of Continuous Comprehensive Evaluation (CCE). It is very important to know more about different methods to assess student progress by summative and formative evaluation. New textbooks reflect Continuous Comprehensive Evaluation and teaching method with respect of discussed concepts. This is more useful to teachers and students.

We thank the VidyaBhavan Society, Rajasthan for their cooperation in designing these new text books, the writers for preparing the lessons, the editors for checking the textual matters and the DTP group for cutely composing the text book.

Teachers play a pivotal role in children's comprehensive use of the text book. We hope, teachers will exert their consistent efforts in proper utilization of the text book so as to inculcate scientific thinking process and inspire scientific approach in the children.

**Director,  
SCERT, Hyderabad**





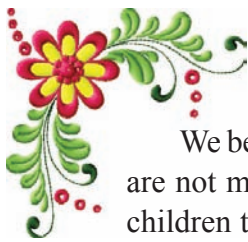


## Dear teachers...

New Science Text Books are prepared in such a way that they develop children's observation power and research enthusiasm. It is a primary duty of teachers to devise teaching- learning processes which arouse children's natural interest of learning things. The official documents of National & State Curriculum Frameworks and Right to Education Act are aspiring to bring grass root changes in science teaching. These textbooks are adopted in accordance with such an aspiration. Hence, science teachers need to adapt to the new approach in their teaching. In view of this, let us observe certain **Dos and Don'ts**:

- Read the whole text book and analyze each and every concept in it in depth.
- In the text book, at the beginning and ending of an activity, a few questions are given. Teacher need to initiate discussion while dealing with them in the classroom, attempt to derive answers; irrespective of right or wrong responses, and so try to explain concept.
- Develop/Plan activities for children which help understand concepts presented in text.
- Textual concepts are presented in two ways: one as the classroom teaching and the other as the laboratory performance.
- Lab activities are part and parcel of a lesson. So, teachers must make the children conduct all such activities during the lesson itself, but not separately.
- Children have to be instructed to follow scientific steps while performing lab activities and relevant reports can be prepared and displayed.
- In the text some special activities as boxed items- 'think and discuss, let us do, conduct interview, prepare report, display in wall magazine, participate in Theatre Day, do field observation, organize special days' are presented. To perform all of them is compulsory.
- 'Ask your teacher, collect information from library or internet' - such items must also be considered as compulsory. (A.S. indicates academic standards in improve your learning.)
- If any concept from any other subject got into this text, the concerned subject teacher has to be invited into the classroom to elucidate it.
- Collect info of relevant website addresses and pass on to students so that they can utilize internet services for learning science.
- Let there be science magazines and science books in the school library.
- Motivate every student to go through each lesson before it is being actually taught and encourage everyone to understand and learn independently, with the help of activities such as Mind Mapping and exciting discussions.
- Plan and execute activities like science club, elocution, drawing, writing poetry on science, making models *etc.* to develop positive attitude among children environment, biodiversity, ecological balance *etc.*
- As a part of continuous comprehensive evaluation, observe and record children's learning abilities during various activities conducted in classroom, laboratory and field.
- Teaching learning strategies and the expected learning outcomes, have been developed class wise and subject-wise based on the syllabus and compiled in the form of a Hand book to guide the teachers and were supplied to all the schools. With the help of this Hand book the teachers are expected to conduct effective teaching learning processes and ensure that all the students attain the expected learning outcomes.





We believe, you must have realized that the learning of science and scientific thinking are not mere drilling of the lessons but, in fact, a valuable exercise in motivating the children to explore solutions to problems all around by themselves systematically and preparing them to meet life challenges properly.

### Dear Students...

Learning science does not mean scoring good marks in the subject. Competencies like thinking logically and working systematically, learned through it, have to be practiced in daily life. To achieve this, instead of memorizing the scientific theories by rote, one must be able to study them analytically. That means, in order to understand the concepts of science, you need to proceed by discussing, describing, conducting experiments to verify, making observations, confirming with your own ideas and drawing conclusions. This text helps you to learn in that way.

What you need to do to achieve such things:

- Thoroughly go through each lesson before the teacher actually deals with it.
- Note down the points you came across so that you can grasp the lesson better.
- Think of the principles in the lesson. Identify the concepts you need to know further, to understand the lesson in depth.
- Do not hesitate to discuss analytically about the questions given under the sub-heading 'Think and Discuss' with your friends or teachers.
- You may get some doubts while conducting an experiment or discussing about a lesson. Express them freely and clearly.
- Plan to implement experiment/lab periods together with teachers, to understand the concepts clearly. While learning through the experiments you may come to know many more things.
- Find out alternatives based on your own thoughts.
- Relate each lesson to daily life situations.
- Observe how each lesson is helpful to conserve nature. Try to do so.
- Work as a group during interviews and field trips. Preparing reports and displaying them is a must.
- List out the observations regarding each lesson to be carried through internet, school library and laboratory.
- Whether in note book or exams, write analytically, expressing your own opinions.
- Read books related to your text book, as many as you can.
- You organize yourself the Science Club programs in your school.
- Observe problems faced by the people in your locality and find out what solutions you can suggest through your science classroom.
- Discuss the things you learned in your science class with farmers, artisans *etc.*

## ACADEMIC STANDARDS

S.No.	Academic Standard	Explanation
1.	Conceptual understanding	Children are able to explain, cite examples, give reasons, and give comparison and differences, explain the process of given concepts in the textbook. Children are able to develop their own brain mappings.
2.	Asking questions and making hypothesis	Children are able to ask questions to understand, to clarify the concepts and to participate in discussions. They are able to make hypothesis on experimental results and given issues.
3.	Experimentation and field investigation.	To understand given concepts in the textbook children are able to do experiments on their own. They are able to arrange the experimental materials, note their observations, collect alternate experimental materials, take precautions, participate in field investigation and making reports on them.
4.	Information skills and Projects	Children are able to collect information (by using interviews, checklist, questionnaire) and analyses systematically. They are able to conduct their own project works.
5.	Communication through drawing, model making	Children are able to explain their conceptual understanding by drawing figures labelling, describe the parts and making models. Able to plotting graphs by using given information or collected data.
6.	Appreciation and aesthetic sense, values	Children are able to appreciate man power and nature, and have aesthetic sense towards nature. They are also able to follow constitutional values.
7.	Application to daily life, concern to bio diversity.	Children are able to utilize scientific concept to face their daily life situations. They are able to show concern towards bio diversity.



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## OUR NATIONAL ANTHEM

- Rabindranath Tagore

*Jana gana mana adhinayaka Jaya he  
Bharatha bhagya-vidhata  
Punjab Sindh Gujaratha Maratha  
Dravida Utkala Banga.*

*Vindhya Himachala Jamuna Ganga  
Uchchala Jaladhi taranga,  
Tava shubha name jage  
Tava shubha asisha mage  
Gahe tava jaya gatha*

*Jana gana mangala-dayaka jaya he,  
Bharatha bhagya –vidhatha,  
Jaya he, jaya he, jaya he,  
Jaya jaya jaya jaya he*

## PLEDGE

- Pydimarri Venkata Subba Rao

“India is my country; all Indians are my brothers and sisters.  
I love my country, and I am proud of its rich and varied heritage.

I shall always strive to be worthy of it.

I shall give my parents, teachers and all elders respect,  
and treat everyone with courtesy. I shall be kind to animals.

To my country and my people, I pledge my devotion.

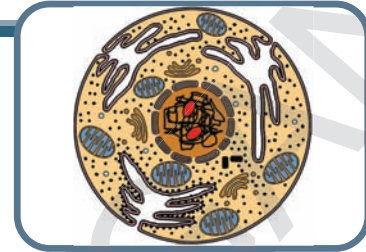
In their well-being and prosperity alone lies my happiness.”



## 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 size and shape, unicellular and multicellular organisms.

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

Onion cells are nearly rectangular while the cheek cells are irregular in shape.

Add other examples as the one given above.

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_

Primarily, cells are studied under the microscope. When we observe the cell under a compound microscope, we can see some parts like cell wall, cytoplasm, nucleus, chloroplast and the mitochondria. However, when the same cells are observed under the electron microscope, a few other structures are also 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

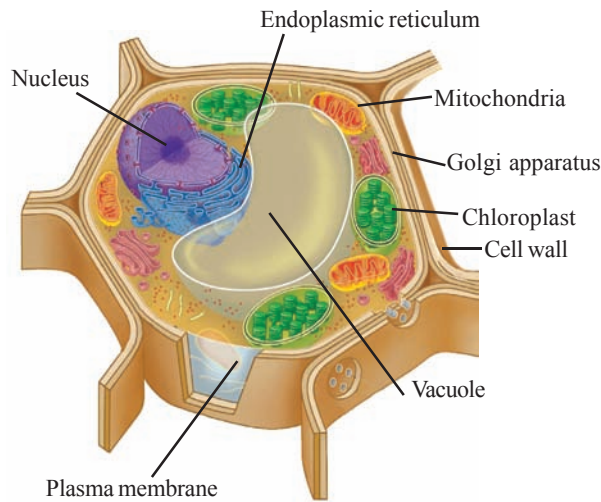
make models of them. These have given valuable information about plant and animal cells. Here we will try to study the model diagram of the cell.

### 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 the plant cells do not have chloroplasts. They are mostly found in the cells of green leaves, tender stems 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. Which cell organelles are found exclusively in plant cell?
3. Compare the parts of plant and animal cells, note down the differences.

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



**Fig-1 Typical Plant 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.

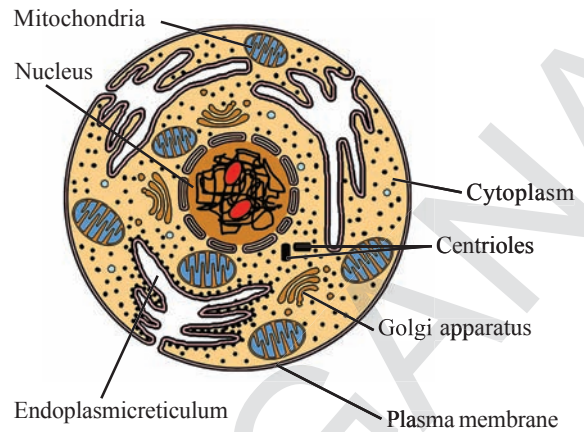
### Activity-1

#### Observing the cell membrane

Take Rheo leaf, tear the leaf in a single stroke. Observe it against the light. Take a small piece of leaf peel 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 Lighter portion of leaf under the microscope.

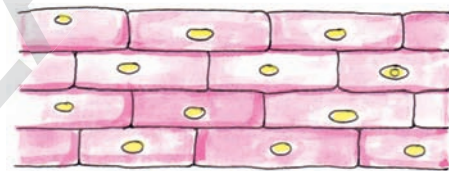
Draw the diagram of what you have seen?

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

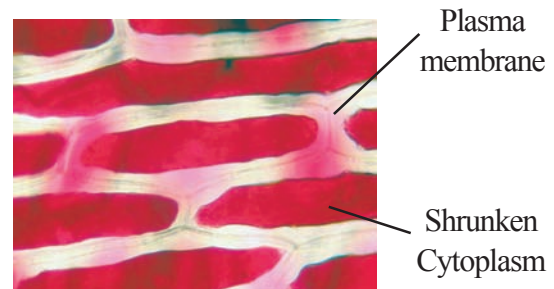


**Fig-2 Typical Animal cell**

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



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



**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 for 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** or plasma 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 various substances which maintain a balance. 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 “Plasma 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 difference between a plant and an animal cells.

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

What are the functions of the cell wall in plant cells?

It exerts an inward wall pressure to resist the outward pressure exerted by the cell sap. Hence, the plant cells can withstand much greater changes of surrounding medium than the 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 scrape a little of the internal lining of your cheek inside your mouth with a clean

tooth pick or spatula or ice-cream spoon.

- Place the scraped material in a watch glass containing a very small quantity of normal saline.
- Then place the material on a glass slide.
- Put a drop of methylene blue and wait for a couple of minutes.
- Put a drop of glycerine over it.
- Place a coverslip. Tap the coverslip with the blunt end of needle so as to spread the cells.
- Wipe off the extra stain with a fine cloth or blotting paper.

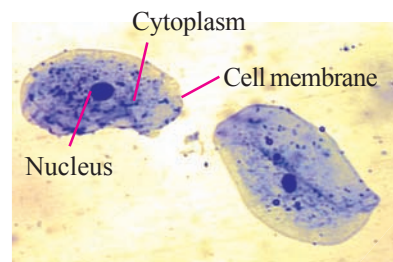
#### Precautions:

- Do not scrape the cheek too hard as it may injure your buccal mucosa.
- Scraped material should be spread uniformly on the slide.
- Excess stains should be drained off.
- There should be no air-bubbles under the cover slip

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

- What is the shape of the cells that you have observed?
- Are these cell structures similar to the structure in onion peel cell?
- Are there any dark 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



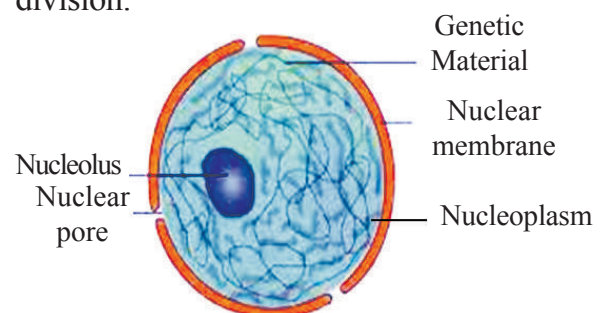
**Fig-4 Nucleus in cheek cells**

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 the 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 as cytoblast.

Barring a few exceptions, almost all eukaryotic cells have a nucleus. Red blood cells in 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 absence of the organised nucleus, cells are categorized into two types, i.e. Prokaryotic cell (without organised nucleus) and Eukaryotic cell (with organised nucleus).

**Prokaryotic Cells** 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 bounded by 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. Except membraneless Ribosomes.

## 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.

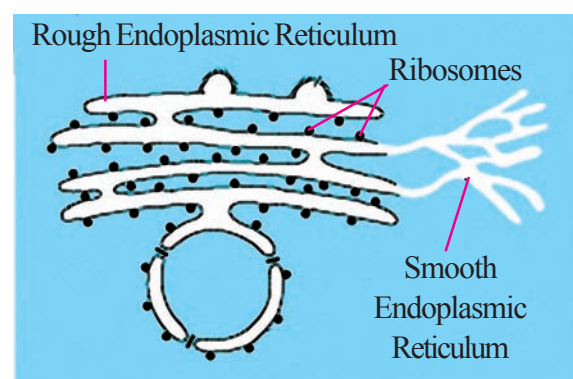
## Cell organelles

Now let us discuss some important cell organelles. 1. Mitochondria, 2. Plastids, 3. Ribosomes, 4. Endoplasmic reticulum, 5. Golgi apparatus, 6. Lysosomes, 7. Vacuoles.

They are important because they carry out very crucial functions in the 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 within the cytoplasm for the transport of



*Fig-6 Endoplasmic Reticulum under microscope*

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

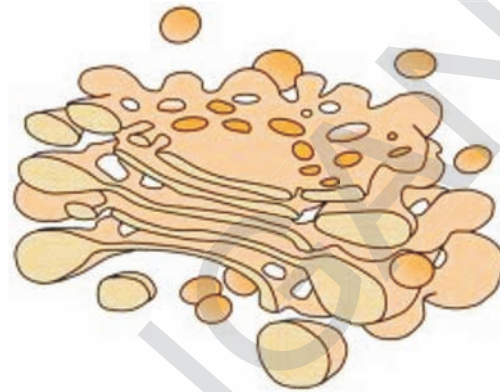
The endoplasmic reticulum (ER) is a large network of membrane-bound tubes and sheets. The ER membrane is similar in structure to the plasma membrane. Endoplasmic reticulum may have some granule like structure on its surface which are called ribosomes, Such ER is called rough endoplasmic reticulum (RER). Areas/sections of ER that do not have ribosomes on them are called smooth endoplasmic reticulum (SER). Rough endoplasmic reticulum is site 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 complex**

Although Camillo Golgi had observed this organelle in the year 1898 using a

compound microscope, its finer structure could be observed only under an electron microscope.



**Fig-7 Golgi Complex**

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 pack 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 number is 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 have the ability

to destroy almost all the structures in the cell but 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. These 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. Then the lysosomes get them digested at times, the lysosomes burst and the enzymes are released to digest the cell. Hence, lysosomes are also known as the suicidal bags of the cell.

## Mitochondria

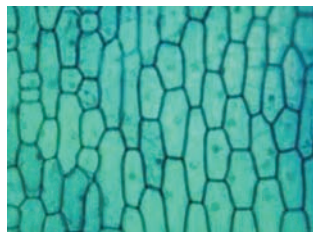
### Activity -2

#### Observing Mitochondria

Let us do this activity with onion peel.

- Make a fresh solution of Janus Green-B in a Beaker
- Mix 200mg Janus Green-B in 100ml of water
- Take a watch glass pour some solution. Put the onion peel in this solution and keep it for about half an hour.
- Keep a piece of onion peel on the slide and wash thoroughly with water.
- Cover the slide with a cover slip and observe it under micro-scope at high magnification.

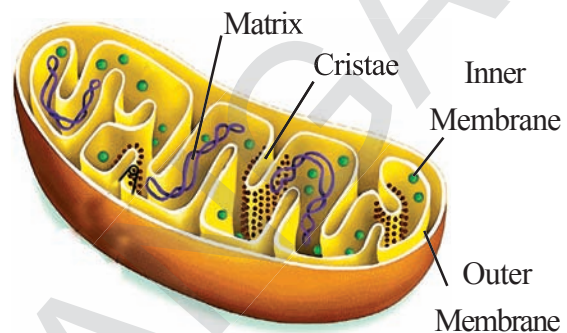
Observe and make a sketch of the same in your note book. Compare it with the given diagram.



**Fig-8(a) Mitochondria in onion peel cell**

You can do this activity by taking other available material like leaves of *Cassia tora* 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 compound microscope, the mitochondria appear as oval or cylindrical dots in the cell. The diagram of mitochondria shown in typical cell is hypothetical. Electron microscope reveals their unique internal structure in great detail.

Information derived from the electron microscope tells us that the mitochondria are made up 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 **powerhouses** of the cell.



## Ribosomes

There are small granule like structures in the cytoplasm of the cell. They are called ribosomes. They are formed of RNA protiens. They are two types. Free ribosomes are scattered in cytoplasm. Attached ribosomes are on the surface of rough endoplasmic reticulum. Ribosomes are the sites for protein synthesis.

## Plastids

### Activity - 3

#### Observation of chloroplast in *Rheo* leaf

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

Let us make a drawing of the observations.

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

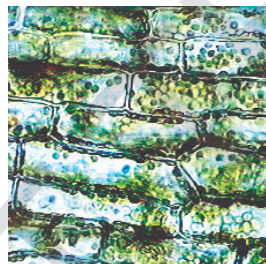


Fig-9(a)

### 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

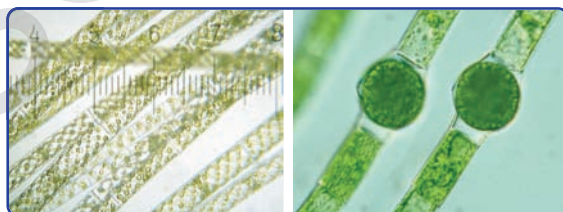


Fig-9(b) Chloroplasts in Algae

that you have observed under the microscope.

Chloroplast is a type of plastids in green colour. Plastids are present only in plant cells. Plastids are mainly of three types: (i) chromoplasts (coloured) (ii) leucoplasts (colourless) and (iii) chloroplasts (green coloured).

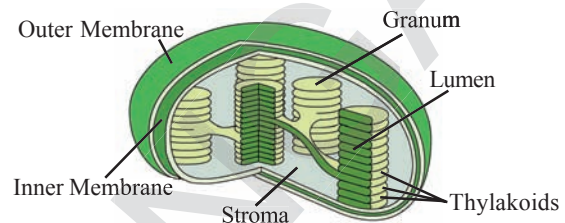


Fig-9(c) : Structure of chloroplast

Chloroplasts are of different shapes i.e. disc, oval etc. In algae, these can be found as ladders or star or spirally coiled or reticulate structures. 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.

### 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.

## 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 safranin solution.
4. Observe the section under low and high power microscope.

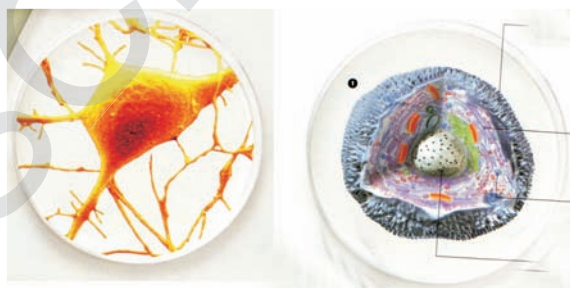
What do you observe?

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. Vacuoles maintain turgor pressure within the cell. They export unwanted substances from the cell.

### 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



*Fig-10 Cell - Three dimensional picture of cell*

to see the thickness of the wall. This three-dimensional image becomes clear if you reduce the intensity of light as well.

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 up 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 Carl Virchow

(1855) first explained that the new cells could be 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 products of cells.
- (ii) All cells arise from pre-existing cells.



### Key words

*Plasma membrane, Selectively Permeable membrane, Prokaryotic cell, Eukaryotic cell, Chromoplast, Leucoplast, 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 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.

Three types of plastids are present in the cell; chromoplasts, chloroplasts, leucoplasts.

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 would happens to the cell if nucleus is removed? Give two reasons to support your answer? (AS 1)



3. Lysosomes are known as suicidal bags of the cell. Why? (AS 1)
4. Why does plant cell possess large sized vacuole? (AS1)
5. "Cell is the basic unit of life", explain the statement.(AS 1)
6. Who and when was "The cell theory" proposed. When did they prepare it? What are its salient features of it? (AS 1)
7. What happens if plasma membrane ruptures or breaks? (AS 2)
8. What would happen to the life of cell if there was no golgi complex? (AS 2)
9. When you are observing the nucleus of cheek cell in laboratory, what precautions do you take ?
10. Read the chapter carefully collect the information about the functions of different cell organelles and make a table which contains serial number. Cell organelle and their function. Don't forget to write your specific findings below the table? (AS 4)
11. Prepare a model of plant cell or animal cell with locally available materials. (AS 5)
12. Prepare a temporary mount of any leaf peel, observe the stomata and draw their picture? Write a short note on the same. (AS 5)
13. Draw the Typical Animal Cell and lable it's parts ?
14. Look at the following cartoon of a cell. Find out the functions of cell organelles (AS 5)

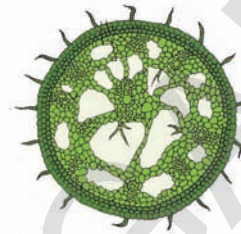


15. How do you appreciate about the organization of cell in the living body?(AS 6)
16. If the organization of cell is destroyed due to physical and chemical influence what will happen? (AS 6)
17. How could you appreciate the function of a tiny cell in a large body of an organism (AS 6)

## Chapter

## 2

## Plant tissues



You have already learnt about different cell organelles and their functions in the previous 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 plant and their functions.

We have studied about the functions of the parts of the plant in the earlier classes. Read the functions given below and write the names 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 cells in the plants that help in carrying out these processes?

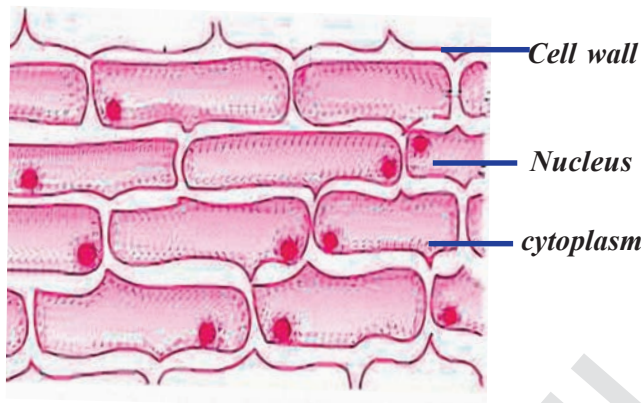
Let us try to find out more about the arrangements of cells in the plants and their functions by the following activities. You have observed the check cells in Class VIII.

Do the following activities once again 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 glycerine on it.



**Fig-1 Onion peel**

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

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

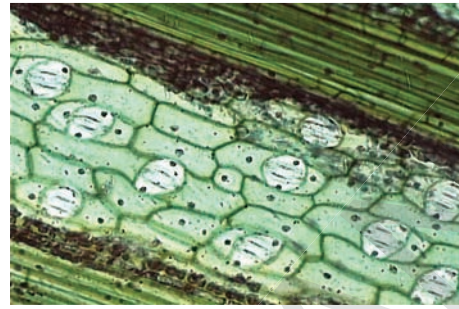
Are all the cells similar?

How are the cells arranged?

## Activity-3

### Cells in a leaf peel.

- Take a betel leaf or *Tradescantia* or *Rheo* leaf.
- Tear it with a single stroke. So that a thin edge be seen at the 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 have observed and compare it with figure-2.

Are all the cells similar?

Is there any difference in their arrangement?

What can we infer from the above activities?

Have you noticed that the cells are in groups in both the activities?

Compare and write a note on the arrangements of the cells that you have observed in both of the activities.

You may have observed that the cells are present in groups with certain arrangement. With the help of the 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 of a leaf. Let us find out how the cells are arranged in the root. For this we need onion root tips.

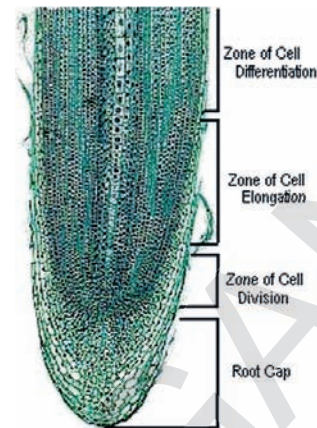


- Take a transparent (plastic/glass) bottle filled with water. Take an onion bulb slightly larger than the mouth of the bottle.
- Put the onion bulb on the mouth of the bottle as shown in the fig-3.



**Fig-3 Onion roots**

- 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 glycerine on it.
- Cover it with a cover-slip.
- Remove excess water with the help of blotting paper.
- Tap the cover-slip gently and press with the blunt end of the needle or brush to spread the material.
- Observe the structure and arrangement of the cells.
- Draw the diagram of that you have observed under the microscope.
- Are all the cells similar?
- How is the arrangement of cells?



**Fig-4 Cells in an 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 the onion bulb on the mouth of the bottle in the same way as you did 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 cutting the tips of the plants with a cutter. She had a doubt and asked the gardener to clear it.

### 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.

### Types of plant tissues.

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**.

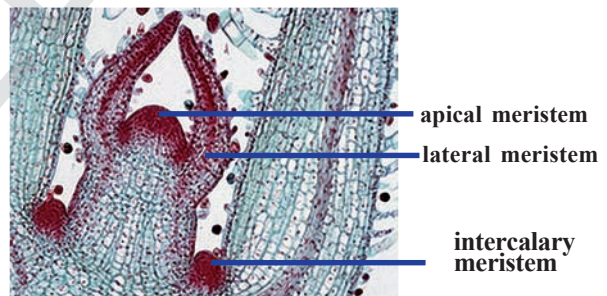
Tissues that form the bulk of the plant body, helping in packing other tissues are called as **Ground tissues**.

Tissues that help in transport of materials are called as **Vascular tissues**.

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

## 1. 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 the girth of 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 **intercalary meristematic (also called Cambium)** tissue.

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

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

### Activity-6

Comparison of Meristematic tissue in root and shoot tips:

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

Table -2

Arrangement of the cells (Tissues)	Shoot tip	Root tip
At the tip		
At the lateral sides		
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 have 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.

Observe it under the microscope.

Draw and label the diagram.

Compare it with figure given below

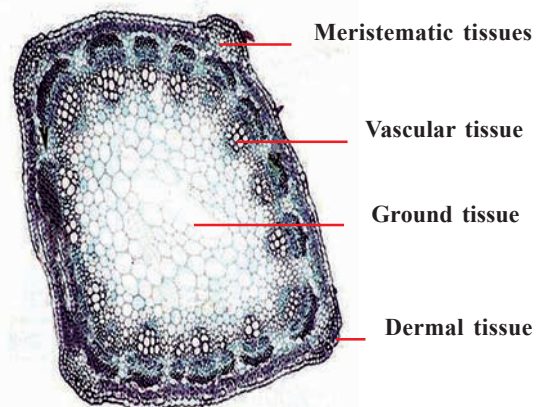


Fig-7 Dicot stem (TS) - Tissues

What are the similarities between the tissues in root and in shoot as shown in the above figure?

Are all the cells similar in shape and structure?



How many 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.

## 2.Dermal Tissue

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

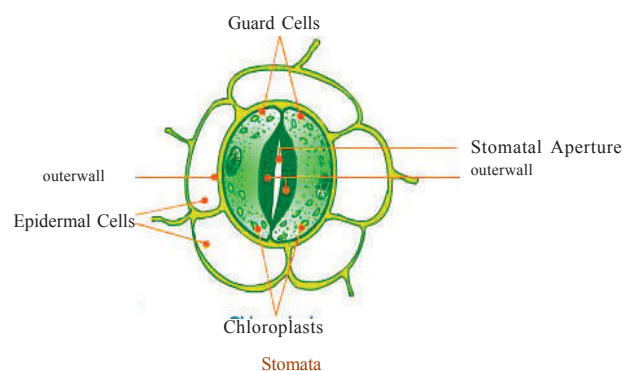
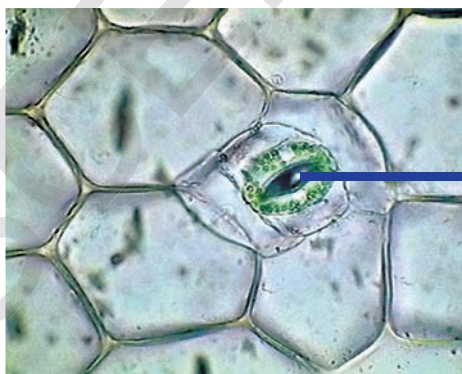
We can find the dermal tissue over the entire surface of the plant body.

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 in a single stroke, so that a thin whitish edge can be seen at the torn end.



*Fig-8 Peel of Rheo leaf – Dermal tissue*

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 the plants.

Dermal tissue (Dermis) usually consists of a single layer of cells showing variations in the types of cells on the basis of their functions and location. These tissues are divided into three different types. They are epidermis (outer most layer), mesodermis (The middle layer) and endodermis (the innermost layer).

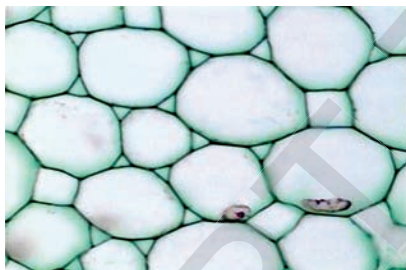
The walls of the cells of dermal tissue are comparatively thicker than the cells of meristematic tissues. In desert plants it may be even more thick and waxy. Small pores are seen in the epidermis of the leaf, called stomata. They are enclosed by two kidney shaped cells, called guard cells. Cells of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

Have you ever seen a sticky substance on the trunk or branches of trees like *Acacia*, *Neem*, etc.,. What is it? Where is the gum secreted from?

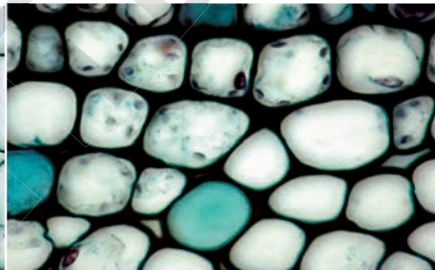
### **Do you know?**

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

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



**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 thick walled, longer cells when compared with

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

### **3. 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 observe that cells appear larger with a nucleus that appear prominent

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.

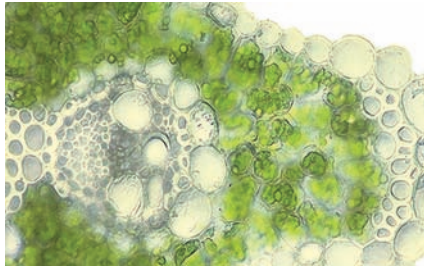
parenchyma.

In the sclerenchyma the cells are thick walled and tightly packed without spaces. So when compared with dermal tissue, the ground tissue is of various types. And some of the ground tissues help in photosynthesis.

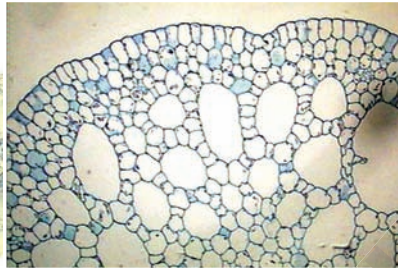
Let us observe the ground tissue of some other stems.

### Activity-9

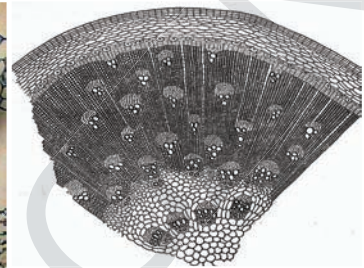
Take permanent slides of Chlorenchyma, Arenchyma, Storage Tissue from your laboratory and observe them under the microscope. Find out the characteristics differences and record them in your notebook.



*Chlorenchyma*



*Arenchyma*



*Storage Tissue*

### ? Do you know?

Nehemiah Grew (1641-1712) was a 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)*

## 4. 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 have done an experiment on transportation in class VII, in the chapter on plant nutrition. We have observed that

when a 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.

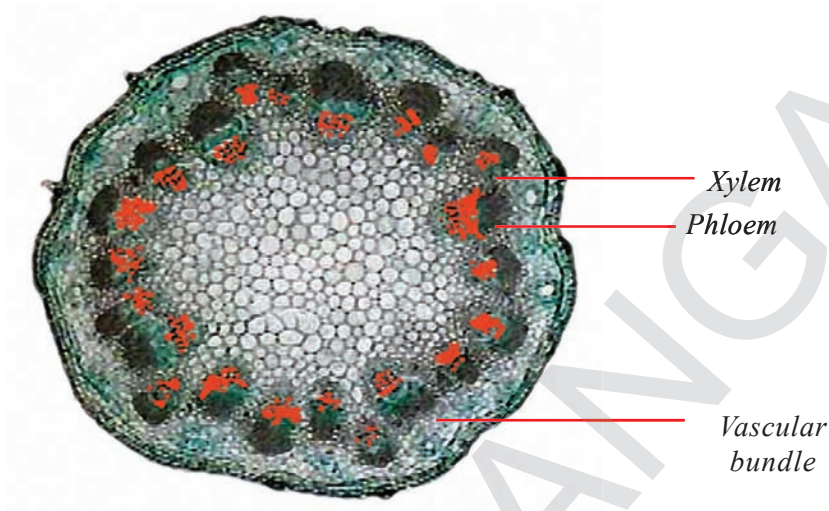
Which part of the plant is responsible for this transport?

Draw a rough sketch of that part and mark the part that appears red.



What do you conclude from your observation?

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

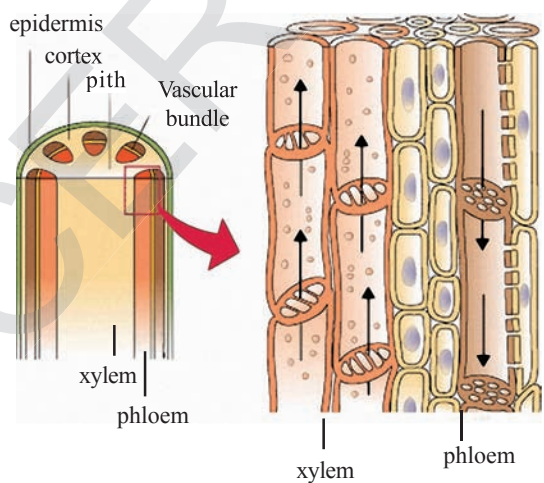


**Fig-11 TS of stem**

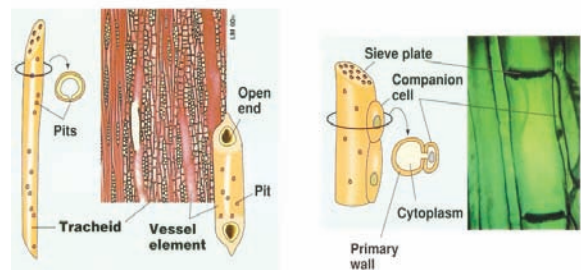
The tissues that appeared red are Xylem tissue, and the cells adjacent to these (As shown in the figure 12) are phloem tissues. Xylem is responsible for the transportation of materials like water and salts from the root. And phloem helps in the transportation of the food material

prepared by photosynthesis to the other 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.



**Xylem and Phloem**



**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 how 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, Lateral meristem, Intercalary meristem, Dermal tissue, Epidermis, Bark, Ground tissue, Parenchyma, Collenchyma, Sclerenchyma, Vascular tissue, Xylem, Phloem, Vascular bundles, Vessels.*



### 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 meristem, Lateral meristem and Intercalary meristem.

Dermal tissue covers the plant body and gives protection.

Ground tissue is abundant 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 helps in 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. Differentiate 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 causes growth in the length of the plant.
  - Growing tissue, which causes growth in the girth of the plant.
  - Large air cavities in the aquatic plants.
  - Food material in parenchyma.
  - 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. Though Chlorenchyma, Arenchyma and storage tissues are parenchymatous in nature . Why do they have different (specific) names? (AS 1)
7. Describe the functions of - Meristem, Xylem and phloem (AS 1)
8. If you want to know more about tissues in plants what questions are you going to ask? (AS 2)
9. "Bark cells are impervious to gases and water". What experiment will you perform to prove this? (AS 3)
10. Collect information about how dermal tissues help the plants. Display it on wall magazine. (AS 4)
11. Draw and label the diagram of the T.S. of stem (AS 5)
12. While observing internal parts of plants, how do you feel about its structure and functions? (AS 6)





## ANNEXURE

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

To get section cuttings pith material is to be taken as 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 glycerine on it.

Stain with a drop of safranin.

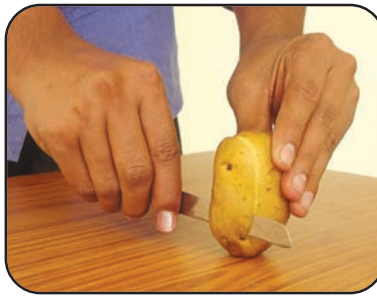
Gently cover with the cover-slip using needle.

Use blotting paper to remove the excess water or glycerine or stain.

Then observe under the microscope.



*(a) Material*



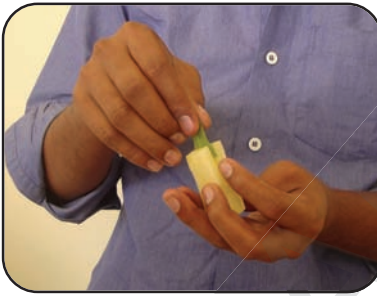
*(b) Making the pith material from potato*



*(c) Making slit in the pith material*



*(d) Cutting specimen to get TS*



*(e) Inserting the Specimen to get TS*



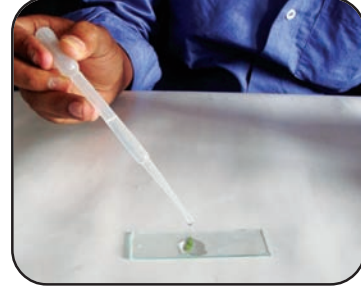
*(f) Section cutting with blade*



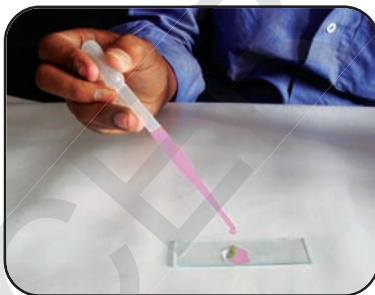
*(g) Taking the thin section with brush*



*(h) Keeping the section on the slide*



*(i) Putting a drop of water, Glycerine*



*(j) Staining with safranin*



*(k) Covering with cover-slip*

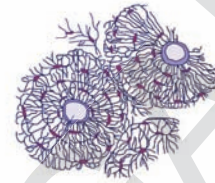


*(l) Observing under the Microscope*

## Chapter

## 3

## Animal tissues



We had learnt 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 functions were carried out by different tissues. We will try to see whether this happens in animals also.

We know that different organ systems carry out different functions.

**Enlist them:**

S.No	Organ system	Function
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 to respond to stimuli.

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 centre 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 discuss the questions.

Put it in dilute HCl for two hours.

Take the skin part of chicken piece.

Place the material with forceps or brush on the slide.

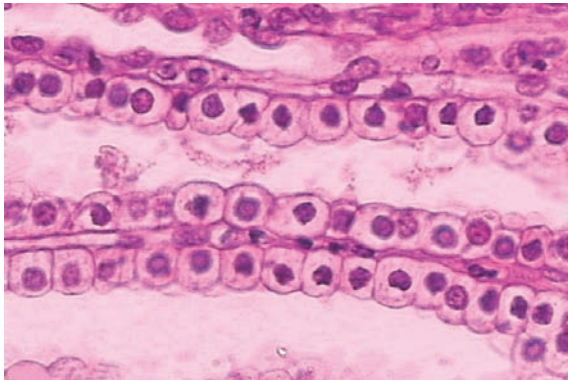
Then keep another slide on it and press both the slides gently.

Place a cover slip tap on it and observe under microscope.

Draw the diagram of what you have observed under the microscope in



your note book. Compare your diagram with the following picture.



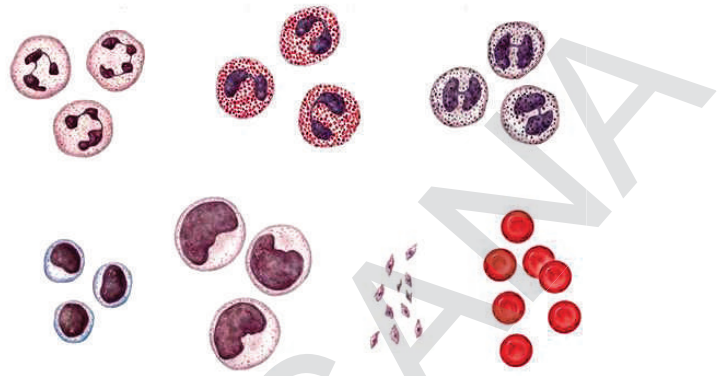
**Fig-1 Epithelial Tissue**

Now try to find out the answers.

- Are all the cells similar?
- How are they arranged?
- Are these cells tightly packed and arranged as continuous sheath?
- Is there any inter cellular space?
- Think, why these cells look like continuous sheath?
- Does membranous tissue cover and protect the animals 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 have observed under the microscope in your note book. Compare your diagram with the following picture.

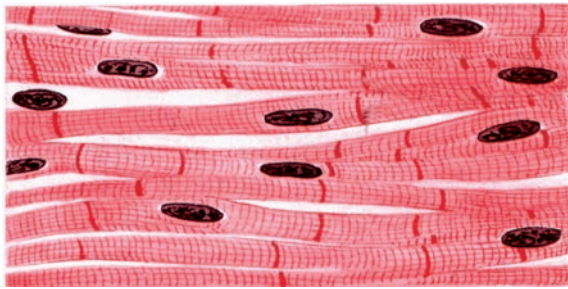


**Fig-2 Blood**

In this procedure you can identify only red blood cells. Compare with above diagram. Though blood contains all the cells shown in the picture, you might not be able to find them under microscope. For this you need a separate technique. Visit a nearby blood testing centre (Pathological lab) and submit a report on it after collecting the information.

### Procedure - 3

- Take a piece of muscle of chicken which is collected for activity-1.
- Put in dilute HCl or Vinegar and leave it for two hours.
- Next morning collect the piece of muscle on a slide with forceps.
- Press gently with another slide, put few drops of water and place a cover slip on it.
- 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?

Procedure - 4

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 do you find any relation between the tissues you observed previously.

Will this tissue help for movements in our body?

There are four major types of tissues in the animals.

Epithelial tissue protects and covers the animals body from inside and out side.

A loosely spaced tissue mainly as rendering support to various organs is the 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 is called, nervous tissue.

Are the functions of all the above tissues the same?

Let us study about tissue in our body.

### Epithelial Tissue:

(Epi means-Outer, Thelium means-Tissue)

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

#### Activity-1

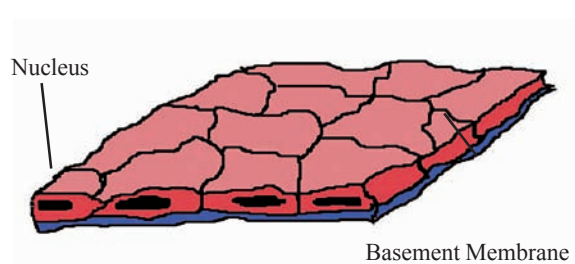
Collect the substance lining the mouth by using wooden spoon and observe this under the microscope. Draw the diagram that you have observed in the microscope, in your note book.

In the activity performed in 8th class you observed cells. Now you observe tissues

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 in the next chapter of “Transport across 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 the skin arranged in the form of layers?

If you drink hot tea or chilled cool drink, how do you feel?

If your skin burns or is wounded which tissue would get effected?

### Activity-2

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



**Fig-5 Cuboidal Epithelium**

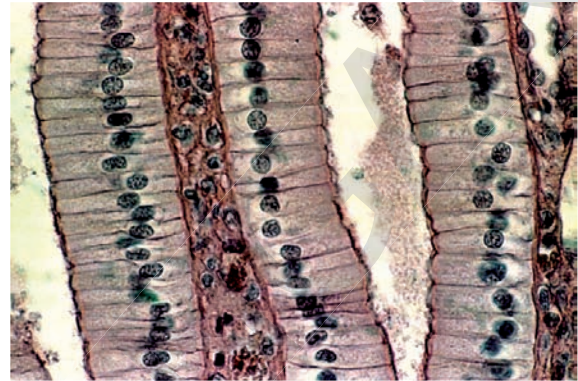
These are the cuboidal epithelial cells which form the lining of organs or tubules like ureters or other parts and provide mainly mechanical support to salivary glands.

### Do you know?

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

### Activity-3

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



**Fig-6 columnar epithelium**

Draw the figure that you have observed under the microscope

How are the cells? Do you find any hair like projections on the outer surface of epithelial cells.

This types of cells are present where ever absorption and secretion occurs. Try to think where is 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 tissues. You learn more about them in the chapter: Adaptations in different Ecosystems.

### Connective tissue

If you tilt your body to any side of your body, what will happen to your internal organs? Is there any displacement? The internal organs are located at specific places without any displacement in organs



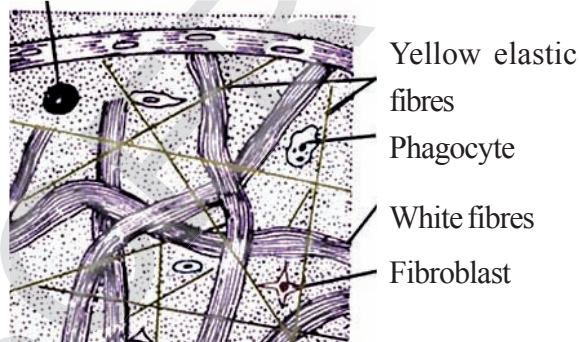
due to connective tissues. The tissue connect organs and muscles. These tissues are called connective tissue.

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 glasswear 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.

Mast cell

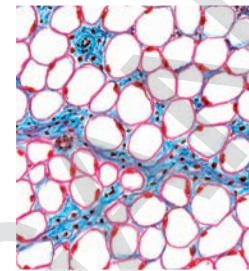


**Fig-7 Areolar Tissue**

The muscles in our body are attached to the skin and bone by this type of tissue. We can see this type of tissue around blood vessels and nerves.

Why do old people shiver more in winter than youngsters? Is there any special arrangement to prevent the escape of heat energy during winter?

Fat storing adipose tissue is found below the skin and between



**Fig-8 Adipose tissue**

internal organs. The cells of this tissue are filled with fat globules. Storage of fat also acts as insulator.

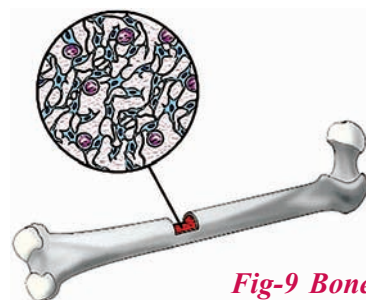
Are all tissues in our body smooth and soft?

Which tissue gives definite shape to body of vertebrae?

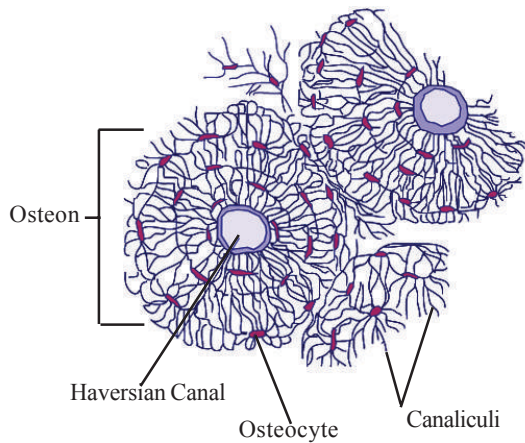
Bone is another type of connective tissue; it forms the frame work that supports the body. It is a major component of the skeletal system of several vertebrae (except some fishes like sharks).

**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.

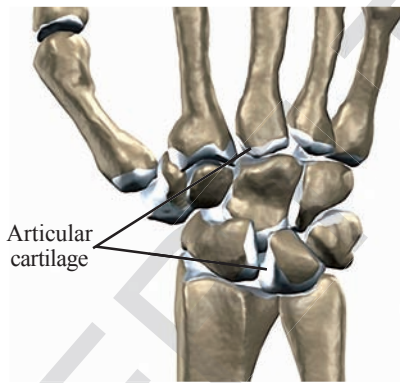


**Fig-9 Bone**



**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 them in position. It is made up of large number of fibres. These fibres are made up of a protein called collagen. This is very elastic in nature.

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

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

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



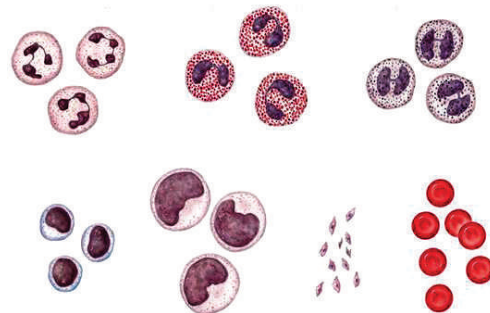
**Think and discuss**

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

**Activity-4**

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

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 float freely in the plasma. Extra cellular space is filled with fluid called plasma. There are no fibres in blood.



**Fig-12 Blood cells**

## Blood

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

There is a 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 the blood current in our body. There is highly sophisticated and well developed mechanism to circulate the blood to the entire body. Our heart pumps nearly 36 thousand litres of blood to a distance of nearly 20 thousand kilometers in the time period of 24 hours. Blood is red in colour. Do you agree with the statement that all animals carrying red blood are your blood relatives? 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 blood is water, which is stored in the plasma.

Besides water, it also has several nutrients such as glucose, amino acids, proteins, vitamins, hormones, required for the body and also excretory products such as lactic acid, urea, salts etc. Plasma also contains factors responsible for blood clotting. Heparin 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 which are red in colour. They have red coloured protein called **haemoglobin**. Because of haemoglobin 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.

Taking blood of an adult we can make a chain of red blood cells around the earth at equator with 7 circles. When you are in your 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 bones. In mammals, mature red blood cells are without nucleus.

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

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

Some white blood cells sacrifice their life to fight against external enemy (micro organisms). These dead WBC come out of wound as pus. Neutrophils are the first line of defence against bacteria. So they are called microscopic policemen.

There are two types of **agranulocytes** lymphocytes and monocytes. Lymphocytes secrete antibodies to guard against foreign material that enter into blood. Monocytes move like amoeba and 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 disc 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. But it is true, if you take into consideration the blood groups. Because, they may not have the same blood group as yours. Land Steiner, a German doctor, found a new blood relation among us. He divided human beings into four major groups. They are A, B, AB and O. The person who lives on another side of the globe is same with your blood group is also a blood relative. Do you agree this? AB group human beings can receive the blood from any other groups. Hence they are called “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 group Identification Kit, Glass Slide, Wax Pencil, Disposable Needle.

#### Kit Components and Storage

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

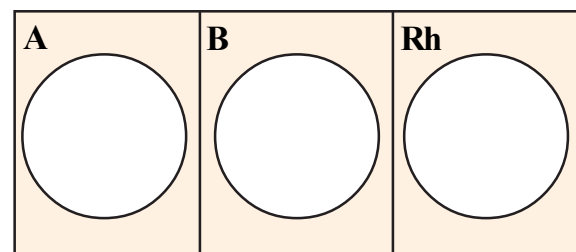
Sl No	Components	Quantity (100 tests)
1	anti-A sera	5 ml
2	anti-B sera	5 ml
3	anti-RhD sera	5 ml
4	porcelain white plate	2
5	Wax pencil	1
6	Needle (24G)	100
7	Instruction manual	1

#### Materials Required (not included in the kit):

Cotton, 70% alcohol, toothpicks.

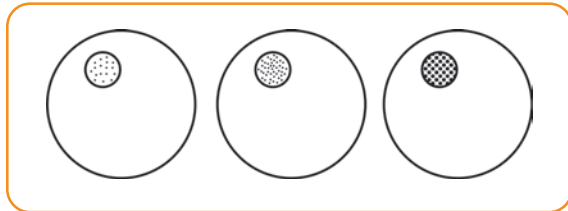
#### Procedure:

1. Take one porcelain 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 Figure 13.



*Fig-13 Template on a porcelain plate for blood grouping.*

- Place one drop of the corresponding antiserum (at room temperature) near the edge but within each of the circles as shown in Figure 14.

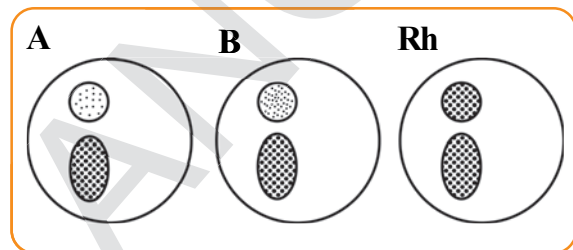


**Fig-14 Addition of anti-sera on the glass slide.**

- Choose a finger (usually left ring finger). Clean this fingertip with 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.
  - 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.
- Quickly, let one drop of blood get into each circle but not touching the anti-sera. Do not touch any of the anti-sera.
  - After putting three drops of blood, apply gentle pressure to the wound with cotton ball.  
Remember to properly dispose the used needle.
  - 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.

- 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 be noted 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 separate disposable needles for each pupil. It is better to conduct such kind of test only with the help of a Health Inspector.

### Muscle Tissue:

If you are wounded deeply, a deep scar would form at the place of wound? If we are wounded on skin, a lighter scar would form. Why? For the reason, that 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?

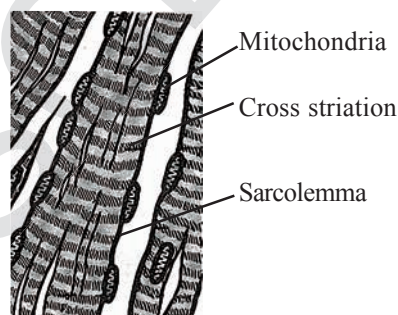
Muscular tissue consists of elongated cells called muscle fibres. This tissue is responsible for movement in our body. Muscles contain special protein called contractile proteins which contract and relax to cause movement.

During winter, body shivers. Why?

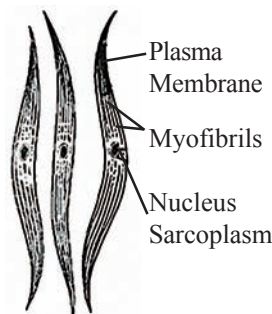
When the body is exposed to cold air, we shiver. During shivering muscles contract and relax producing large amount of heat. This keeps the body hot.

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

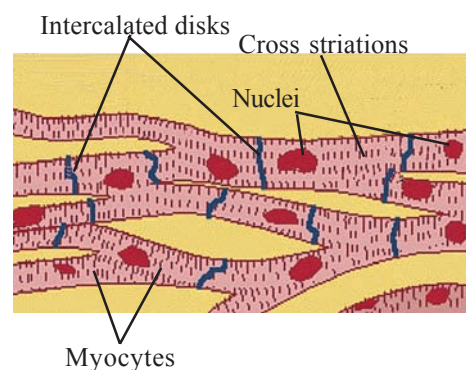
We can move some muscles by our conscious effort. For example the muscle present in inner limbs move according to our wish and will Such muscles are called voluntary muscle. These muscles also called as skeletal muscles as they are mostly attached to bones and help in body movement; these muscles show 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 have many nuclei in the cytoplasm (multi nucleated).



**Striated muscles**



**Non-striated muscles**  
Fig-16



**Cardiac muscles**



### 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 and the contraction and relaxation of blood vessels are involuntary. We cannot 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 nucleated). 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 ends. All the muscle cells in cardiac muscle have striations. Though it resembles the striated in its structure, it is an involuntary muscle. Presence of intercalated disks is the characteristic feature of cardiac muscle.

### Nervous Tissue

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 will you feel?

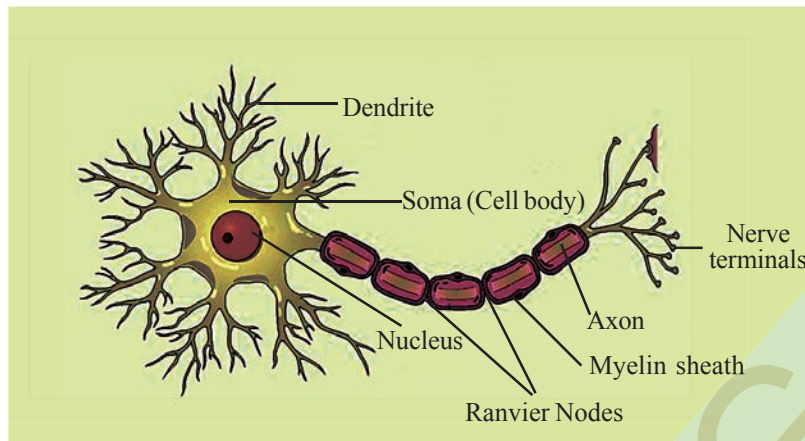
The feelings like the above situations is because of specialized mechanism in our body. It works like electric current passing through wires. Brain, spinal cord and nerves play active role in this mechanism.

### Activity-6

Collect a slide of nerve cells from the slide box. Observe it 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 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. Dendrites



**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 dendrite. They are sharp, branched, more in number. One projection of the cyton is somewhat longer than remaining projections. This is

called axon. Some nerve cells have axon covered with sheath like structure. This sheath is called as Myeline sheath. Gas or nodes present at regular intervals on myeline sheath are known as Ranvier Nodes.

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



### Key words

***Epithelial tissue, Connective tissue, Insulator, Bone marrow, bone, cartilage, Muscle tissue, Nerve tissue, Ranvier nodes, Blood groups.***



### 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, unstriated and cardiac are three types of muscle tissues.

Nervous tissue is made of neurons that receive and conduct impulses.



### Improve your learning

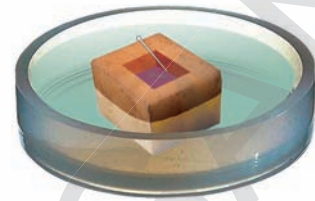
1. What do you understand by the term tissue? (AS1)
2. What is the specific function of the cardiac muscle? (AS1)
3. Differentiate between striated, unstriated muscles on the basis of their shape and site / location in the body. (AS1)
4. Name the following. (AS1)
  - a) Tissue that forms the inner lining 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.
5. Identify the types of tissue in the following: Linings of the organs; skin, bone, internal lining of kidney tubule. (AS1)
6. If you touch at elbow, you get a shock like feeling. Why? (AS 7)
7. Why the blood is called a connective tissue.(AS1)
8. What happens, if the platelets are not present in the blood? (AS2)
9. Show the difference between the three types of muscle fibres with diagrams. (AS3)
10. Write the procedure to identify your blood group with the help of kit? (AS 3)
11. Collect the old blood reports of your friends / relatives and prepare a project report on the contents of the blood (AS 4)
12. Draw a neatly labelled diagram of a neuron. (AS 3)
13. 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 its ill effects? (AS 6)
14. How is blood test useful to diagnose the disease. Explain with a daily life situation.(AS 7)



## Chapter

## 4

## Plasma 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 the cell and their specific duties in the chapter “Structure and functions of the cell”. It is very interesting to know how substances pass through cells. There is a wonderful mechanism. Let us learn.

Table-1

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 the cell? Why?

Which substances should come out of the cell? Why?

## Activity-1

## Get in-go out

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

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 this different types of

substances are required by the cell. They are solids like glucose, liquids like water, and gases like oxygen. To understand the entry or exit of substances through 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 teaspoon of sugar to the first beaker, one teaspoon to the second and one and a half teaspoon 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) Did you ever observe that your mother dipped wilted 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 kept in tap water*

Keep swollen kishmish of the previous activity or fresh grape or carrot in it.

Leave it overnight. And observe in the next morning what happens. Do you find any change in the size of kishmish.

In the lab activity - 2a, water is moving from ..... to .....

In the lab activity - 2b, water is moving from ..... to .....

Let us think how water goes in and comes out of Kishmish. Does the layer permits water to pass through?. How does it works? The cells in the outer layer of kishmish permit water to pass through.

Learn more about the process. Let us do the following activity.



### Lab Activity

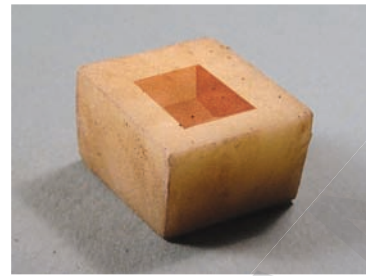
### Osmosis

**Materials needed:** One raw potato, beaker / bowl, two pins, Water, Sharp knife.

**Procedure:** Take the raw potato and boiled potato. Peel off the skins. Cut cube shaped cups from them as shown in the figure (you could make some other shapes as well).



*Fig-3(a) Cut the potato into cube shaped*



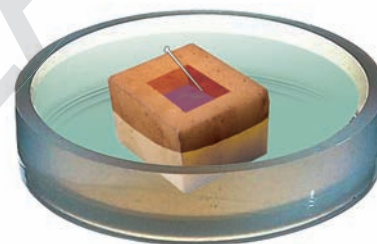
*Fig-3(b) Scoop to make a cup*

Prepare a few amount of saturated sugar solution.

Pour the sugar solution in the potato cup to a level as shown in the figure.

Mark the level of sugar solution by piercing the pin.

Keep the potato cup in the bowl/beaker.



*Fig-3(c) The final arrangement*

Pour water in the beaker / bowl to half of the height of the potato cup. Ensure that the potato cup does not float or submerge in water.

Leave the arrangement for half an hour and note your observations

Repeat the above experiment by taking sugar solution in the beaker and water in the potato cup. Note your observation and compare with that of your previous one.

By comparing potato and kishmish activities, do you find anything in common among them? What is it?

From your observations you can conclude that water always moved towards



the sugar solution. What might be the reason?

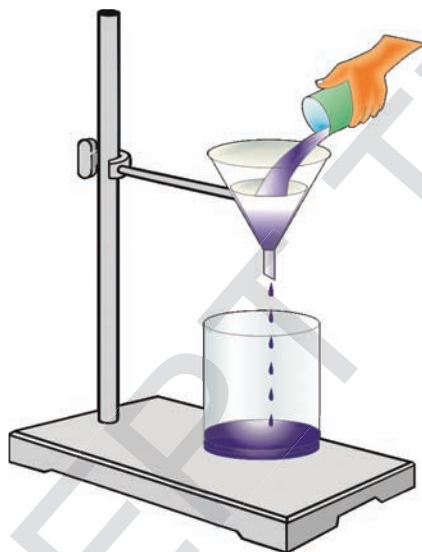
Such process, in which water moves towards sugar solution is called Osmosis. (In Greek Osmos means pushing).

We see that the movement of water through membrane in osmosis i.e. from less solute concentrated to more solute concentration.

To understand how materials may be moving in and out of cells through the cell membrane, let us do the following activity.

**Activity-2**

**Filtration**



*Fig-4(a) Conventional procedure*



*Fig-4(b) Alternative procedure*

To perform this activity we need the following materials:

Two beakers, Funnel, Filter paper, Retort stand, Sugar, Iodine and Wheat / rice flour, 500ml plastic bottle, cotton cloth.

**Procedure :**

1. Arrange the filtering apparatus as shown in the figure (4a) or the alternative method as in figure (4b).
2. Prepare wheat or rice powder solution in a beaker by adding one tea spoon of powder in 100ml of water.
3. Add a drop of tincture iodine to the solution.
4. Now pour the solution into the funnel.

Then observe,

What remains on the filter paper or the cloth?

What did the filter paper/ cloth allow to pass through?

Which substance is not allowed by the filter paper to pass through?

Why are certain substances not allowed to pass through the filter paper? Guess.

Cells also act in the same way while allowing the substances to pass through the plasma membrane.

With the understanding of above activities let us try to understand the nature of the Plasma membrane.

- a) It allows water to pass through it.
- b) It allows certain materials dissolved in water to pass through.

c) It will not allow certain materials to pass through it.

Allowing materials to pass through is called **permeability**.

In the previous activities we have observed the movement of water and materials in plants.

To know more details about plasma membrane or cell membrane, let us go through the following paragraphs.

The outermost, extremely delicate, elastic and membranous covering of the cell that separates its contents from the external environment is called plasma membrane. Protoplasm of a cell consists of two parts, cytoplasm and nucleus. Plasma membrane is **selectively permeable** because it allows entry of certain substances, exit of some substances while preventing passage to remaining substances. Plasma membrane is a **living flexible membrane**.

### Functions of plasma membrane

**Shape** : It provides a definite shape to semi fluid contents of the cell.

**Mechanical Barrier** : It functions as a mechanical barrier that protects the internal contents of the cell.

**Selective Permeability** : The membrane determines what substances are to be allowed entry or exit from the cell.

**Endocytosis** : The flexibility of the membrane enables the cell to engulf food and other substances (foreign particles) from its external environment by endocytosis. Amoeba acquires its food by this process.

**Recognition** : It has substances over its surface which function as recognition centres and points of attachment. They help in tissue formation, distinction of foreign substances and defence against microbes.

**Flow of Information** : Helps for flow of information amongst different cells of the same organism.

**Osmosis** : It occurs due to presence of tiny water channels in the plasma membrane.

**Cell Continuity**: At places plasma membranes of adjacent cells become continuous to form plasmodesmata and cell junctions.

**Specialization** : Plasma membrane gets modified to perform different functions, e.g. absorption in microvilli.

### Transport across the membrane

The membrane acts as a physical barrier between the organelles of a cell and the cytoplasm and between the cell and its surrounding environment. The membrane is said to be:

- Impermeable if the substances do not pass through the membrane.
- Permeable if the substances, both solute (substance which is dissolved) and solvent (medium in which solute dissolves) can pass readily through the membrane.
- Semipermeable if the membrane is permeable to solvent but prevents the passage of solutes.
- Selectively permeable if the membrane allows the passage of solvent and some selected solutes.

You already learnt about animal cell. Now let us do another activity to understand the movement of water in animals.

### Activity-3

**Material required :** Three beakers, Petri dish, Salt, Dilute HCl/ Toilet cleaning acid, two equal sized raw eggs, Cloth to wipe, A strip of paper for measurement, One table spoon.

#### Procedure:

Keep the raw eggs in dil. HCl / toilet cleaning acid for 4 to 5 hours



*Fig-5(a) Egg in HCl*

Observe what happens. Take out the egg with the help of table spoon.

Wash the eggs under tap water.

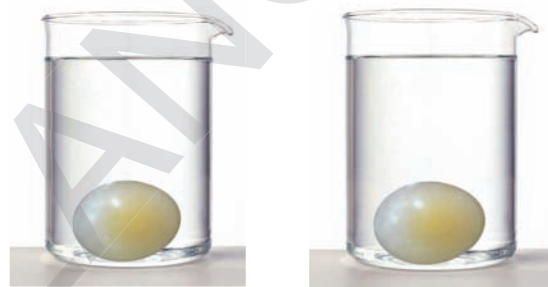


*Fig-5(b) Washing egg in tap water*

Measure the circumference of each egg with long strip of paper, at its widest place, and mark on the paper with pen or pencil. (For this you need teachers help to take care in measuring perfectly).

Prepare concentrated salt solution in a beaker.

Place one egg in the beaker with tap water and place the other in the salt water.



*Fig-5(c) Deshelled egg in salt solution*

*Fig-5(d) Deshelled egg in tap water*

Leave the beakers for 2 to 4 hours.

Take the eggs out, wipe them and measure the circumference with the same strip of paper. Mark on the paper with pen or pencil.

Do you find any difference in the circumference of the egg. Please fill the blanks.

The egg placed in salt water shrinks, the shrinking is due to.....

The egg placed in the tap water swells, the swelling is due to .....

The process in which water molecules leave the cell is called **Exosmosis**.

The process in which water molecules enter the cell is called **Endosmosis**.





### Lab Activity 3

## Preparing a semi permeable membrane

When you break a boiled egg you might have observed a thin layer surrounding the egg white. This is the layer which prevents free entry of materials into the egg. Only certain materials are allowed to enter the cell. Thus the membrane is called as **semi permeable**.

(you can make use of the eggs used in the previous activity)

Take one raw egg.

Keep the raw eggs in dil.HCl for 4 to 5 hours.

The shells which are made up of  $\text{CaCO}_3$  are dissolved.

Wash the eggs under tap water.

Carefully pierce a pencil sized hole in the egg membrane and drain the contents.



*Fig-6 The Egg membrane*

Wash the membrane with fresh water. Now your semi permeable membrane is ready.

Now perform the following Activity using the egg membranes.

### Materials Required:

Two egg membranes, Three beakers, Sugar, Water, Thread, Measuring jar, Disposable syringe.

Take one egg membrane and fill it with 10 ml of saturated sugar solution with a syringe. Tie its mouth with a (the pencil sized hole) thread. Measure 100 ml of tap water in a beaker. Keep the egg membrane in fresh water beaker. Leave it for overnight. Take the second egg membrane and fill it with 10 ml of tap water with the syringe. Prepare 100 ml of saturated sugar solution. Leave it overnight (use the same



*Fig-7(a) Fill with 10ml of salt solution*

*Fig-7(b) Tie the mouth*



*Fig-7(c) Egg membrane in fresh water*

sugar solution prepared for the other activity)

Measure the contents of the egg membranes and beakers and note in your book. Give reasons for your observation.

In the activities done so far, we have observed how water move across membranes from solutions of less concentration to the higher through a process called as osmosis.

### Do you know?

Three fourth of the earth is covered with oceans. Though plenty of water is there, we cannot use it, since it is salty. If we remove salts from it we can use it.

**Freddie Mercury** and **David Bowie** removed salt from sea water by using a semi permeable membrane by a process called de-salination. When heavy pressure is applied on salt solution, which is separated from fresh water with semi permeable membrane, the water moves from salt solution into fresh water leaving the salt behind. This process is known as '**reverse osmosis**'. Nowadays domestically used reverse osmosis machines are available in the market, which filters salt water through three membranes.

### Importance of osmosis to living organisms

Water enters the roots through osmosis.

Water moves between the cells through osmosis.

It helps in opening and closing of stomata.

It brings about movement of water and minerals in certain plants.

In our body waste materials are filtered from the blood.

In our body useful materials are absorbed along with water through osmosis.

### Diffusion

There are other ways in which materials move in a medium. Let us study one such process by the following activity.

If a bottle of scent is opened in one corner of a room, what will happen?

How do we feel? Its smell spreads in the entire room. Let us think of the following.

How does the smell spread in the entire room?

Is the smell spreading uniformly in the entire room?

Can you reach the scent bottle if you are blind folded?

When blind folded how you are able to locate the scent bottle?

Can you give any other such examples?

There are other processes in which substances move in a medium. Let us study another such process by the following activity.

### Activity-4

#### Diffusion with coffee powder

Experiment with coffee powder. Let us Take half bowl of water. Prepare a small ball of coffee powder. Slowly put it in water. Observe what happens. Write a note on what you observed.

Do this activity as many ways as you could like.

Putting the pinch of coffee powder first and adding water slowly.

Pouring hot water on the pinch of coffee powder etc.

Note your observations for each situation and write down what you infer.

Let us see whether other substances also behave in the same manner.

### Activity-5

Keep a small Crystal of  $\text{KMnO}_4$  (Potassium permanganate) in the centre of the Petridish with the help of a Forceps.

Carefully fill the Petridish with water. (It is better to use filler or dropper)

Observe the movement of Pink Colour in the Petri dish every minute.

Also observe the spreading of colour from center to periphery.

Repeat the experiment with other substances (E.g.: copper sulphate) and compare the result.

Do you find any relation between Time and Movement?

For better understanding, the movements of molecules in water, observe the following activity.

### Activity-6

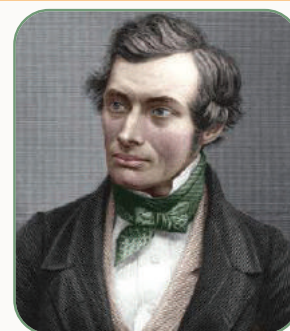
This activity can be done with other substances like copper sulphate crystals, water based ink etc. Compare the movement of coffee powder and  $\text{KMnO}_4$ , copper sulphate, ink in water and write your inference.

The process, by which some materials when kept in a medium like air and water spread equally throughout is called **Diffusion**.

So far we have studied about osmosis and diffusion. There are other processes that occur across the cell membrane about which we shall study in higher classes.

### ? Do you know?

Thomas Graham, Scottish physical chemist, worked on diffusion of gases. Graham measured the rate of diffusion of gases and also studied about diffusion of substances in solutions. He had inferred that a more soluble substance in a medium diffuse faster than a less soluble substance. This popularly known as 'Graham's law of diffusion.







### Key words

*Diffusion, Osmosis, Permeability, Semi Permeable membrane, Plasma membrane, Solute, Saturated solution.*



### What we have learnt?

The cell transports various substances like solids, liquids and gases through them.

The plasma membrane is not permeable to all the substances equally.

The materials are transported across the membrane by the process called diffusion, osmosis and other methods.

The processes are useful in daily life also. Air freshners, agarbathi, mosquito repellents works on the principle of diffusion.

Reverse osmosis work on the principle of osmosis.

Osmosis does not take place in dead cells.



### Improve your learning

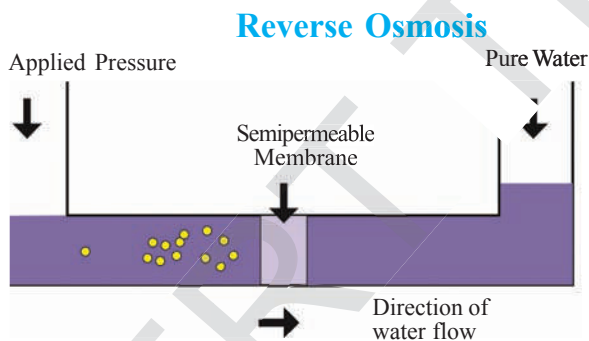
- The structure which controls the entry and exit of the materials through the cell is (AS1)
  - Cell wall
  - Cell membrane
  - Both
  - None of them
- Fill in the blanks (AS 1)
  - The smell of flowers reaches us through the process of .....
  - The MIC gas of Bhopal tragedy was spread throughout the city through the process of .....
  - Water enters the potato osmometer due to a process called .....
  - The fresh grape wrinkles, if kept in salt water because of .....
- What do you mean by permeability of membrane? Explain with suitable example. (AS 1)
- If the dried vegetables are kept in water they become fresh. What is the reason? (AS 1)
- Name the process by which we can get fresh water from sea water? (AS 1)
- What will happen to a marine fish if kept in fresh water aquarium? Support your answer with reasons. (AS 2)

7. Why do the doctors administer saline only, not the distilled water. (AS 2)
8. What will happen if 50% glucose solution is injected intravenously (into vein)? (AS 2)
9. What will happen if cells do not have ability of permeability? (AS 2)
10. What are your observations in experiments to know about diffusion. (AS 7)
11. Discuss with your friends and write the list of incidences where diffusion occurs?
12. Draw the flowchart showing different stages in doing the experimnet with egg. (AS 5)
13. You have purchased a coconut in the market. By shaking it you found that there is less water in the coconut. Can you fill the coconut with water without making a hole in it? (AS 6)
14. How diffusion is useful in everyday life? (AS 7)
15. Give examples of three daily life activities in which osmosis is involved. (AS 7)



## ANNEXURE

1. Have you ever seen water purifier. Generally we use water filter which contains purifying candles. If you want to get pure water you need reverse Osmometer. This instrument purifies water by the process of reverse osmosis.



## 2. Dialysis :

In our body the kidneys filter waste materials from blood by the process of osmosis. When the kidneys fail to filter, the toxic material remains in the body. The body will be poisoned by this, resulting in death.

**Dr. William Kolff** a Dutch physician in the year 1947 constructed the dialysis machine. (Dialysis is a Greek word. Dia means through; Lysis means splitting).

The body wastes are filtered by machine. The machine works on simple principle of Osmosis and filtration across a semi permeable membrane.

### 3. Effect of different solutions on blood cells :

When the animal cells which are without a cell wall like that of plant cells, undergo drastic changes when placed in different types of solutions. When red blood cells are placed in hypertonic solution shrink. The red blood cells placed in hypotonic solution, like distilled water, swell and burst.

Point to be remembered. The animal cell if kept in hypotonic solution will burst due to lack of cell wall. The plant cell will not burst due to the presence of cell wall.

#### **Do you want to drink a cool drink when you are thirsty?**

What will all the animals and birds do when they are thirsty? They drink water.

The modern people are drinking cool drinks to quench their thirst. Do the cool drinks really quench thirst as water does?

The cool drink is prepared with sugar and dissolved  $\text{CO}_2$  in it. The cool drink is a concentrated solution of sugar.

What will you think will be the effect of cool drink on our body?

#### **Do you eat preserved, sugared food during journey?**

The answer generally will be **YES**. When we are traveling in a bus we get dehydrated faster than when we walk, due to high air velocity. The sugared food like potato chips or other food stuff in attractive packing will naturally water your mouth. After eating the 50gms. of chips, did you observe we feel thirstier? Why did this happen?

After eating preserved food like potato chips we feel thirstier. The balance between the salt and water is disturbed. To maintain the balance we have to drink more water after eating salted / sugary food.

What is the better food during a journey?

The natural fruits with 80% to 90% water in them, not only quench your thirst but also reduce your hunger.



## Chapter

## 5

# Diversity in Living Organisms- Classification



There are many plants and animals around us. We know very little about them. Most of them belong to a world not visible to the naked 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 plateaus 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 nature's miracle.

## Diversity in plants

### Activity-1

#### Observation of leaves of different plants

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



Table - 1

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 (monocots and dicots)

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.

Table - 2

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	Tap root/ 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?

Do you find –plants with fibrous roots bearing flowers in clusters? (or) do you find them in some other pattern.

Carefully observe the plants collected by you and note down the

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 few 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 from each other.

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 lens 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.

Table - 3

S. No.	Name of the Seed	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 the differences you have 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 plants to complete the following table( you can take the help of annexure to this chapter as well)

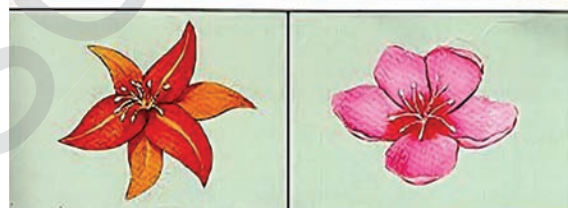
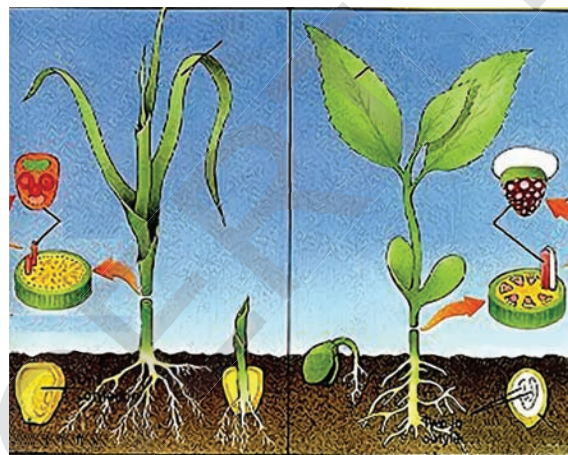
Table - 4

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.

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.



Monocot plant

Dicot plant

Fig-1

### 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 lens to get a closer view.

Are all insects of the same size or shape?



**Table - 5**

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 do 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 will be 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

**Activity-6**

**Variation in animals (external characters)**

**Variations in humans:**

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

**Table - 6**

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 characteristics in any of 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

#### Variations in two different plants of the same species

Collect two plants of the same species (e.g., Rose) from your surroundings. Observe them carefully and fill the table.

Table - 7

S. No.	Name of the Plant	Hight of the Plant	No. of Leaves	Size / Shape of the Leaves	Colour of the Flowers	Leaf	Venation
1.	Plant -1						
2.	Plant -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 of 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?

Classification makes our study more focussed and helps us to handle huge population of organisms.

It helps to study the organisms in a proper and systematic manner.

It gives better knowledge and understanding of organisms that are studied.

It helps in understanding the relationship among the organisms and their interdependence.

It helps to make comparison in an easier way.

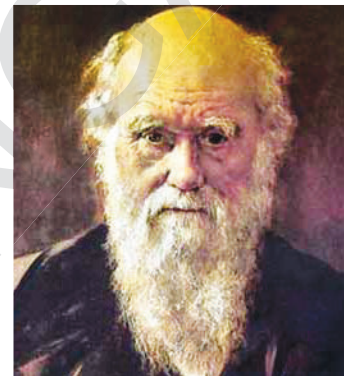
It gives us an idea of evolution (How organisms have evolved in nature?)

## Classification and evolution

All living things are identified and categorized on the basis of their structure and function. Some characteristics are likely to make more wide-ranging changes in the 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 when compared to the younger.



*Charles 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. Charaka and Sushruta had classified the plants on the basis of their medical importance. There after Parasara 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 biologists 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	3 kingdoms	2 empires	4 kingdoms	5 kingdoms	3 kingdoms	6 kingdoms
(not treated)	Protista	Prokaryota	Monera	Monera	Bacteria	Bacteria
					Archaea	
Vegetabilia	Plantae	Eukaryota	Protoctista	Protista	Eukarya	Protozoa
				Plantae		Chromista
			Plantae	Fungi		Plantae
Animalia	Animalia		Animalia	Animalia		Fungi
						Animalia

Although biologists in the 16<sup>th</sup> and 17<sup>th</sup> 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 Carolus Linnaeus 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 later 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,



*Carolus Linnaeus*

family, order, class, phyla etc were defined by Linnaeus on the basis of the similarities and differences studied by him in groups of organisms.

The first major break from the Linnaean classification 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 advanced one over the previous system because it captured the diversity of life in a better way. Three groups of organisms i.e, Monera, fungi, and protista - 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 hypothesis 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 dispersed in cytoplasm.

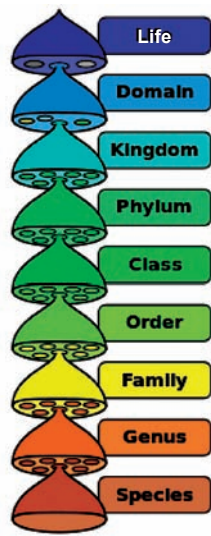
The cell walls of bacteria unlike the archaea contain a fat like chemical peptidoglycan..

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 Hierarchy**

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

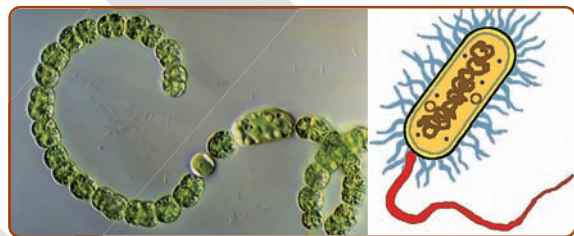
How many cells are found in the organism?

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 into 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 Nostoc**

**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 (protocista)

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?

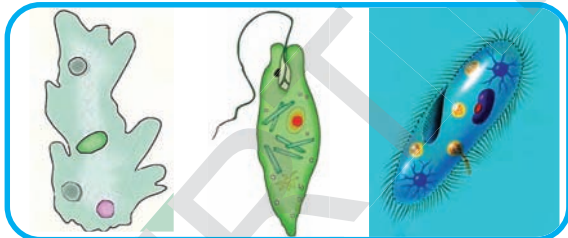
Do you find root like structures? Guess why?

### Characteristics of protists

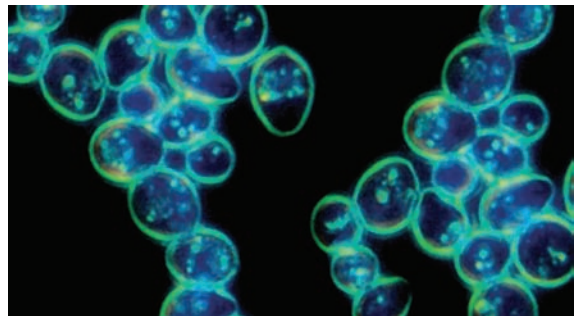
- A. Most are one-celled (unicellular), but some have many cells.
- B. Cells have a membrane around the nucleus.
- C. Some get nutrients and energy by eating other organisms.
- D. Some get energy from the sun, and nutrients from the water around them.
- E. These live either solitary or in a colony.
-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

### Characteristics of fungi

- A. Most are many-celled (multi-cellular) 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.



*Fig-4 Amoeba, Euglena, Paramecium*



*Fig-5 Bread mould, Mushroom, Yeast*

### 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.

- D. Most of these reproduce by spores.
- E. Examples are yeast, mushrooms, bread moulds, and lichens.

### 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.

Let's 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



*Fig-6 Moss (funaria)*

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-6.

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.



*Fig-7 Sporophylls of Fern & Cycas*

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



*Fig-8 Mango*



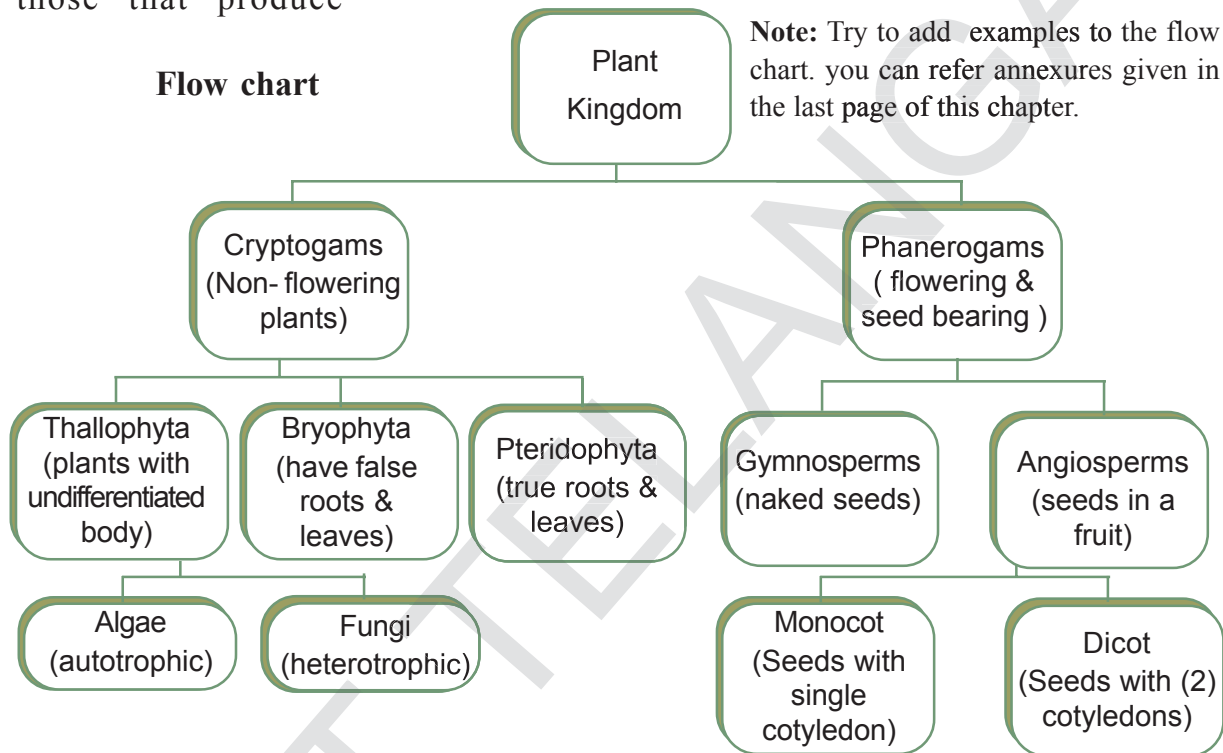
Plants like moss and fern which do not produce flowers and have sporangium as reproductive structures are called non-flowering plants or cryptogams, those that produce



*Fig-9 Pine Cone*

heterotrophic. Their cells do not have cell-walls. Most animals are motile. They are further classified based on the differentiation of body structure.

Major groups are:



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).

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

### Classification of Animals

These are organisms which are eukaryotic, multicellular and

### Porifera (Pore bearing)

The word Porifera means organisms with pores. These are non-motile animals attached to some solid support. There are holes or 'pores',



*Fig-10 Sycon*

all over the body. These lead to a canal system that helps in circulating water throughout the body to bring in food and oxygen. Outer cells are covered with spicules that act as skeleton. The body design involves very minimal differentiation and division into tissues. They

are commonly called '**sponges**' and are mainly found in marine habitats. Some examples are Euplectella, Sycon, Spongilla etc.

### Coelenterata/Cnidarians

These are aquatic forms showing more body design differentiation when compared with Poriferans. There is gastrovascular cavity in the body. The body is made up of two layers of



*Fig-11 Hydra*

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 which form coral islands huge as say an island (1800 sqkm), is called coral reefs while others like hydra, jellyfish and sea anemones are common examples. Make a report on coral reefs referring to book in your school library.



*Fig-12 Tape worm*

### 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, that 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 well developed organs can be accommodated. The body is flattened dorsoventrally, from top to bottom, that is why these animals are called flatworms. They are either free living or parasitic. Some examples of free living animals like planarians or parasitic animals like liverflukes and tapeworms.

### 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 intestine (roundworm or pinworms).



*Fig-13 Round worm*

### Annelida (Segmented Worms)

Annelida 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.

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 on land. Earthworms and leeches are familiar examples (see Fig.16)



**Fig-14 Earthworm**

### Arthropoda (Jointed legs)

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 filled with blood. 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).

**Cockroach**



**Scorpion**



**Prawn**



**Fig-15 Arthropods**

### 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 spines, 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/Star fish**

Discuss about water vascular system with your teacher.

### 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



supporting 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.

Ex. Herdmania, Amphioxus



**Herdmania**  
(Urochordata)



**Amphioxus**  
(Cephalochordata)

*Fig-18*

## Chordata

Some biologists divide phylum chordata into three subphyla viz.,  
1. Urochordata 2. Cephalochordata  
3. Vertebrata. (see Annexure 3).  
Subphylum Hemichordata is now treated as phylum Hemichordata. In the year 1988 Cavalier and Smith gave a new classification which was approved by the International Biological Society (IBS) in the year 2004.

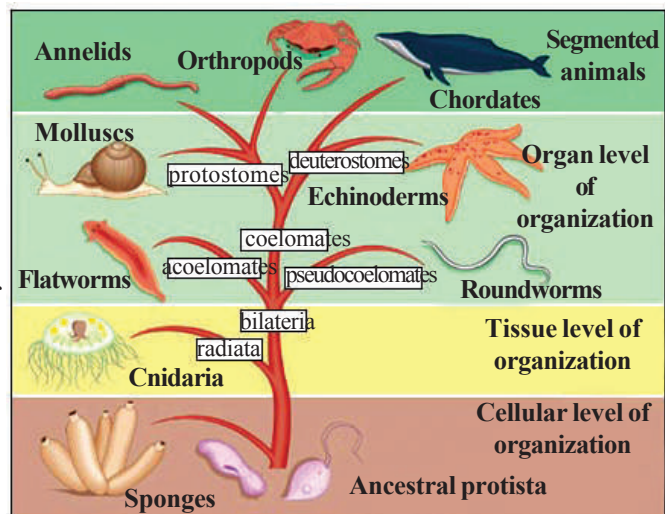
## Vertebrata

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.
  - (vi) Have caudal (tail) fin
- Vertebrates are grouped into five classes.
1. Pisces
  2. Amphibians
  3. Reptiles
  4. Birds / Aves
  5. Mammals

Among the above mentioned classes pisces, amphibians, reptiles are cold-blooded animals. They can change their body temperature according to change in their surroundings. Birds (aves) and mammals are warm-blooded animals. They maintain their body temperature constant without changing it according to changes in the temperature of their surroundings.







**Animal classification**



**Vertebrates**

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

1	2	3	4	5												
<p><b>Fish (Pisces)</b> have fins and tail, breathe underwater using gills, Cold blooded animals heart has only two chambers.</p>  <p>Fish</p>	<p><b>Amphibia</b> young live in water, but adults live on land, smooth slimy skin, lay eggs. First vertebrates, can live both in water and on land, Poikilothermic, hibernate during winter, aestivate during summer, Heart is three chambered.</p>  <p>Frog</p>	<p><b>Reptiles</b> have dry skin and scales, lay eggs, breath air through lungs. Cold blooded animals, most of them have a three chambered heart, Incompletely divided four chambered heart, but crocodiles have four chambered heart.</p>  <p>Crocodile</p>	<p><b>Birds (Aves)</b> have feathers, two wings, claws, lay eggs. Warm blooded animals, four chambered heart.</p>  <p>Bird</p>	<p><b>Mammals</b> Suckle young ones (feed babies with milk, skin covered by hair/ fur breathe air through lungs give birth to fully formed young once)</p> <table border="1"> <thead> <tr> <th>Land Mammals</th> <th>Marine Mammals</th> <th>Flying Mammals</th> </tr> </thead> <tbody> <tr> <td> <p><b>Mammalia</b> Outer ears four limbs (arms / legs)</p> <table border="1"> <thead> <tr> <th>Marsupials</th> <th>Primates</th> <th>Rodents</th> </tr> </thead> <tbody> <tr> <td> <p>Care and feed their young ones in their sacks.</p>  <p>Kangaroo</p> </td> <td> <p>Well developed hands / feet with fingers / toes, can judge distance, very intelligent social animals/ form bonds with family &amp; friends.</p>  <p>Monkey, Man</p> </td> <td> <p>Gnawing animal, large incisor teeth (two parts) use like chisels to gnaw on hard foods.</p>  <p>Rat</p> </td> </tr> </tbody> </table> </td> <td> <p>Animals which grow and live in the sea water, some only have sparse covering of hair.</p>  <p>Dolphin</p> </td> <td> <p>use echolocation, nocturnal, live in tree hollows &amp; caves.</p>  <p>Bat</p> </td> </tr> </tbody> </table>	Land Mammals	Marine Mammals	Flying Mammals	<p><b>Mammalia</b> Outer ears four limbs (arms / legs)</p> <table border="1"> <thead> <tr> <th>Marsupials</th> <th>Primates</th> <th>Rodents</th> </tr> </thead> <tbody> <tr> <td> <p>Care and feed their young ones in their sacks.</p>  <p>Kangaroo</p> </td> <td> <p>Well developed hands / feet with fingers / toes, can judge distance, very intelligent social animals/ form bonds with family &amp; friends.</p>  <p>Monkey, Man</p> </td> <td> <p>Gnawing animal, large incisor teeth (two parts) use like chisels to gnaw on hard foods.</p>  <p>Rat</p> </td> </tr> </tbody> </table>	Marsupials	Primates	Rodents	<p>Care and feed their young ones in their sacks.</p>  <p>Kangaroo</p>	<p>Well developed hands / feet with fingers / toes, can judge distance, very intelligent social animals/ form bonds with family &amp; friends.</p>  <p>Monkey, Man</p>	<p>Gnawing animal, large incisor teeth (two parts) use like chisels to gnaw on hard foods.</p>  <p>Rat</p>	<p>Animals which grow and live in the sea water, some only have sparse covering of hair.</p>  <p>Dolphin</p>	<p>use echolocation, nocturnal, live in tree hollows &amp; caves.</p>  <p>Bat</p>
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## 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, Helminthes- 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 Platyhelminthes and Nematy helminthes are together called Helminthes.

### Observe in your School Lab; the Specimen of an Earthworm

Collect a big earthworm 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 an earthworm is made up of several ring-like structures. (annulus: rings, edios: form)

Hence they are included under Annelida. Body cavity is clearly visible in it. Discuss about the locomotion of an earth worm with your teacher.

### 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 say 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, poda-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 a Snail.**

Observe a snail collected from a pond and keep it 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?

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

Pearls are produced from a mollusc called Oyster. Discuss with your teacher how are pearls formed in pearl oyster.

### **Observe in your School Lab; the Specimen of a 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. (echinos: spines, derma: skin)

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

They are bottom dwellers and benthic.

Most are pentamerous, 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 fishes. This is the back bone of the fish. From fish onwards, all animals possess back bones and they are termed as Vertebrates (animals that have vertebral 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 do you see 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 cautious 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 use local names.

Do you know the common names of potato in different languages?

Suppose you use the name batata where people know only English, will 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

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

place would not match with the other.

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 labelled sketch of the organism (use dissecting microscope if necessary)

Write a brief description of the organism, focussing 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?
- This is how organisms are clasified in a specific order.



### Key words

*Flora, Fauna, Diversity, Variation, Classification, Evolution, Animal kingdom, Domain, Phylum, Class, Order, Family, Genus, Species, Binomial 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 kingdoms are:

- i. Whether they are made up 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 distinct scientific name is called Nomenclature.

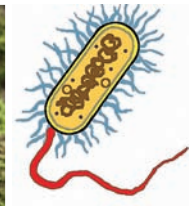
Nomenclature provides a uniform way of identification of the vast diversity of life around us.

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 lead to diversity in living organisms? State reasons (AS1)
2. What was the basis for early classifications? (AS1)
3. What are the advantages of classifying organisms? (AS1)
4. How do monocots differ from dicots? (AS1)
5. Name the kingdom to which these organisms belong according to Whittaker. (AS1)



6. 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 .....
7. Write some common characters of Pisces, Reptilia and Aves. (AS 1)
8. What is the need of classification? What questions will you ask? (AS 2)
9. One day Kavitha soaked seeds of green grams, wheat, maize, peas and tamarind. After they became tender, she tried to split the seeds. 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				

10. 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)
11. Make a flow chart of invertebrates in the kingdom Animalia, based upon their characteristic features. (AS 5)
12. Explain how animals in vertebrata are classified into further subgroups.(AS1)
13. How can you appreciate the effort of scientists in classifying a wide range of organisms? (AS 6)
14. Sujata says Bat is not a bird but a mammal. How can you support Sujata's statement?(As 7)



### ANNEXURE-1



*Maize plant*



*Rice plant*



*Grass plant*



*Bean Plant*



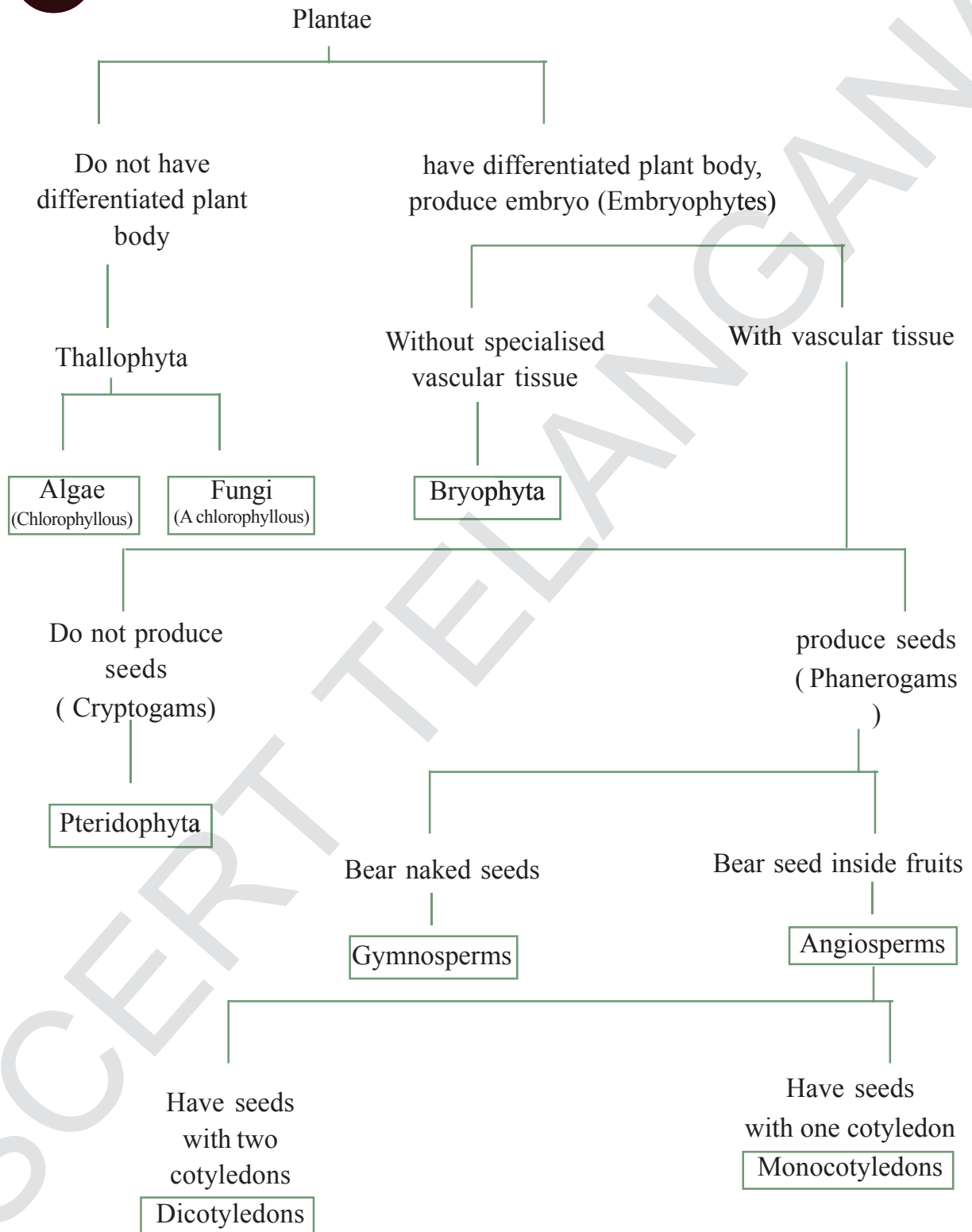
*Green gram plant*



*Ground nut plant*



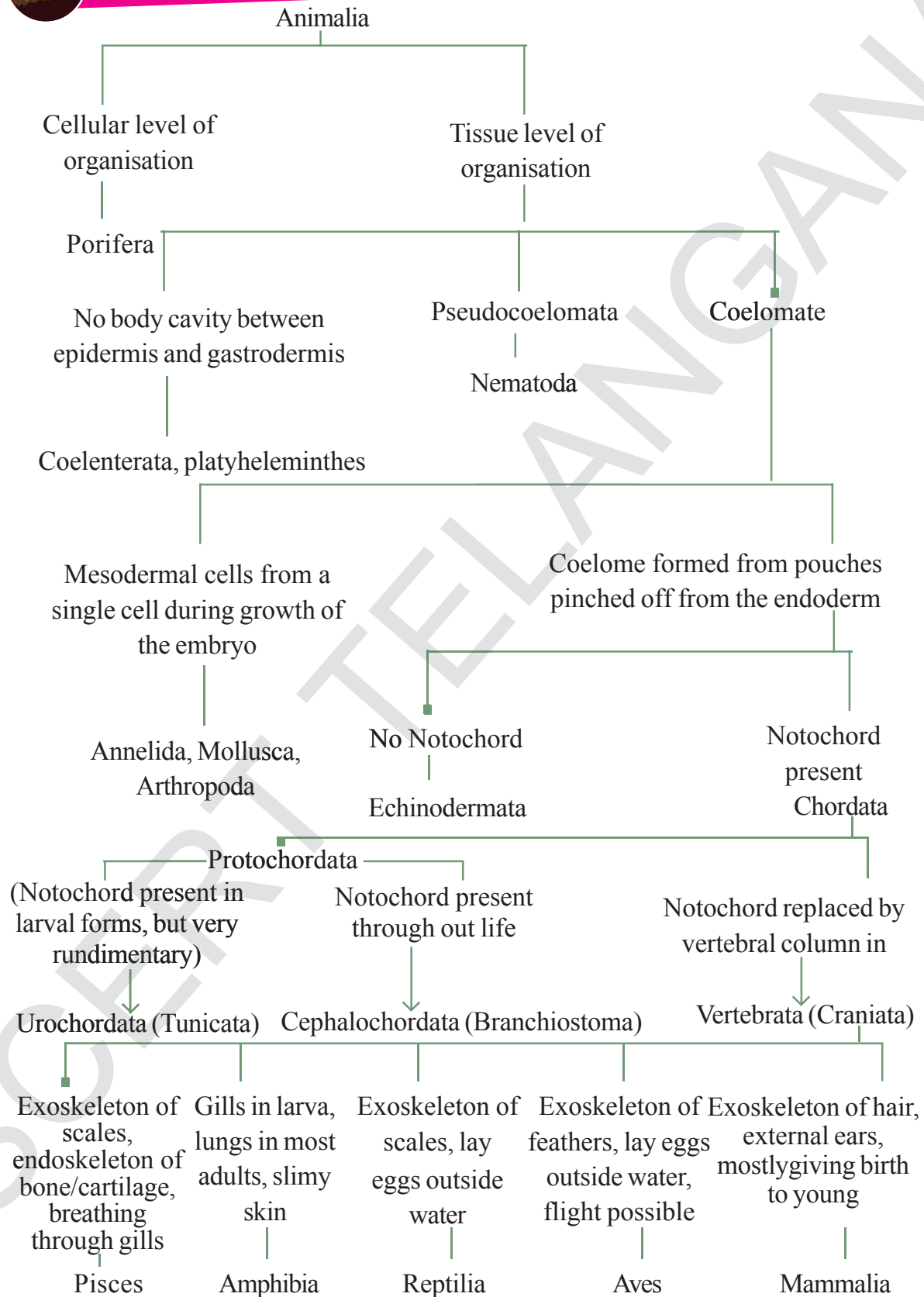
**ANNEXURE-2**







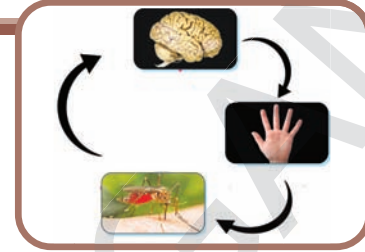
**ANNEXURE-3**



## 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 with 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 information 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 towards certain informations of our environment that are important for us and

influence some activity (called as stimuli). For example tasty food draw us towards them and our mouth starts watering. Our senses also help us to 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 bonds with 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, flavour preference by our brain is usually based on 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!

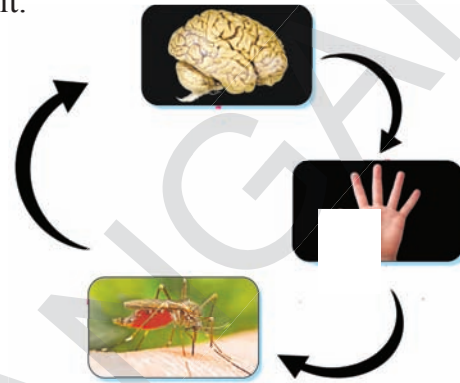
Stimuli from the environment around are received by our body through sense organs. As we already know, they are the eyes, ears, nose, tongue and skin. Let's try to understand the path of receiving a stimulus and expressing a response (sensation).

### 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 sensory 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 respond.

For example, when a mosquito bites you on your leg the sensation is carried to the brain through sensory nerves. The brain sends the message to the hand to kill the mosquito through motor nerves. Then we kill it.



*Fig-1 schematic representation of nerve stimulation to response.*

### Activity-1

Write a few lines about flower in your note 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? Give reasons.

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 by, adding a quarter

tea spoon full of sugar every time to find out how much sugar needed to taste maximum sweetness. This means sugar in solution has stabilized your sensation.

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!).

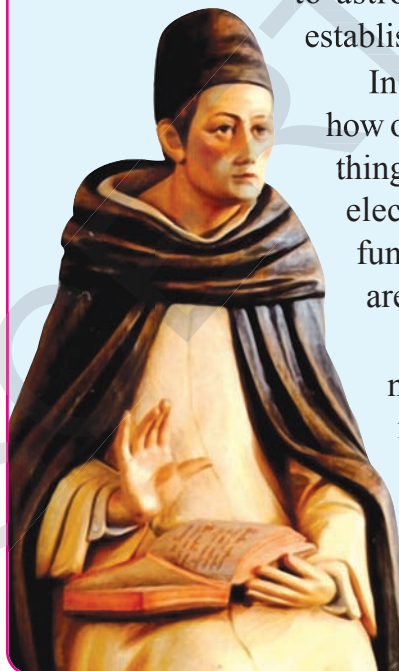
This usually happens because a higher level of the same stimulus masks that of the lower level. Remember the poem

### 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).

Albertus Magnus 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 has been 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 amazing 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 sense organs, but in fact, we may have many more senses. 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!



“Tinaga Tinaga Vemu Thiyyanundu”. If you continuously eat neem leaves, they will taste sweet.

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 sense organs 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 focus a beam of torchlight on your friend's eye.

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

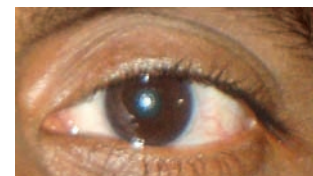


Fig-2(a) The Human Eye

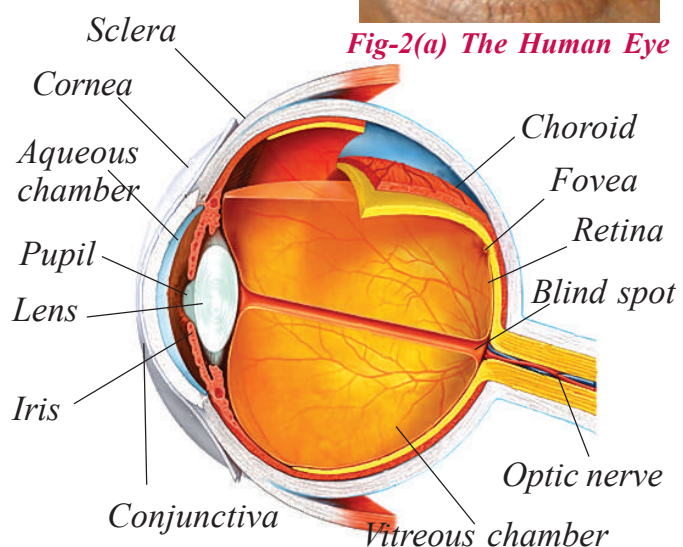


Fig 2(b) Human eye: schematic cross sectional view

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 focus 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 lacrimal 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 which 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.

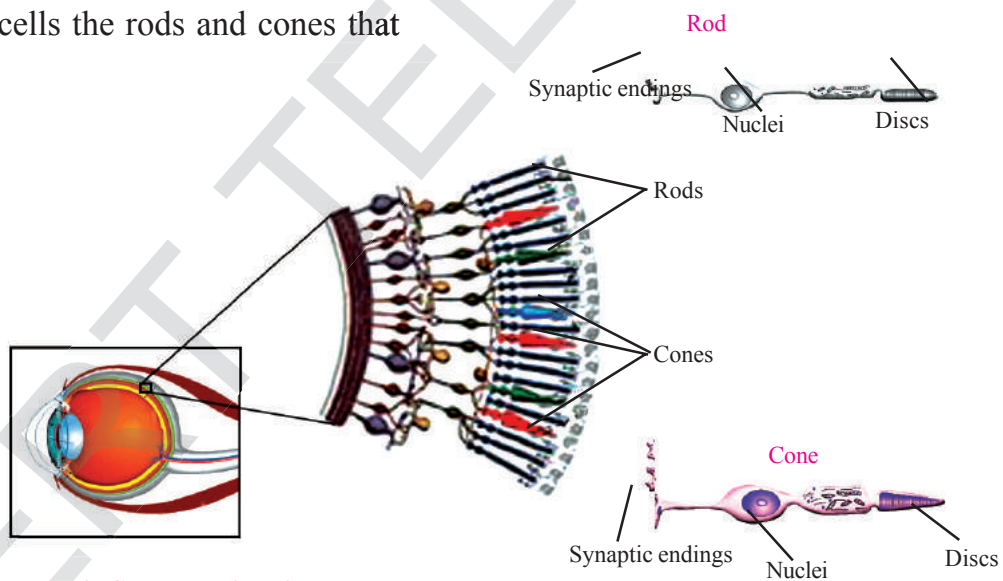
### Cells and tissues in the Eye

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.

Nearly 125 million tiny rods containing the pigment rhodopsin “are present in our eyes, they detect low intensities of light at night, though they cannot make the fine distinctions that give rise to our sensations of colour.



*Fig-3 Cones and rods*

Making the fine distinctions necessary for colour 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.

The cones are concentrated in a small region called Fovea in the center of the Retina.

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.

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 your 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 green line on either side.



Fig-4

### Eye protection

Each eye is protected by eyelids, eye lashes, eye brows and lacrimal 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 lacrimal 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 happens if we don't have eye lashes?  
How are tears useful to 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 do 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 transparent 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 moderate 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 lit room. What happens discuss your experiences in the class room?

Do you know that 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. That is how we see movies.

### Eye and Illusions

### Activity-7

Take two pieces of white papers of 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? Let us observe the following figures.

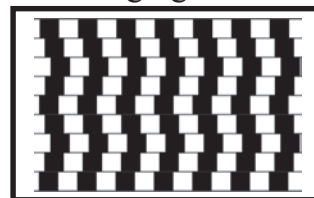


Fig-5(a)

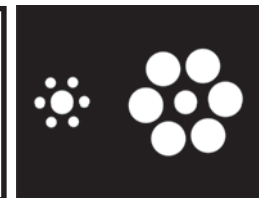
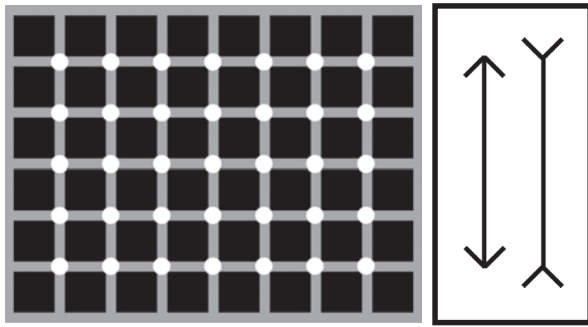


Fig-5(b)

fig-5a :Are these lines straight or not  
fig-5b: Which one is having big circle in the centre?



**Fig-5(c)**

**Fig-5(d)**

*fig-5c: Why do the dots appear grey painted 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 greyish 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, Xerophthalmia, myopia (near sightedness), Hypermetropia (far sightedness), glaucoma, 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 do you take care of your eyes? Let us observe the following check list and note the points you get.

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 sparks, eclipse.	Yes/No

How many 'Yes' points did you get? Are you aware of any other eye care measures?

Discuss in group and note down in your note book.

The more 'Yes' points you get the better you take care 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 to know the inner parts of ear?

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

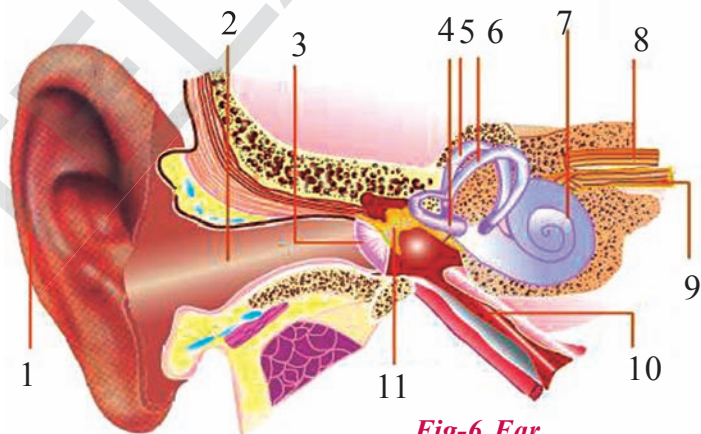


Fig-6 Ear

### 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.

What happens if we don't have external Pinna?

### 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 ear which 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. It 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 vestibuli and scala tympani are filled with perilymph. Scala media is filled with endolymph. It contains organ of corti and tiny cells called primary sensory cells.

Cochlear nerve fibres form cochlear nerve. The vestibular and cochlear nerves join together and form auditory nerve.

Prepare a theme chart with the knowledge gained about the structure of ear and exhibit in the class.

### The Hearing/Auditory Sensation

External ear collects the sound waves. They enter into the auditory meatus. 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 corti. 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? Discuss your observation in the class.



## 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 ears maintain balance.

## Caring for the ears

Don't insert any sharp edged thing in the ears to clean the ear canal.

If any blockage occurs due to ear wax, use the ear drops, or a few drops of hydrogen peroxide oil to loosen it.

A specialist may be consulted whenever needed.

It is very dangerous to pour 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.

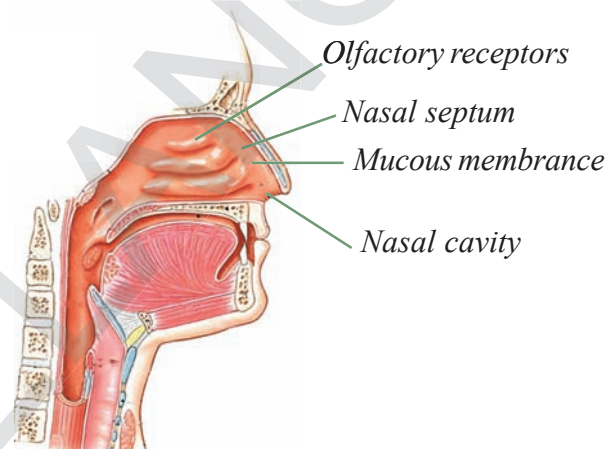
## Nose

### 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 mucous membrane and small hairs. Olfactory receptors are present in the mucous membrane.

## Smell and our Nose

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



*Fig-7 Nose*

## The Smell or Olfactory sensation

Smell of certain flowers like Artabotrys (Sampenga) and certain fruits like Jack fruit (Panasa) are liked by some people but not by others. How do you come to know something smells good or bad?

Biologically, the sense of smell, or olfaction, begins with chemical events in the nose. There, odour (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 odour chemicals. These odour 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 odours you are able to smell?

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

We also know that the receptor cells of nose 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 system and endocrine or hormone secreting system.

If you are suffering from cold, do 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.

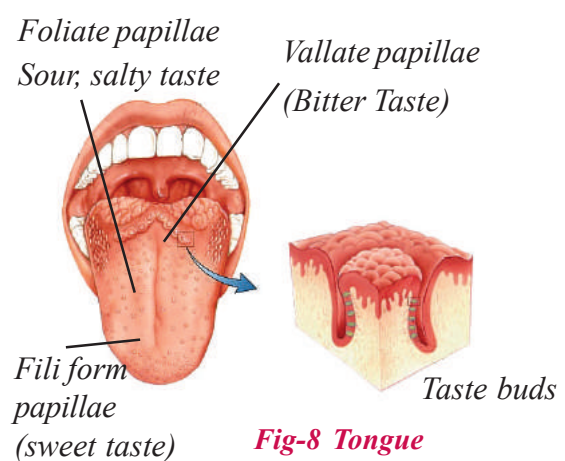


Fig-8 Tongue

### 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 flavours really come from odours. (Much of the "taste" of an onion is odour, not flavour. 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 savoury flavour found in protein-rich foods, such as meat, seafood, and cheese. .

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 flavours 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 high taste sensitivity, that 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-10

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-11

Observe your tongue by standing in front of the mirror by protruding it 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-12

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 was given to him. 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 are we suggested not to take too cool or too hot food material?

If you are suffering from fever why you are not able to enjoy the taste of food?

### Skin

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

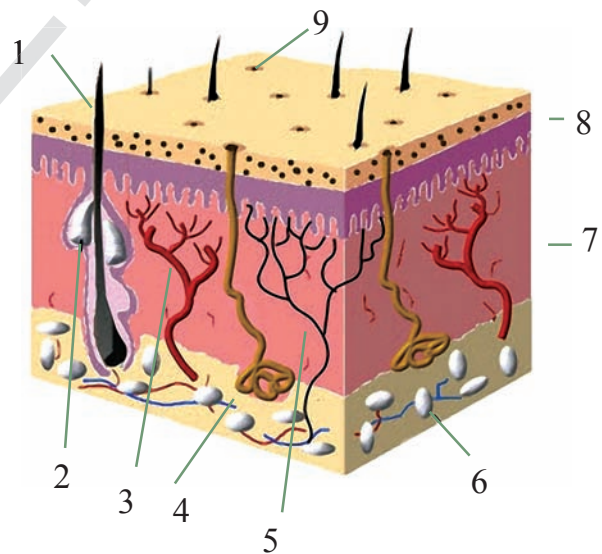


Fig-9 Skin

### Structure of the skin

- |                 |                 |
|-----------------|-----------------|
| 1. hair         | 2. Oil gland    |
| 3. blood vessel | 4. sweat gland  |
| 5. nerve        | 6. fat globules |
| 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 receptors. It is the largest organ of all. It provides the first level of protection to the body.

How sensitive is our skin?

### Activity-13

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 your friend to close her/his eyes. Now starting from the tip of the thumb keep pricking lightly with your toothpick bundle all over the palm and keep asking your friend how many points she/he could identify each time. Remember to record with cross, if

there is no sensation and with numbers depending on the number of points identified.

Repeat this with some of your friends.

Where do you find maximum sensation on the palm?

Where do 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-14

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?

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 vitamins.

Fungal diseases such as ring worm.

### Do you know?

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 livelihood.



### Key words

*Sensory receptors, lacrimal 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, semicircular canals, cochlea, basilar membrane, auditory nerve, chemoreceptors, olfactory sense, fungiform papillae, filiform papillae, vallate papillae, foliate papillae. Melanin, cutaneous receptors, tactile receptors, leucoderma*



### What we have learnt?

Sense organs are five, they 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.

Lacrimal glands secrete lubricant for the eye aiding in movement 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 sebaceous glands are present in the ear.

Tympanum or ear drum is present at the end of the auditory meatus or ear canal. 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 amplify 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 don't get the 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.

1. Choroid 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 focussed by external pinna and ear canal 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  
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. What happens if our skin loses its sensory nature? (AS 2)
- IX. Form a group with five students in your class and collect information of eye diseases and its characteristics by talking with ophthalmic assistant. (AS 4)
- X. Draw and label the diagrams, showing the structure of the (AS 5)**
1. Eye
  2. Ear
  3. Tongue
- XI. How would you pay concern towards disabled people who are lacking sensory organs?
- XII. How do you appreciate the functions of sensory organs which helps us to enjoy the beauty of nature? (AS 6)
- XIII. Sagar is not able to listen things properly. Guess what would happen to him. What suggestions would you like to give 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 do fish need not learn to swim?
- How can butterfly find nectar?
- How do ants search their food and pass information to each other about this?
- Who teaches 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 affect their behaviour?

### What do we mean by Animal Behaviour?

Animal Behaviour is the scientific study of the of the interaction of animals

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 ones.



*Fig-2 Weaver bird*

The study of animal behaviour begins with understanding how an animal's Physiology and Anatomy are integrated with its behaviour. Both external and

internal stimuli prompt behaviours  
 External stimuli includes the sounds, smells, threats from other animals and weather. Internal stimuli includes hunger and fear. Scientists are drawn to the study of animal behaviour for varied reasons and the field is extremely broad, ranging from research on feeding behaviour and habitat selection to mating behaviour 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 researchers. The following types have been studied so far

- Instinct
- Imprinting
- Conditioning
- Imitation

### Instinct

Instinctual behaviours are the 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 object, 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 them.

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. He received Nobel Prize in 1973 for his contribution in physiology and medicine.

## 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.

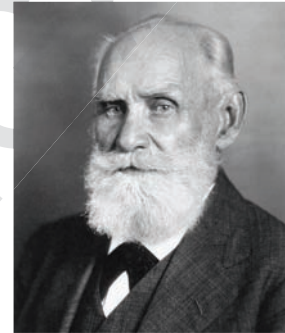
When school bell rings at the end of break time, the students leave the playground and go to their classrooms.

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

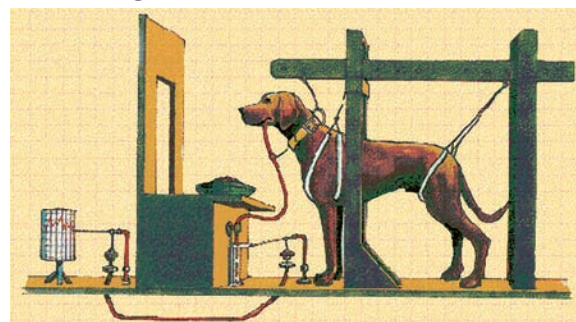
experiences they had learnt when to perform which function. They would be wrong sometimes.

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, which 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.



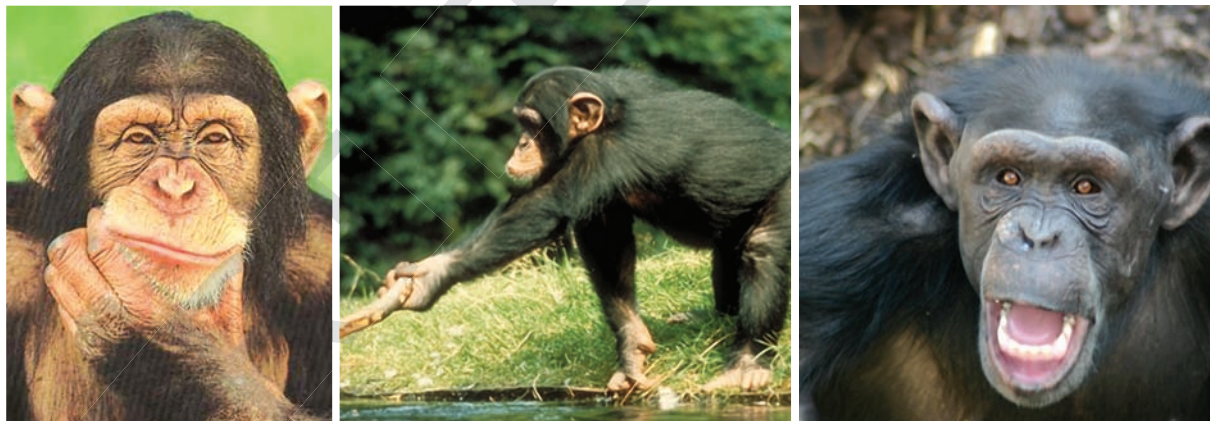


**Fig-6 Electric fences stop grazing animals straying**

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.



**Fig-7 Behaviour of Chimpanzee**

## Human behaviour

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

Let us study about the various methods of behaviour in humans.

## 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 Kohler observed that, 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 merchant.

## Instinct

Humans have instincts, but it is possible for us to overcome natural urges to follow certain behaviour. For example, hungry persons might start eating immediately when they sit down at the dining table, but they have learned that good manners means 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 lead 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 to 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 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 each other to warn danger. Some scientists are interested in such signals. They record and study them to work out what the signals mean, you would have observed how ants respond when they meet one another.

## 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 help 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

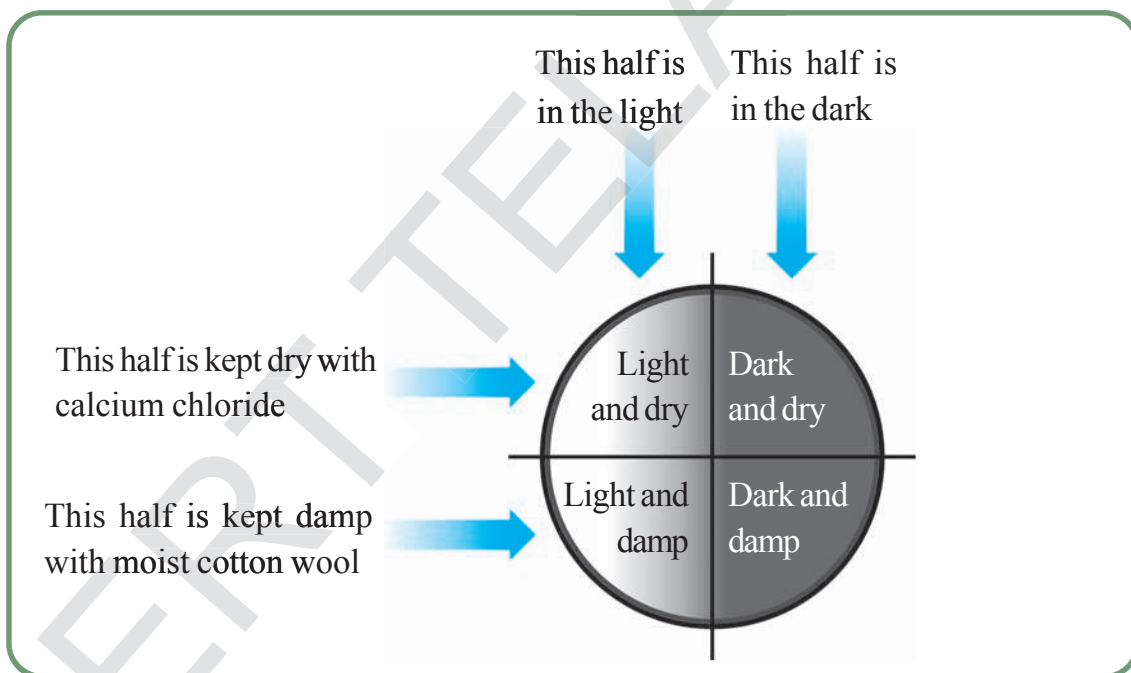
Cover the box and leave the setup for 15-20 minutes.

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 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 train your dog not to enter your kitchen. Does it ever enter into the kitchen?

Ants which usually go in a line reach sweet kept in a 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 only during night. How could they know what is a day and what is a night?

When you untie the neck of your bull at the time of ploughing, 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 and strong to build its nest. How do they know the quality of the materials?

Puppies, kitten fight with each other when they see a piece of cloth. They try to tear 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 them making nests. It varies from species to species. Birds build their nests in different ways. Tailor bird selects three broad leaves one for bottom, two for top and sides they also collect threads to make their nest for 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 surroundings.

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 cuts big trees by its sharp teeth to



*Fig-10 Beaver carrying log*



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

Wasp is an intelligent bee which builds its home keeping in view of 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 air 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 keep in 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 intelligence. In other words, we can say that you know what others think of you and vice versa. 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 scrub jay had stolen them. 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*

Squirrels 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, straw 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. Some times it forgets the place. In nature it helps in spreading of seeds.



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 laboratory of Hawaii 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, Irene Pepperberg bought a parrot and trained it. Slowly she made it learn more

than 100 words. Then she arranged the words in such a way that Alex could frame its own sentences. After some days, She 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.

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 calf. You also see this different types of behaviour in other animals.

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



### Do you know?

Some animals spray bad smell through their body to protect themselves 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.

### Activity-2

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 branch 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 Dutch 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, Ethology.*



## What we have learnt

Animals show 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.

The scientific study of animal behaviour is called Ethology.



## Improve your learning

- What is the advantage of reflex action? (AS 1)
  - It has to be learned
  - It happens differently each time
  - It does not have to be learned
  - None of them
- 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)
  - Imitation
  - Conditioning
  - Instinct
  - Imprinting
- Describe all types of behaviour discussed in the lesson with appropriate examples. (AS 1)
- Differentiate between (AS 1)
  - Imitation and Imprinting
  - Instinct and Conditioning
- How human behaviour is different from behaviour of other animals? Explain with an example. (AS 1)
- Observe ants going in a line. Ask your teacher how they communicate and write a note on this. (AS 4)
- "Understanding of animal behaviour creates positive attitude towards animals." How do you support this statement? Explain with suitable examples. (AS 6)
- Look at this picture. How do you feel about sibling care nature of animals. Have you ever seen such kind of situations in your surroundings? Explain in your own words. (AS 7)



## Chapter

## 8

## Challenges in improving agricultural production



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, methi 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 several 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 grain per month or 600kgs 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 decade production of food grains didn't satisfy 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 needs.

Write your suggestions to improve food production.

.....  
.....  
.....  
.....

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 that 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 rice and wheat. Suppose the plants grow 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 the following table.

**Table-2**

<b>Method</b>	<b>Production (kg/hectare)</b>	<b>Gain (kg/hectare)</b>
<b>Time of planting</b>		
A month after the onset of rains	3,400	
Immediately after the onset of rains	5,830	2,430
<b>Density of planting</b>		
plants per hectare 39,600	4,100	
plants per hectare 19,800	5,130	.....
<b>Weeding</b>		
Once	4,040	
Twice	5,200	.....
<b>Nutrient application</b>		
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 k.g/hectare. Planting after one month after the onset of rains resulted in production gain of 3,400 k.g/hectare. Which means the production reduced by 2,430 k.g/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. This leads to environmental problems. 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. Crop rotation
5. Cultivating 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 in your VIII class. Short term varieties produce grains more than long term varieties.

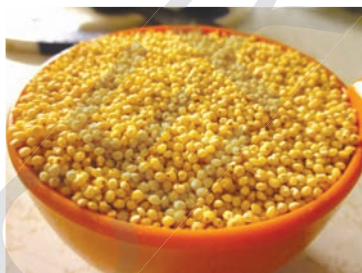
Alternating of crops preserve the soil fertility. Mixed crop system helps the farmers to produce variety of crops as well as increase in the production.

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

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

### Improving high yielding crop 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 yield. Refer annexure for more information.



*Fig-2(a)  
Hybrid variety  
grains*

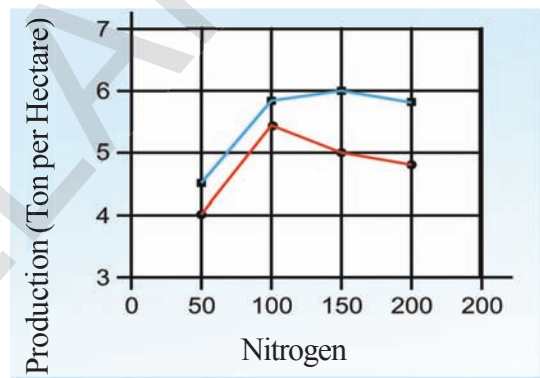


*Fig-2(b) Local  
variety grains*

### High yielding crop management methods:

#### (A) Irrigation

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 both the irrigated and unirrigated fields. The results of the experiment are illustrated in Graph-1.



#### Supply of Nitrogen (Kg. Per Hectare)

- 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 is the difference in crop production when the same quantity of nitrogen is applied to both irrigated and unirrigated fields?

### 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 know that the plant combines water and carbon dioxide with the help of sunlight to produce carbohydrates. Starch is one such carbohydrate. Different types of sugars and cellulose are also carbohydrates. A chemical analysis will show that 100 grams of water reacts with 260 grams of carbon dioxide to form 180 grams of carbohydrates.

But the plant roots do not use all the water they absorb 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.



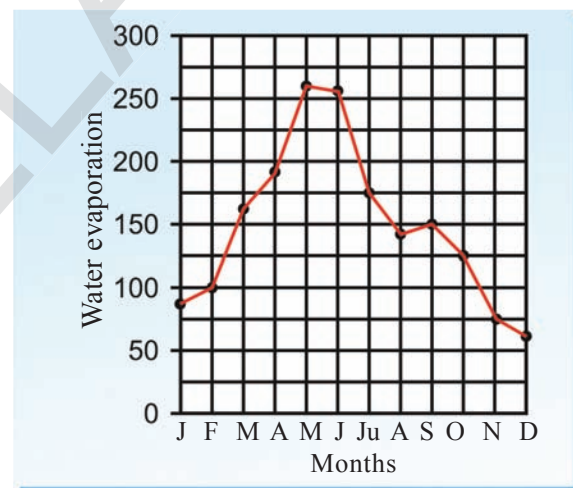
**Fig-3 Transpiration**

If you tie a plastic bag over a leaf, you will be able to see how much water a plant releases into 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. This is known as transpiration. You learn more about it in higher classes.

### 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 shows us how much water evaporates from plants in different seasons.



**Water evaporation month wise ( in m.m )**

**Graph-2**

Find out from the graph the months in which the most water evaporates from plants.

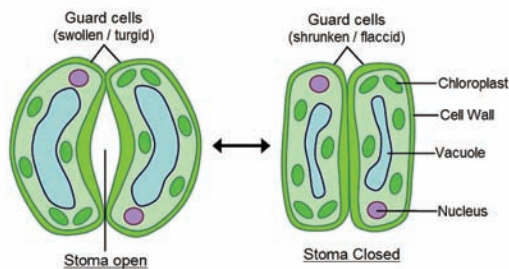
Are these the same months in monsoon season when the rainfall is heavy?

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 pores 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’ of class VII 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 find out 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 substances in the chapter, “Transportation of material across the cell membrane” and in the chapter “Plant Cell”. Try to think of how xylem and phloem are useful in transportation.

Water is essential for Agriculture.

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 by irrigating them with water from 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 follow 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 Bahadur Canals of Nagarjuna Sagar in Telangana map. Identify the districts covered.

Collect the data regarding to mission Kakatiya and discuss in your class.

### B) 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 Macronutrients. Some nutrients are necessary for plants in small quantities. These are called Micronutrients. Ex: Iron, Manganese, Boron, Zinc, Copper, Molybdenum, Chlorine, Nickel etc.

These mineral nutrients 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 (Units: Kg / Hectars / Season)**

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

When any of these crops are sown in a field, they absorb these amounts of nutrients, every time.

### C) 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.

## D) 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 a 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 crop rotation 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	Helps roots to penetrate 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, pulses/ 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 synthesize 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.

## E) 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 is 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 with Sunflower

Groundnut grown along with Red gram

Sorghum grown along with Pea



*Fig-5 Red gram in Haldi*



*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. You will learn more about nitrogen fixation in Bio-Geo-chemical cycles.

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 Root 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.

## F) Organic manure

Do you ever saw a herd of goats in a vacant field? Why shepherds make arrangements to stay their goats and sheep 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 increases.

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

Groundnut, Gingelly, Castor, Coconut, Neem, Jatropa 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 ton of organic manure is given in Table 5.

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

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 formed by mixing cow-dung, hay, urine etc)

Suppose a paddy crop is grown in a field and five ton 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?

### G) 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 /ton)
Lobia, beans	7.1
Dhaincha	6.2
Kulthi	3.3
Green gram	7.2
Sun hemp	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.

### H) 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 collect 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.

### I) 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 tonnes of organic wastes. They said that after using this organic manure, investment on chemical fertilizers and other pesticides became reduced and the quality of their agricultural products increased.*



*Fig-10 Vermi compost culturing*



*Fig-11 Vermi compost beds*





**Think and discuss**

In what way vermi compost is better than chemical fertilizer.

**J) 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 yield. It is also used as food for hens and fish in ponds.



**Fig-12 Panchagavya**

**Table - 7 : Bio fertilizers**

Bacteria		Algae	Fungi	
Nitrogen Fixers:	Phosphorus Solubulisers:	Nitrogen fixer:	Phosphorus moralizers:	phosphorus solubuliser:
Ex: <i>Rhizobium</i> <i>Azotobacter</i> <i>Azospyrillum</i>	Ex: <i>Bacillus</i> , <i>Pseudomonas</i>	Ex: <i>Bluegreen algae</i>	Ex: <i>Micorrhiza</i>	Ex: <i>Pencillium</i>

**K) Organic farming**

By using chemical fertilizers, we can get high yield 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, usage 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 came into existence. This is our ancient practice. 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 pyrethroids (insecticides), to get higher yielding.

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



Generally bio fertilizers are two types. First type are nitrogen fixers and the other type are Phosphorus mobilizers and solubilizers. 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 quantity and the type of nutrient he gets from that fertilizer before applying it in fields.

**Table 8: Percentage of nutrients in different chemical fertilizers**

Name of the 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 the table 7.23 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?

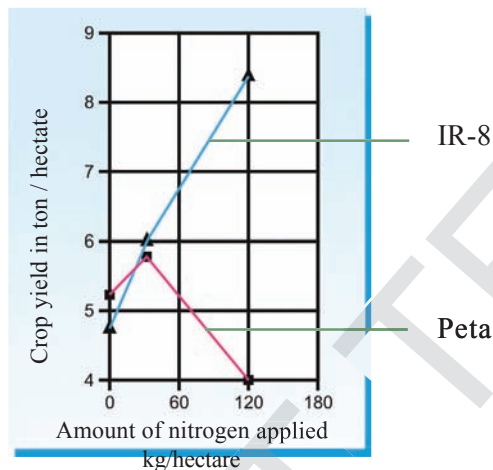
If 50 kg of Superphosphate is added to the soil, how much Phosphorus would the soil get?

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 irrigated water or to place them under the soil.

### The amount determines the effect

It is not necessary that the production of all crops increases equally if an equal amount of nutrients are supplied. 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 always 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 irrigated 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, in a field along with the crop plants other unwanted plants grow. 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 sunlight 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 and explain the effect on crop production if a field is free of weeds. What will happen to the yield, if weeding is not done?

### 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.

The diseases caused by insects and microorganisms effect 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 help to get rid of weeds from fields. 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 into lungs, blood and shows its effect in their bodies and show long term . 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, Prakasam 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 Insects 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. It makes easy to capture them.

Discuss with your friends and try to find out some other alternates for pesticides.

### **Natural pest controlling methods**

Generally farmers use synthetic Pyrethroids like Pesticides, Insecticides to control pests on crops. There are so many natural pest controlling techniques.

Which methods are followed by our farmers?

Some insects control the harmful insects and they are called friendly insects. Spiders, Dragon fly, Chrysolids, Lady bird beetle, etc., are the insects that eat larvae of Jassids, Thrips, and Stem borers.



Some fungi (like *Trichoderma* species and some bacteria (like *Bacillus thuringiensis*) are capable of destroying pests like stem borers in tobacco etc.



**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 gingelli prevent gram caterpillar. After Red gram, cultivating maize and corn prevents spotted bore worm and dried disease. These are called Akarshaka Pantalu.

Do you know why Jetropa in cotton fields and marigold in Mirchi fields are cultivated?

Improvement in food production and sustaining soil health, as well as environmental protection are the challenges of agricultural practices. Farmers should be aware of quality, innovative practices in agriculture. To know about progressive farmer read the annexure.



### Key words

*Weeds, insecticides, fertilizers, fungicides, irrigation, Drip irrigation, predatory insects, immunity, bacterial culture, crop rotation, mixed crop, organic fertilizers, vermi compost.*



### What we have learnt?

In our country food production is not increasing in accordance with increase in population.

Factors for the increase of food production are quality and variety of seeds planted, properties of the soil, availability and proper application of irrigation and fertilizers, weather, controlling insect attacks, controlling the weeds etc.

Mixed crop system helps the farmers to produce varieties of crops as well as increase in soil fertility and crop production.

Crop rotation preserves 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 the process of photosynthesis.

Absorption of CO<sub>2</sub> 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 by cultivating another crop.

Humus and water holding capacity are increased in the soil by applying the natural manure.

Any plant 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 through which our country could increase the production of rice to meet 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 that are used for growing the high yielding variety of crops? (AS1)  
(b) Can high yielding varieties be grown without them as well? How? (AS1)
4. What are the essential measures that a farmer needs to take before sowing the seeds of a crop? (AS1)
5. Suppose you had a farm in a drought stricken area of your state what crops would you grow and how? (AS1)
6. What measures will you take to save your field from seasonal outburst of insects?(AS1)

7. 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)
8. 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 cultivated without using pesticides in Ramaiah's field? (AS 2)
9. Observe the fields in your surroundings and collect the information from farmers about the process to remove weeds.(AS3)
10. Make a list of the major weeds in your area (you have already conducted the project). Find out the different weeds that grow along with different crops in your area? (AS 4)

Name of the Crop	Weeds that grow along with crop

11. Draw a block diagram of water resources in your village? (AS 5)
12. What threats to nature do chemical fertilizers, pesticides, insecticides and herbicides pose? (AS 6)
13. Organic manure is helpful to Bio diversity. How do you support this statement? (AS6)
14. Spraying high dose of pesticides is hazardous to bio diversity and crop yielding. How can you support this statement? (AS 6)
15. What are the adverse effects of using high yielding varieties of seeds? (AS1)
16. How would you educate a farmer to use organic fertilizers instead of chemical fertilizers. (AS 4)
17. Venkatapuram village is in drought prone area. Somaiah wants to cultivate sugar cane in his fields. Is it beneficial or not? What questions will you ask him to convey your opinion (AS 7)
18. Natural pest controlling methods are useful to Bio diversity. Comment it? (AS 7)



## ANNEXURE

### 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?

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

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.

## Lab Activity

### 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 needs patience . 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?

You know Tomato and potato. Do you Know Pomato? Look at this photo.



*Pomato*

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 are 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 result whole diversity of the food grains. Traditional and local varieties become extinct. Such mono-cultural practices lead to 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 should raise our voice against this issue.

**Comparison chart**

	<b>Chemical Fertilizer</b>	<b>Organic fertilizer (compost / biofertilizer)</b>
Example:	Ammonium sulphate, ammonium phosphate, ammonium nitrate, urea, ammonium chloride etc.	Cottonseed meal, blood meal, fish emulsion, and manure and sewage sludge, vermi compost.
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.
Rate of production:	High, because of immediate supply of nutrients.	Moderate, because of slow release of nutrients.
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

## 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 and glorified his agricultural practices .

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 acres. I used to grow food grains like paddy, groundnut, redgrams, green grams, black grams etc., vegetables like tomato, brinjal 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 15% 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 are exposed to maximum sunlight while others to limited sunlight. This is possible only because of biodiversity. Drumstick plants are grown



under coconut and Heliconia 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 successful 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 to 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

# Adaptations to Different 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 adapt different means for better survival. For example, some trees such as Mangroves like *Avicennia* 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 Mangroves**

These “knees” (aerial roots) 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 definitely 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 activity 1 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.

What is meant by adaptations?

Describe your opinion.

Organisms in nature create adaptable situations around them on the basis of their needs. They also adapt to situations specifically. For example in *Opuntia*, the leaves are reduced to spines so that transpiration loss is checked 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. *Aloe vera* are found in our surroundings these days as well but you may have heard that they are generally called as desert plants (xerophytes).



*Aloe vera*



*Opuntia*

Fig-2



### Think and Discuss

Can you give some examples of fleshy leaf plants?

Why xerophytic plants do not have broad leaves?

You may see *Agave* (Kittanara), a Xerophytic 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 details the Boabab tree? Its trunk is swollen. What do you think it contains? It stores water in its trunk and survives the scorching heat of dry seasons.



Fig-3 Desert plants (*Baobab tree*, *Cactus*)



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



*Fig-5 Cactus*

voluntarily to protect from blowing sand. Long legs - keeps the body away from hot ground.



*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, Sandgrouse*



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 bounces off objects to find prey or protect from predators.

Cats, Rats, Bats, Owls are the Nocturnals generally seen in our surroundings. 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. 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 and 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<sup>2</sup>). You studied about in the chapter 'Force and

Pressure' in VIII class Physical Science text book and let us recall them.

This limits our study of ocean depths significantly unless we use diving craft specifically designed to maintain one atmosphere.

### Secret of swimming

Swimming is the fundamental characteristic feature of aquatic animals. Their bodies have certain adaptation to fight with pressure of underwater current. Let us try to find out these secrets.

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 some 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 our muscles.

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 fishes even have lung-like swim bladders to control their buoyancy (ability to float in a medium). They move up in the water column by releasing 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 take dissolved gases like Oxygen from the water needed to release the energy from food. Simple animals, such as Anemones or worms, take the gases through their skin. Mobile animals use gills, or even lungs to take 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 fishes 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 high pressure, 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-coloured Clownfish have adapted symbiotic relationships with Anemones to protect both the Clownfish and the Anemone from predators. Some 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.

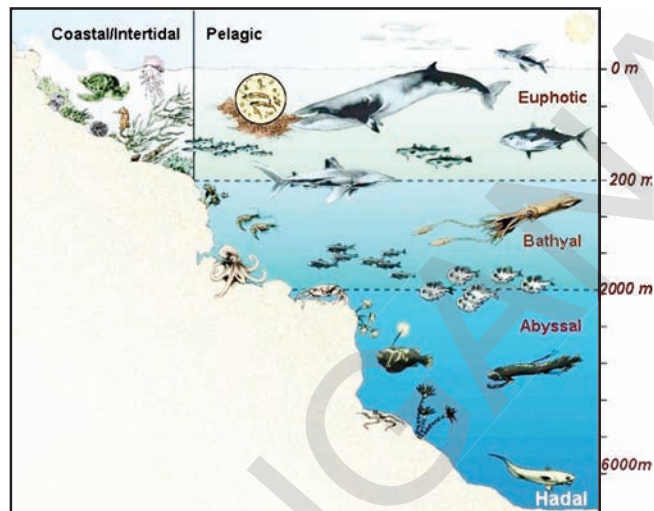
Ask your teacher about symbiosis, camouflage, go to internet and find out some more details to prepare a paper and submit in your school symposium.

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 <sup>o</sup> c	0-200m	Planktons, physalia, dolphins, flying fish, green turtles, sea anemones.
Bathyal zone (twilight zone)	Dimly lit	4 <sup>o</sup> c - 39 <sup>o</sup> C	200m-2000m	Whales, lantern fish, red, brown kelps, sea cucumbers, fish, squids, octopus, sponges, corals etc.
Abyssal zone (dark zone)	Dark	2 <sup>o</sup> - 3 <sup>o</sup> C	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. They may have big eyes sensitive to very dim light.



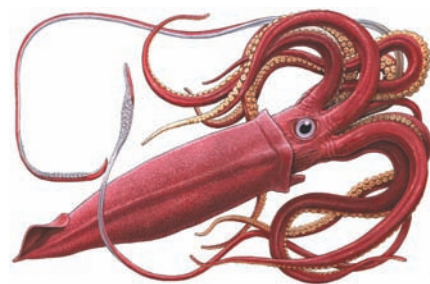
*Fig-10 Ray fish*

### 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 darkness of deep 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 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

In Jelly fishes, Decomposers 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, Laknavaram of Warangal, Paleru Cheruvu of Khammam, Koyal sagar in Mahaboob nagar, Ali sagar in Nizamabad etc. are fresh water ecosystems in Telangana state.

Does the Lakkavaram lake of Warangal comes under fresh water ecosystem or not. Why? Give reason.

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 affect the organisms and their populations in different ways.

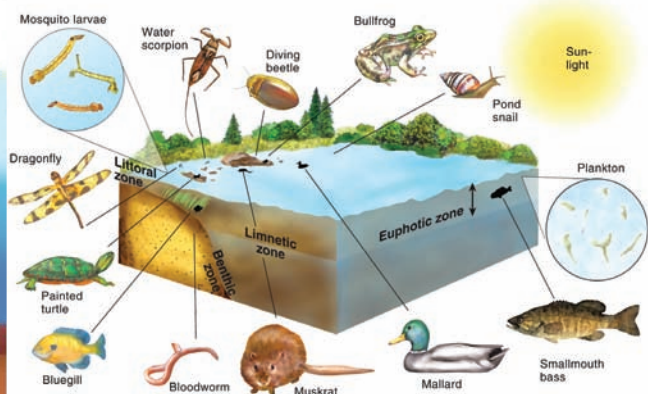
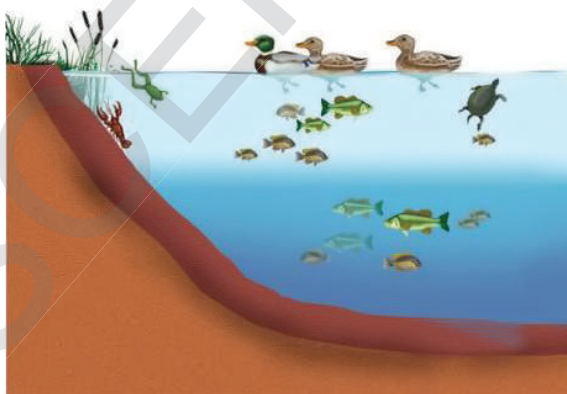


Fig-12 Zones in Lake Ecosystem and Types of Organisms present

**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 (saprophytes - microbes that decompose 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 acquire 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 in lake**

Mammals (like Badgers, Otters) live near water and are capable of swimming to catch their main food source, particularly fish. You have studied about Beaver in Animal behaviour.

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 swim over the surface of ponds, playing a critical role in the food supply for other animals.

Many species of Ducks, Cranes and Swans also reside in and around the lake ecosystem feeding on a number of different items including fish.

Think, how webbed feet helps duck?

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 adaptations

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 float, 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 which has 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 in 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 water in the lakes and ponds gets frozen, killing all the organisms. You have studied about fresh water ecosystems. Discuss the following points in your class.

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 and 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 examples of adaptations

#### Adaptation to temperature in plants

The effect of temperature on plants of terrestrial ecosystem can be seen in different ways.

Do all plants shed their leaves at same time in a year throughout the world.

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,



**Fig-14 Fall season  
modified stem**

usually keep the stomata closed during the day to reduce transpiration loss. High temperatures also lead to adaptations like reduced leaf.

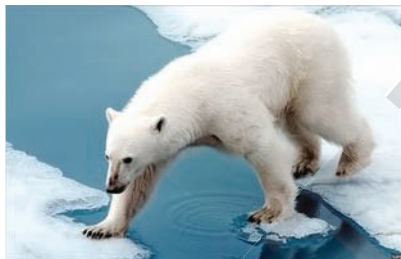
Let us recall why xerophytic plants have modified stems and leaves.

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

Body 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 fur over its body?

In what way thick skin helps the Seal to protect from cold weather?



*Fig-16 : Seal*

Animals living in these regions adapt themselves in different ways. They have a thick layer of fat deposited under their skin, 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 up 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-17 : 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 you need to go to library or internet and also take your teachers help for more examples.

## Lichens

You may have observed greenish patches 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-18 : Lichen**

Figure -18 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 of *Algae* 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 symbiotic adaptations lichens are able to survive even in extreme conditions.

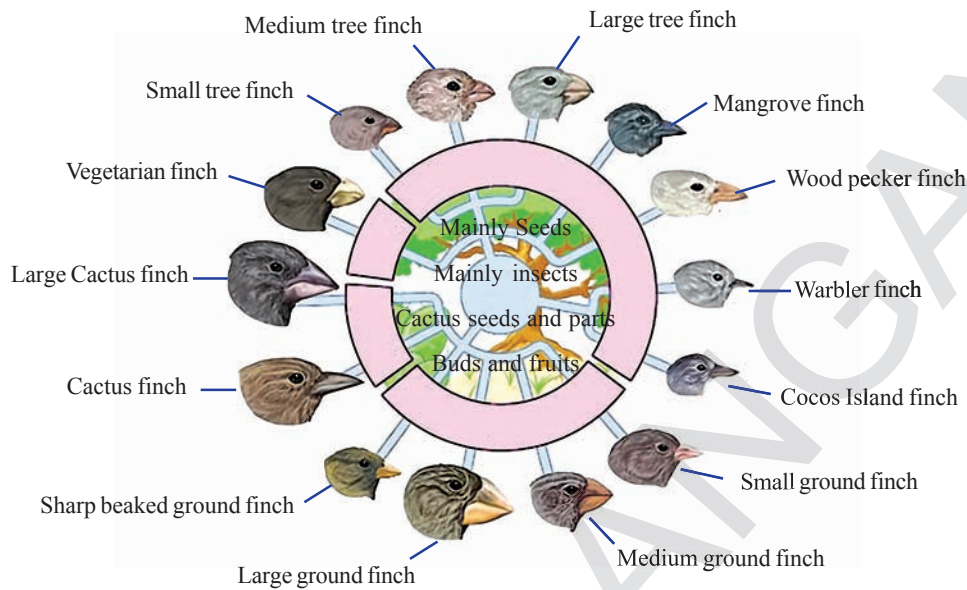
Adaptation to environment is not a simple phenomena. If we keep a cow in a desert, will it be modified like a camel? If a giraffee is kept in a forest with short trees or plants it would not convert like a goat. Adaptation takes place over a long period of duration.

## 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 the group of Galapagos 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-19**

Try to guess if there is 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-19. 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 adjust 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. What special adaptations can be seen in the following organisms? (AS1)  
a) mangrove trees b) camel c) fish d) dolphins e) planktons.
4. If an animal of euphotic zone has to survive in abyssal zone, what adaptations are required to survive there? (AS1)
5. Marine water fishes drink more water than fresh water fishes. Do you agree? Justify. (AS 1)
6. Write the effect of temperature on the organisms adapted in a lake and pond in a tabular form. (AS1)

7. In the chapter on ecosystem, we had studied about the mangrove ecosystems. In what way it is differ from marine ecosystem. (AS1)
8. How frogs protect themselves from cold and heat. (AS 1)
9. The Murrel (korramatta) and Rohu are fishes found in rivers. Will they be able to live in the Mangroove forest ecosystem? Give reasons for your answer. (AS 2)
10. Collect some aquatic plants- cut the leaves and stems Observe them under microscope and record your observations like presence air /absence of air spaces etc., and answer the below. (AS 3)
  - a) Why they float on water
  - b) Which factors helps to float.
  - c) Draw a diagram of what you have observed under microscope?
11. Visit a nearby pond or a lake. Record the organisms you have observed and their adaptations? (A S 4)
12. Collect information of one lake from internet and prepare a table of organisms adapted at different zones? (AS 4)
13. Are there any rivers meeting in the Bay of Bengal in the Mangroove forest ecosystem collect information and make a note on them? (AS 4)
14. Draw a lake showing different zones. Why are they called so? (AS 5)
15. Amphibians are wonderful creatures on the earth. How do you appreciate their adaptation? (AS 6)
16. How do you appreciate the processing protection pebble plants from the enemies (AS 6)
17. 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)

## Chapter

## Soil pollution



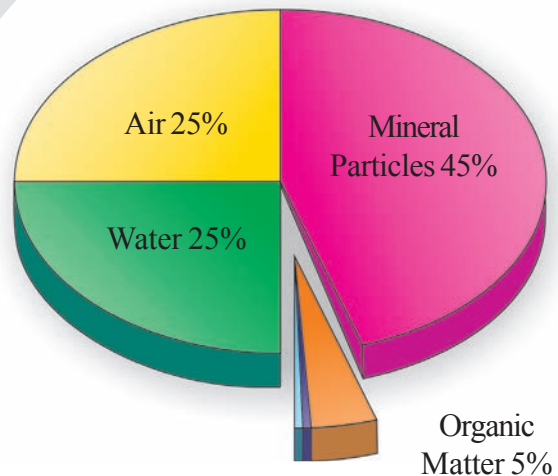
Our living Planet, consists of Atmosphere, Earth and Water. The interaction of the Atmosphere, Lithosphere, Hydrosphere and Biosphere is continuing for years together. It was clean and enjoyable. But due to the various activities of man, the composition and complex nature of environment got changed. The activities include industrialization, construction, transportation, agriculture and deforestation etc., 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?

Air, water and soil are three major natural resources, alongside soil is one of the marvellous products of nature without which there would be no life. It is a natural medium for plants to 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 is a habitat for many

organisms like, bacteria etc., which in turn feed and support plant life.

Healthy soil means the soil which produces healthy plants, on eating which animals also remain healthy.

### 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, 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 is mainly the parent material.

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 improve 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 physical properties of soil 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 dead and decaying plants, animals and residues of 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.

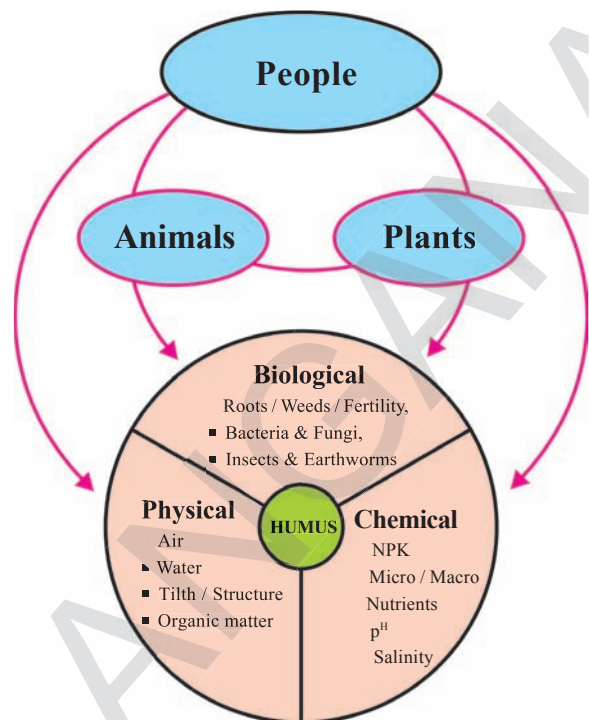
The pH of soil is important to know the type of vegetation that grows in the soil and the type of organisms that live there. Also, presence of organic matter in soil has a close relationship with soil pH. Soil richer in organic matter is acidic in nature as a result of degradation of various substances that produces various acids in soil. Availability of plants nutrients depends on the pH of soil.

The availability of Na, 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 decrease 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 Properties of soil**

Soil microbes also have an influence in controlling the quantities and effects 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 promoting fertility. Soil microbes convert organic forms of elements to their inorganic forms and liberate Carbon dioxide, Ammonium, Sulphate, Phosphates and inorganic forms of other elements. This process is known as 'Mineralization'.

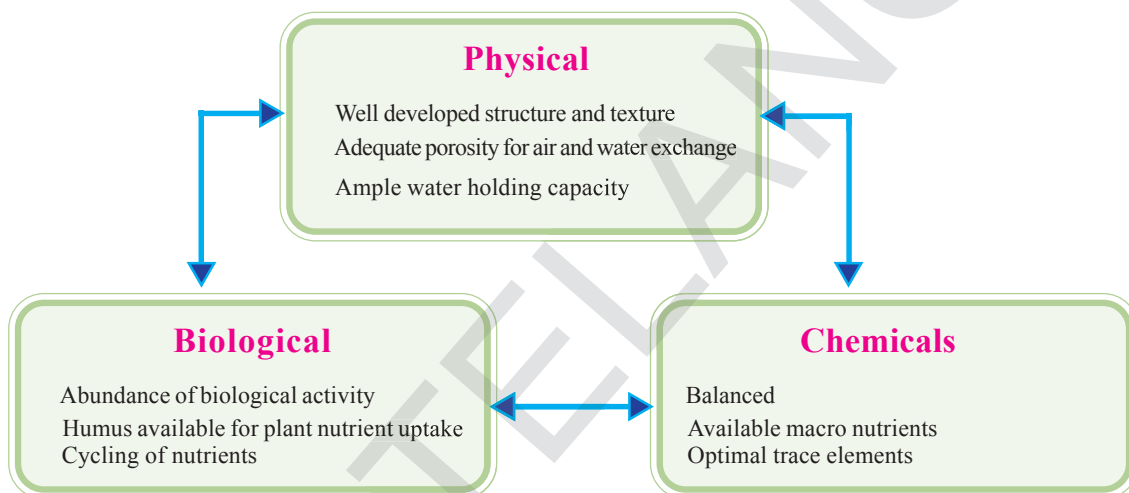
This is the basis of nutrient cycles in all major ecosystems of the world. Besides their role in controlling the rates of production of inorganic forms from various organic forms, soil microbes, particularly, soil bacteria also control the forms of ions in which these nutrients occurs. We shall study 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

How can you say that soil is fertile one. Discuss with your classmate write your opinion.

Fertility of soil depends on 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 Fertility 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. Soil structure, Mycorrhizal action helps to absorb nutrients from the soil and deposit it into soil organic matter thus stabilizing soil structure.

In addition to the above, soil  $P^H$ , its acidity or alkalinity, is highly relevant to how readily nutrients become available in soil.

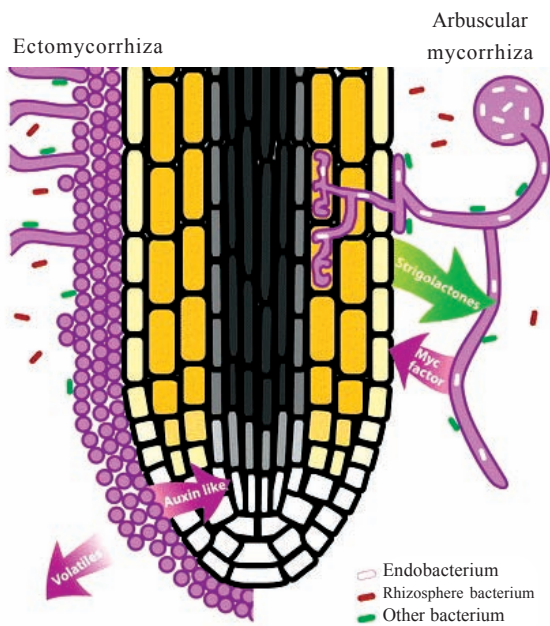


Fig-4

### Nitrogen fixing bacteria

Proper soil fertility management is very important for successful crop production and farming. Organic farmers regulate soil fertility by protecting the soil and feeding it organic material, thus ensuring quality yield. When the soil is fertile in the organic sense, it can produce good crop yields for several years. You learned about organic farming 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 him. Ramu said you should not throw waste in the varandah. Drop it in the bin / basket.

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.

**Table - 1**

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.

$$\text{Per capita wet Wastes produced at home} = \frac{\text{Total weight of wet waste materials}}{\text{No. of persons in your family}}$$

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 year. 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.

**Activity-3**

Take a polythene bag/plastic bucket / or any container. Fill half of it with soil. Keep wet waste and other wastes in it. (Waste should include vegetable peels, rubber, plastic etc). Add some more soil and sprinkle water regularly on it. Till it and observe in 15 days intervals. Note your observations in the table.

**Table - 2**

Material	What has happened in the 1 <sup>st</sup> fortnight	What has happened in the 2 <sup>nd</sup> fortnight	What has happened in the 3 <sup>rd</sup> fortnight
Vegetable peels			
Vegetable with removed peel			
Banana			
Plastic cup			
paper			
rubber			

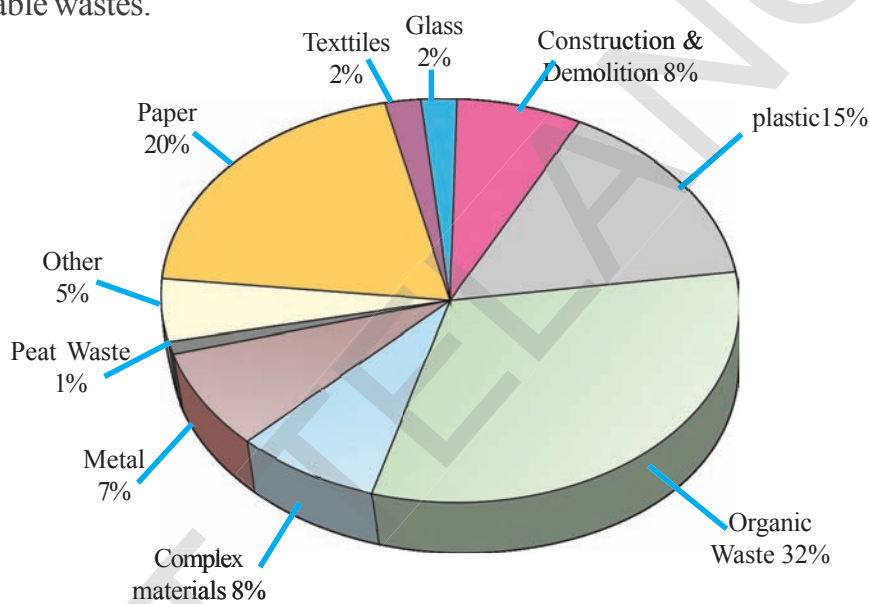


Take banana, plastic cup, paper and rubber. Now think, why are some of the waste materials mix with soil quickly while some do not?

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, chemicals like 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-days 'e-waste' (computers, mobile waste) also leads to soil pollution



**Fig-5 Soil pollutants**

Decomposition is the process of degradation of materials into simpler substances turning them into nutrients and making available to plants. Thus, biodegradable materials contribute directly to the fertility of the soil. However when there is an excess of bio-degradable material, it contributes the imbalance in the nature with negative impact. 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. Farmers use cow dung every year in the fields. Polluted water also pollutes soil. Solid waste is a mixture of plastics, cloth, glass, metal, organic matter, sewage, sewage sludge, building debris, generated from households etc., commercial and industrial 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

as well as land filling by municipal waste are growing causes 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. Due to atmospheric deposition (air pollution) soil gets contaminated significantly. Soil pollution can be classified into the following categories based on sources:

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 intensity of pollution correlates 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, Sulphur 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 ( $\text{NH}_4\text{NO}_3$ ), 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.

Over usage of NPK fertilizers reduce quantity of vegetables and crops grown on soil over the years. It also reduces the protein content of Wheat, Maize, Pulses 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 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.

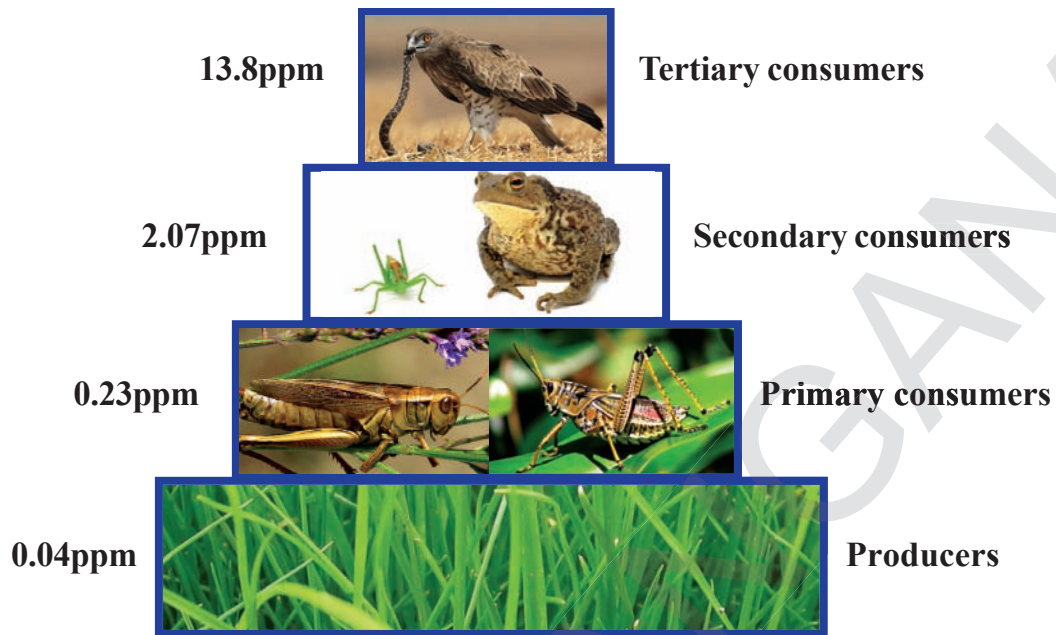
Besides DDT, other most important pesticides are BHC (Benzene Hexa Chloride), Chlorinated di Hydro Carbons, Organo Phosphates, Aldrin, Malathion, Dieldrin, Furodan, etc. The remnants of such pesticides used on pests may get absorbed by the soil particles, which then contaminate crops grown in that soil. The consumption of such crops causes the pesticide 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 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 or 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, mankind has been generating waste, from 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 because of the Industrial Revolution there is a 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 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 and poisonous 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.

We have to pay attention to hazardous solid waste like oils, battery metals, heavy metals from smelting industries and organic solvents. 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 business such as dry cleaners and gas stations contribute as well.

Toxic chemicals leached from oozing storage drums into the soil underneath homes, cause 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 land 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 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 CO<sub>2</sub>.

## 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 tonnes 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

As solid wastes and hospital wastes create many health problems: They may have dangerous pathogen besides dangerous medicines, injections.

## Pollution of underground Soil

Underground soil in cities is likely to be polluted by

Chemicals released by 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

Luckily, when right atmospheric conditions arrive, air and water pollutions can get reduced at great extent. But in case of land pollution unless some removes the pollutants, soil can't be restored. 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 for building or for agriculture. Houses might be built on brown field (former industrial land).

1) 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 resources 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 chemicals enter 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 poisonous and hazardous gases
- Release of radioactive rays causing health problems
- Increased salinity in the soil.
- 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 leach 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 four (4R's) R's: Reduce, Reuse, Recover 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 be 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.

### Reforestation / Recovery of materials

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 Telangana 32 towns 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 2021.

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 Waste Management*

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

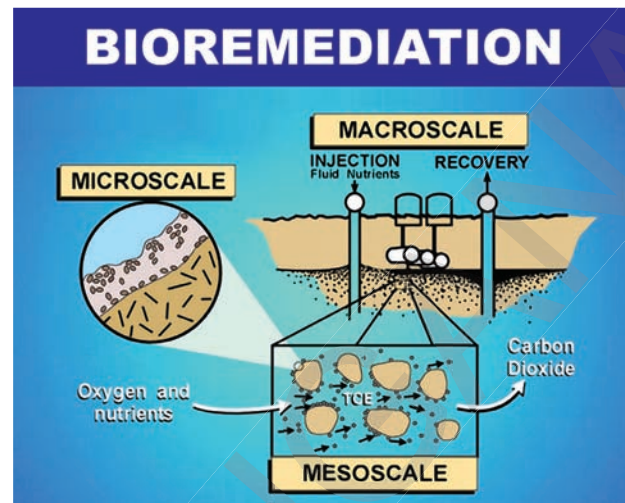
areas is the simplest and most widely used technique of solid waste management. Environmental and aesthetic considerations must be taken into consideration before selecting the dumping sites. Incineration of other wastes is expensive and leaves a huge residue and adds to air pollution.

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.

### Bio-remediation

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 soil, water, and sediments. Plants have also



*Fig-10 Bio remediation*

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 off 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 mass, 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 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 tilling. 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 fertility.

### Watering 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

*Soil pollution, Organic soil, mycorrhiza, mineralisation, bio degradable waste, non bio degradable waste, bio magnification, bio remediation, Incineration, Pyrolysis, Phytoremediation, bio accumulation.*



### 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, four R's principles: Reduce, Reuse, Recover and Recycle, reforestation, proper solid waste management and bioremediation.

Conservation of soil can be achieved through agricultural practices and measures that can be taken from our home.



### Improve your learning

1. Define soil pollution. (AS1)
2. Chemical fertilizers are useful to crops. In which way they cause environmental pollution? (AS1)
3. Describe environmental friendly methods to profitably dispose off human waste and cattle waste. (AS1)
4. What steps can be taken to reduce pollution due to particulate matter from industries? (AS1)
5. What is a medical waste? Why it is called hazardous waste? What is the safe way to dispose medical waste? (AS1)
6. What farm practices impact soil? Do they impact soil in a positive or a negative way? (AS1)
7. Rank the positive impact agricultural practices in order in which you think they should be used for the benefit on your farm. (AS1)
8. What are the three main physical properties of soil? What effects do this have on the plants? (AS1)
9. What is pH? What is its range? What are the negative impacts if the pH of soil is too low or too high?(AS1)
10. What is soil fertility? What steps are to be taken to improve soil fertility? (AS1)
11. What is organic matter? Why it is important to plants? (AS1)
12. What are the factors affecting organic matter levels in soil? How this level of organic matter can be increased? (AS1)
13. What is solid waste? Explain best practices for solid waste management. (AS1)
14. What is bioremediation? How it helps in controlling soil pollution? (AS1)
15. How would soil texture affect the up take of nutrients from soil? What would be its impact on crop production? (AS 2)
16. Why soil conservation is important to us? What will happen if no preventive measures would be taken? (AS 2)
17. Name 5 living things that live in soil. What do these things do to affect the soil? (AS 4)
18. Prepare flow chart to describe soil pollution, causes and methods of control.(AS 5)
19. Look at the following logo what does its mean. (AS 5) 
20. "plastic bags a big environmental nuisance"- How do you support this statement? (AS 6)
21. 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)
22. Rank the negative impact practices in your area in the order in which you think they should be eliminated. (AS1)
23. Ramu said soil health is important? How can you support him? (AS 7)



## ANNEXURE

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 magnesium 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?



They are called dung beetles (Scrab Beate) 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 boring 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 used 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. They live in habitat that range from forests to deserts. Most of them prefer the dung of Herbivores. Some eat excreta of omnivores.

They help new trees to grow for us. The seeds which the animals eat come out undigested. The seeds are buried along with dung. Soon a new tree sprouts.

On a busy night 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

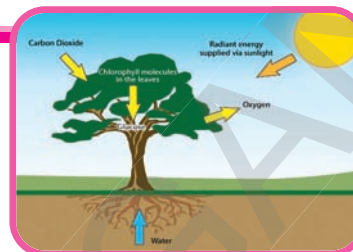
the soil and causes problems for groundwater recharge. Plastic disturbs the soil microbe activity, and once ingested, can kill animals. Plastic bags can also contaminate foodstuffs due to leaching of toxic dyes and transfer of pathogens. In fact, a major portion of the plastic bags i.e. approximately 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 us. 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

## 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 on earth (elements essential for the living cell) from environment to organisms and back through certain pathways are known as biogeochemical cycles.

### Bio-geo-chemical 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. Bio-geo-chemical pathways determine the path of transfer of matter on earth. Let us look at some of the major biogeochemical cycles.

Bio-geo-chemical 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 bio-geo-chemical 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 reactions 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 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

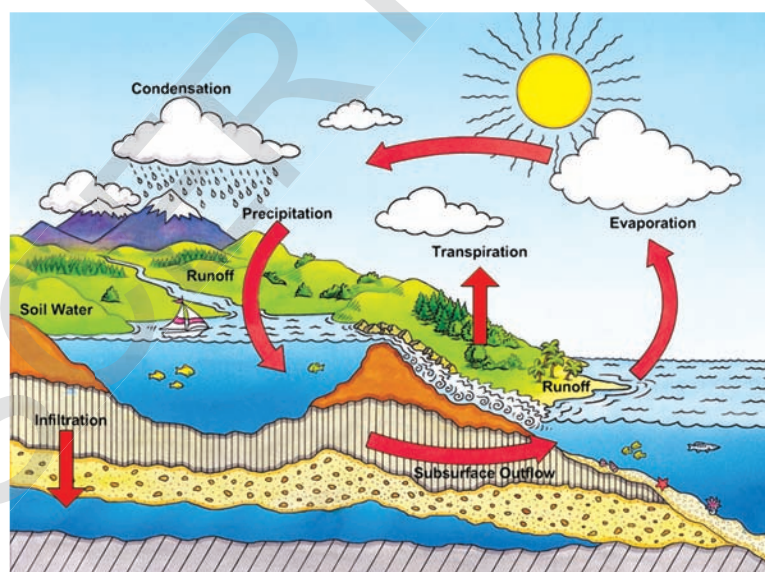


Fig-1 Water cycle

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.

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 the water that falls on the land does not immediately flow back into the sea. Some of it sinks 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  $\text{SO}_2$  and oxides

of nitrogen in rain water leads to 'Acid Rains'.

## 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 ( $\text{N}_2$ ) 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 which plants may take up from the soil by some biochemical process (caused by certain bacteria like Rhizobium, Nitrosomonas etc) and physicochemical processes (caused by lightning). 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 ( $\text{N}_2$ ) 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 nitrogenous compounds are added to the soil after a leguminous crop is grown.

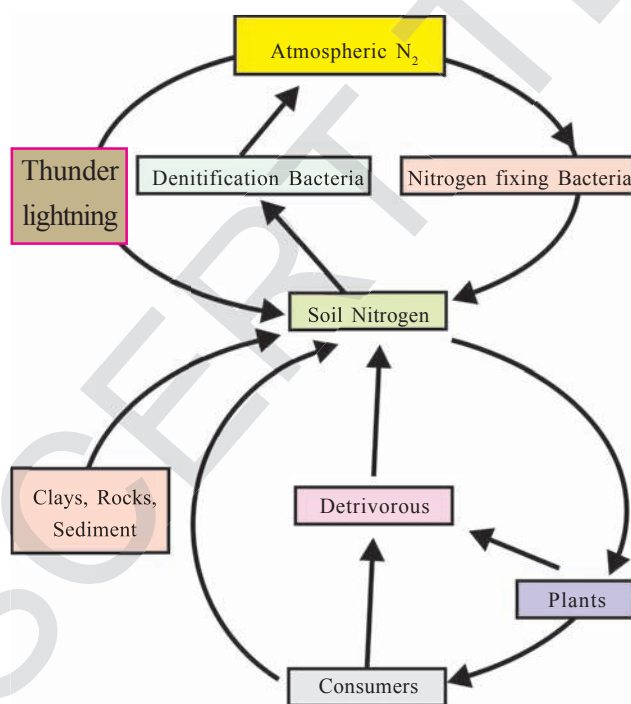


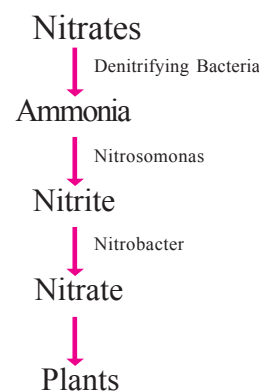
Fig-2 Nitrogen fixation

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 de Nitrifying 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:



## 3. Assimilation

Nitrogen compounds mainly as nitrates or ammonium ions( $\text{NH}_4^+$ ) are taken up from soil 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 ( $\text{NH}_3$ ) from Nitrates and other Nitrogenous compounds is 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 organic 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 ( $\text{NO}_3$ ) is converted back to gaseous nitrogen ( $\text{N}_2$ ). Denitrification occurs primarily in wet soils where water makes it difficult for microorganisms to get oxygen. Under these conditions, certain organisms - known as denitrifying 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.

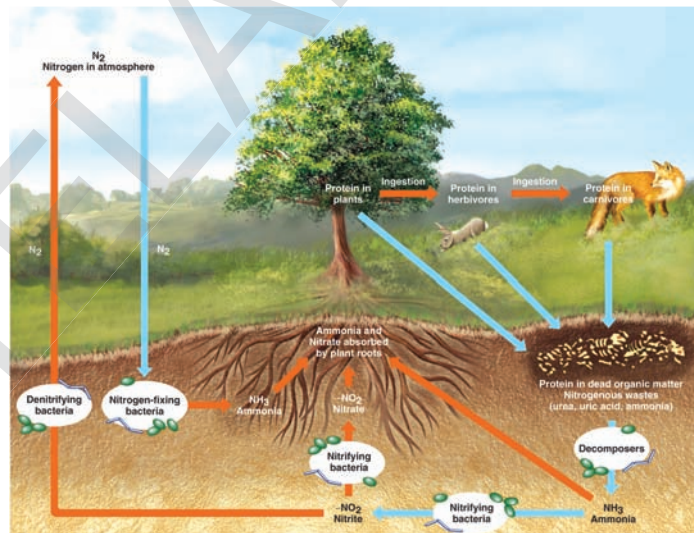


Fig-3

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 are 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.

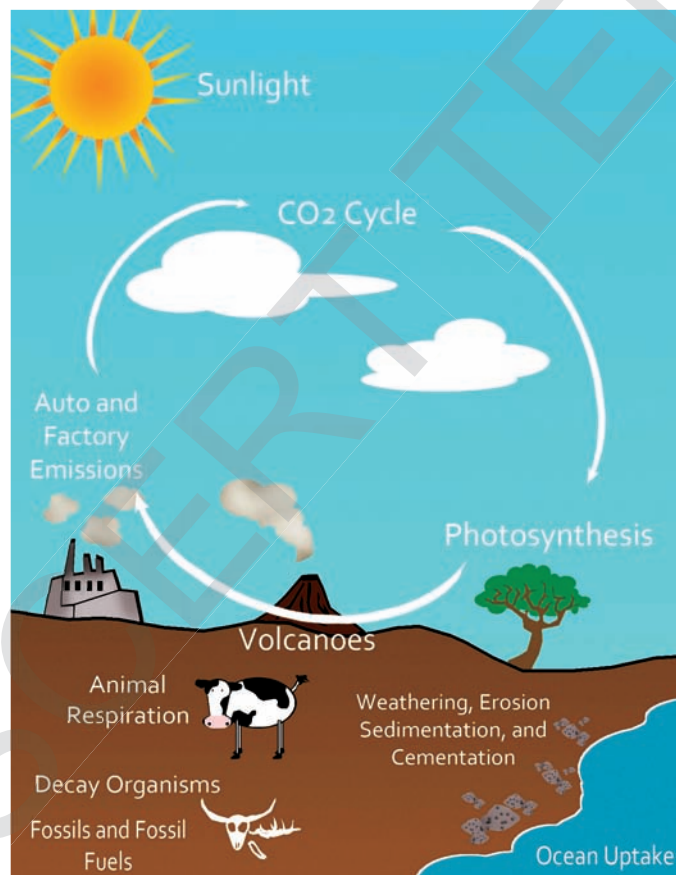


Fig-4 Carbon cycle

Carbon dioxide is also responsible for maintaining the Earth as a Green house with temperature conditions suitable for life. Thus, Carbon exists in the biosphere as the central element of life. Carbon Dioxide or CO<sub>2</sub>, 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<sub>6</sub>H<sub>12</sub>O<sub>6</sub>). In oceans, photosynthesis is carried out by microscopic aquatic plants called phytoplankton. The carbohydrates then become the source of chemical energy to cells in all plants and animals. In plants, some carbon remains as simple glucose for short-

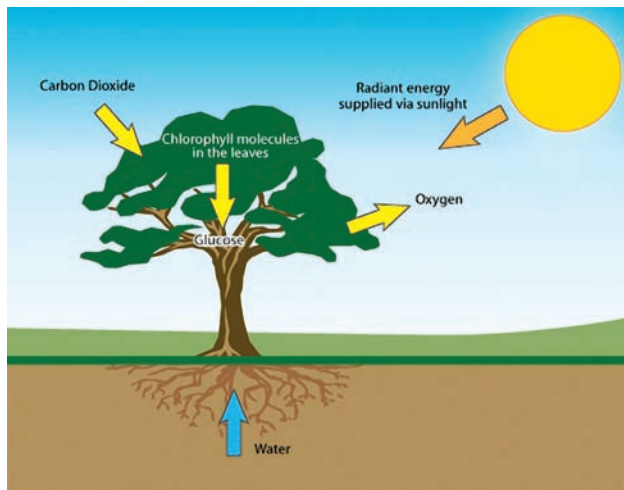


Fig-5

term energy use, while some are converted to large complex molecules such as starch for long term energy storage.

### Cycling and storage

The movement of carbon dioxide 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 carbon dioxide 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.  $\text{CO}_2$  from these resources becomes available when either fossil fuels are burnt or insoluble carbonates are converted to soluble bicarbonates. The return of carbon dioxide to the atmospheric reservoir is accomplished in many ways.

Mainly through respiratory processes wherein food molecules are broken down for energy and  $\text{CO}_2$  gas and other

byproducts are emitted. Combustion of fossil fuels and other carbon containing substances, forest fires, volcanic emissions etc. also return carbon dioxide 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  $\text{CO}_2$ , although some is destined for long 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  $\text{CO}_2$  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  $\text{CO}_2$  (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  $\text{CO}_2$  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.

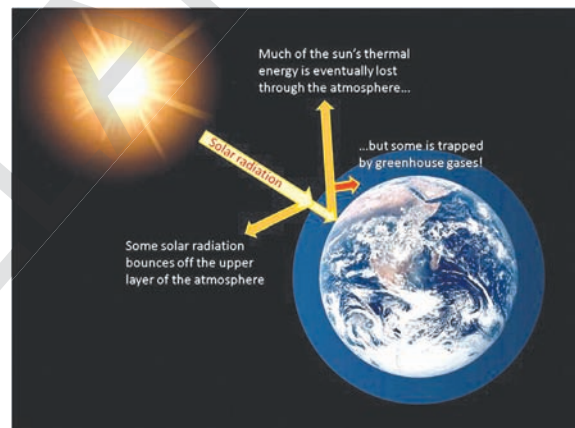
Humans have also altered the biological carbon cycle, increasing atmospheric  $\text{CO}_2$  levels, through forest clearing and land use. Trees store large amounts of carbon; when they die and decompose, much of this stored carbon is released as  $\text{CO}_2$ .

However, when humans clear large places of forest, primarily through the use of fire, the levels of atmospheric carbon is affected in two ways. First, during combustion, stored carbon is released directly into the air as  $\text{CO}_2$ , 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 Green house gas, the increase in atmospheric  $\text{CO}_2$  due to human activities has resulted in an enhanced Green house 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 di Oxide, 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

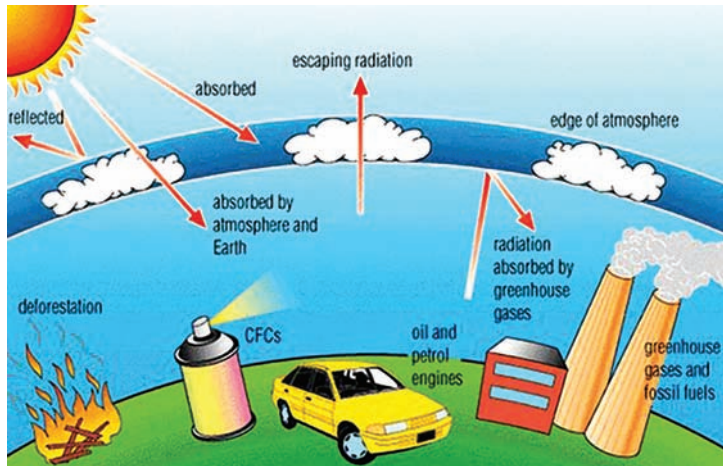


**Fig-6 Green house effect**

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 Climatic 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.

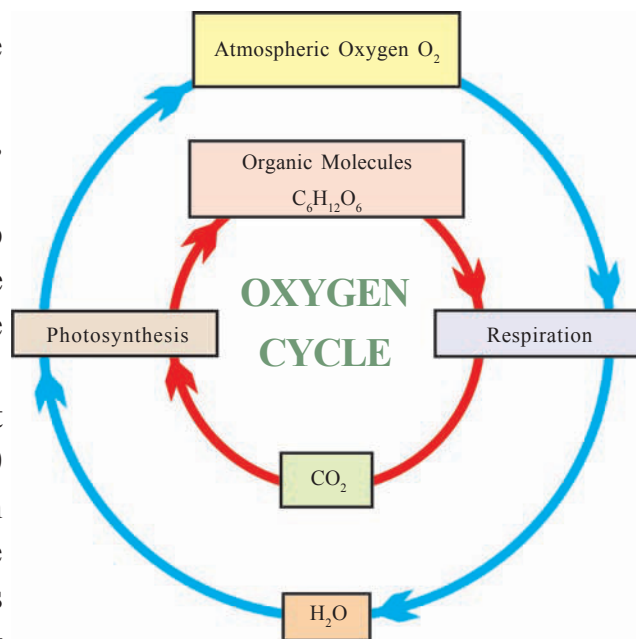
**Procedure:** Make a hole near the top of the plastic bottle with the nail. Insert the first thermometer into the hole. Place the second thermometer next to the bottle. Make sure that the same amount of sunlight reaches both thermometers. After 10 minutes, note temperature values from both thermometers. 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:

1. Do both thermometers record the same temperature? If no, which one is higher?
2. 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.

What causes bad smells from your drains.

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. Mount, Everest, the tallest mountain on the planet, is only about

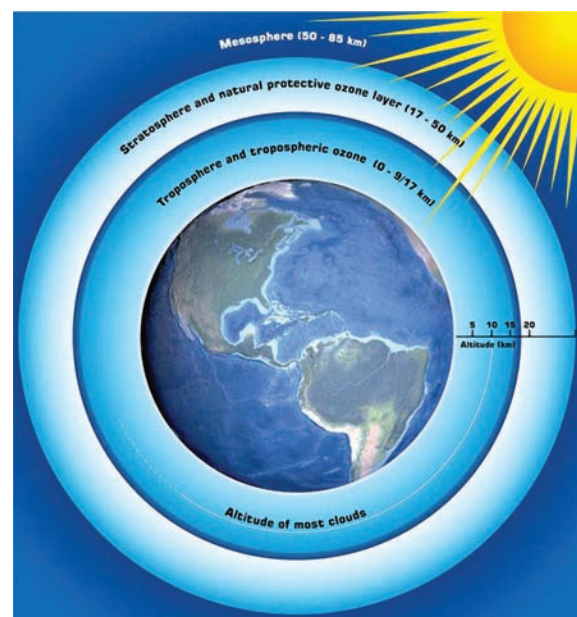


Fig-9 Ozone layer

9 km 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 colour and has a strong odour.

Normal oxygen, which we breathe, has two oxygen atoms and is colourless and odourless. 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.

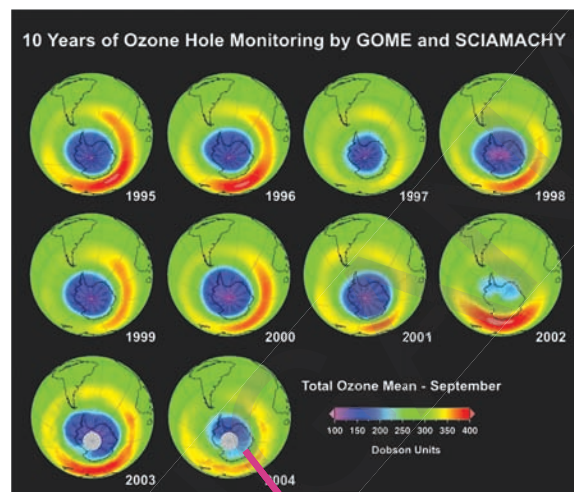
Most important of all it absorbs the portion of ultraviolet light which causes many harmful effects, including various types of skin Cancer and harm to some crops, certain materials, and some forms of marine life.

Collect the information about effects of Ozone from your school library/Internet and present it in your school assembly.

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

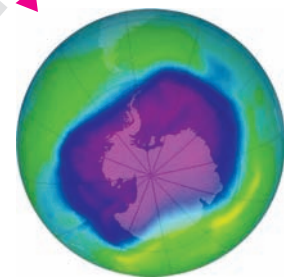


*Fig-10 Ozone depletion*

fluorine atoms to the stratosphere, where they destroy ozone in chemical reactions. Important examples are the Chloro Fluoro

Carbons (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.

Usage of refrigerators, Air conditioners and fossil fuels leads to destroy the natural structure of Environment. Drinking pot water, relaxing under trees. Using bicycles are the ecofriendly practices. Select the best one from the above for your practice.





## Do You Know?

### 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 (*Chloro Fluoro Carbons*) 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 Hydrological Cycle, Nitrogen Cycle, Nitrogen Fixation, Nitrification, Assimilation, Ammonification, Denitrification, Carbon Cycle, Greenhouse Effect, Global Warming, Oxygen Cycle, Ozone Depletion, Eco-friendly practices.*



### 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 vapours 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 lightening 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 emissions from human activities lead to ozone depletion? And what are the principal steps in stratospheric ozone depletion caused by human activities? (AS1)
3. Why could we say that biogeochemical cycles are in "balance"? (AS1)
4. If all the vegetation in the pond died, what effects would it have on the animals? Why? (AS 2)
5. Write an experiment to prove Green house effect on temperature. (AS 3)
6. Go to a nearby pond observe organisms living in the pond and bio degradable substances mixing in water. How they effect those organisms? write your observation.(AS4)
7. Describe interdependence of biotic and abiotic components by taking Nitrogen cycle as an example. Draw Nitrogen Cycle. (AS 5)
8. Write an essay explaining the importance of Ozone layer. (AS 6)
9. "Burning of fossil fuels a concern for scientists and environmentalists" How do you support this statement? (AS 6)
10. "Co<sub>2</sub> play a vital role in plant life process" - comment? (AS 7)
11. How human activities cause an imbalance in biogeochemical cycles? (AS 7)
12. List three ways we, as humans, have affected the water cycle.(AS 7)
13. Prepare an article for newspaper on the item "How human activities effects the environment". (AS 7)
14. Prepare slogans on green house effect and read them out in the school assembly.(AS6)
15. Draw oxygen, water and nitrogen cycles. (AS5)