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NEW TRENDS IN

Biology

ICSE

Class 7

EVERGREEN

Curriculum

Theme 1 : Tissue

Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
Plant Tissues ✦ Definition of tissue. ✦ Classification of plant tissues: Meristematic and permanent (simple and complex). ✦ Meristematic tissues: characteristics (any two), simple structure, location, function, examples. ✦ Simple permanent tissues: parenchyma, collenchyma, sclerenchyma (simple structure, location and functions of each), examples. ✦ Complex permanent tissues: xylem, phloem (only nature of cells and function. Elements of xylem and phloem not to be mentioned).	✦ Showing and explaining the different plant tissues to children - their location, structure, characteristics and functions charts and models. ✦ Encouraging children to develop charts and models. ✦ Drawing diagrams by children of kinds of tissues and differentiating between them. ✦ Collecting more information on plant tissues, such as tissue culture by children in groups or individually. **Experiment** ✦ Keep a twig of petunia with white flowers in a beaker containing coloured water and observe the flowers after a few hours (flowers will become coloured). ✦ Perform an experiment and ask the children to observe and record what happens to the plant seedlings if the roots are removed and seedlings are kept in coloured water.	✦ Permanent slides on kinds of tissues. ✦ Charts and models. ✦ PPTs and Videos on tissues. ✦ Photographs and pictures of tissues.
Animal Tissues ✦ Epithelial tissue: simple location, and function (types of epithelial tissue not to be mentioned). ✦ Connective tissue location and functions of areolar, adipose, bone, cartilage, blood, ligament, tendon. ✦ Muscular tissue: location and one function of: ✤ *striated (voluntary or skeletal muscle),* ✤ *unstriated (involuntary/ smooth muscle),*	✦ Showing diagrams of the following tissues: Epithetical, Connective, Muscular and Nervous tissue, through charts and models. ✦ Providing opportunities to children to: ✤ *draw diagrams of animal tissues.* ✤ *label them* ✤ *write functions of each kind of tissue* ✤ *collect more information on animal tissues* ✤ *model/charts of animal tissues.* ✦ Showing children, the model of the nervous system and pictures of dendron and axon.	✦ Specimens, charts and models. ✦ Models and pictures of nervous system. ✦ Children's drawings.

Theme 1 : Tissue

Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
✤ *cardiac (specialized muscle).* ✦ Nerve tissue: parts of neuron (cell body, dendron, axon). **Note:** *Only basic structure and basic functions of the above mentioned tissues to be done.*	✦ Asking children to draw a diagram of nerve tissue. ✦ Discussing functions of nervous system.	

Theme 2 : Kingdom Classification

Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
✦ Meaning and concept of classification. ✦ Need and advantages of classification. ✦ Characteristics of each kingdom with suitable examples: (i) **Monera:** bacteria - shape; useful bacteria, harmful bacteria (applications related to daily life to be discussed); (ii) **Protista:** *Amoeba* - basic structure and life processes (nutrition, locomotion, respiration, excretion and reproduction by binary and multiple fission); (iii) **Fungi:** basic structure of mould, nutrition and respiration in mould, useful fungi, harmful fungi (applications related to daily life to be discussed); (iv) **Plantae:** characteristics and examples (classifi-cation of plantae not to be discussed); (v) Animalia (a) Vertebrates. (b) Invertebrates: 9 major Phyla, Porifera, Cnidaria, Coelenterata, Platyhel-minthes, Nematoda, Annelida, Arthropoda, Mollusca, Echino-dermata) (Two characteristics and two examples of each Phylum).	✦ Providing opportunities for observation through visit to a nearby garden/zoo or a nature walk. ✦ Asking children to classify or group these plants and animals in their own way. ✦ Learning about different organisms belonging to each kingdom and asking them to write about examples of each kingdom. ✦ Drawing pictures of organisms belonging to each kingdom. ✦ Encouraging children to collect more information on each phylum. ✦ Assigning projects to make picture cards and writing their features on the other side.	✦ Plants and animals in their natural habitats. ✦ Zoo to see the diversity of life. ✦ Specimen from the laboratory. ✦ Charts, models and photo-graphs. ✦ PPTs and Videos. ✦ Picture cards.

Life Skills : Appreciative diversity of life

Theme 3 : Plant Life

Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
PHOTOSYNTHESIS ✦ Definition, basic process, factors affecting photosynthesis: (light, carbon dioxide, water, chlorophyll), significance of photosynthesis, setup. ✦ Experiment to demonstrate photosynthesis process. **RESPIRATION** ✦ Basic process, word equation; respiration as a process which releases energy; respiration in plants: two types (aerobic and anaerobic: basic concept, word equations for both, examples) ✦ Respiration and photosynthesis in plants, difference in both processes.	✦ Revisiting previous concepts. ✦ Building on children's previous learning. ✦ Asking children to observe the colour of leaves and also name plants that have yellow or red coloured leaves, discussing the reasons for such colours. ✦ Providing opportunities for observation of stomata and chloroplasts present in the leaves using a microscope. ✦ Drawing picture of stomata and chloroplast and labelling their parts. ✦ Summarizing the process of photosynthesis with the help of a word equation (No symbols) ✦ Demonstrating experiments in setup on photosynthesis and respiration with the support of elders. ✦ Demonstrating to children the hydrilla experiment to show evolution of oxygen during photosynthesis. ✦ Discussing the difference between aerobic and anaerobic respiration and citing examples of both. ✦ Discussing differences between the respiration and photosynthesis process in plants and asking children to explain both the processes in their own words.	✦ Charts. ✦ Plants like hydrilla (water plant), mushroom, money plant, yeast, leaves of croton, Rhoeo (to see colour of leaves and performing experiments). ✦ Permanent slides/fresh preparations of epidermal peels of leaves (to observe stomata) and Hydrilla leaf to study stomata and plastids. ✦ PPTs, videos.

Theme 4 : Human Body

Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
EXCRETORY SYSTEM **Excretion: Definition.** ✦ Organs and their excretory products (kidneys, sweat glands, lungs); ✦ Renal Excretory System - kidneys, ureter, urinary bladder, urethra (location and functions to be explained along with diagram); ✦ Role of kidneys in filtration of blood through millions of nephrons (details not required, structure of nephron not to be discussed); common disorders of the urinary system: Urinary Tract Infection, kidney stone.	✦ Building on children's previous learning. ✦ Explaining the various parts of excretory and nervous system with the help of charts, models, PPTs and videos ✦ Explaining the difference between excretory and waste products. ✦ Asking children to draw labelled diagrams of the following: ✤ The excretory system showing the various parts along with labelling. ✤ The nervous system — the brain, spinal cord, and nerves.	✦ Charts and models. ✦ PPTs and videos. ✦ Model of the brain and human excretory system. ✦ Children's drawings.

Theme 4 : Human Body

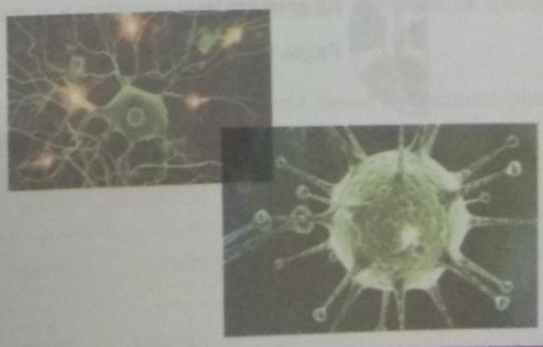
Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
NERVOUS SYSTEM ✦ Main parts: brain, spinal cord, nerves. ✦ Brain: cerebrum, cerebellum, medulla oblongata (location and function). ✦ Spinal cord: location and function. ✦ Nerves: what are nerves; their general function.	✦ Discussing common disorders of the urinary system. ✦ Assigning group projects on making models and charts on both systems. ✦ Providing children opportunities to share their personal experiences.	

Theme 5 : Health and Hygiene

Key Concepts	Suggested Transactional Processes	Suggested Learning Resources
ALLERGY ✦ Concept of allergy. ✦ Allergens: Common allergens like dust, pollen grain, mites, strong sunlight, particular food items. ✦ Entry routes of allergens: mouth, nose, skin. ✦ Symptoms of allergic reaction. ✦ Types of allergies: seasonal and perennial with examples. ✦ Precautions and care to be taken by a person who is prone to allergies.	✦ Enlisting causes of allergy. ✦ Discussing with children the concept of allergy, explaining the various aspects of entry route of allergens, symptoms produced, precaution to be taken to control allergic reactions. ✦ Providing opportunities for discussion with the school physician. ✦ Organising group discussion on prevention and care of allergy. ✦ Discussing various ways to keep oneself healthy and safe.	✦ PPTs, Videos, photographs. ✦ Permanent/temporary slide of *Aspergillus conidiophores*. ✦ Photographs/ slide showing mites, pollen, etc. in house dust. ✦ Physician.

Integration : Health and Physical Education.

Life Skill : Health awareness.

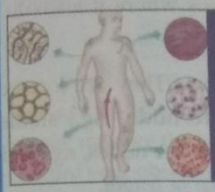


Contents

Theme-1

Tissue

CHAPTER 1



Tissues

Introduction

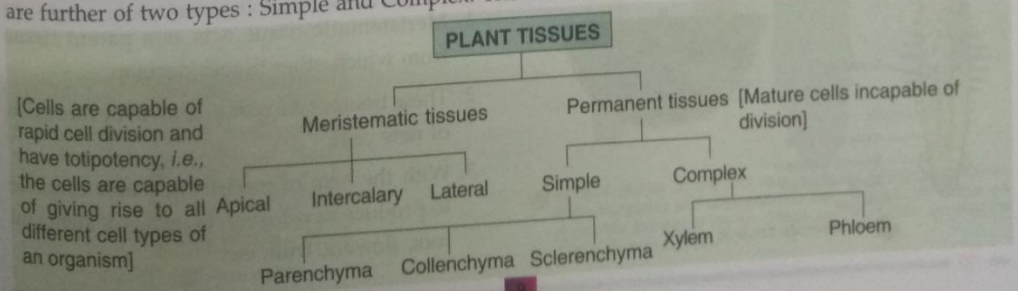
Groups of cells having a common origin and performing similar functions are called **tissues.** Study of tissues is called **histology** (Gk. *histos – tissue*, *logos* - study). Tissues are present in all multicellular organisms whether plants or animals.

Learning New Words

Tissue : A group of similar cells that perform a common function and have a common origin is called a tissue.
Meristematic tissue : It is composed of a group of similar cells which have capacity to divide and form new cells.
Permanent tissue : They are derived from meristematic tissue and comprising of non-dividing cells.
Vascular tissue: Conducting tissues, responsible for the transport of water and dissolved minerals (Xylem) and food (Phloem) from one part of the plant to the other.
Connective tissue : Supporting and binding tissue which connects different tissues or organs of the body and forms a packing material around them.
Bone : Rigid skeletal connective tissue which forms the framework of the body and protects vital organs.
Cartilage : Skeletal connective tissue which provides flexibility to the soft tissue.
Ligament : Connective tissue that connects two bones.
Tendon : Connective tissue that connects muscles to the bones.
Involuntary muscle : The smooth and cardiac muscle which cannot work at our will.
Voluntary muscle : The skeletal muscles which work at our will.
Adipose tissue : Tissue that stores fat in our body.
Nervous tissue : Tissue present in our brain and spinal cord which receives and sends signals (stimulus) in our body.
Muscular tissue : Tissue that contains contractile proteins and causes either pull or push action in our body.
Epidermal tissue : The tissue which is in the form of a continuous layer and there are no intercellular spaces present.
Histology : Study of tissues.

Tissues can be divided into two types – plant and animal tissues.

Plant tissues are of two types : Meristematic tissue and Permanent tissue. Permanent plant tissues are further of two types : Simple and Complex. The outline classification of plant tissues :



MERISTEMATIC TISSUES

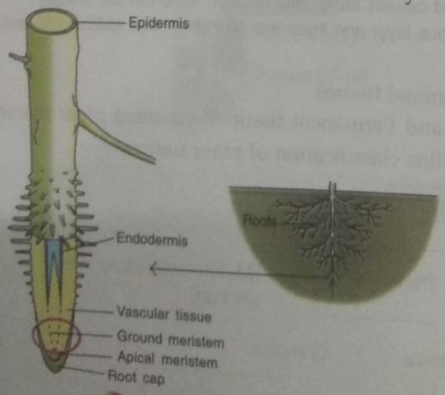
This tissue contains thin walled, undifferentiated and actively dividing cells (meristematic cells) which are found in those zones of the plant where growth can take place. Meristematic cells give rise to various organs of the plant and keep the plant growing.

Nature : Cells of meristems divide continuously and help in increasing the length and girth of the plant.

Meristematic tissues show the following characteristics :

- The cells of meristematic tissue are similar in structure and have thin cellulose cell walls.
- The meristematic cells may be spherical, oval, polygonal or rectangular in shape.
- The meristematic cells are compactly arranged and do not contain any intercellular space between them.
- Each meristematic cell contains dense or abundant cytoplasm and a single large nucleus.

Location : Meristematic tissues are growth tissues and are found in the growing regions of the plant. According to their position in the plant, meristems are apical, lateral and intercalary.

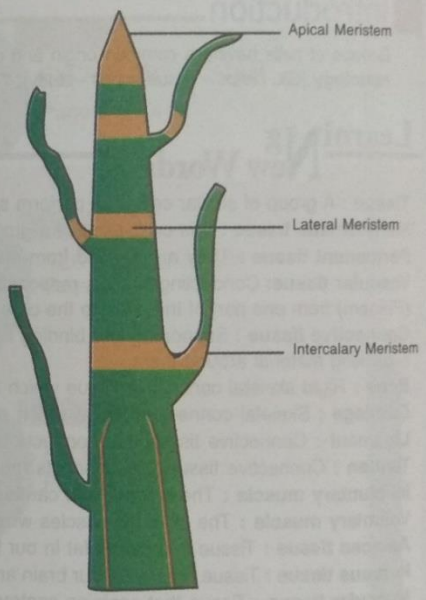


Meristematic tissue in roots

1. ***Apical meristems :*** These are situated at the growing tips of roots, stems and branches and *leads to elongation.*

2. ***Lateral meristem :*** These are found between the bark and wood of trees where it leads to the *increase in thickness (girth) of stem.*

3. ***Intercalary meristem :*** They are located at the base of leaves or internode, *e.g.*, stems of grasses, also above or below the nodes, *e.g.*, (mint). They help the *organ to grow in length.*



Shoot tip

Functions :

1. Meristematic tissue acts as a parent tissue from which other tissues develop.
2. These tissues take part in growth by formation of new cells.
3. With the help of meristems, plants continue to produce new leaves, branches of stem and root, flowers, fruit, etc.

Activity 1

To study that how apical meristem causes growth in length.

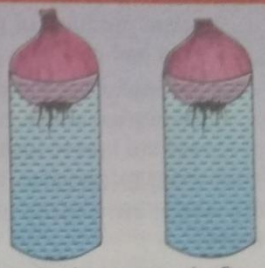
Apparatus : Two glass jars, two onion bulbs, scissors or scalpel, water.

Working : Take two glass jars. Fill them with water. Place the onion bulb over the mouth of each jar in such a way that stem base of the bulb dips in water. Observe daily. Roots develop from the base of the bulbs in both the jars.

Measure the length of roots on day 1, 2 and 3.

Again, measure the length of roots on each day *i.e.*, 5,6,7.

Record your observation as given below :



Length	Day 1	Day 2	Day 3	Day 4	Day 5
Jar A					
Jar B					

(*a*) What changes do you observe in two onion placed in different jars ?

(*b*) Which tissue do you think is responsible for increasing the length of roots ?

PERMANENT TISSUES

Permanent tissues are formed by continuous division of the meristematic tissue. These newly formed cells elongate, mature and get differentiated into various types of tissues. These are composed of cells that have lost the power of division, having attained their definite form and size. They form the bulk of the plant body. They may be dead or living. Depending upon their structure, they are classified into two types :

(*a*) Simple Permanent Tissue :

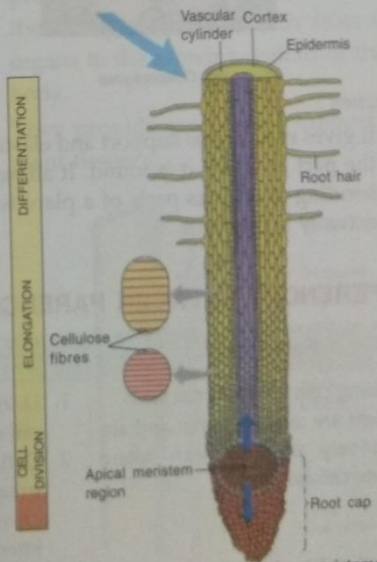
These tissues are made-up of cells which are similar in structure and function. They are protective and supportive in function. They are of three types :

(*i*) *PARENCHYMA* : It is the most abundant tissue in plants present in almost all organs of plants like stems, roots, leaves, flowers, seeds and fruits.

Parenchyma

Structure :

- It consists of isodiametric (having equal diameter) living cells which may be oval, round or polygonal in shape.
- They are thin walled and have intercellular spaces between them.
- They have large vacuoles.



Vertical section of the root apex showing meristematic tissue. Both elongation and differentiation can be seen. New cells are constantly forming at the tip. These elongated cells, causing the root to increase in size.

Functions :

- These store food material as in potato and waste products of plants such as tannins, gum and crystals.
- Parenchyma cells in leaves contain chloroplast which helps in photosynthesis and are known as chlorenchyma.

(ii) COLLENCHYMA : This tissue have living cells, which are usually elongated and thick at corners.

Structure :

- Intercellular spaces are usually absent in this tissue.

Location :

- The cells of collenchyma are located below the epidermis of dicotyledonous stem, midribs of dicot leaves and in the leaf stalk.

Collenchyma

Function :

- It gives mechanical support and elasticity to the part in which it is found. It allows easy bending in various parts of a plant without actually breaking it.

(iii) SCLERENCHYMA : Sclerenchyma cells are dead cells and they are devoid of protoplasm.

Structure :

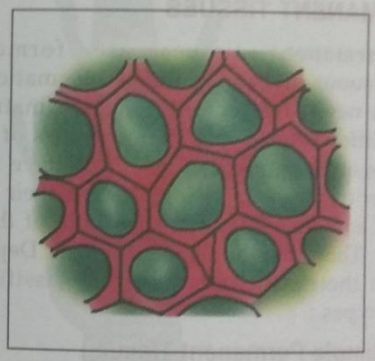
- The sclerenchyma is composed of extremely thick walled cells with little or no protoplasm.
- The cells are highly elongated, narrow and spindle shaped.
- Intercellular space absent.

Location :

- Sclerenchyma occurs in abundance in stems, roots, veins of leaves and hard coverings of seeds and nuts.

Function :

- They give mechanical strength and rigidity to the plant body, sclerenchyma fibres are used in the manufacture of ropes and certain textile fibres.



Sclerenchyma

DIFFERENCES BETWEEN PARENCHYMA, COLLENCHYMA AND SCLERENCHYMA

Parenchyma	*Collenchyma*	*Sclerenchyma*
1. Living cells with thin cell walls.	1. Living cells with slightly thick cell wall.	1. Dead cells with thick cell walls.
2. Cells are uniformly thin and are loosely packed with large intercellular spaces.	2. Cells are elongated and irregularly thickened at the corners with very little intercellular spaces.	2. Cells are long and narrow as the walls are thickened due to lignin (a type of cementing material). These walls are so thick that there is no internal space.
3. Cell wall is made-up of cellulose.	3. Thickening around cells are due to the deposition of pectin and cellulose.	3. Thickening in the cell is due to the deposition of lignin.

4. It is the most abundant tissue present in epidermis (outer covering) and softer tissues, such as mesophyll of leaf, flower and fruit.	4. It is found below epidermis in the petiole, leaves and stems.	4. It is found in the husk of coconut, in stems (around vascular bundles), in the veins (of leaves), in the hard coverings (of seeds and nuts).
5. It provides support, stores food, waste products (such as tannin, gum, crystals, etc.)	5. It provides mechanical support and elasticity. It allows leaf and stem to bond.	5. It is the main mechanical tissue of plant which provides rigidity to leaves and strength to seed coverings. It helps the plant to withstand various types of mechanical strains.

- When parenchyma or collenchyma cells contain chloroplast then it is called *chlorenchyma* and these cells perform photosynthesis.
- In aquatic plants, parenchyma cells contain large air cavities which provide buoyancy (ability to float). Such parenchyma is called aerenchyma.

(b) Complex Permanent Tissue :

Complex permanent tissue consists of more than one type of cells which work together as a unit and perform a common function. *Xylem* and *Phloem* are called the complex or vascular tissue. Xylem and Phloem together form *Vascular bundles.*

- They are conducting tissues.

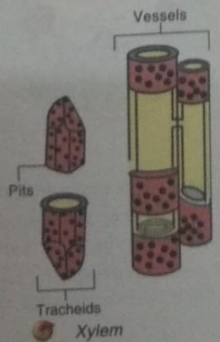
(i) XYLEM :

Nature :

- Xylem contains dead vascular and mechanical tissue. It is a conducting tissue. It is composed of vessels, tracheids, fibres and xylem parenchyma.

Functions :

- They are involved in the upward transport of water and dissolved minerals from the roots to the different parts of the shoot.
- They give mechanical strength to the plant body.



Xylem

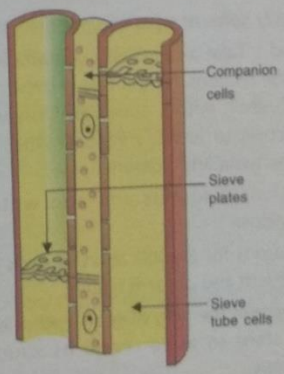
(ii) PHLOEM :

Nature :

- Phloem is a living conducting tissue which contains different types of cells such as sieve tubes, phloem fibres, phloem parenchyma and companion cells.

Functions :

- Phloem transports photosynthetically prepared food materials from the leaves to the storage organs and later from storage organs to the growing regions of the plant body.
- They provide mechanical support to the plant tissue.



Phloem

Activity 2

To study the function of Xylem.

Method : Place different types of plant stems in red coloured solution and leave them for few hours. Cut thin section of stems with a blade and examine them under a microscope one by one. Note your observations.

Observation :

You will observe that only part of the vascular bundles get red colour indicating this region to be Xylem. Thus, it is the xylem which conducts water in plants. Write the colour of the vascular bundles present in that plant type and draw rough sketch of those vascular bundles.

DIFFERENCES BETWEEN XYLEM AND PHLOEM

Xylem	*Phloem*
1. It consists of dead cells.	1. It consists of living cells.
2. The cell walls of xylem tissue are thick.	2. The cells walls of phloem tissue are thin.
3. It transports water and minerals from roots to different parts of shoot.	3. It transports food from leaves to growing regions of the plant body.

Activity 3

To identify different types of plant tissues.

Method : Take a piece of cucurbita stem. Cut thin transverse sections. Mount one of these on a clean glass slide. Cover it with a coverslip. Observe it under the microscope to identify Parenchyma, Collenchyma, Chlorenchyma and Sclerenchyma.

Draw their diagrams and also write down your observations.

Give reasons for identification of each of them. Also, locate xylem and phloem tissues.

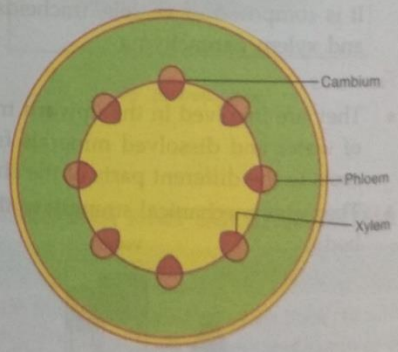
You may take the help of your teacher to cut a section of the stem so as to reveal its structure under a microscope.

Try to make your observations as indicated in the table.

Name of the tissue	*Nature of cells*	*Any other characteristic feature observed*
Parenchyma		
Collenchyma		
Sclerenchyma		
Xylem		
Phloem		

Fact File

❖ ***Vascular tissue :*** This tissue – also called **conducting tissue**–consists of different types of cells working together as a unit to perform a given function. Vascular tissue is of two types : *xylem* and *phloem*. Both xylem and phloem are tubes running throughout the plant. They are concerned with transportation of materials within the plant body. In the stem, xylem and phloem occur together as distinct bunches called *vascular bundles*—xylem lying towards the centre and phloem lying outside. Given Figure shows the ring-like arrangement of vascular bundles in a stem.

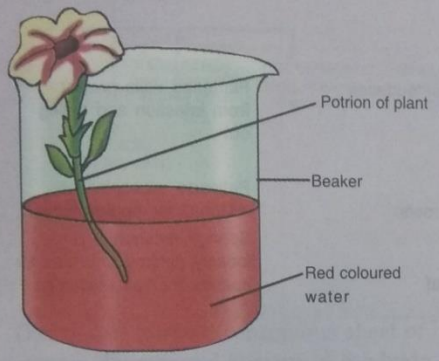


You might have seen that some people carve their names on trees. Now, you can guide them that, excessive carving on the bark may harm the tree as phloem lies just underneath the bark.

Activity 4

To show that water moves up through Xylem vessels.

Method : Keep a twig of petunia plant with white flower in a beaker containing red coloured water. After few hours the colour of the flower changes red. Take the plant out and make a transverse section of the stem. Observe under a microscope. Some cells show red coloured portion. These clearly shows that all the cells do not conduct water but only few cells do it and these are xylem vessels.



The stem contains Xylem which conducts water.

Inference :
Flower in the beaker remains fresh for a few days when kept in water because xylem vessels keep on conducting water for all parts of the plant.

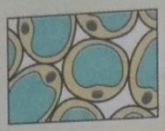
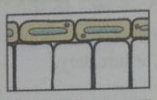
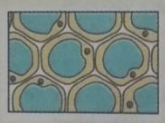
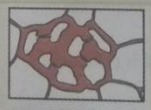
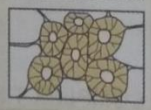
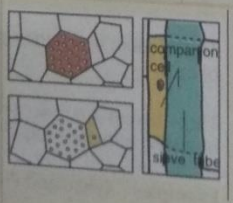
DIFFERENCES BETWEEN MERISTEMATIC AND PERMANENT TISSUES

Meristematic Tissue	*Permanent Tissue*
1. Cells of this tissue divide throughout their life.	1. They lose the ability to divide and to take up specific function.
2. They are located at specific region of the plant, *i.e.*, apical, lateral, intercalary.	2. They are distributed throughout the plant body.
3. Cells of this tissue are very active, have dense cytoplasm, thin walls and prominent nuclei. They lack vacuoles.	3. They are vacuolated, vary in shape and size. Their cell wall may be thick.
4. This tissue leads to growth of the plant.	4. This tissue causes differentiation of cells.
5. Cell wall is cellulosic.	5. Cell wall is made-up of cellulose/lignin/ suberin.

DIFFERENCES BETWEEN SIMPLE AND COMPLEX TISSUES

Simple Tissues	*Complex Tissues*
1. These tissues are made- up of only one type of cells.	1. These tissues are made-up of more than one type of cells.
2. These tissues are mainly responsible for storage and mechanical support. **Examples :** Parenchyma, Collenchyma and Sclerenchyma.	2. These tissues are mainly responsible for transport of water, minerals, sugars and other metabolites. **Examples :** Xylem and Phloem.

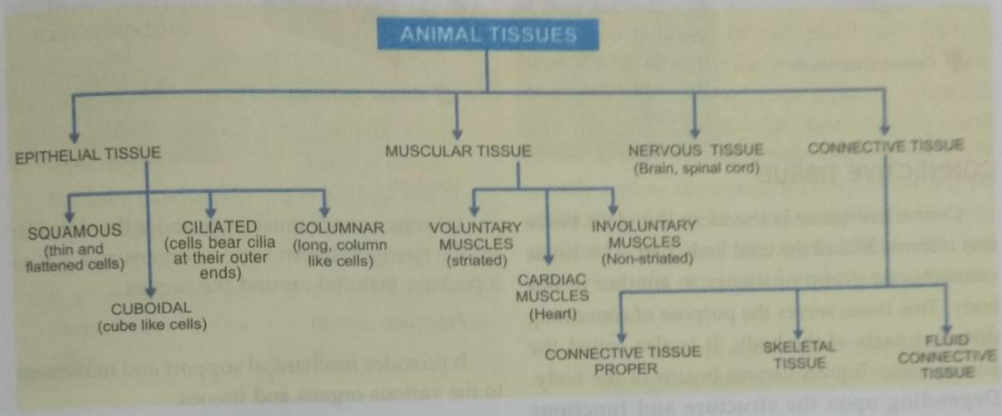
SUMMARY OF THE MAIN TISSUES OF A FLOWERING PLANT

Tissue	Diagram	Distribution	Functions
A. Parenchyma		Cortex, pith, vascular bundles	Basic packing tissue, support and storage
Modified parenchyma.			
1. Epidermis		Covers all outer surfaces of plant :	Flattened cells protect from infection and drying out
2. Mesophyll		Stem, leaves, roots Main part of leaf	Palisade mesophyll is adapted for photosynthesis, Spongy mesophyll is loosely packed to create air spaces for gas exchange
B. Collenchyma		Outer cortex, angle of stems and midribs	Provides support
C. Sclerenchyma :			
1. Fibres		Outer region of cortex, (around vascular bundle)	Support
2. Sclereids		Cortex, pith, phloem, shells and stones of seeds	Support/protection
D. Xylem dissolved ions		Vascular system	Transport of water
E. Phloem :			
1. Sieve tubes		Vascular bundles	Translocation of food
2. Companion cells		Vascular bundles	Control of sieve tubes

ANIMAL TISSUES

The bodies of animals are made-up of different kind of tissues. Based upon the structure and functions, simple tissues in multicellular animals are of four basic types :

1. Epithelial (covering) tissue
2. Connective (supportive) tissue
3. Muscular (contractile) tissue
4. Nervous (message conveying/response to stimuli) tissue.



EPITHELIAL TISSUE

This tissue, forms a continuous sheet of cells that covers the external surface of the body like skin as well as lines the cavities of internal organs like mouth (cheek cells), stomach, intestine and wind pipe.

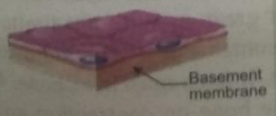
Structure :

- In epithelial tissue, the cells are present end to end without intercellular spaces. The cells may be flat, irregularly shaped, cuboidal or in the shape of columns.

Functions :

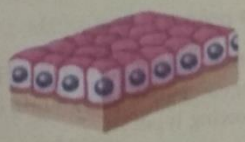
- It provides protection and prevents the entry of germs.
- It prevents the underlying cells from injury, entry of germs and from drying up (dessication).

On the basis of shape of the cells epithelial tissue is classified into the following four types :



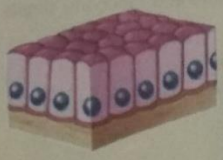
Squamous epithelium

Squamous epithelium consists of a single layer of large, flat cells with central nuclei placed on a thin basement membrane. These cells can be compared to the tiles on the floor. The membranes lining the blood vessels and the inner lining of cheek are examples.



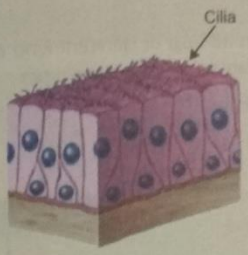
Cuboidal epithelium

Cuboidal epithelium is composed of a single layer of cuboidal cells placed on a basement membrane. The salivary glands and the thyroid glands are internally lined by this epithelium.



Columnar epithelium

Columnar epithelium is composed of tall, cylindrical cells, the height of each cell being greater than its width. The nuclei are oval and are usually found at the base of the cells. Inner lining of the intestines is an example.



Ciliated epithelium

Ciliated epithelium Epithelial cells sometimes bear hair-like cilia on their free surface. For example, the windpipe or trachea is internally lined by ciliated epithelial cells.

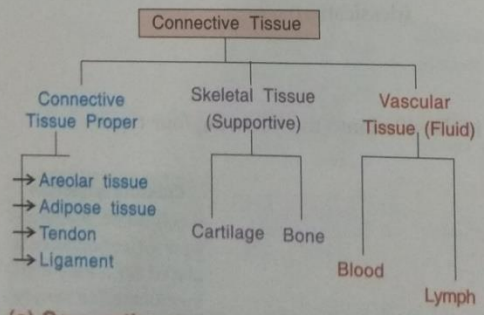
CONNECTIVE TISSUE

Connective tissue is the most abundant tissue and it forms 30% of the total body part. This tissue connects one group of tissues to another in our body. This tissue serves the purpose of connecting different parts of the body. It is also called the *joining tissue*. It joins various organs of the body. Depending upon the structure and functions performed by the connective tissue, it is further classified into three types :

(*a*) Connective tissue proper

(*b*) Skeletal tissue

(*c*) Fluid or vascular tissue.



(a) Connective tissue proper :

It is most abundant type of connective tissue. It holds various tissue together in any organ. It is further divided into following types :

Areolar Tissue : This is the basic and most widely distributed connective tissue in animal body

Location :

It forms a continuous layer under the skin, fills up the spaces between various organs and acts as a packing material around the organs.

Functions :

It provides mechanical support and movement to the various organs and tissues.

Adipose Tissue : It is a connective tissue which is specialised to store fat. Fat is stored inside the cells called adipocytes.

Location :

- Adipose tissue is found beneath the skin and between the internal organs.

Functions :

- It is a storage tissue where fat is kept in reserve for use when required.
- It forms shock absorbing cushions around important organs.
- Adipose tissue present beneath the skin helps to shape the body surface.
- It forms the insulating layer below the skin.

Tendon : It is a small cord like dense fibrous connective tissue of great strength but limited flexibility. Tendon contains parallel bundles of white fibrous tissue. It joins muscle to bone. It helps in moving the bone on contraction and relaxation of the muscle.

Ligament : It is a cord-like dense fibrous connective tissue of considerable strength and

high elasticity. Ligament contains yellow fibrous connective tissue. It binds a bone with another bone. It allows bending and rotation movements over a joint.

DIFFERENCES BETWEEN LIGAMENTS AND TENDONS

Ligaments	*Tendons*
1. Ligaments connect two bones together.	1. Tendons connect bones to muscles.
2. This tissue is very elastic with considerable strength.	2. This tissue has great strength but limited flexibility.
3. It is formed of yellow fibrous connective tissue.	3. It is formed of white fibrous connective tissue.

(b) Skeletal tissue :

It is the hard connective tissue that forms supporting framework of the body. They form endoskeleton in vertebrates (animals with backbone). It is of two types :

(*i*) Cartilage, and

(*ii*) Bone.

Cartilage : It is a specialised connective tissue, which is compact, firm but still flexible. It consists of a ground substance called matrix which contains cartilage cells and fluid-filled space called *lacunae*.

Location :

- It occurs in the rings of windpipe and at the end of bones of the fore and hind limbs so that the friction between the bones is reduced. It is also present in the walls of respiratory passages such as nose tips, ear, pinna, epiglottis and lower ends of ribs.

Functions :

- It gives support and provides elasticity to the soft tissues.
- It facilitates bone movements as it is a shock absorbing tissue.

Bone : It is the hardest connective tissue that forms the skeleton of vertebrates. It is made of matrix and cells. The matrix is filled with various inorganic salts like calcium phosphate, calcium carbonate, magnesium phosphate and calcium fluoride. These make the bones strong and hard. The matrix is present in the form of concentric layers around a central canal. Bone cells are present in minute spaces called *lacunae*. The long bones are usually hollow containing a cavity called *marrow cavity*. It is full of bone marrow which is richly supplied with blood vessels. *Red blood cells* and *white blood cells* are formed in the bone marrow.

Location :

- Bone is a hard and compact tissue and forms the rigid endoskeleton of the body.

Functions :

- Bones form the framework that protect the internal organs like brain, heart and lungs.
- It serves as a reservoir of calcium, phosphorus and proteins.
- It helps in the body movement as it forms a system of levers.

DIFFERENCES BETWEEN BONE AND CARTILAGE

Bone	*Cartilage*
1. The matrix is hard and formed of protein (ossein) calcium and magnesium phosphate.	1. The matrix of cartilage is solid but elastic and formed of protein (chondrin) but generally contains no salts.
2. Matrix is arranged in rings called lamellae and haversian canals.	2. Matrix not arranged in rings and has no canals.
3. Bones are inflexible and porous.	3. Cartilage is flexible and non-porous.
4. Blood vessels are present in bones.	4. Blood vessels are absent in cartilage.

(c) Vascular tissue :

It is the fluid tissue that keeps on moving in the body. It helps in the transportation of various materials such as gases, food, excretory products, hormones, etc. It has a ground substance called plasma in place of matrix which is a straw coloured fluid. It is of two types :

(*i*) Blood (*ii*) Lymph

Blood : It is a red coloured sticky, alkaline, slightly saltish in taste, heavier than water, fluid tissue. It is made-up of two parts, the plasma and three types of cells.

(*i*) RBCs (Red blood corpuscles).

(*ii*) WBCs (White blood corpuscles).

(*iii*) Blood platelets or thrombocytes.

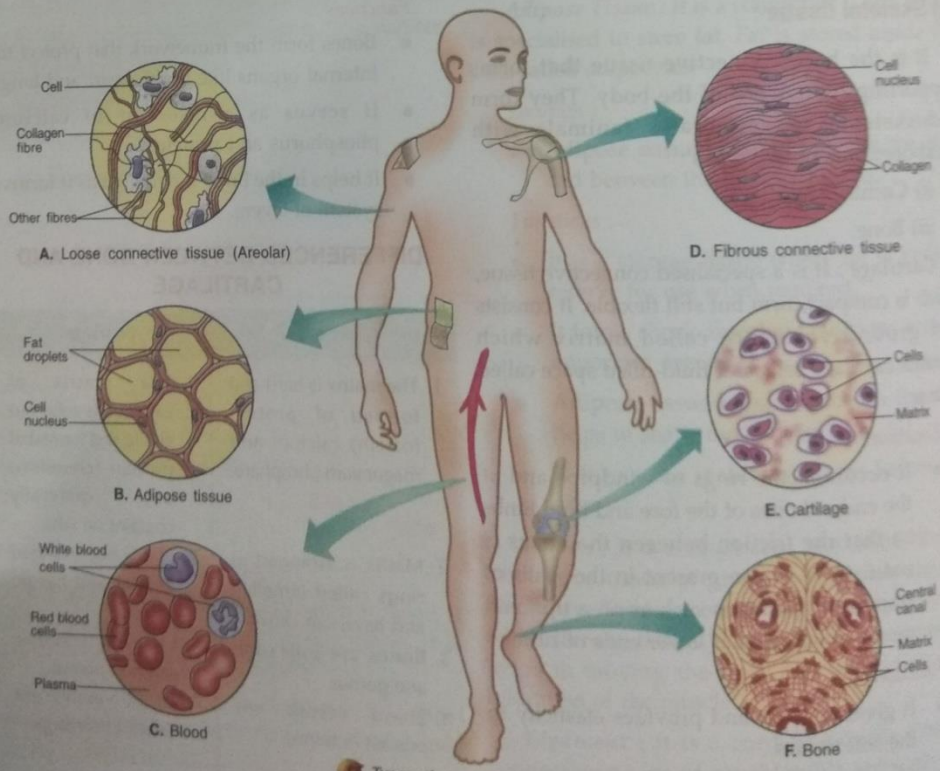
Functions :

- The major function of blood is to transport substances from one part to another inside the body. This includes nutrients, metabolic wastes, hormones and gases.
- It maintains the temperature of the body.
- Platelets promote coagulation of blood and help in wound healing.
- White blood cells also provide immunity by producing antibodies.

Lymph : It is a colourless or yellow coloured fluid. It is blood plasma without RBCs and proteins. It plays a very important role in protecting the body against infection.

Functions :

- Lymph is an important tissue for nutrients and hormones.
- It acts as a middle man between tissues and blood.
- It brings CO_2 and wastes from tissues to blood and nutrients, oxygen, hormones from blood to tissues.



Types of connective tissue.

DIFFERENCES BETWEEN BLOOD AND LYMPH

Blood	Lymph
1. Blood is red in colour.	1. Lymph is straw-coloured or colourless fluid.
2. Red blood cells are present which possess haemoglobin and provide red colour to it.	2. Red blood cells are absent.
3. Large protein molecules are present.	3. Large protein molecules are absent.
4. Blood flows in blood vessels, *i.e.*, arteries, veins and capillaries.	4. Lymph flows in lymph vessels and between tissues.

MUSCULAR TISSUE

It is contractile tissue which possesses contractile proteins inside cells held together by connective tissue. It consists of long, cylindrical cells called muscle cells or muscle fibres. It occupies nearly 40% of the total weight of the body. It is found in every part of the body where movement is involved. It forms the muscles of the body. It can contract and relax.

Functions :

- Muscle tissue is a contractile tissue.
- It causes the movement of the body and its various parts, such as arms and legs, by contraction and relaxation (expansion).

Classification :

Muscle cells can be divided into three types based on their structure, function and location. These are of three types.

(*i*) striated (*ii*) smooth (*iii*) cardiac

(i) Striated Muscle (Voluntary or Skeletal muscle) :

These muscles join the bones to each other and are, therefore, called skeletal muscles.

They are long, cylindrical and non-tapering. The muscle fibres do not branch and run parallel to one another longitudinally. Each fibre is multinucleated and possess alternate dark and light bands giving them striated appearance. Therefore, these are also called striated muscles.

Location :

- These muscles are present in body parts which we can move at our conscious will. These parts include limbs, face, neck, tongue, diaphragm.

Functions :

- Skeletal muscles have a large number of contractile proteins enabling them to contract and expand rapidly.
- They are attached to the bones and help in the movements of all parts of the body.

(ii) Smooth Muscle (Involuntary or Unstriated): They are spindle shaped, unbranched muscle cells which are called smooth muscle fibres because they do not contain striations. These fibres are uninucleated with a single, centrally located nucleus.

Location :

- The smooth muscles are found in visceral organs, *e.g.*, walls of stomach, oesophagus, intestine, urinary bladder, blood vessels, iris of eye and bronchi, etc.

Functions :

- Smooth muscles are involuntary muscles as they cannot contract or expand at our will.
- Smooth muscles present in the wall of gastrointestinal tract help in peristaltic movement. These movements and the progressive movements which push the food downward in a wave-like manner.

(iii) Cardiac Muscle (Specialised Muscle) : They are involuntary striated and non-fatigued muscle fibres which occur in the wall of the heart

performing rhythmic contraction and relaxation continuously. They are composed of cylindrical, non-tapering fibres but shorter than skeletal muscle fibres.

Location :

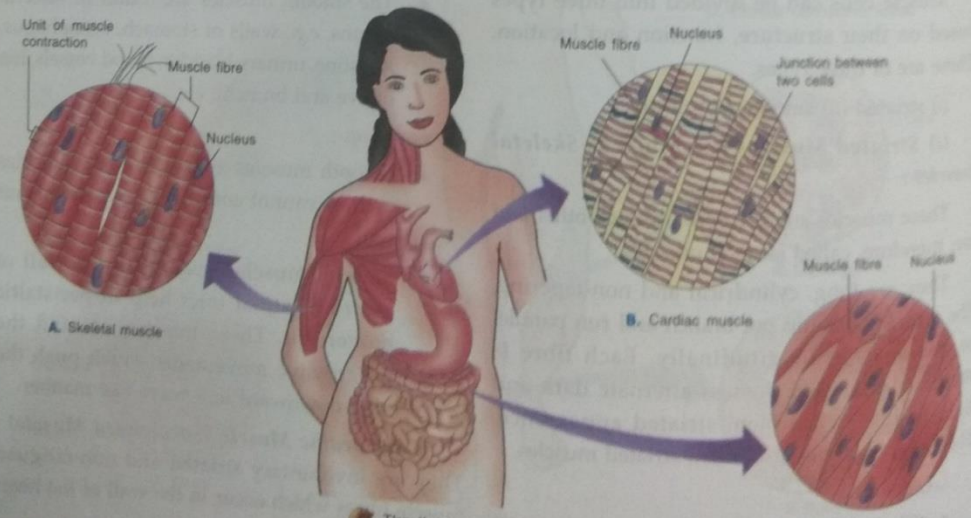
- These muscles are found exclusively in the heart.

Functions :

- Cardiac muscles are involuntary muscles like smooth muscles and undergo rhythmic contraction and relaxation.
- They contract, relax and work continuously without any rest.
- Contraction and relaxation of cardiac muscle cause pumping activity of heart.

COMPARISON OF THREE TYPES OF MUSCLES

	Striated (Voluntary or Skeletal muscle)	*Unstriated (Involuntary smooth muscle)*	*Cardiac Muscle*
Shape	• Striped, striated, long and cylindrical, non-tapering and unbranched	• Unstriped, unstriated, spindle shaped (long with pointed ends)	• Cylindrical and branched
Action	• Helps in the movement as they are attached to the skeleton	• Controls movement of substances along tubes	• Helps in pumping the blood (heartbeat)
Nucleus	• Multinucleate	• Uninucleate	• Multinucleate
Location	• Attached to the skeleton	• Tubular organs, gut, reproductive system, glands, bronchioles	• Present in the heart
Control	• Voluntary (Under individual's will)	• Involuntary (not under individuals control)	• Involuntary, myogenic (self generating)



The three types of muscle.

NERVOUS TISSUE

Nervous tissue is a highly specialised tissue which consists of basic units called neuron or nerve cells that transmit messages in our body.

Structure :

A neuron is made-up of three parts.

(*i*) Cyton (*ii*) Dendrites (*iii*) Axon

(*i*) Cyton or cell body which contains a central nucleus.

(*ii*) The dendrons are short processes arising from the cyton and further branching into dendrites.

(*iii*) Axon is a single long cylindrical fibre that extends from the cyton.

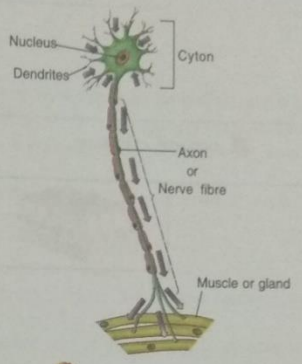
Nervous tissue is highly specialised for reception and discharge of stimuli and transmission. The dendrites receive the impulses and axon takes impulses away from the cell body.

Location :

- The neurons are concentrated in the brain and spinal cord.

Function :

- The neurons are specialised for receiving impulses. They receive impulse, get stimulated and rapidly transmit the impulse from one part of the body to the other.
- It exerts control over all body activities.
- It co-ordinates the functioning of different body parts.



Structure of a Nerve cell.

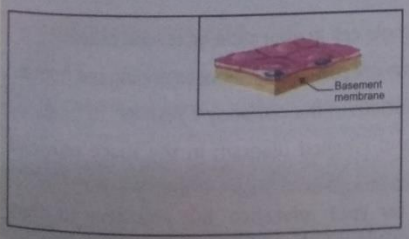
DIFFERENCES BETWEEN AXON AND DENDRITE

Axon	*Dendrite*
1. It is long uniformly thickened fibre-like process of a neuron.	1. It is a short tapering process of a neuron.
2. It carries impulses away from the cell body.	2. It carries impulses towards the cell body.

Activity 5

To study different animal tissues.

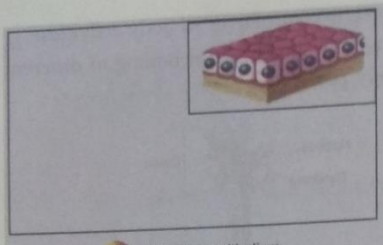
Request your teacher to provide prepared slides of different animal tissues. (Epithelial)



Squamous epithelium

❖ Focus the slides one by one under the microscope and view them carefully.

1. **Epithelial tissue :**
   - The epithelial tissues are mainly of three types—squamous, cuboidal and columnar epithelium.
   - The four types of epithelial tissues can be easily identified on the basis of the shape of the cell.
   - Observe the shape of the cells in the three slides and give your observations in the table given below.

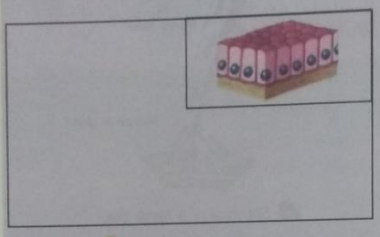


Cuboidal epithelium

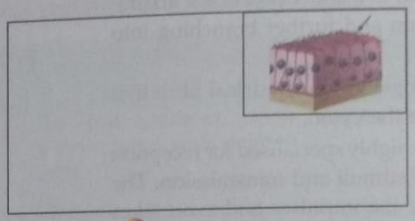
Type of epithelial tissue	Shape of the cells
1. Squamous	.....
2. Cuboidal	.....
3. Columnar	.....
4. Ciliated	.....

Observations :

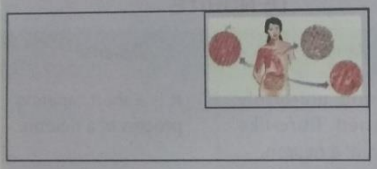
- Draw neat and labelled diagrams of different epithelial cells in the spaces provided alongside.



Columnar epithelium



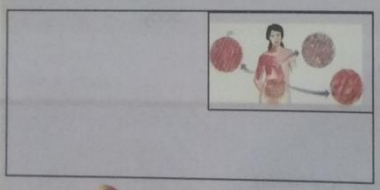
Ciliated epithelium



Striated muscle

2. Striated Muscle (voluntary) :

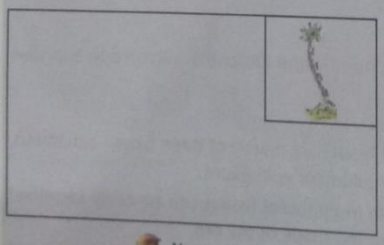
- Examine the long fibres.
- Do the fibres show any cross striations throughout the length ?
- Draw the diagram in the space provided alongside.



Non-striated muscle

3. Non-striated (involuntary) muscles :

- Examine the long fibres closely.
- Do you find spindle shaped cells, each with a centrally located long nucleus.
- Draw the diagram in the space provided alongside.



Nerve cell

4. Nerve Cell :

- Do you see a single cell in your slide or several cells ?
- Observe the main cell part and the fibre extending out from it.
- Do you see a nucleus in the cell body ? Yes/No.
- Draw a neat and labelled diagram in the space provided alongside.

Note :

- Hint is given for your reference. But you have to draw diagram after observing the slide under the microscope.
- Draw neat diagrams of the tissue you have observed. Draw the diagrams of plant tissue also.

Things to Remember

1. All living organisms are made-up of cells.
2. Group of cells which are similar in structure and functions constitute tissues.
3. Plant tissues are of two types-meristematic and permanent tissue.
4. Meristematic tissue is present at the root or shoot tip (apical) and between the xylem and phloem (lateral meristem).
5. Permanent plant tissue may be simple (parenchyma, sclerenchyma and collenchyma) or complex (xylem, phloem).
6. Xylem conducts water and minerals from the root to the leaves and is composed of vessels, tracheids, fibres and xylem parenchyma.
7. Phloem transports food material from the leaves to different parts of the plant and is composed of sieve tubes, phloem fibres, companion cells and phloem parenchyma.
8. Phloem and xylem together form the vascular bundles.
9. Animal tissues are of four types-Epithelial, muscular, nervous and connective tissue.
10. Epithelial tissue forms the lining of various organs of the body and protects them. It is of four types-squamous, columnar, cuboidal and ciliated.
11. Muscular tissue is responsible for the movement and is present in every part of the body. It is of three types : Striated, Smooth and Cardiac muscle tissue.
12. Brain, spinal cord and nerves are all composed of nervous tissue. The cells of nervous tissue are called neuron.These cells are highly specialised to conduct impulses (signals).
13. Connective tissue consists of cells of different kinds. They connect one group of tissues to another. Bone, cartilage, ligament, tendon and blood are the examples of connective tissue.

Exercises

A. Name the following :

1. Cell body of neuron.
2. Heart muscles.
3. Parenchyma cells containing chloroplast

B. Short answer questions :

1. Which tissue is present in the growing tips of roots and stem ?
2. Name the tissue that is responsible for the transmission of stimulus. Draw its diagram also.
3. Give the location and function of epithelial tissue.
4. How are plant tissues classified ? Give an outline of this classification.

C. Long answer questions :

1. How is connective tissue different from other tissues ?
2. Name the various types of cells present in xylem. What is the function of this tissue ?
3. Give a brief account of various types of cells found in connective tissue.
4. Give outline classification of animal tissues.
5. Define muscular tissue. Classify and explain different types of muscles with the help of diagram.

D. Choose the odd one from each of the following :

1. Epithelial tissue, meristematic tissue, muscular tissue, nervous tissue.
2. Blood, cartilage, lymph, plasma.

3. Parenchyma, collenchyma, xylem, sclerenchyma.
4. Cyton, cardiac muscle, dendrites, axon.

E. Fill in the blanks :

1. A long cylindrical process arising from the cyton is called ..... .
2. ..... are forms of complex tissue.
3. Parenchyma is present in the ..... regions of the plant.
4. A nerve cell is called a ..... .
5. ..... tissue is situated at the tip of root and stem and helps in growth of the plant.

F. Write true or false and correct the incorrect statement :

1. Xylem and phloem are the vascular bundles.
2. Ligament connects bone to bone.
3. A nerve cell is called neuron.
4. The oxygen produced during photosynthesis comes from CO_2.
5. Phloem and xylem together form the vascular bundles.

G. Choose the correct answer :

1. A group of cells which is similar in structure and function is known as :
   (*a*) Molecule (*b*) Matrix (*c*) Tissue (*d*) Organ.
2. Voluntary muscles are :
   (*a*) Spindle shaped (*b*) Spherical (*c*) Cylindrical and branched
   (*d*) Cylindrical and unbranched.
3. The blood without the red corpuscle is :
   (*a*) Matrix (*b*) Plasma (*c*) Lymph (*d*) Xylem
4. Xylem consists of :
   (*a*) Vessels, sieve tubes, xylem fibres and phloem parenchyma.
   (*b*) Tracheids, phloem fibres, companion cells and vessels.
   (*c*) Vessels, tracheids, fibres and xylem parenchyma.
   (*d*) Vessels, sieve tubes, fibres and xylem parenchyma.
5. Meristematic tissue have :
   (*a*) Cells which divide for sometime (*b*) Dead cells
   (*c*) Undividing cells (*d*) Continuously dividing cells.
6. Vascular bundles are composed of :
   (*a*) Phloem parenchyma and vessels (*b*) Xylem and phloem
   (*c*) Collenchyma and parenchyma (*d*) Collenchyma and xylem.
7. Blood is a :
   (*a*) Muscular tissue (*b*) Connective tissue (*c*) Nervous tissue (*d*) Epithelial tissue.
8. Movement or the passage of food in the intestine is caused by the contractions of :
   (*a*) Cardiac muscles (*b*) Unstriated muscles (*c*) Striated muscles (*d*) Connective tissue.

9. Ligament connects :

(*a*) Muscle to bone (*b*) Muscle to the skin (*c*) Muscle to muscle (*d*) Bone to bone.

10. Parenchyma is a type of :

(*a*) Complex tissue (*b*) Simple tissue (*c*) Xylem (*d*) Phloem

H. Match the columns :

Column A	Column B
1. Xylem and phloem	(*a*) Histology
2. Axon and dendrites	(*b*) Meristems
3. Study of tissues	(*c*) Cardiac muscle
4. Growing tips of root	(*d*) Vascular bundles
5. Heart	(*e*) Neurons

I. Differentiate between the following :

1. Voluntary, Involuntary and Cardiac muscles.
2. Parenchyma, Collenchyma and Sclerenchyma.
3. Xylem and Phloem.
4. Meristematic and Permanent tissue.

J. Activity/Project/Research Work :

1. Try to find out the reasons for the following :
   (*a*) The disease that damages connective tissue can impair most of the body's organs. Why ?
   (*b*) What type of plant tissue makes up wood ? What is bark ?
   (*c*) What will happen if apical meristem is damaged or cut ?

K. Value Based Question :

Ravjot identifies an animal tissue whose cells are filled with fat globules and the tissue acts like an insulator or as areolar tissue. Her classmate Palak suggests that she is wrong and rectify her answer.

(a) Name the tissue. (b) What values does Palak show ?

Theme-2 Kingdom Classification

CHAPTER

2

Kingdom Classification

Introduction

Our earth is inhabited by a large variety of living organisms. The diversity in organisms can be observed in size, form, shape, etc. The variety in living organisms existing on earth is called ***biodiversity***. The limit of biodiversity is endless.

Learning New Words

Classification : The method of arranging organisms into groups or sets on the basis of similarities and differences is called classification.

Lichens : They are symbiotic combination of an alga and a fungus.

Acellular : Unicellular organisms whose body is not divided into cells.

Encystment : Formation of a cyst by secreting hard resistant covering (cyst wall).

Fungi : They are non-green heterotrophic organisms having glycogen and oil as stored food material.

Cold-blooded or Poikilothermal animals : Animals in which body temperature varies according to surrounding environment.

Warm-blooded or Homeothermal animals : Animals in which the temperature remains constant and does not change with the change of environment, temperature.

Acoelomates : Animals without body cavity.

Osculum : A wide opening in sponges for passing out water.

Sedentary : Animals which remain fixed to a substratum.

TAXONOMY

The functional branch of biology dealing with the identification, nomenclature (naming) and classification of living organisms is called *'Taxonomy'*.

'Carolus Linnaeus' (1707-1778) is known as the 'Father of taxonomy'.

CLASSIFICATION

The systematic grouping of organisms into categories on the basis of their similar and dissimilar characteristic and structural relationships is called *classification*.

Importance : It is essential to understand the interrelationships among different groups of organisms :

- Enables to study a wide variety of organisms easily.
- It helps us in identifying a correct desirable plant to be crossed to another desirable plant so as to improve the quality of a certain plant.
- It proves the idea of common ancestry of all the living organisms.
- It helps us in identifying which characteristic is to be used as the basis for making broadest divisions.

MODES OF CLASSIFICATION

Different criteria have been used by different taxonomists from time to time to classify living organisms in different ways. But, the following two systems of classification are commonly used.

TWO-KINGDOM SYSTEM OF CLASSIFICATION

Aristotle have divided the living world into two kingdoms *i.e.* (*i*) Plantae and (*ii*) Animalia.

Linnaeus also divided the living world into two kingdoms in 1758 as Aristotle did.

(*i*) *Kingdom Plantae* : All the plants constitute Kingdom Plantae. This kingdom includes bacteria, fungi, algae, ferns, mosses, etc.

(*ii*) *Kingdom Animalia* : All the animals collectively constitute the kingdom animalia. This kingdom includes protozoans, sponges, jelly fishes, worms, insects, etc.

Drawbacks in two-kingdom classification :

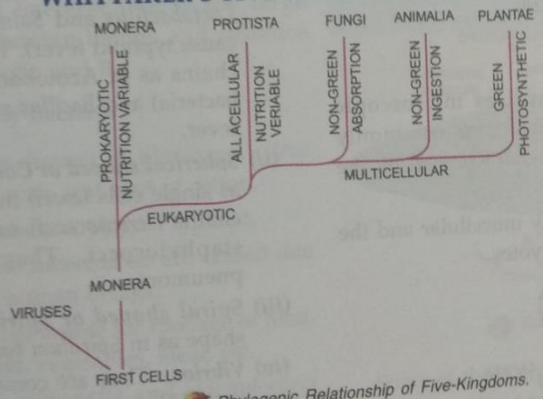
Later taxonomic studies clearly showed that some organisms neither fit into kingdom plantae nor kingdom animalia. In some characteristics they resemble with plants and in other features, they are similar to animals. A clear line cannot be drawn between these two kingdoms. *e.g.*, Euglena possesses chlorophyll and is capable of doing photosynthesis in sunlight like that of plants but it is heterotrophic and does not possess cell wall like animals.

FIVE-KINGDOM SYSTEM OF CLASSIFICATION

ROBERT H. WHITTAKER, an American taxonomist in 1969 has proposed a new five-kingdom classification of living organisms.

The main criteria for classification used by Whittaker include cell structure (prokaryotic or eukaryotic). Complexity of organisms (unicellular or multicellular) and mode of nutrition (absorptive, autotrophic or heterotrophic).

WHITTAKER'S FIVE-KINGDOMS CLASSIFICATION



Phylogenic Relationship of Five-Kingdoms.

The five kingdom classification given by Whittaker is as follows :

(1) ***Kingdom Monera* :** Unicellular, prokaryotic organisms such as bacteria, blue-green algae and mycoplasmas.

(2) ***Kingdom Protista* :** Unicellular, eukaryotic organisms, *e.g.* protozoans, algae.

(3) ***Kingdom Fungi* :** Multicellular, eukaryotic organisms having absorptive mode of nutrition, *e.g.* all fungi.

(4) ***Kingdom Plantae* :** Multicellular, eukaryotic organisms having autotrophic mode of nutrition, *e.g.* plants.

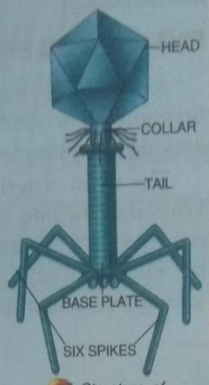
(5) ***Kingdom Animalia* :** Multicellular, eukaryotic organisms having ingestive mode of nutrition, *e.g.* animals.

Whittaker did not include viruses in his scheme of classification. Viruses are considered as

connecting links between living and non-living. They are the package of nucleic acids (DNA or RNA) covered by protein covering.

Do You Know?

- **Viruses are connecting links between living and non-living :**
  - (*i*) They are obligatory parasites and live outside the host cell as inactive non-living biochemicals.
  - (*ii*) The body of viruses contains the genetic material (DNA or RNA), covered by a proteinaceous covering called **capsid** enclosing .
  - (*iii*) The viruses infect bacteria, animal cells and plant cells.

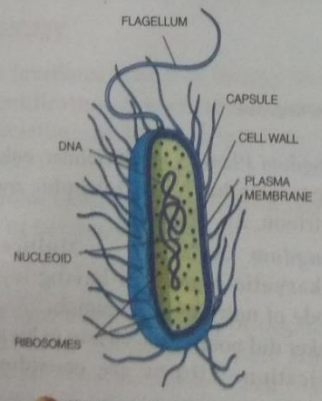


Structure of bacteriophage - a virus that infect bacteria

KINGDOM MONERA

Kingdom Monera comprises microscopic unicellular, prokaryotic organisms commonly known as *bacteria*. They are characterised by the following features :

(1) Monerans are basically unicellular and the most primitive prokaryotes.



Kingdom Monera e.g., Bacteria

(2) Their body cells do not have well defined nucleus.

(3) Membrane bound cell organelles like nucleus, mitochondria and endoplasmic reticulum are absent.

(4) Cell wall present.

(5) Mode of nutrition may be autotrophic or heterotrophic.

It includes bacteria, blue-green algae or cyanobacteria and mycoplasmas.

Bacteria

1. The bacteria are unicellular microscopic organisms.
2. They lack nuclear membrane (prokaryotes) and chlorophyll.
3. They get their food from the living or dead organic material, *i.e.*, heterotrophic.
4. Cell organelles absent.

Shapes : Bacteria occur in four shapes.

(*i*) ***Rod shaped or Bacilli : e.g.*** *Escherichia coli* which lives in the intestine of humans. These may occur as single rods as in *E. coli*, *Lactobacillus* and *Salmonella typhi* (which cause typhoid fever). These rods may form chains as in Azotobacter (nitrogen fixing bacteria) and *Bacillus anthracis* which cause fever.

(*ii*) ***Spherical shaped or Cocci :*** They may occur as single cells (*cocci*) in pairs (*diplococci*) in chains (*streptococci*) or in clusters called staphylococci. They cause bacterial pneumonia.

(*iii*) ***Spiral shaped or Spirilla :*** It is spiral in shape as in *Spirillum bacteria*.

(*iv*) ***Vibrios :*** They are comma shaped bacteria as in *Vibrio cholerae* (Causes cholera).

Rod-shaped bacterium with flagellae.

Spherical bacteria (Cocci).

Useful actions of Bacteria :

Most bacteria are beneficial to other living organisms.

- Bacteria promote the formation of curd and cheese by the process of fermentation in which milk sugar (lactose) is converted into lactic acid by the action of bacteria.
- Bacteria act upon fruit juices to produce vinegar and wines.
- Bacteria act as natural scavengers since they decompose the organic waste rapidly. They are useful in the formation of compost and manures.
- Bacteria are used to make antibiotic like *streptomycin* and vitamin B complex tablets.
- Some bacteria like Rhizobium (found in nodules of leguminous plants) and Azotobacter (soil bacteria) absorb free nitrogen from air and convert it into nitrates which are used by the plants.
- Some useful bacteria live in the large intestine of human beings and produce vitamin C, Biotin and B_{12}.

Harmful Action of Bacteria :

- Bacteria cause *diseases* in plants *e.g. citrus canker*, potato scab, leaf spot of cotton.
- Diseases like cholera, plague, typhoid, pneumonia and tuberculosis are caused due to bacteria in human beings.
- Bacteria are responsible for spoilage of food, rotting of fruits, vegetables, meat, etc.
- Bacteria like *salmonella* and *staphylococci* cause food poisoning.

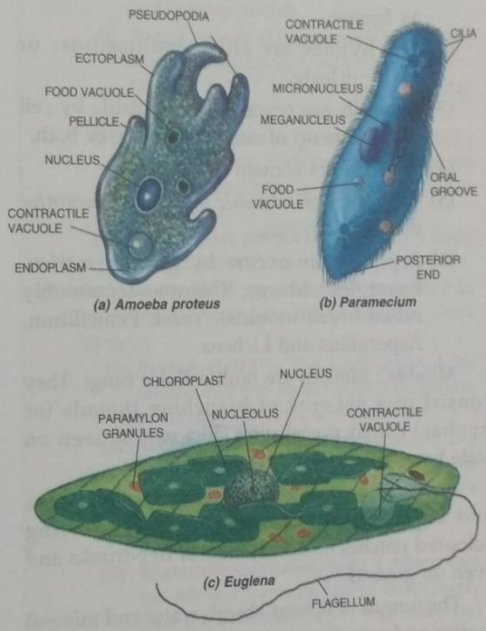
KINGDOM PROTISTA

Kingdom Protista includes unicellular organisms having eukaryotic cell. They are characterised by the following features :

1. They are the *acellular* (unicellular) eukaryotes.
2. Locomotory organelles may be pseudopodia, cilia or flagella.
3. Various membrane bound cell organelles are present.
4. The body may be covered by simple plasma membrane. The cell wall is absent.
5. *Respiration* and *Excretion* take place through the body surface by means of diffusion.

Some common protists are :

(1) Amoeba (2) Paramecium (3) Euglena.



Some common protists.

Some of these organisms use appendages such as hair-like cilia *e.g.*, (Paramecium) or whip like Flagellum (*e.g.*, Euglena). Their mode of nutrition can be autotrophic (*e.g.*, unicellular algae such as, Chlorella, Chlamydomonas or heterotrophic (*e.g.*, Protozoans).

Protists reproduce *asexually* by *binary fission*, *multiple fission* or *sporulation* in favourable conditions.

In these organisms the single cell performs all the functions.

e.g., Amoeba – single celled organisms take and digest food, respire, excrete, grow and reproduce with the help of only one cell.

KINGDOM FUNGI

Kingdom fungi includes Eukaryotic, multicellular organisms having absorptive mode of nutrition. It is characterized by the following features :

They may be parasitic or saprophytic :

(1) The body of fungus is filamentous and is called *mycelium*. The filaments are known as *hyphae*.

(2) The hyphae are either multicellular or multinucleate.

(3) The cells are covered from outside by cell wall made-up of *chitin or cellulose* or both.

(4) They do not contain chlorophyll.

(5) They are *heterotrophic* and have *absorptive* mode of *nutrition*.

(6) *Reproduction* occurs by *spore formation*. Examples : Mucor, Rhizopus (commonly called bread moulds), Yeast, Penicillium, Aspergillus and Lichens.

Moulds : Moulds are multicellular fungi. They consist of a network of branching threads (or hyphae) called mycelium. They can be seen on stale bread, old pickles, rotting fruits.

Lichen is a symbiotic association of a fungus and alga. Lichens grow as the slow-growing coloured patches on rocks, bark of tree-trunks and even on ground.

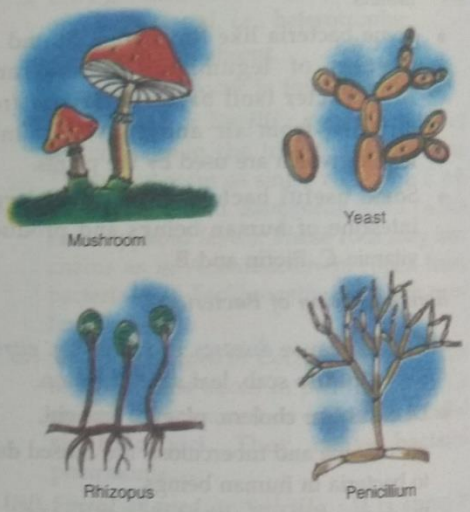
The fungus of lichens absorb water and mineral matter and supplies it to the algae. The algae, in turn prepare food and supply it to the fungus. This is called symbiosis.

Importance of Fungi :

1. Yeast is used in making bread, cakes, idli and dosa, etc. Yeast is rich in vitamin B.
2. Yeast is also used for commercial production of alcohol and wine by growing them on natural sugars present in grains like barley, wheat, rice and crushed fruit juices, etc.
3. Some fungi such as mushrooms are directly used as food.
4. Some medicines are prepared from fungi, penicillin (an antibiotic) is made from *Penicillium notatum*.
5. They help in recycling of nutrients in the biosphere.

Harmful effects of Fungi :

1. Some fungi cause skin diseases.
2. They cause diseases in plants *e.g.* loose smut of wheat, potato blight.
3. Some of the fungi spoil food and hot clothes, shoes, wooden material, books, etc.
4. Type of fungus lives between the toes in humans and cause terrible itching. This causes a disease known as athletes' foot.



Different types of fungi.

KINGDOM PLANTAE

Kingdom plantae includes all eukaryotic multicellular organisms having photosynthetic mode of nutrition. They are classified by the following features :

(1) Plants are multicellular having eukaryotic cells and photosynthetic mode of nutrition. Food is stored as *starch*.

(2) The body of plants is usually branched and irregular.

(3) Plant cells are covered from outside by cell wall made-up of cellulose.

(4) The plants are usually fixed or free floating.

(5) The body is differentiated into root, stem, leaves and flowers.

(6) Green coloured *chlorophyll* is present in their leaf cells. It helps in photosynthesis. It includes algae, bryophytes and tracheophytes.

KINGDOM ANIMALIA

Kingdom animalia includes organisms characterised by the following features :

(1) The animals are eukaryotic and multicellular organisms having ingestive mode of nutrition.

(2) Various organs are present inside the body.

(3) They move freely from place to place and possess locomotory organs except some sponges and corals.

(4) Their body cells are without cell wall.

(5) In their body cells food is stored as Glycogen.

Kingdom animalia has been broadly classified into ten major Phyla. The classification of *Animalia* is based on the body design and differentiation.

These are as follow :

1. Phylum Porifera
2. Phylum Coelenterata (Cnidaria)
3. Phylum Ctenophora
4. Phylum Platyhelminthes
5. Phylum Aschelminthes (Nematoda)
6. Phylum Annelida
7. Phylum Arthropoda
8. Phylum Mollusca
9. Phylum Echinodermata
10. Phylum Chordata

INVERTEBRATES AND VERTEBRATES

All phyla from porifera to echinodermata are grouped together under the category of Invertebrates, *i.e.*, animals without a backbone.

The Phylum chordata represents all such animals which have a backbone and are popularly called *Vertebrates*, *i.e.*, animals with a backbone.

Knowledge Enhancer :

(A) Body Cavity (COELOM) : It is the internal body cavity or coelom in which well-developed body organs can be accomodated. The presence of coelom results in estensive organ "*differentiation*". The organisms are described into different categories on the basis of body cavity as :

(*i*) **Acoelomate :** Having no internal body cavity. *e.g.*, Phylum Porifera, Coelenterata and Platyhelminthes.

(*ii*) **True Coelom (Eucoelomate) :** Having internal body cavity lined with mesoderm layer, *e.g.*, Phylum Annelida, Echinodermata and Vertebrata.

(*iii*) **Pseudocoelomate (False body cavity) :** Having internal body cavity but not lined with mesoderm layer. *e.g.*, Phylum Nematoda.

(*iv*) **Haemocoel (Reduced Coelom) :** Body cavity filled with blood.

(B) Body Symmetry : It means dividing the body into equal and identical parts. It is of following three types :

(*i*) **Asymmetrical :** The body cannot be divided into two equal halves through any plane, *e.g.*, Amoeba, some porifera.

(*ii*) **Radially symmetrical :** It means that, any line passing the centre divides the body into two similar halves, e.g., Porifera (some), Coelentrata, adults of Echinodermata.

(*iii*) **Bilaterally symmmetrical :** It means that the left and the right halves of the body have the same design, *i.e.*, their body can be divided into two similar halves only through one plane (through the middle axis).

(C) Embryonic Layers : The layers of germ cells from which body of an organism develops. On this basis organisms are classified into two types :

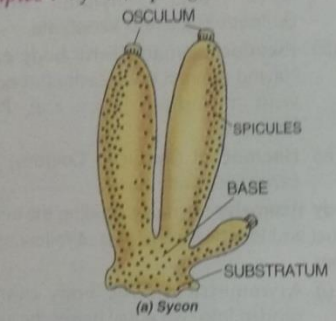
(*i*) **Diploblastic :** Body is made-up of two layers of cells, one makes outer layer of the body (*ECTODERM*) and the other forms inner lining of the body (*ENDODERM*).

(*ii*) **Triploblastic :** It means that, there are three layers of cells from which tissues differentiate, *i.e.*, body is made. These three layers are : *Ectoderm*, *Mesoderm* and *Endoder*....

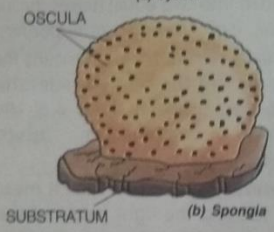
1. PHYLUM PORIFERA (Prous-Pore, ferre-to bear)

1. They are exclusively aquatic in their habitat. Mostly marine with few exceptions which are found in freshwater.
2. They are sedentary (attached to the substratum) and lack locomotory organs.
3. The body bears a large number of pores called *ostia*. Through ostia water enters the body cavity. A large aperture called *osculum* is meant for removal of water.

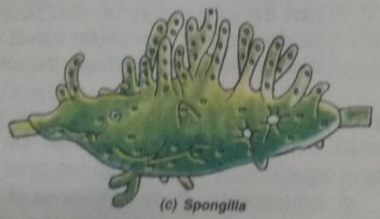
Examples : Sycon, Spongilla, Leucosolenia etc.



(a) Sycon



(b) Spongia

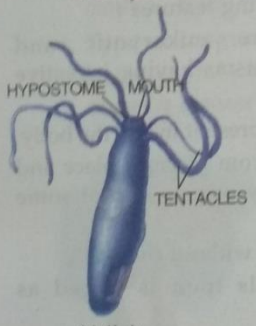

(c) Spongilla

Some common poriferans (sponges)

2. PHYLUM-COELENTERATA (Cnidaria) (sac like animals)

- They are sac-like animals having *radially symmetrical* body. They may be *sedentary* or free living in water.
- Mostly *marine* but a few are freshwater species.
- Throughout the body is present a continuous cavity called *coelenteron* or *gastrovascular cavity*. It communicates with outside through mouth only. Around the mouth are present finger-like structures called *tentacles*.
- They contain nematocysts (stinging cells).

Examples : Hydra, Aurelia, Metridium, etc.



(a) Hydra

(b) Aurelia

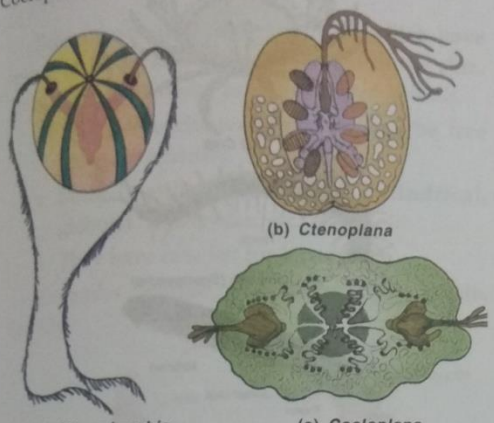
(c) Metridium

Some common coelenterates.

3. PHYLUM-CTENOPHORA

- They are exclusively *marine* in habitat.
- They are *diploblastic* having tissue level of organisation.
- *Reproduction* is sexual only. Fertilisation is external.
- They have radial body symmetry and lack coelom.

Examples : Pleurobrachia, Ctenoplana, Coeloplana, etc.

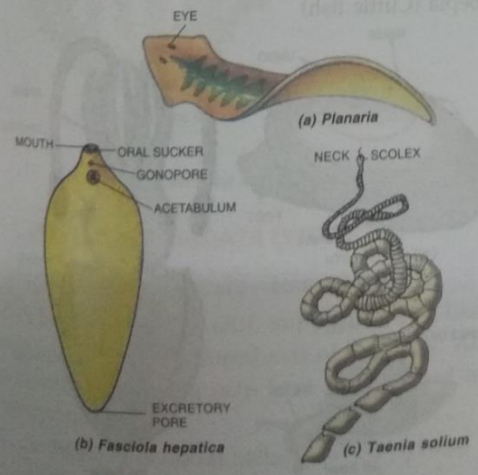


Some common ctenophores

4. PHYLUM-PLATYHELMINTHES (Flatworms), (Platys-flat, Helminth-worm)

1. They are flattened dorsoventrally forming a leaf like or ribbon-like body having *bilateral symmetry*.
2. They are having organ-system level of organisation.
3. They are *acoelomates*, *i.e.*, without any body cavity.

Examples : Planaria, *Fasciola hepatica* (Liver fluke), *Taenia solium* (Tapeworm).

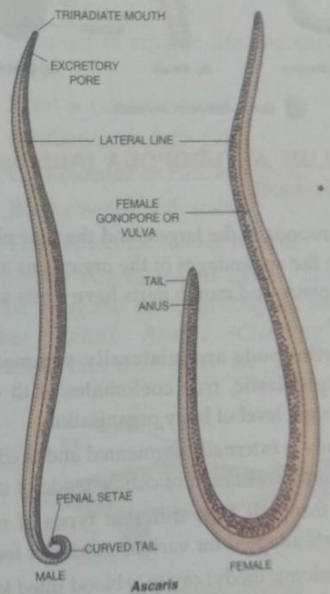


Some common platyhelminthes.

5. PHYLUM NEMATODA (Nema-Thread) (Eidos-form)

1. They are found in all types of habitat, *i.e.*, in freshwater, sea water and soil.
2. They are bilaterally symmetrical, unsegmented and cylindrical in shape.
3. Alimentary canal is complete *i.e.* opens at one end as mouth and at the other end as anus.

Examples : *Ascaris*, *Wuchereria* (*Filarial worm*).

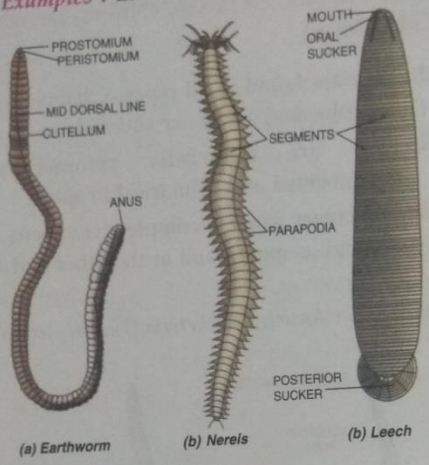


Nematodes; Roundworms.

6. PHYLUM ANNELIDA (Annelus-little ring Eidos-form)

1. They may be marine, freshwater, terrestrial or parasitic in their habitat.
2. They have bilaterally symmetrical body.
3. Body is metamerically segmented, *i.e.* divided into small segments externally by grooves called *annuli* and internally by vertical partitions called *septa*.

Examples : Earthworm, Nereis, Leech.



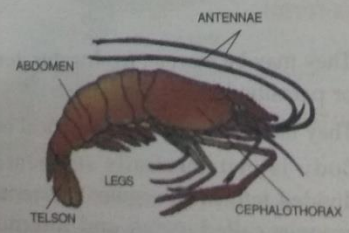
Some common annelids.

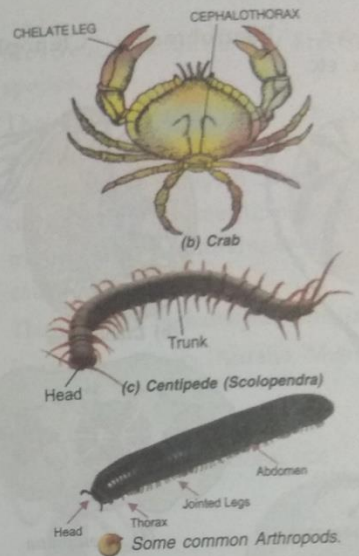
7. PHYLUM ARTHROPODA (Arthros-joint Podos-foot)

Arthropoda is the largest and the first phylum in which the appendages of the organisms such as legs, antennae and mouth parts have joints and are movable.

- Arthropods are bilaterally symmetrical, triploblastic, true coelomates with organ system level of body organisation.
- Body is externally segmented and is covered by an exoskeleton of cuticle made of chitin.
- Arthropods have different types of mouth parts adopted for various modes of feeding.
- Coelomic (body) cavity is blood filled known as *haemocoel*.

Examples : Palaemon (Prawn), Aranea (Spider), Centipede (Scolopendra).





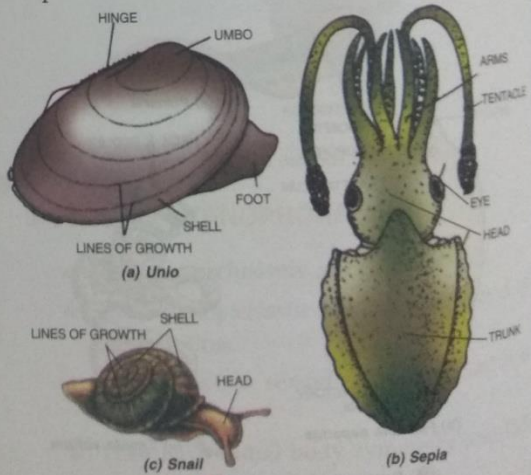
Some common Arthropods.

8. PHYLUM MOLLUSCA (Soft bodied animals)

Molluscs have extremely soft body covered by a thin fold of skin called *Mantle*.

- They are mostly *marine* or freshwater but a few are terrestrial in habitat.
- The body of molluscs is divisible into *head*, *visceral mass* and *foot*.
- The head bears mouth, eyes and tentacles. The visceral mass encloses body organs.
- The coelomic cavity is reduced (*haemocoel*).
- They have an open circulatory system, *i.e.*, blood does not flows in the blood vessels.

Examples : Unio, Snail, Octopus (Devil fish), Sepia (Cuttle fish)



Some common Molluscs.

9. PHYLUM ECHINODERMATA (Spiny-skinned animals)

Echinodermata includes animals which have spines all over their body embedded in the skin. Thus, these are known as *spiny-skinned animals.*

- They are exclusively *marine*, may be free living or *sedentary.*
- Body is either star shaped, cylindrical, globular, flower-like, etc.
- They have *tube feet* for locomotion.

Examples : Starfish, Sea cucumber, Sea urchin, Sea lily.

(a) Starfish

(b) Sea cucumber

(c) Antedon (Sea lily)

Some common echinoderms.

10. PHYLUM-CHORDATA (Vertebrata)

(Chorde-Cord/string; ata - bearing)

Chordates have a stiff, supporting rod-like *notochord* in the mid-dorsal axis of the body. All vertebrates including man have a notochord in embryonic life.

- Presence of dorsal hollow nervous system.
- Presence of Tail in most chordates.
- Presence of two pairs of limbs.
- Vertebral column forms the main axis of their internal skeleton which may be of bones or cartilages.

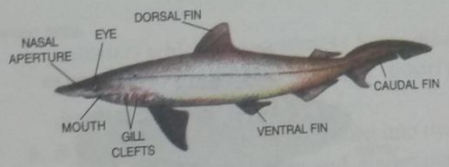
Phylum chordata is divided into five classes :

1. Class Pisces
2. Class Amphibia
3. Class Reptilia
4. Class Aves
5. Class Mammalia

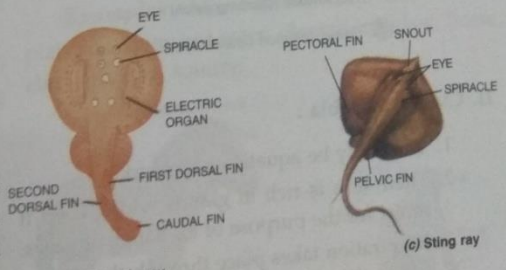
I. Class Pisces :

1. Adapted to aquatic life and include all fishes.
2. Heart is two chambered.
3. Respiration through gills.
4. Cold-blooded or Poikilothermal.
5. Body covered with scales.
6. Fins for locomotion are present.

Examples : Cartilaginous fishes : *Electric ray (Torpedo), Sting ray, Scoliodon (Dogfish) Bony fishes – Labeo (Rohu), Anabas (Climbing perch), Hippocampus (Sea horse) male,* etc.



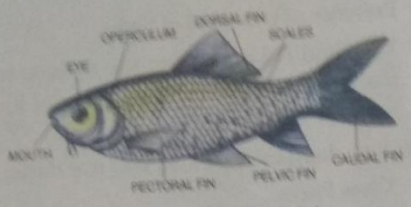
(a) Scoliodon (Dogfish)



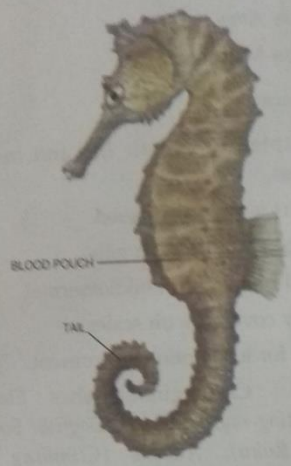
(b) Electric ray

(c) Sting ray

Some common chondrichthyes.



(a) Labeo rohita (Rohu)



(b) Hippocampus (Sea horse) male

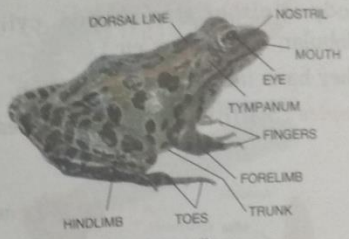
(c) Anabas (Climbing perch)

Some common osteichthyes.

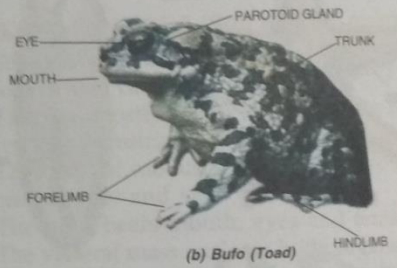
II. Class Amphibia :

1. They may be aquatic or terrestrial.
2. Their skin is rich in glands which keep it moist for the purpose of exchange of gases.
3. Respiration takes place through the skin or lungs or lining of buccal cavity.
4. Heart in amphibians is three-chambered.
5. The upper and lower eyelids are immovable. A third eyelid called *nictitating membrane* is present.
6. They are *oviparous (lay eggs)*. Fertilisation is external.

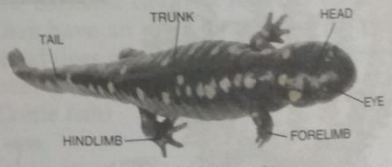
Examples : Rana (Frog), Bufo (Toad), Salamander, etc.



(a) Rana Frog



(b) Bufo (Toad)



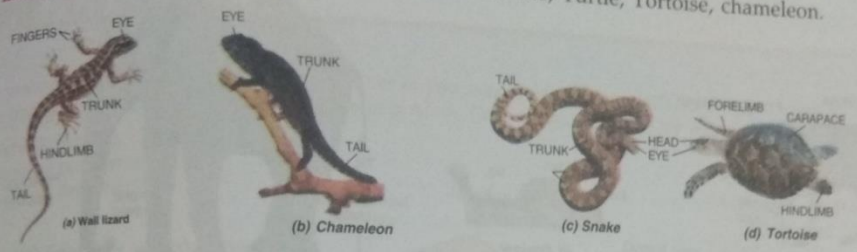
(c) Salamander

Some common amphibians.

3. Class Reptilia :

1. The skin of reptiles is rough and dry, covered with epidermal scales.
2. Respiratory organs are lungs only.
3. The heart is incompletely four-chambered.
4. They are unisexual, *oviparous* and fertilization is internal.
5. The reptiles are *cold-blooded or poikilotherms* and undergo *hibernation* during winter season.

Examples : Wall lizard(*hemidactyles*), Crocodiles, Snakes, Turtle, Tortoise, chameleon.



Some common reptiles.

4. Class Aves :

1. Birds are *arboreal animals* (living on trees) and make their nest on the trees.
2. The body is boat-shaped and divisible into head, neck, trunk and a small tail.
3. The body of birds is covered with coloured feathers.
4. Out of the two pairs of limbs, the forelimbs are modified as *wings* for the purpose of flight.
5. They are unisexual. Fertilisation is internal. They are *oviparous* and the eggs contain a large quantity of *yolk*.
6. They are *warm-blooded or homeotherms*.

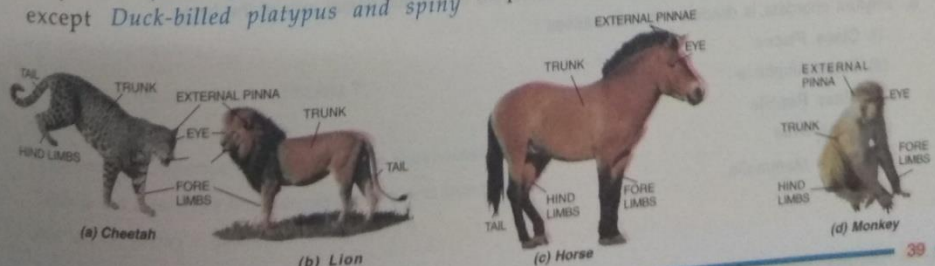
Examples : Pigeon, Sparrow, Crow, Peacock, Parrot, Eagle, Fowl.

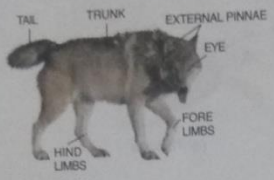
Some common birds.

5. Class Mammalia :

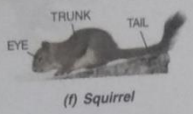
1. Presence of functional mammary glands in female to secrete milk.
2. Presence of hair on any part of the body.
3. Presence of external pinna.
4. The skin contains a number of *sweat glands and sebacious glands.*
5. They are *viviparous (give birth to young ones)* except *Duck-billed platypus and spiny anteaters* which are *oviparous*. Some like kangaroos give birth to very poorly developed young ones.
6. Body cavity of mammals is divided into two parts, *i.e.*, thoracic cavity and abdominal cavity by a muscular dome-shaped *diaphragm*.

Examples : Man, camel, lion, duck-billed platypus, spiny ant eater, cheetah, monkey, horse, elephant, dog, squirrel.

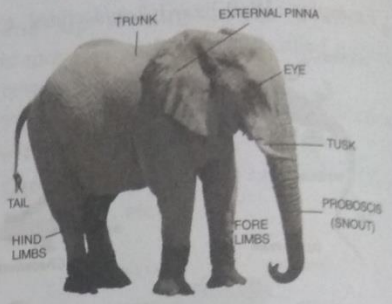




(e) Dog



(f) Squirrel



(g) Elephant

Some common mammals.

MAJOR DIFFERENCES BETWEEN VERTEBRATES AND INVERTEBRATES

Characters	Vertebrates	Invertebrates
1. Vertebral column	Present (formed of vertebrae)	Absent
2. Brain box (Cranium)	Present so called *craniata.*	Absent
3. Heart	Ventral	Absent or on dorsal or lateral sides
4. Epidermis	Many layered	Single layered
5. Haemoglobin	Present inside the RBCs	Absent or present in plasma
6. Endoskeleton	Present, formed of cartilages and bones.	Absent
7. Nerve cord	Dorsal and hollow	Ventral and solid when present

Things to Remember

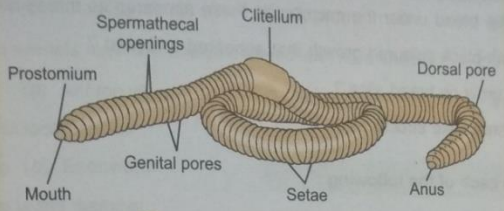
1. The functional branch of biology dealing with the identification, nomenclature and classification of living organisms is called 'Taxonomy'.
2. Monerans are basically unicellular and the most primitive prokaryotes.
3. Protista are the acellular (unicellular) or colonial eukaryotes. Locomotory organelles may be pseudopodia, cilia or flagella.
4. Kingdom fungi includes Eukaryotic, multicellular organisms having absorptive mode of nutrition.
5. Kingdom plantae includes all eukaryotic multicellular organisms having photosynthetic mode of nutrition.
6. Kingdom animalia includes organisms characterised by the following features :
   (*a*) The animals are eukaryotic and multicellular organisms having ingestive mode of nutrition.
   (*b*) Various organs are present inside the body.
7. Chordates have a stiff, supporting rod-like notochord in the mid-dorsal axis of the body.
8. Phylum chordata is divided into five classes :
   (*i*) Class Pisces
   (*ii*) Class Amphibia
   (*iii*) Class Reptilia
   (*iv*) Class Aves
   (*v*) Class Mammalia

Activity 1

To make picture cards : You may collect pictures or you may draw diagram with labellings as given in your book. Try to collect information for each organism or phylum. One example is given for your reference.

Scientific Name :
Pheretima posthuma
Phylum : Annelida.

Special Features : Earthworms have the ability to replicate lost segments but it varies between species and depends on the extent of damage.



Structure of the earthworm.

Phylum's Features :
- Body metamerically segmented.
- True coelom, bilaterally symmetrical.
- Locomotory organs are setae or parapodia.
- Excretory organs are setae.

Organism's Features :
- Segmented body made-up of ring like segments called annuli.
- Clitellum (14-16) present which secretes sticky clear mucus that covers the worm.
- Mouth is pointed and its first segment is called *peristomium*. On its lower side a small sensory lobe projects which is known as *prostomium* which helps in sensing the soil during digging.

Adaptive Features :
- Cylindrical body helps in burrowing.
- Moist skin (due to mucus gland) does not allow soil to stick and help to breathe.
- Anterior end sense the soil, eat and convert soil into fertile and hence called farmer's friend.

Exercises

A. Name the following :

(*a*) Animals which spend their lives fixed to a substratum.

(*b*) Formation of a cyst by secreting a hard resistant covering.

(*c*) Animals that live in sea water.

(*d*) A wide opening in sponges for passing out water.

(*e*) A true internal body cavity in which well developed organs can be accommodated.

B. Short answer questions :

1. How Monera are different from Protista ?
2. Define the following terms :
   (*i*) Coelom (*ii*) Oviparous (*iii*) Viviparous (*iv*) Haemocoel (*v*) Classification.
3. Tabulate the differences between vertebrates and invertebrates.
4. Why is it necessary to classify the living world ?

C. Long answer questions :

1. Name the major phyla of kingdom animalia giving two features and examples of each phylum.
2. Give any five uses of bacteria and give any five harmful effects.
3. Explain the basis for grouping into five kingdoms.
4. A slice of bread was moistened with water and was left, under warm conditions for 2-3 days. A greenish black coloured growth appeared on the bread under the microscope these appeared as thread-like structures.
   (*i*) What is greenish-black coloured growth that appeared on bread ?
   (*ii*) Why did these grow on bread slice ?
   (*iii*) What are the thread-like structures ?

D. Choose the odd one from each of the following :

1. Amoeba, Paramecium, Fungi, Euglena.
2. Mushroom, Rhizopus, Penicillium, Bacterium.
3. Pseudopodia, Flagellum, Cilia, Ostia.
4. Hydra, Aurelia, Metridium, Planaria.
5. Earthworm, Ascaris, Nereis, Leech.

E. Fill in the blanks :

1. Lichens are a symbiotic combination of ..... and ..... .
2. In Mollusca, the body is divisible into ..... , ... and ..... .
3. Presence of ..... , ... and ..... are the diagnostic features of Chordata.
4. Five-kingdom system of classification was given by ..... .
5. Hair-like cilia or whip like flagella for locomotion are present in ..... kingdom.
6. ..... is a phylum of spiny skinned sea animals.

F. Write true or false and correct the incorrect statement :

1. Animals living on trees are called arboreal.
2. Reptiles may be aquatic or terrrestrial.
3. Frog is a warm-blooded animal.
4. The heart of mammalian is completely four chambered.

G. Choose the correct answer :

1. Who proposed 5-kingdom of classification :
   (*a*) Carolus Linnaeus (*b*) Eichler (*c*) Schimper (*d*) R. Whittaker.
2. Binomial nomenclature was given by :
   (*a*) Darwin (*b*) Theophrastus (*c*) Linnaeus (*d*) Aristotle.

3. Haemocoel is found in :

(*a*) Arthropoda (*b*) Mollusca (*c*) Echinodermata (*d*) Both (*a*) and (*b*).

4. Animals living on trees are called :

(*a*) Aerial (*b*) Arboreal (*c*) Nocturnal (*d*) Flying.

5. Jointed appendages and chitinous skeletons are characteristic features of :

(*a*) Arthropoda (*b*) Annelida (*c*) Chordata (*d*) Echinodermata.

6. The Phylum in which animals have soft bodies covered with hard shell is :

(*a*) Mollusca (*b*) Arthropoda (*c*) Nematoda (*d*) Annelida.

7. Which one is warm-blooded animal :

(*a*) Rat/human being (*b*) Earthworm (*c*) Fish (*d*) Frog.

8. Which one is an egg laying mammal :

(*a*) Platypus (*b*) Bat (*c*) Whale (*d*) Seal.

9. Fungi are characterised by :

(*a*) Mycelium and hyphae (*b*) Chitin containing wall

(*c*) Glycogen as food reserve (*d*) All of the above.

10. Forelimbs are modified to form wings in :

(*a*) Birds (*b*) Cockroach (*c*) Housefly (*d*) Spider.

H. Match the columns :

Column A	Column B
(1) Amphibia	(*a*) Cyanobacteria
(2) Lichens	(*b*) Planaria, liverfluke
(3) Blue-green algae	(*c*) Chitin
(4) Platyhelminthes	(*d*) Presence of hair
(5) Fungus	(*e*) Paramecium
(6) Mammals	(*f*) Starfish
(7) Protozoans	(*g*) Symbiotic relationship
(8) Phylum Echinodermata	(*h*) Cold-blooded

I. Differentiate between the following :

1. Algae and Fungi
2. Vertebrates and Invertebrates
3. Kingdom Monera and Kingdom Protista
4. Amphibians and Pisces
5. Arthropoda and Annelida

J. Activity/Project/Research Work :

1. Visit to a nearby garden/zoo or a nature walk and identify plants/land vertebrates in your area.
2. List some organisms having a common feature of plants and animals and justify their position in classification.
3. A weed is growing on the border of your playing ground. How will you group these plants ?
4. Try to collect more information on each phylum, draw pictures of organisms belonging to these phylum.
5. Make project of making picture cards and write detailed information of a particular organism on either side of it.

K. Value Based Questions :

1. Rahul lives in a coastal village. He is a son of fisherman. Whenever any unwanted animal comes in the net, instead of killing it, he puts back the same in the sea. Answer the following questions based on the above information.
   (*i*) What would have happened had he killed those animals ?
   (*ii*) Give a reason to justify that Rahul's action is environment friendly.
   (*iii*) How can you contribute in the preservation of flora or fauna ? Mention any one step.
2. Seeing a bat flying over the roof of her house, Babita asked her father following questions :
   (*i*) What is this night flying bird ?
   (*ii*) How does it see during night ?
   (*iii*) What does it eat and how does it obtain its food ?

Theme-3

Plant-Life

CHAPTER 3

Photosynthesis

Introduction

Photo means Light, ***Synthesis*** means to combine.

All living things need energy to live and this energy comes from food. Plants get their energy in a different way. They use a process called photosynthesis.

Plants take water from the *soil* through their veins, which are called xylem. The water goes to the leaves. The leaves take carbon dioxide from the air into the plant. The carbon dioxide mixes with the water. *Energy* from the sun helps this process and this results in the formation of simple carbohydrate (a type of sugar) known as glucose. This glucose is a plant food. It gives the plants energy to grow.

Learning New Words

Destarching : Removal of starch from the plant.
Translocation : Transportation of organic food from the leaves to other parts of the plant through phloem.
Photosynthesis : The process by which green plants make their own food (like glucose) from carbon dioxide and water by using energy from sunlight in the presence of chlorophyll is called photosynthesis.
Chloroplasts : They are the organelles in the cells of green plants which contain chlorophyll and where photosynthesis takes place.
Stomata : The tiny pores present on the surface of the leaves of the plants for the exchange of gases are called as stomata.
Thylakoids : The structural units of chloroplasts made-up of membranes which contain pigment chlorophyll.
Grana : Stacks of thylakoids are called grana.

The term photosynthesis was first used in 1898 by *Barnes*. Photosynthesis is the most common method of synthesis of food which is done by all green plants.

NUTRITION IN PLANTS

Green plants manufacture their own food by the process of photosynthesis. (*Photo* – Light; *Synthesis*— to make)

In this process, plants use carbon dioxide and water as the raw material. The green pigment present in the cells of a leaf is known as *chlorophyll* which captures energy from the sunlight and prepares food (glucose) by a series of complex chemical reactions.

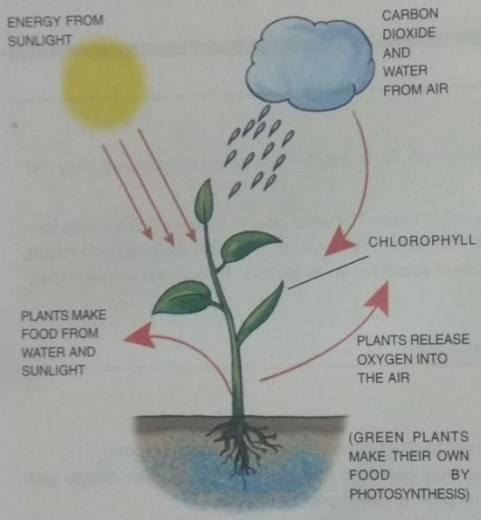
PHOTOSYNTHESIS

It is a *process by which green plants make their own food with the help of CO_2, water and chlorophyll in the presence of sunlight.*

$$\text{Carbon dioxide} + \text{Water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{Glucose} + \text{Oxygen}$$

The process can be represented by an equation

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{12H_2O} \longrightarrow \underset{\text{Carbohydrate (glucose)}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} + \underset{\text{Water}}{6H_2O}$$



Photosynthesis.

The main events that occur during the process of photosynthesis can be summarised as :

(*i*) Absorption of light energy by chlorophyll molecule.

(*ii*) Conversion of light energy to chemical energy.

(*iii*) Splitting of water molecules with formation of hydrogen and oxygen.

(*iv*) Conversion of carbon dioxide into glucose.

Plants utilise CO_2 released by animals and convert it into useful oxygen which is again used by animals during respiration.

Fact File

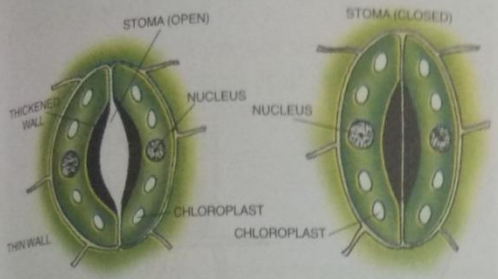
- Plants take **minerals** from the soil to grow. Nitrogen helps them to grow and make leaves. Phosphorus helps them to grow strong roots. Potassium helps the plant to make **fruit** and also keeps them healthy.
- Plants need large amounts of nitrogen, phosphorus and potassium. The soil does not always have enough of these nutrients.
- Gardeners use fertilizers to give plants more nutrients. Fertilizers are like sort of vitamins for plants. Some fertilizers are made from chemicals. Others are made from natural things like cow manure.
- The food prepared by green leaves of a plant is in the form of a simple sugar called glucose. The extra glucose is changed into another food called starch (stored in the leaves of the plant).

STOMATA

Stomata are the microscopic openings on the surfaces of plant leaves that allow for the easy passage of water vapours, carbon dioxide and oxygen. They are crucial to the function of leaves as photosynthesis requires plenty of carbon dioxide as well as release of waste oxygen (for plants) and excess of water vapour. *"Stomata"* means *"mouth"* in the Greek language. The main site of stomata is on leaf surfaces, but they are found on all above parts of the plant. The number of stomata that are present in a plant depends on environmental conditions, such as higher light levels and moisture or lower carbon dioxide levels. Their number increases in better environmental conditions to maximise the rate of photosynthesis. In warmer environments and particularly in dry air, plants lose a great amount of water through their stomata and in such conditions stomata closes and rate of photosynthesis decreases. This is done by plants to save their water reserves.

MECHANISM OF OPENING AND CLOSING OF STOMATA

The opening and closing of stomata is regulated by turgidity of guard cells. The stomata are open when the guard cells are turgid. On losing the turgidity in guard cells, the stomata are closed.



(A) Turgid guard cells and stoma opened

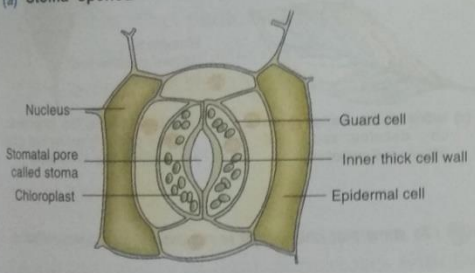
(B) Flaccid guard cells and stoma closed

The opening and closing of stoma.

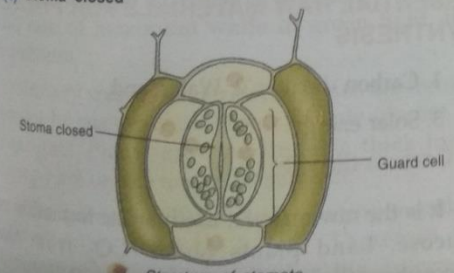
Structure of stomata

Each stoma has two bean-shaped guard cells. They have inner thick walls as compared to the outer walls. When the guard cells are full of water (turgid), they swell and bulge outwards and the stoma opens. (See fig (*a*))

(*a*) Stoma opened



(*b*) Stoma closed



Structure of stomata.

When the guard cells lose water (flaccid), they lose their turgidity and the stoma closes (See fig. (*b*))

Functions :

- Stomata helps in the exchange of gases between the leaves and the atmosphere.
- It helps in the process of transpiration.

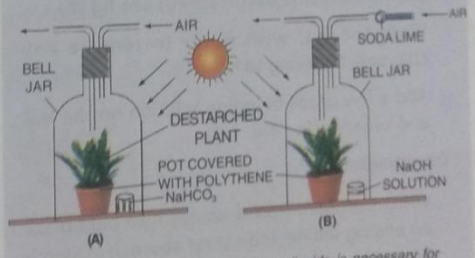
Activity 1

To demonstrate that CO_2 is necessary for photosynthesis.

Requirements : Two similar potted plants, two bell jars, watch glass, sodium hydroxide, $NaHCO_3$, corks, delivery tube, etc.

Procedure :

- Take two similar potted plants which are nearly of the same size.
- Keep them in a darkroom for three days to destarch them.
- Cover both the plants with bell jars and label them as A and B.
- Inside set-up A, keep $NaHCO_3$ (Sodium bicarbonate). It produces CO_2.
- Inside set-up B keep NaOH (soda lime). It absorbs CO_2.
- Use vaseline to seal the bottom of the jars to the glass plates so that the set-ups becomes airtight.
- Keep both the set-ups in the sunlight at least for 6 hours.
- Perform the starch test on both of the plants.



Experiment to prove that carbon dioxide is necessary for photosynthesis.

Observations :

1. The leaf of plant B (which contains NaOH) remains colourless showing the absence of starch.
2. The leaf of plant A (which does not have NaOH) turns blue-black showing the presence of starch.

Inference :

1. Since the CO_2 was absorbed by NaOH in the case of plant B, therefore, photosynthesis does not occur and there is no positive starch test.
2. The normal photosynthesis process takes place in plant A in the presence of CO_2. This means that CO_2 is necessary for photosynthesis.

Activity 2

To demonstrate that Chlorophyll is necessary for photosynthesis.

Method :

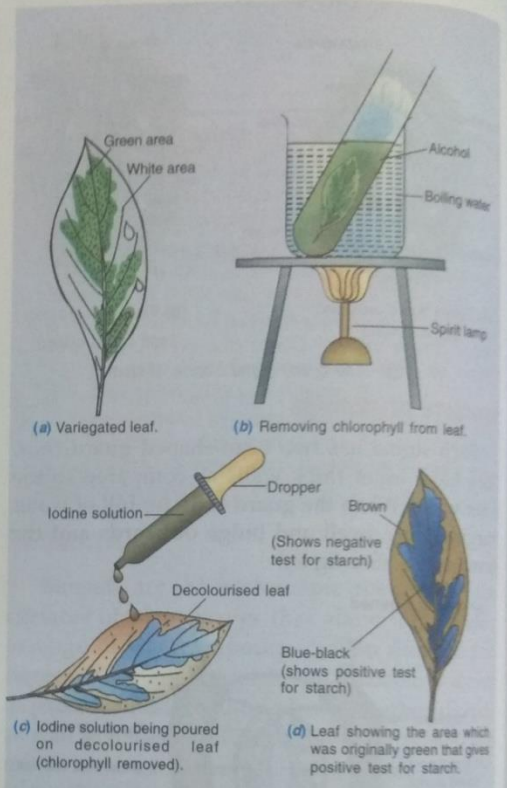
- Take a plant which has variegated (partly green and partly white or yellow) leaves as that of Croton or Coleus. (The green portion contains chlorophyll whereas white portion lacks chlorophyll).
- Destarch the plant by keeping it in a darkroom for 48-72 hours (See fig. (a)).
- Later, place the plant in the sun for two days.
- Pluck the variegated leaf and trace its outline on a sheet of paper to mark its green and non-green areas.
- Boil the leaf in alcohol to remove chlorophyll (leaf will become decolourised) See fig (b).
- Wash the leaf with water to remove any chlorophyll sticking to it.
- Add a few drops of iodine solution on the leaf and observe (See Fig. (C)).

Observation :

White portion of leaf does not turn blue-black on adding iodine, indicating absence of starch while the other part (which was originally green) turns *blue-black* on adding iodine indicating that starch is present in this inner part of leaf (See fig. (*d*)).

Conclusion :

Starch is formed due to photosynthesis and photosynthesis occurs in that portion of leaf where chlorophyll is present. Hence, it can be said that, *"Chlorophyll is necessary for photosynthesis."*



(*a*) Variegated leaf. (*b*) Removing chlorophyll from leaf.

(*c*) Iodine solution being poured on decolourised leaf (chlorophyll removed).

(*d*) Leaf showing the area which was originally green that gives positive test for starch.

To show that chlorophyll is necessary for photosynthesis.

ESSENTIAL RAW MATERIALS FOR PHOTOSYNTHESIS

1. Carbon dioxide, 2. Water, and
3. Solar energy.

1. Carbon dioxide :

It is the raw material used for the formation of glucose. Land plants obtain CO_2 from the atmosphere through the stomata.

2. Water :

Water is the second raw material for the process of photosynthesis. Plants absorb water from the soil with the help of their root system. Other materials like nitrogen, phosphorus, iron and magnesium are taken up from the soil.

3. Solar Energy :

For the process of photosynthesis solar energy is needed. This energy is trapped by the green coloured pigment–chlorophyll present in the chloroplast.

Fact File

- The process mostly takes place in the chloroplasts of plant leaf mesophyll cells. The energy for photosynthesis comes from light.
- In the leaves of a plant a substance called **chlorophyll** is present. Chlorophyll makes leaves green. It also traps the energy from the sun so the plant can use.
- Photosynthesis depends upon temperature. It does not occur during high temperature or very low temperature.
- Photosynthesis is the process where a plant uses the sun's energy to turn light into chlorophyll.

FACTORS AFFECTING PHOTOSYNTHESIS

Factors that affect photosynthesis are :

(1) Light intensity (sunlight)

(2) Concentration of CO_2 in the atmosphere.

(3) Temperature, and

(4) Availability of water.

1. Light intensity :

The rate of photosynthesis depends on the quantity and quality of light. It increases with the increase in light intensity. In blue and red lights, the rate of maximum while in green light, it is minimum.

In very weak light, no starch grains are formed, except by plants which grow in shade (do not get sunlight). Plants growing under a thick forest canopy are unable to receive sunlight.

The intensity of light is low during mornings and evenings (twilight hours). Therefore, the amount of CO_2 released during the process of respiration is equal to the amount used during photosynthesis. This state is called *compensation point*.

2. Carbon dioxide :

The rate of photosynthesis increases with an increase in the concentration of CO_2, provided the quality of light is not a limiting factor. It has been seen that, very high concentration of CO_2 cause the stomata to close. This prevents exchange of gases and, consequently, the rate of photosynthesis decreases.

3. Temperature :

The effect of temperature varies with the habitat of plants. The plants of cold climates have the ability to conduct photosynthesis at a much lower temperature than those of warm climates.

Usually the optimum temperature range for photosynthesis is 10-35 °C. Upto 30 °C, the rate of photosynthesis doubles with each increase of 10 °C.

Extremely high temperature affect the activity of the enzymes and, therefore, the rate of photosynthesis too decreases.

4. Water :

Generally, the rate of photosynthesis decreases under water-deficient conditions.

Only about one per cent of the water absorbed by the roots is utilized in photosynthesis; yet water is an important factor.

If water is insufficient, the stoma open very little or remain closed to prevent its further evaporation by transpiration; and because the stomata open very little or remain closed, CO_2 cannot enter the leaves and, therefore, photosynthesis is slows down or stops completely. Due to water deficiency, the protoplasm gets dehydrated which affects the enzymes involved in photosynthesis is thus decreasing photosynthesis rate.

Knowledge Enhancer :

Some other internal factors that may affect the role of photosynthesis are :

1. **Anatomy of the leaf :**
   (*a*) It includes the number of stomata with their structure and distribution in the leaf.
   (*b*) The thickness of cuticle and distribution of vascular bundles also affects the rate of photosynthesis.
2. **Accumulation of photosynthetic products :** Heavy accumulation of sugar and starch in the mesophyll cells slows down the process of photosynthesis or it can even completely stop the process.

3. **Presence or absence of Ions :**
   (*a*) There is no photosynthesis in the absence of oxygen.
   (*b*) In the absence of potassium, starch grains are not formed; potassium is needed as a catalyst for the synthesis of carbohydrates.
4. **Amount of chlorophyll :** The rate of photosynthesis increases to a some extent with an increase in the amount of chlorophyll present in the leaf.
5. **Age of the leaf :** As the leaf develops (matures), the rate of photosynthesis increases gradually reaching a maximum around its maturity followed by a decline with age.

Activity 3

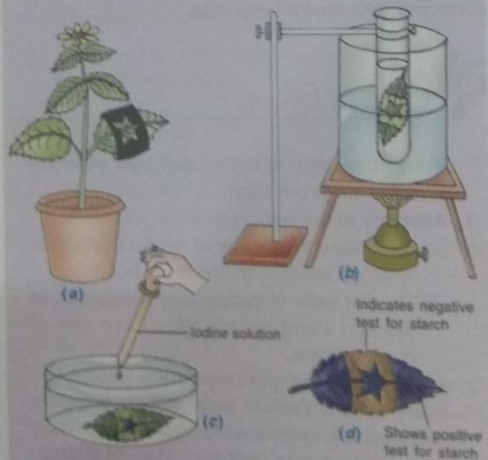
To show that sunlight is necessary for photosynthesis.

Conditions necessary for Photosynthesis :

1. Sunlight
2. Chlorophyll
3. Carbon dioxide and water

Method :

- Take a green potted plant and cover a part of its leaf with black paper. (See fig a).
- Destarch the plant by keeping it in a darkroom for 48-72 hours.
- This is done to ensure that the whole starch is used up by the plant and any starch formed is during the experimental condition only.
- Later, place the pot in sunlight for two days.



To demonstrate that sunlight is essential for photosynthesis.

- Remove the leaf from the plant. Take off the black paper.
- Keep a beaker containing water over a tripod stand and heat it.
- Take a big test tube filled with alcohol. Put it in the beaker with water as shown in the figure (b).
- Let it boil till the chlorophyll is extracted from the leaf and alcohol turns green. (This process will remove chlorophyll and leaf will turn colourless.)
- Take out the leaf and wash it in warm water.
- Add a few drops of iodine solution on the leaf (see fig. (c)).

Inference :

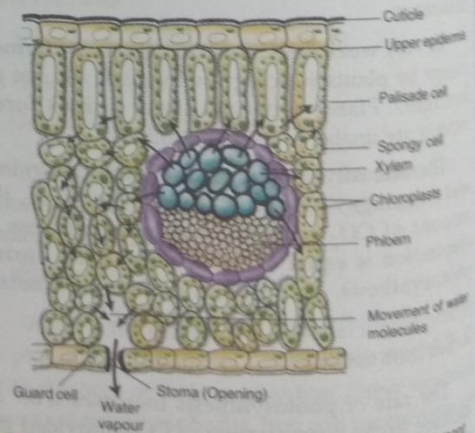
- Part of leaf covered with black paper does not show colour change, because photosynthesis process has not occurred in that area.
- The uncovered part of the leaf turns blue-black because photosynthesis took place in that part only (See fig. (d)). The colour of iodine solution (dark brown) changes to blue-black in the presence of starch.

Precaution :

Never boil alcohol directly on the flame as it can catch fire.

STRUCTURE OF LEAF : REVEALING THE REGION OF PHOTOSYNTHESIS

Most of the photosynthesis occurs in the leaves of green plants. The internal structure of leaf is specialised to carry out photosynthesis. The outer layer of the leaf is made-up of a single layer of cells



Vertical section through a leaf blade showing arrangement of cells, tissue and stomata.

called *epidermis*. *Plastids* can be seen just below the upper epidermis in a tissue called the *palisade*. After this, there is a layer of loosely-packed cells called *spongy layer*. Both the layers are made-up of cells which contain chloroplast which have chlorophyll pigment for absorbing sunlight for photosynthesis. Xylem and phloem tissues are present in the veins of the leaves.

The *xylem* transports water to the cells of the leaf. The *phloem* carries the food made during photosynthesis to other parts of the plant.

The lower epidermis has small openings called *stomata* through which gases are exchanged.

The green plants *take carbon dioxide* from air for photosynthesis. The carbon dioxide gas enters the leaves of the plant through the stomata present on their surface.

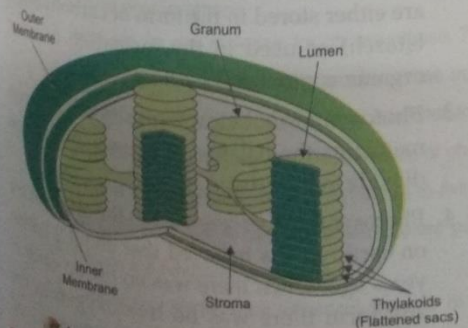
The *water* required by plants for photosynthesis is absorbed by the roots of the plant. It is then transported upward through xylem vessels to the *leaves* where it reaches the photosynthetic cells and utilised in photosynthesis.

The *two raw materials* carbon dioxide and water are required by the plants to prepare energy food called carbohydrates (such as glucose and starch).

Plants also need other raw materials such as nitrogen, phosphorus, iron and magnesium from the soil.

SITE OF PHOTOSYNTHESIS–CHLOROPLAST

Photosynthesis occurs in the organelles called *chloroplasts* present in the photosynthetic cells (or mesophyll cells) of green plants.



Internal structure of chloroplast (diagrammatic).

Chloroplasts are minute oval bodies bounded by a double membrane, and their interior contains closely packed flattened sacs of membranes *(thylakoids)* arranged in pile *(grana)* lying in a colourless ground substance called *stroma* (Fig). Ordinarily, there may be 40-50 chloroplasts in a cell. *The pigment* ***chlorophyll*** *is contained in the walls of* ***thylakoids***. It is a highly complex substance, composed of carbon, hydrogen, oxygen, nitrogen and magnesium. Chloroplasts are mainly contained in the mesophyll cells located between the upper epidermis and the lower epidermis *i.e.*, in palisade cells and spongy cells of leaves. These are also found in the guard cells of stomata and in the outer layers of young green stems.

Most of the common plants have leaves which are totally green (because all the parts of such leaves contain the green pigment called chlorophyll). But there are some plants whose leaves are partly green and partly white. These leaves are termed as *'Variegated leaves' e.g.*, the plants such as Croton and Coleus have variegated leaves.

Variegated leaves.

Leaves are the food factories for the plants. The green plants synthesise major part of their food from simple inorganic substance like carbon dioxide and water in the presence of sunlight.

Besides leaves, photosynthesis also takes place in other green parts of the plant-in green stems and green branches. The desert plants have scale-or spine like leaves to reduce loss of water by transpiration. These plants have green stems which carry out photosynthesis.

Activity 4

To find out the fact why most of the plants look green while there are plants which have leaves of different colours.

The chlorophyll pigment in the leaves absorbs most of the blue and red regions of the incident light. The pigments are not capable of absorbing the green region of the visible light, therefore, the green light is reflected from the plants and that is why they look green.

The leaves are green in colour because of the green pigment chlorophyll in them. The leaves *other than green* have other *pigments* which impart various other colours of the leaves such as red, yellow, orange, brown etc. These leaves also contain chlorophyll but the large amount of other pigments in these leaves mask the green colour. Photosynthesis takes place in these leaves also.

These pigments also give characteristic colours to flowers, fruits and roots.

It should be noted that, plants must have more than one pigment in older to take in light from different wave lengths that chlorophyll is not good at absorbing. *Carotene* is an orange pigment which do photosynthesis by transmitting light to chlorophyll molecule.

Activity 5

To show that oxygen is given out during photosynthesis.

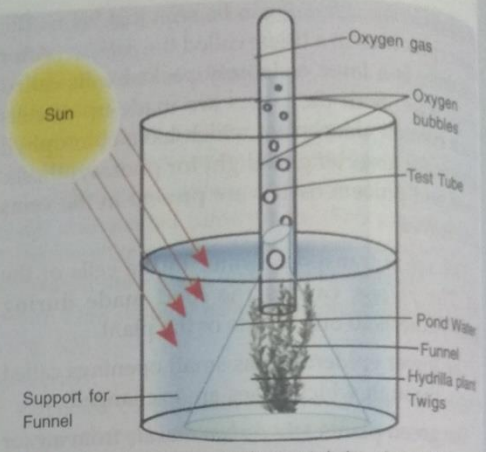
Requirements : A beaker, a funnel, a test tube, conical funnel, pond water and twigs of an aquatic plant such as *Hydrilla*.

Procedure : Fill some water in the beaker and put the twigs of hydrilla in it.

Keep an inverted conical funnel so that it covers the twigs. Now, keep an inverted test tube filled with pond water over the funnel as shown in the figure. Put this apparatus in sunlight. Keep it for sometime and write your observation.

Put this apparatus in a shaded area, keep it for sometime and write down your observation.

Now, put the apparatus in a completely dark area, keep it for sometime and write your observation.



To show that oxygen is given out during photosynthesis.

Observations : You will observe that when the apparatus was in *sunlight*, there appeared *more number of air bubbles* from *the twigs of hydrilla* than when it was kept in a shaded area. In total darkness, no bubbles appeared at all.

Inference : It proves that oxygen is given out during photosynthesis.

Note : The gas collected in the test tube can be tested by introducing a buring splinter or match stick which burns with a glowing flame, thus providing the gas inside to be oxygen.

SIGNIFICANCE OF PHOTOSYNTHESIS

1. It is the primary source of organic food and energy (ATP) for all forms of life either directly (all photosynthetic plants) or indirectly (animals and decomposers like fungi and bacteria).
2. Excess of sugars produced by photosynthesis are either stored in the form of carbohydrates (starch) or used in the formation of other organic compounds.
3. Photosynthesis helps to purify air and also maintains the balance of oxygen and carbon dioxide in the ecosystem.
4. Photosynthetic process led to the origin of life on earth. It was believed that about 2 billion years ago, when there was no life on earth in any form there was no free oxygen in the atmosphere. Thus, this process of

photosynthesis was responsible for converting the totally anaerobic condition on primitive earth into the aerobic conditions present now.

5. Origin of fossil fuels (natural gas, coal, petroleum) is considered to be the accumulation of organic material which was formed by the deep burial of plants and animals million of years ago. The energy stored in all these fuels is basically solar energy that was trapped and stored during photosynthesis millions of years in the primitive earth.

Things to Remember

1. Photosynthesis enables the green plants to make their own food.
2. The survival of all animals in the world directly or indirectly depends upon the food made by the plants.
3. Oxygen, which is essential for survival of all living organisms is produced during photosynthesis. Carbon dioxide is used by plants during photosynthesis.
4. Essential raw materials for photosynthesis are : Carbon dioxide, water and solar energy.
5. Factors affecting photosynthesis are : (1) light intensity (2) concentration of CO_2 (3) Temperature, and (4) Availability of water.

Exercises

A. Name the following :

1. Green pigments of plants.
2. Small tiny pores present on the surface of the leaves.
3. Plants that prepare their own food from basic raw material.
4. The process by which plants make food.
5. The food stored in the leaves of a plant.

B. Short answer questions :

1. Define photosynthesis.
2. What are the raw materials for photosynthesis ?
3. Where does the energy for the process come from ?
4. Which pigment converts light energy into chemical energy ?
5. Give the various factors that affect the rate of photosynthesis.
6. What is the importance of photosynthesis to living things other than plants ?
7. Why is it important to destarch a plant before performing any experiment on photosynthesis ?
8. Explain the functions of stomata.
9. Explain how temperature influences the rate of photosynthesis.
10. Where does the plant get each of the raw materials required for photosynthesis ?

C. Long answer questions :

1. How will you prove that CO_2 is essential for photosynthesis ?
2. Draw a well-labelled diagram of the structure of a stomata.
3. How will you prove that light is necessary for photosynthesis ?
4. Explain the raw materials needed for the process of photosynthesis.
5. What is the role of light in photosynthesis ?

D. Choose the odd one out from the following :

1. Photosynthesis, leaves, stomata, nitrogen
2. Algae, green plants, autotrophs, saprotrophs
3. Chloroplasts, green plants, stomata, carbon dioxide
4. Nitrogen, phosphorus, iron, water
5. Sunlight, chlorophyll, carbon dioxide, carbohydrate

E. Fill in the blanks :

1. The two bean shaped cells in stoma are known as ..... .
2. ..... found in the green leaves is required for the process of photosynthesis.
3. Carbon dioxide is used during the process of ..... .
4. Plants take carbon dioxide from the atmosphere mainly through their..... .
5. During photosynthesis plants take in ..... and release ..... .
6. The ..... is the cell organelle where photosynthesis occur.
7. ..... is the process in plants that links light energy with chemical energy.
8. The stored food in the leaves is ..... .
9. The opening and closing of stomatal pore depends upon ..... .
10. The raw materials needed during photosynthesis are ..... and ..... .

F. Write true or false and correct the incorrect statements :

1. The immediate product of photosynthesis is glucose.
2. Photosynthesis occurs in all the cells of a plant.
3. Stomata is stimulated by light.
4. Plants that manufacture their own food are termed as heterotrophs.
5. The oxygen produced during photosynthesis comes from CO_2.

G. Choose the correct answer :

1. Transport of water in plants takes place through :
   (*a*) phloem (*b*) stomata (*c*) xylem (*d*) epidermis

2. The green pigment chlorophyll is present in :
(a) roots (b) stem (c) flower (d) leaf

3. The organisms that prepare their own food are :
(a) heterotrophs (b) autotrophs (c) saprophytes (d) parasites

4. The process that converts light energy into chemical energy is :
(a) respiration (b) digestion (c) photosynthesis (d) excretion

5. The opening in the leaves through which exchange of gases takes place are called :
(a) lenticels (b) stomata (c) nostrils (d) pharynx

6. The opening and closing of the stomatal pores depends upon :
(a) oxygen (b) water in guard all (c) temperature
(d) concentration of CO_2 in stomata

7. The oxygen liberated during photosynthesis by green plants come from :
(a) glucose (b) water (c) carbon dioxide (d) chlorophyll

8. Gaseous exchange in plants takes place through :
(a) stomata (b) chloroplast (c) lenticels (d) cuticle

9. The green pigment present in the leaves is :
(a) xanthophyll (b) chlorophyll (c) chromophyll (d) carotenoids

10. What name is given to tiny pores present on leaves ?
(a) stomata (b) guard cell (c) chlorophyll (d) cuticle

H. Match the columns :

Column A	Column B
1. Transport of water	(a) Heterotrophs
2. Green plants	(b) Guard cells
3. Cannot make their own food	(c) Xylem
4. Stomata	(d) Green pigment
5. Chlorophyll	(e) Autotrophs

I. Differentiate between the following :

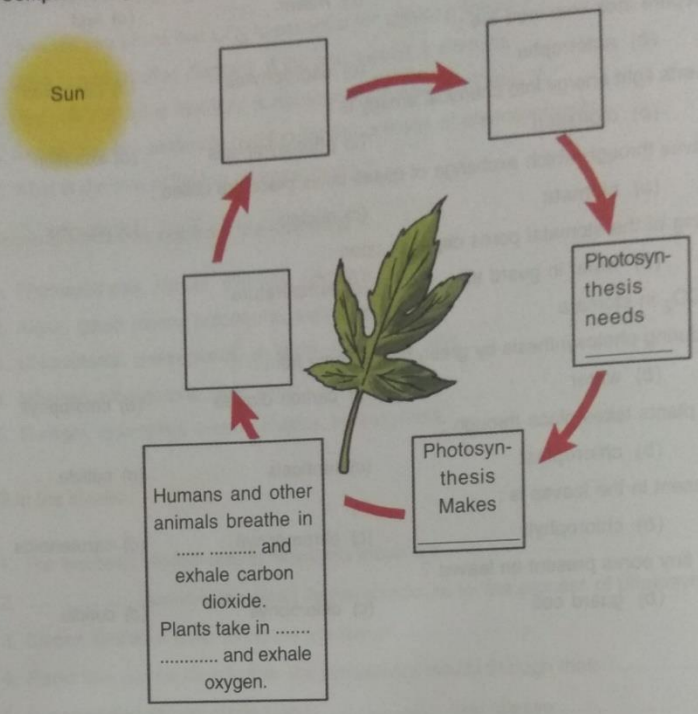
1. Chloroplasts and Stomata
2. Autotrophs and Heterotrophs
3. Xylem and Phloem
4. Variegated leaves and Simple Leaves
5. Stomata and the Guard cells

J. Activity/Project/Research Work :

1. **Photosynthesis equation**

Energy + ... + ... $\xrightarrow{h\nu}$ Glucose + ...

Complete the given flow chart :



II. An organism A which cannot move from one place to another makes a simple food B from the substances C and D available in the environment. This food is made in the presence of a green coloured substance E present in organ F in the presence of light energy in a process called G. Some of the simple food also get converted into a complex food H for stroage purpose.

(*a*) What is (*i*) Organism A

(*ii*) Food B

(*iii*) Food H ?

(*b*) What are C and D ?

(*c*) Name (*i*) green coloured substance 'E' and (*ii*) organ F.

(*d*) What is the Process 'G' ?

CHAPTER 4

Respiration

Introduction

Both plants and animals use food molecules as building blocks to : (*a*) construct and repair cells, and (*b*) obtain energy. We know that plants can manufacture their own food whereas animals cannot. They have to obtain it from their diet; but once inside the plant or animal cell, these food molecules, mainly glucose, are degraded in similar step-by-step manner and the energy present in the food is converted to ATP.

Respiration or the complete oxidation of glucose, is the chief source of energy in most cells.

Learning New Words

Respiration : Process of releasing energy from food.

Aerobic respiration : The type of respiration in which breakdown of glucose occurs with the use of oxygen is known as aerobic respiration.

Anaerobic respiration : The type of respiration in which food is broken down without using oxygen is known as anaerobic respiration.

Lenticels : The small openings or slits present in the woody stems for the exchange of gases.

External respiration : It involves taking in oxygen rich air (during inhalation step) and giving out of air rich in carbon dioxide (during exhalation step).

Fermentation : Partial oxidation of glucose in the absence of O_2 producing ethyl alcohol (C_2H_5OH) and CO_2.

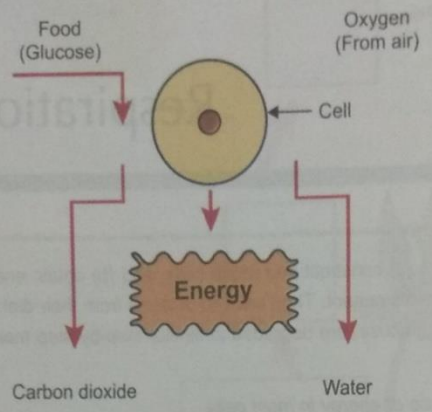
The mechanism by which organisms obtain oxygen from the environment and release carbon dioxide is termed breathing. Respiration is a much more complex process. It involves breathing (mechanism of exchange of gases) and oxidation of digested food occurring in the cells in order to release energy.

RESPIRATION

Respiration is a fundamental process of energy release in all living organisms. Energy is released by the breakdown of the digested foodstuffs during the process of respiration. It occurs in all living cells. Thus, it is considered as *Catabolic* (in which breakdown occurs) *process*. The energy rich foodstuffs (glucose and fructose) are changed to water and CO_2 during respiration accompanied with the release of usable energy in the form of ATPs. The experiment given below indicates that CO_2 is given out during exhalation (step of breathing).

$$\text{Food} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water} + \text{Energy}$$

Thus, respiration includes breathing as well as the oxidation of food in the cells of the organisms to release energy.



Respiration produces energy from food (like glucose)

Do You Know?

Mitochondria are the sites of aerobic respiration in the cells.

Activity 1

To carry out the fermentation of sugar by using the anaerobic respiration of yeast.

Method :

Take some sugar solution (or fruit juice) in a test tube and add a little yeast to it. Close the mouth of the test tube with a cork and allow it to stand for sometime. Now, open the cork and smell.

Inference :

- A characteristic smell of ethanol is obtained from the test tube.
- A gas is evolved during this process.
- When this gas is passed through lime water, the lime water turns milky showing that it is carbon dioxide.

Remember

Human beings obtain energy by aerobic respiration but anaerobic respiration takes place in our muscles when oxygen gets used up faster in the muscle cells that can be supplied by the blood. This results in the formation of lactic acid.

The anaerobic respiration by muscles bring about partial breakdown of glucose to form lactic acid. The accumulation of lactice acid causes *muscle cramps*.

- We can get relief from muscle cramps by taking a hot water bath or a massage which improves the circulation of blood in the muscles.

Knowledge Enhancer :

- ✔ (*a*) The anaerobic respiration in plants (like yeast) produces ethanol and carbon dioxide as end products.
- ✔ (*b*) The anaerobic respiration in animal muscle tissue produces lactic acid as the end product.

RESPIRATION IN PLANTS

During daytime hours, a plant builds up food, *i.e.*, glucose and starch by *photosynthesis*. It also breaks down some food by respiration. It makes more food then it breaks down, so its leaves take in carbon dioxide.

At night, when the *photosynthesis* process stops then the plant only breaks down food by *respiration*. Then its leaves take in oxygen. In plants, respiration takes place in different ways. Plants respire through their parts such as stems, roots, leaves, etc. All the parts of a plant (like root, stem and leaves) perform respiration individually.

* Respiration in plants also involves the exchange of oxygen and carbon dioxide. So oxygen and carbon dioxide are called *respiratory gases*.

1. Respiration in roots :

The roots of a plant take the oxygen required for respiration from the air present in-between the soil particles by the process of *diffusion*. The root

Knowledge Enhancer :

✓ In plants, the gases diffuse through :

(i) lenticels,

(ii) stomata, and

(iii) intercellular spaces.

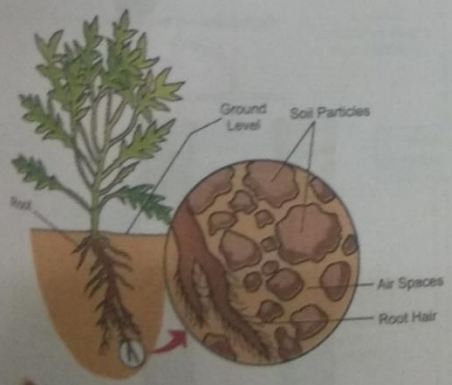
(i) **Lenticels** (*Latin lenticella* = a small window) : These are spongy areas in the cork surfaces of stems, roots, and other plant parts; and allow interchange of gases between internal tissues and the atmosphere through the periderm. Lenticels are found in vascular plants.

(ii) **Stomata** (singular stoma. Greek *stoma* = mouth) : Minute openings bordered by guard cells in the epidermis of leaves and stems through which exchange of gases occurs.

(iii) **Intercellular spaces** (Latin *inter* = between) : Spaces between the cells.

hair are in contact with the air in the soil. Oxygen (from air in the soil particles) diffuses into root hairs and reaches all other cells of the root for respiration.

Carbon dioxide gas produced in the cells of the root during respiration moves out through the same root hair by the process of diffusion. Thus, the respiration in roots occurs by the diffusion of respiratory gases (oxygen and carbon dioxide).



Roots *absorb oxygen from air present in-between the soil particles through root hair.*

2. Respiration in stems :

The stems of most herbaceous plants have stomata. The exchange of respiratory gases (oxygen and carbon dioxide) takes place through

Fact File

You must have observed that land plants die if they are waterlogged for a long time. This is because the air between the soil particles surrounding the roots gets expelled by water and fresh atmospheric oxygen required for aerobic respiration is unable to reach the roots. Under these circumstances the root may respire anaerobically and produce alcohol, but the alcohol ultimately kills the plants.

stomata. The oxygen from air diffuses into the stem of a herb plant through stomata and reaches all the cells for respiration. The carbon dioxide gas produced during respiration diffuses out into the air through the same stomata.

If the stem is woody, then the gaseous exchange takes place through the cracks in bark or through slits called *lenticels* and reaches all the inner cells of the stem for respiration. The carbon dioxide gas produced in the cells of the stem during respiration diffuses out into the air through the same lenticels.

Differences between stomata and lenticels

Stomata	*Lenticels*
1. Located on the lower surface of dicot leaves, both surfaces of monocot leaves.	1. Located on the stems and branches of woody plants.
2. Remain open during daytime.	2. Remain open every time.

3. Respiration in leaves :

The leaves of a plant have tiny pores called *stomata* as well as *intercellular spaces*. The exchange of respiratory gases in the leaves takes place by the process of diffusion through stomata. Oxygen from air diffuses into a leaf through stomata and reaches all the cells where it is used in respiration. The carbon dioxide produced during respiration diffuses out from leaf into the air through the same stomata.

Thus, the process of photosynthesis takes place during the daytime. During this process, *carbon dioxide* is used up and *oxygen* is given out.

Remember

- Respiration in leaves occurs during the daytime as well as at night.
- Photosynthesis occurs only during the daytime (no photosynthesis occurs at night).

A part of *oxygen* given out as a result of photosynthesis is used up by the plants for respiration and rest is given out through stomata.

Carbon dioxide given out by respiration is used up by the plant for photosynthesis. And in this way the cycle continues.

Knowledge Enhancer :

- ✔ Leaves have both stomata as well as intercellular spaces. If the leaves are *isobilateral*–a condition in which the upper and lower surfaces are similar–then the stomata are present on both upper and lower epidermis; but in *dorsiventral* (in which dorsal and ventral surfaces are not similar) leaves, the stomata are present only in the lower epidermis. Intercellular spaces are present in-between the spongy parenchyma of the mesophyll cells of the leaves.
- ✔ The gaseous exchange (of oxygen and carbon dioxide) takes place through the stomata and intercellular spaces in leaves.

Do You Know?

- Every part of the plant may be leaves, stem and even deepest placed roots respire. Oxygen is obtained from the atmosphere through :
  (1) Stomata in leaves
  (2) Lenticels in stems
  (3) General surface of the roots.

Fact File

- Ploughing or tilling the soil creates tiny air spaces around soil particles and provides source of oxygen for the roots. Waterlogged and compact soil do not have air spaces which affect respiration of roots.
- One should not sleep under the trees during night as there is no photosynthesis in darkness. Rather plants release large amount of CO_2 during respiration.

BASIC PROCESS OF RESPIRATION

For respiration there is a constant supply of oxygen which is provided by the process of breathing. It involves taking in oxygen rich air (during inhalation step) and giving out of air rich in carbon dioxide (during exhalation step). This process is also known as *external respiration*.

- The process of respiration which releases energy takes place inside the cells of the body is known as cellular respiration.

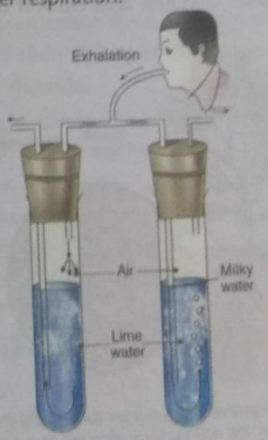
Activity 2

To show that exhaled air contains CO_2.

Method : Take two test tubes. Fill them up to half with freshly prepared lime water. Fix rubber stoppers with two holes in both the test tubes. Insert the glass tubes in both the stoppers. Blow through a straw, into the lime water several times. What happens to the lime water ? Why this change is observed ?

Observation and Inference :

It will be observed that the lime water through which exhaled air is passed turns milky. The lime water in other test tube also shows a slight milkiness in its colour. This is due to the presence of carbon dioxide in the atmospheric air. This shows that more carbon dioxide is present in exhaled air, which comes out from our mouth after respiration.



Presence of CO_2 in exhaled air.

The release of energy takes place only with the help of several chemical reactions generally catalysed by enzymes. These reactions which take place in all living organisms are together termed as *cellular respiration* or *internal respiration*.

The energy released is stored in the form of ATP (Adenosine Triphosphate) molecules.

Reaction :

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \xrightarrow{\text{Respiratory Enzymes}} \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O}$$

+ Energy

This entire process takes place partially in the cytoplasm and in the mitochondria of every cell in the body.

Differences between cellular respiration and breathing

Cellular respiration	*Breathing*
1. It is the oxidative breakdown of glucose.	1. It is taking in of fresh air and giving out of foul air.
2. It is a biochemical process.	2. It is a physical process.
3. It produces energy and stores in the form of ATP.	3. It consumes energy.
4. A series of respiratory enzymes bring about the oxidation.	4. No enzymes are involved.
5. It is an intracellular process.	5. It is an extracellular process.

TYPES OF RESPIRATION

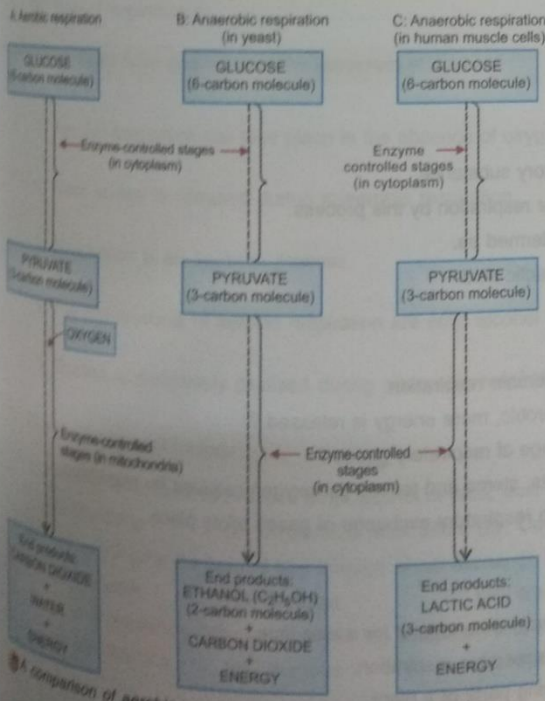
(*i*) Aerobic respiration or Cellular respiration.
(*ii*) Anaerobic respiration.

(*i*) Aerobic respiration or Cellular respiration : The oxygen which enters the lungs and then the cells of the body, is used for oxidation (lowering) of glucose. In this process food is completely oxidised to form carbon dioxide and water.

Glucose + Oxygen ⟶ Carbon dioxide + Water

It is called *aerobic respiration* as it occurs in the presence of oxygen.

(*ii*) Anaerobic respiration : In certain micro-organisms like fungi, yeast and bacteria glucose is partially oxidised into lactic acid or ethyl alcohol and carbon dioxide in the absence of oxygen. This is called *anaerobic respiration or fermentation*. The energy released during this process is very less.



A comparison of aerobic respiration, and anaerobic respiration (in yeast and human muscle cells).

Differences between aerobic respiration and anaerobic respiration

Aerobic respiration	*Anaerobic respiration*
1. It is the process of breakdown of glucose in the presence of oxygen.	1. It is the process of breakdown of glucose in the absence of oxygen.
2. Glucose is completely oxidised.	2. Glucose is incompletely oxidised.
3. The end products formed are CO_2, H_2O and energy.	3. The end products formed are CO_2, ethyl alcohol and energy in case of plants.
4. Energy released is more (38 ATP molecules).	4. Energy released is less (2 ATP molecules).
5. It takes place in all higher organisms.	5. It takes place in lower organisms like *yeast*.

Differences between photosynthesis and respiration

Photosynthesis	*Respiration*
1. It takes place only in green plants.	1. It takes place in all living organisms.
2. Seat of photosynthesis is chloroplast.	2. Seat of respiration is mitochondria.
3. It occurs only during the daytime.	3. It occurs during day and night.
4. Synthesis of sugar takes place and oxygen is given out.	4. Breakdown of sugar takes place and carbon dioxide is given out.

Things to Remember

1. Respiration is a fundamental process of energy release in all living organisms.
2. Respiration in plants occurs through roots, stem and leaves.
3. In roots, gaseous exchange occurs through diffusion, in stem, there are stomata (in green stem) and lenticels (in old stem) while it occurs through stomata and intercellular spaces.
4. Respiration is of two types : Aerobic (it occurs in the presence of oxygen) and anaerobic (it occurs in the absence of oxygen).

Exercises

A. Name the following :

1. Openings present on the bark of old stems.
2. Oxygen is utilised for the breakdown of respiratory substance.
3. The roots of a plant take the oxygen required for respiration by this process.
4. When more energy is released the process is termed as.
5. Type of respiration in which the end product is lactic acid.

B. Short answer questions :

1. Name the substance which is produced in anaerobic respiration.
2. In which type of respiration *i.e.*, aerobic or anaerobic, more energy is released ?
3. Which part of the roots is involved in the exchange of respiratory gases ?
4. Name the process by which plant parts like roots, stems and leaves get oxygen required for respiration.
5. Name the areas in a woody stem through which respiratory exchange of gases takes place.

C. Long answer questions :

1. Explain why, a land plant may die if its roots remain waterlogged for a long time.
2. Tabulate the differences between aerobic and anaerobic respiration.
3. Describe the process of respiration in the following parts of a plant :
   (*a*) Root (*b*) Stem (*c*) Leaves.

4. What type of respiration takes place in :
   (*a*) Yeast (*b*) In humans ?
5. Describe the importance of respiration in plants.

D. Choose the odd one out giving reasons :

1. Yeast, ethyl alcohol, glucose, anaerobic respiration, bacteria.
2. Cellular respiration, internal respiration, glucose, oxygen, anaerobes.
3. Lactic acid, anaerobic respiration, fermentation, ethyl alcohol, glucose.
4. Glucose, oxygen, carbon dioxide, water, yeast.
5. Ethanol, carbon dioxide, yeast, fermentation, diffusion.

E. Fill in the blanks :

1. Carbon dioxide is released during the process of ..... .
2. Exchange of gases in plants takes place through the cracks in bark is ..... .
3. Yeast undergoes ..... respiration.
4. The final products obtained in the anaerobic respiration are ..... , ... , ...
5. ..... is the energy currency of the cells.
6. The breathing and respiration in woody stem of a plant takes place through ..... .
7. During Marathon race, we sometimes get painful contractions of leg muscles due to the accumulation of ..... .
8. The process of respiration which releases energy takes place inside the cells of the body is known as ..... .
9. The mechanism by which organisms obtain oxygen from air and release carbon dioxide is called ..... .
10. Seat of respiration is ..... .

F. Write true or false and correct the incorrect statement :

1. Aerobic respiration can take place in the absence of oxygen. ☐
2. More energy is released during anaerobic respiration. ☐
3. Respiration is an anabolic process. ☐
4. The end products of aerobic respiration are ethyl alcohol and carbon dioxide. ☐
5. Glucose is completely oxidised during anaerobic respiration. ☐

G. Choose the correct answer :

1. Glucose is oxidised to produce ethyl alcohol or lactic acid during the process of :
   (*a*) Breathing (*b*) Anaerobic respiration (*c*) Combustion (*d*) Aerobic respiration.
2. The openings in the bark of tree through which exchange of gases takes place are called :
   (*a*) Lenticels (*b*) Stomata (*c*) Nostrils (*d*) Gum.
3. Cellular respiration occurs partially in the cytoplasm and in :
   (*a*) Mitochondria (*b*) Nucleus (*c*) Golgi bodies (*d*) Ribosomes.

4. Which of the following is known as the energy currency of the cells in biology ?
(*a*) RNA (*b*) DNA (*c*) ATP (*d*) ADP.

5. When air is blown from mouth into a test tube containing lime water, the lime water turned milky due to the presence of :
(*a*) Oxygen (*b*) Carbon dioxide (*c*) Nitrogen (*d*) Water vapour.

6. Which of the following increases in the muscle cells when they are not getting sufficient oxygen ?
(*a*) Carbon dioxide (*b*) Lactose (*c*) Lactic acid (*d*) Uric acid.

7. Which of the following is not produced during anaerobic respiration ?
(*a*) Ethanol (*b*) Water (*c*) Carbon dioxide (*d*) ATP.

8. Fermentation takes place in :
(*a*) Yeast (*b*) Aerobic bacteria (*c*) Mitochondria (*d*) Lenticels.

9. Internal respiration may be defined as :
(*a*) Breathing in and releasing oxygen in the tissue.
(*b*) The oxidation of food substance to release energy.
(*c*) The building up (synthesis) of complex substance.
(*d*) Getting rid of carbon dioxide that would accumulate in the tissues.

10. Respiration in roots, stems and leaves occurs by the process of :
(*a*) Transpiration (*b*) Diffusion (*c*) Osmosis (*d*) Translocation.

H. Match the columns :

Column A	Column B
(1) Lenticels and stomata	(*a*) Yeast
(2) Anaerobic respiration	(*b*) Partial oxidation of glucose in the absence of oxygen
(3) Diffusion	(*c*) Respiration
(4) Fermentation	(*d*) Gaseous exchange
(5) Oxidation of food	(*e*) Roots, stems, leaves

I. Differentiate between the following :

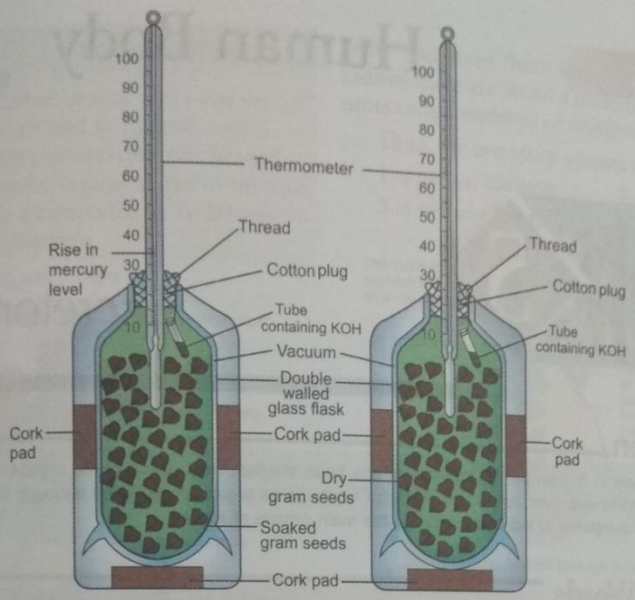
1. Respiration and Photosynthesis.
2. Lenticels and Stomata.
3. Cellular respiration and Breathing.
4. Aerobic and Anaerobic respiration.
5. Respiration and Fermentation.

J. Activity / Project / Research Work :

1. **Experiment to show evolution of heat during respiration.**

Materials required : Two sterilised thermosflasks, soaked and dry seeds, two thermometers, two small test tubes with KOH solution, cotton thread.

Procedure : Fill the two sterilised flasks with dry and soaked seeds, respectively. Fix a thermometer in each flask so that their bulbs lie embedded in the seeds. Suspend a small test tube of KOH solution in each and then plug the mouths of the flasks with cotton (See Fig.).



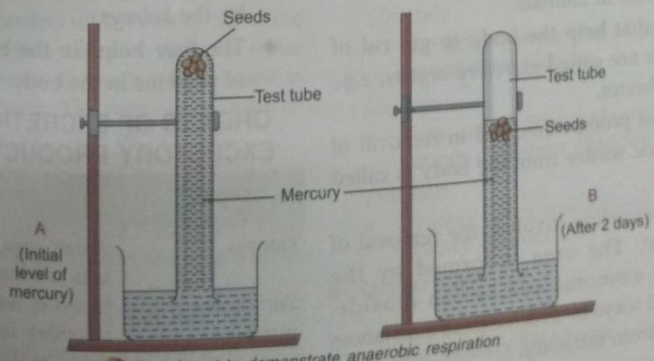
Evolution of heat during respiration.

Record the temperature of the two flasks at the start and after 4-5 hours. The thermometer of the flask having soaked seeds will show a higher temperature while there is no change in mercury level of the other thermometer which records the temperature of non-respiring seeds. Thus, in respiration heat is evolved.

Note : For performing this experiment, students can lose their water bottles also provided their is not much heat loss.

2. Experiment to demonstrate anaerobic respiration.

Procedure : Take 8-10 soaked pea seeds and push them into the mouth of a test tube filled with mercury and invert in a beaker of mercury. The seeds will float to the top of the mercury. After about 2 days the level of mercury in the test tube will fall and the liberated gas will be found to be CO_2. CO_2 can be tested by introducing KOH into the test tube which will float up through the mercury and on coming in contact with CO_2 it would absorb the gas and the level of mercury would again rise. The CO_2 gas can also be tested by adding lime water which will turn milky. A similar experiment can be set up in which the seeds may be killed. What would then be the observation ? Record your observation in your practical file.



Experiment to demonstrate anaerobic respiration

Theme-4

Human Body

CHAPTER 5

Excretory System

Introduction

The excretory system in human beings consists of two bean shaped, dark red coloured organs called kidneys. In the humans, along with kidneys, liver, lungs and skin also functions as organs of excretion although their role is less as an excretory organ as compared to kidneys which are the main organs of excretion.

Learning New Words

Excretion : Removal of metabolic wastes, excess of salts and excess of water from the body.
Accessory excretory organs : Kidneys are the chief excretory organs. Skin, lungs, liver and large intestine act as accessory organs.
Nephron : The structural and functional unit of kidney.
Micturition : Passing out urine is called micturition.
Haematuria : Disease in which urine contains blood.
Dialysis : The removal of unwanted substances from the body through artificial kidney is called dialysis.
Osmoregulation : To maintain the water contents constant in the body.

EXCRETORY SYSTEM

Excretion is a process of removal of metabolic waste (nitrogenous) materials from the body. It takes place by means of excretory organs. Various life processes like nutrition, respiration, etc. produce many unwanted and toxic substances like CO_2, urea, uric acid in animals.

The organs that help the body to get rid of metabolic waste are called *excretory organs, e.g.,* kidneys in vertebrates.

The biological process involved in removal of the excess or toxic wastes from the body is called *excretion*.

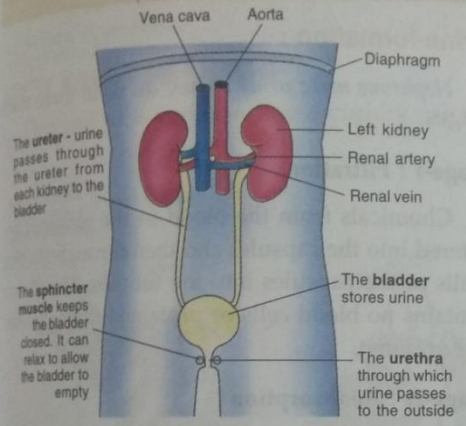
In **humans,** excretion involves the removal of urea and sweat. The urea is formed by the combination of ammonia and carbon dioxide. There are several ways in which excess substances can be excreted from the body.

- Carbon dioxide is breathed out by the *lungs*.
- Sweat glands present in the *skin* help in the elimination of sweat from the body through its pores. The sweat mainly consists of water, salts and urea.
- Many waste substances are excreted in urine by the *kidneys*.
- The *liver* helps in the breakdown of excess of proteins in the body.

ORGANS OF EXCRETION AND THEIR EXCRETORY PRODUCTS IN HUMANS

Organs	Excretory products
Kidneys	Water, urea, uric acid, excess of salts as urine (nitrogenous waste)
Skin (Sweat glands)	Excess of water, salts (like sodium chloride), lactic acid and urea in the form of sweat.

Organs	Excretory products
Lungs	Carbon dioxide and water vapour in exhaled air (gaseous waste)
Liver	Bile pigments (Bilirubin, Biliverdin), toxins, urea(produced in the liver and transported to the kidneys for excretion).



The layout of the human excretory system.

Fact File

- **Renal artery :** Branch of the main artery (AORTA) which supplies oxygenated blood to the kidney.
- **Renal vein :** It collects deoxygenated blood from the kidney and carries it to the main vein (vena cava).

The urinary system is very elaborate in human beings. The system consists *of pair of bean-shaped kidneys* on either side of backbone. The kidneys convert urea into urine. Urine leaves the kidneys through tubes called *ureters* which empty the urine into a sac called *the urinary bladder*. It has a canal like *opening* called *urethra* through which urine is eliminated from the body. The passage of urine to the outside is called *urination or micturition*.

STRUCTURE OF A KIDNEY

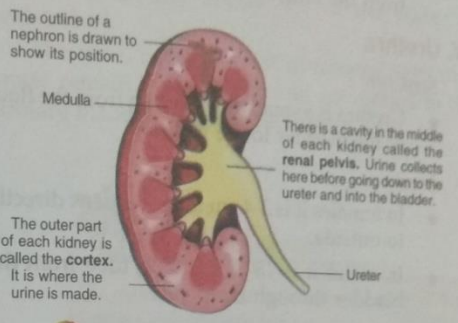
Each of our kidneys is about 7 to 10 cm long and 2.5 to 4 cm across. Our kidneys show two main regions :

- Outer cortex
- Inner medulla

In the cortex region, urine is made and from the medulla, the urine flows into a cavity called *renal pelvis* and from there into the ureter. Inside each kidney there are about a million very small filtering units called *nephrons* or *uriniferous tubules.*

Thus, the excretory system of man consists of :

1. a pair of kidneys
2. a pair of ureters
3. a urinary bladder
4. urethra



A vertical section through a human kidney.

I. Kidney

Structure :

- The kidneys of man are reddish brown, bean shaped.

Location :

- They are present just below the stomach, one on either side of the vertebral column.

Functions :

- 1. Elimination of toxic substances.
  2. Regulation of water balance.
  3. Regulation of blood pressure.
  4. Excretion of nitrogenous waste products.
  5. Helps in osmoregulation.

II. Ureters

Structure :

- The ureters are a pair of long tubes which extend from kidneys.

Location :

- They extend from kidneys to the posterior surface of urinary bladder.

Function :

- Ureters carry urine from the kidneys to urinary bladder.

III. Urinary bladder

Structure :

- The urinary bladder is a bag like muscular organ.

Location :

- It is located in the pelvic region.

Function :

- The urinary bladder serves as reservoir for urine before it leaves the body. It can hold about 0.5–1 litre of urine. It also expels urine from the body.

IV. Urethra

Structure :

- Urethra is a small tube leading from the floor of the bladder to the exterior.

Location :

- In females it is 3-4 cm long. It opens directly to outside.
- In males it is 18-20 cm long tube from the bladder through the penis.

Function :

- The female urethra serves as passageway for urine only whereas in males, it serves as a passageway of semen as well as urine.

ROLE OF KIDNEYS IN FILTRATION OF BLOOD THROUGH MILLIONS OF NEPHRONS

The purpose of excretion is the removal of metabolic wastes, excess of salts and excess of water from the body. For example, CO_2 which is a metabolic waste of respiration is eliminated through the lungs.

Similarly, nitrogenous waste products such as urea and uric acid as well as excess of salts and water are removed in the form of urine from the kidneys.

The purpose of urine formation is the filtration of blood to eliminate all the excretory substances. To filter all the impurities from the blood numerous clusters of capillaries called glomeruli are present in the kidneys. These glomeruli are present in cup shaped Bowman's capsules of *nephrons* which are the *functional units of kidneys*.

Nephrons filter the waste products from the blood. Blood is filtered in the nephrons to eliminate wastes like salts, urea, uric acid and excess of water from the urine.

Urine formation :

Nephrons make urine : They do so in three main stages.

Stage-I : Filtration

Chemicals from the blood in the *glomeruli* are filtered into the capsules and then through the thin walls of the capsules into the tubules. The filtrate contains no blood cells or proteins but has wastes like *urea* in it.

Stage-II : Reabsorption

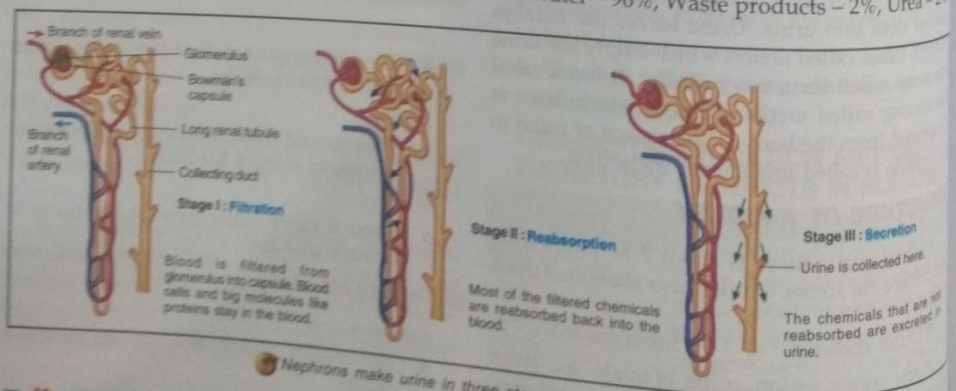
As the filtrate moves down the tubules, useful substances like sugars, amino acids, water and salts are reabsorbed by the cells of the walls of the tubules so that the levels of chemicals in the blood remain constant. This stage is controlled by hormones.

Stage-III : Secretion

The chemicals which are not reabsorbed stay in the nephrons and are excreted. They collect in the pelvis of each kidney and become urine.

The *urine* has the following *composition* :

Water – 96%, Waste products – 2%, Urea – 2%



Nephrons make urine in three stages (Urine formation).

Fact File

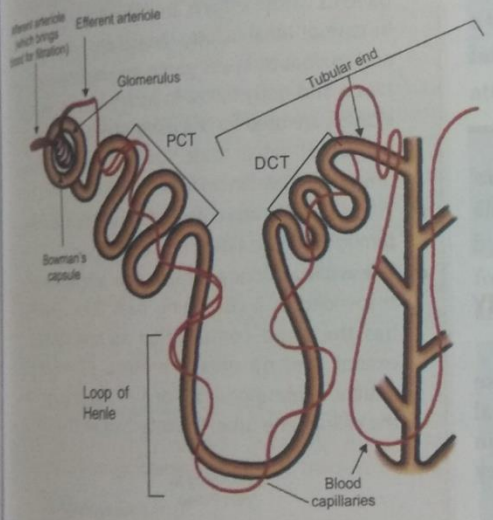
- There are more than one million **nephrons** in each kidney.
- **Ammonia** is produced by the breakdown of amino acids in the liver cells.
- **Urea** is formed in the liver cells when ammonia combines with carbon dioxide. It is transported by blood to the kidneys for its removal.

KNOW ABOUT NEPHRON

One end of a nephron has a cup-like shape called *Bowman's Capsule* which encloses a tuft of capillaries called the *glomerulus*. The other end leads into a large tube called *Collecting end*.

At the end of glomerulus, filtration of nitrogenous waste from the blood plasma is done. This filtrate passes through the tubular part of the nephron (in the form of very small molecules or ions). From this filtrate most of the mineral salts and usually about 70% of the water is reabsorbed.

The urea, small amount of mineral salts and water remain in the filtrate and are carried to the urinary bladder as urine (See figure).



Structure of a Nephron.

Knowledge Enhancer :

The major osmoregulatory functional regions of the kidney (nephron) include :

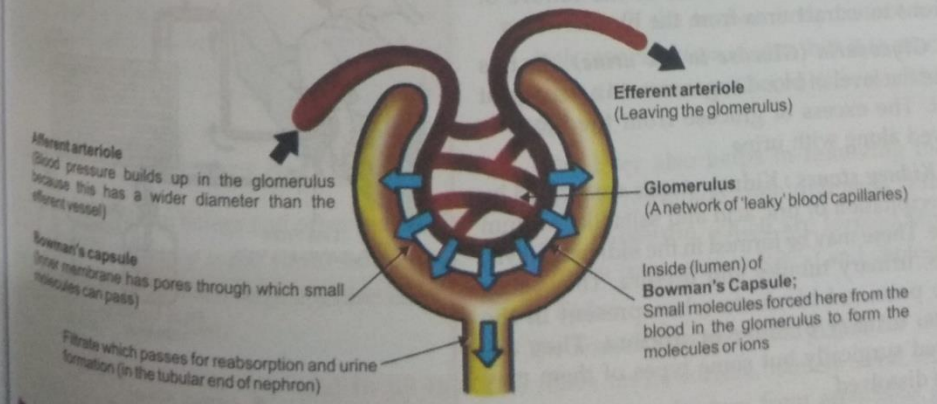
Glomerulus and Bowman's capsule. It is the major site of blood filtration.

Proximal convoluted tubule (PCT). It is primarily involved in reabsorption of salts, water, and nutrients. It is also important in regulating blood pH.

Loop of Henle. It functions to establish the osmotic concentration gradient in the kidney, which is necessary for concentration of urine.

Distal convoluted tubule (DCT). It is the major site of hormonal regulation of sodium chloride and water reabsorption.

- ✔ It is also involved in the regulation of blood pH.
- ✔ It is also the target site for ADH (Anti Diuretic Hormone), the hormone which regulates blood volume.



Filtration in the glomerulus and Bowman's capsule.

Do You Know?

- The presence of glucose in the urine indicates that the person may be suffering from diabetes.
- The bacteria *streptococcus* produces a toxin which can damage the tiny filters in the kidney. This results in the passage of blood cells and albumin into urine which is a sure sign of damaged kidneys.
- In hot weather, we can lose upto 12 litres of water and 30 g of salt in a day through sweating.
- An adult skin weighs about 3 kg and has about 8 million sweat glands.
- There are over a million nephrons in each kidney and each nephron is about 3 cm long.
- The quantity of urine excreted by an adult is 1500 mL every 24 hours.

Activity 1

Try to find out the reasons behind kidney failure. Enquire doctors about the various kinds of food and food habits which can keep your kidneys healthy.

COMMON DISORDERS OF THE URINARY SYSTEM

1. Haematuria (Blood in urine) : In this disease blood is passed out along with urine. The usual cause of this disease is the toxin produced in certain types of fever and infection in urinary tract, kidney stone or tumour.

2. Uraemia : In this disease excessive urea is retained in the blood because of the failure of nephrons to extract urea from the blood.

3. Glycosuria (Glucose in the urine) : In this disease the level of blood sugar rises to a very great extent. The excess of glucose from the blood is removed along with urine.

4. Kidney stones : Kidney stones are formed by the precipitation of uric acid and salts like calcium oxalate. These may be formed in the kidneys, pelvis, ureters, urinary tubules and urethra. They cause severe pain and blockade when present in the ureters, urinary bladder or urethra. They are removed surgically but some types of them may also be dissolved.

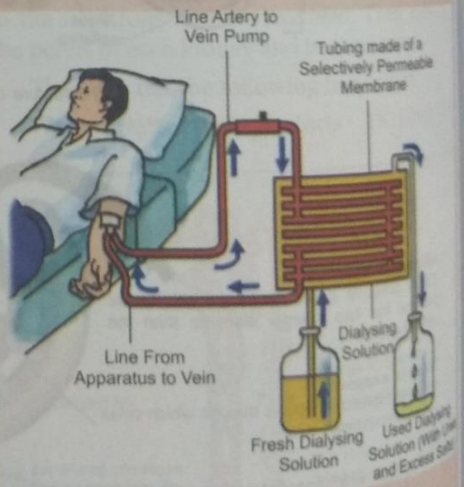
Activity 2

Try to discuss common disorders of the urinary system. For this you may consult kidney specialist, your science teacher or your friends if their parents are in medical field. Conduct a campaign and spread awareness in your school about the various methods of preventing disorders of the urinary system.

Knowledge Enhancer :

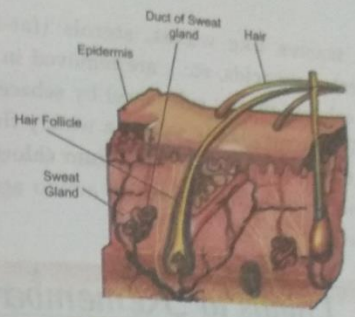
ARTIFICIAL KIDNEY

- ✔ Artificial kidney is a device to filter the blood of patients whose kidneys are completely damaged. In case of renal failure, the various mineral salts and toxic substances go on accumulating in the blood and body fluids. In such patients, artificial kidneys are used for the removal of surplus water, excess of salts, toxic substances and other unwanted substances from the blood.
- ✔ *The removal of unwanted substances from the body through artificial kidney is called Dialysis.*
- ✔ The artificial kidney consists of a *cellophane tube*, suspended in a circulating bath fluid. The fluid has the same composition as normal blood except that no urea is present. Blood of the patient is pumped from one of the arteries into the cellophane tube. It is attached with a vein on



Artificial Kidney.

the other end. Substances present in the blood and bath fluid diffuse through the pores in the cellophane tube according to their concentration gradient. In this way, nitrogenous waste products, excess of salts and other excretory products diffuse out of the blood and purified blood passes into the vein of the patient. Plasma proteins remain in the blood because pores in the cellophane tube are too small to permit the passage of these large molecules.



Skin of man showing sweat glands and blood vessels.

Fact File

- There are three important homeostatic mechanisms that are operational in our body, viz., osmoregulation, thermoregulation and regulation of blood sugar levels. Osmoregulation is the control of the levels of water and mineral salts in the blood. It is a homeostatic mechanism.
- Marine vertebrates lose water to a hypertonic environment; compensate by drinking large quantities of water and excreting salt through rectal glands, gills, salt-excreting glands, or kidneys.
- Freshwater organisms constantly take in water from their hypotonic environment; compensate by excreting large volumes of dilute urine and by active uptake of salts from the environment.
- Osmoregulation involves three processes :

  Filtration : It is the removal of substances from blood, creating a filtrate containing water, salts, glucose, vitamins, urea, etc.

  Secretion : It involves the addition of substances from blood to filtrate.

  Reabsorption : It involves the taking back of some substances present in the filtrate back into the blood, *e.g.*, water, salts, glucose, vitamins, etc.

ACCESSORY EXCRETORY ORGANS

Excretion in human beings and other mammals is also brought about by some additional organs such as lungs, liver, skin and large intestine known as accessory *excretory organs*.

1. Lungs : Lungs are also said to be the additional excretory organs. They help in the removal of metabolic wastes of respiration, i.e., water and CO_2. The lungs maintain the blood-gas homeostasis through elimination of CO_2. When lungs fail to eliminate enough CO_2, the kidneys attempt to compensate.

2. Liver : It helps indirectly in removing the nitrogenous wastes, *i.e.*, it converts highly toxic ammonia to less toxic urea, which in turn removed by the kidneys. Breakdown of protein results in the formation of ammonia. Liver converts it into urea and the process is called urea cycle.

2 molecules of Ammonia (NH_3) + 1 molecule of carbon dioxide (CO_2) $\xrightarrow[\text{carrier molecules + Enzymes}]{\text{Urea cycle}}$ 1 molecule of urea

- Although the human body cannot tolerate *high concentrations of urea*, but it is much less toxic than ammonia and is *removed by the kidneys*.
- The liver also helps in removing inactive steroid hormones, bile pigments (Bilirubin and Biliverdin which are formed from the broken fragments of RBCs) and cholesterol.

3. Skin :

The human skin possesses glands for secreting two fluids on its surface, namely *sweat* from the sweat glands and *sebum* from sebaceous glands.

Certain wastes like waxes, sterols (fat-like molecules), fatty acids, etc. , are removed in the form of sebum (an oily substance) by sebaceous glands. The sweat glands secrete a watery fluid, salty in taste, which contains sodium chloride, some amount of lactic acid, urea, amino acids, glucose, etc.

4. Large intestine : It is responsible transporting waste so it can be excreted general, it collects wastes from all over the and then extracts usable water, allowing for removal of solid waste.

Things to Remember

1. *Excretion* is a process of removal of metabolic waste (nitrogenous) materials from the body.
2. *Excretion* in humans involves the removal of *urea* and *sweat*.
3. The passage of urine to the outside is called *urination* or *micturition*.
4. The functional and filtering units of kidneys are *nephrons*.
5. Common disorders of the urinary system includes : Haematuria, uraemia, glycosuria and *kidney stones*.
6. From the filtrate which passes through the tubular part of the nephron, most of the mineral salts and usually abou 70% of the water is reabsorbed.
7. The urea, small amount of mineral salts and water remain in the filtrate and are carried to the urinary bladder a *urine*.
8. The skin removes excess salt, lactic acid, urea, etc.
9. Each nephron consists of a Bowman's capsule (a double-walled chamber), glomerulus (a dense knot of capillar network found within the Bowman's capsule), the proximal convoluted tubule, the loop of Henle, the distal convolute tubule and the collecting tubule.
10. The Bowman's capsule and the glomerulus together form the Malpighian body.
11. Reabsorption and secretion involve active transport, therefore, are physiological processes while ultrafiltration (filtratio under pressure) is a physical process.
12. Many kidney problems can be treated by dialysis, where a machine acts as a kidney. Blood flows through selectivel permeable cellophane tubes which are bathed in a solution that is isotonic to blood. Large molecules like plasma proteins and cells remain confined in the blood whereas small molecules like urea are allowed to diffuse out.
13. Kidney transplants are an alternative to dialysis.

Exercises

A. Name the folloiwng :

1. Structural and functional unit of kidney.
2. Act of passing urine.
3. To maintain the water contents constant in the body.
4. Removal of unwanted substances from the body through artificial kidney.

B. Short answer questions :

1. (*a*) Excretion (*b*) Micturition (*c*) Nephron (*d*) Osmoregulation.
2. What is the need of excretion ?

3. Where kidneys are located ?
4. Write the names of excretory organs present in man.

C. Long answer questions :

1. What are the three steps involved in the process of making urine ? Explain.
2. Draw a labelled diagram of urinary system in human beings.
3. Describe in brief accessory excretory organs.
4. Discuss the various functions of kidneys.
5. Name some common disorders of kidneys in man and explain in brief.
6. Write a short note on nephrons.

D. Choose the odd one from each of the following :

1. Ureter, kidney, urinary bladder, urethra, lung.
2. Heart, lung, liver, kidney, skin.
3. Urethra, uterus, urinary bladder, ureter.
4. Neurons, ureters, nephrons, kidneys.

E. Fill in the blanks :

1. Urine contains nitrogenous waste in the form of _____ .
2. In case of kidney failure _____ is used to remove the metabolic wastes.
3. Process of passing out urine is called _____.
4. In _____ blood passes out along with urine.
5. _____ is the structural and functional units of the kidney.

F. Write true or false and correct the incorrect statement :

1. The passage of urine to the outside is called urination.
2. The functional and filtering units of kidneys are neurons.
3. Ribs are called the additional excretory organs.
4. The filtering unit in the kidney is nephron.

G. Choose the correct answer :

1. The filtering unit in the kidney is :
   (*a*) ureter (*b*) urethra (*c*) nephron (*d*) renal tubule.
2. A network of capillaries present in the Bowman's capsule is called :
   (*a*) urethra (*b*) glomerulus (*c*) ureter (*d*) nephridia.
3. The process of maintaining constant water content in the body is known as :
   (*a*) excretion (*b*) osmoregulation (*c*) thermoregulation (*d*) ultrafiltration.

4. Human kidney is made-up of more than one million :

(*a*) neurons (*b*) nephrons (*c*) ureters (*d*) nephridia.

H. Match the columns :

Column A	Column B
1. Kidney	(*a*) Nephrons
2. Osmoregulation	(*b*) Micturition
3. Urinary bladder	(*c*) Excretion
4. Cellophane tube	(*d*) Artificial kidney
5. Structural and functional unit	(*e*) To maintain constant water content

I. Differentiate between the following :

(*i*) Ureter and urethra.

(*ii*) Excretion and excretory organs.

(*iii*) Filtration and reabsorption.

(*iv*) Male and female urethra.

J. Activity/Project//Research work

1. Try to find out the excretory wastes of different vertebrate animals and give reasons for the formation of the wastes in their body.