SURA'S

BIOLOGY

(SCIENCE)

Class X

Based on the latest syllabus issued by NCERT

Salient Features

- All concepts are concisely covered in simple language with colourful diagrams.
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SURA PUBLICATIONS
Chennai

2021-22 *Edition*

ISBN : **978-93-5330-215-3**
Code No : CB10_05

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Preface

"Each has his own tree of ancestors,
but at the top of all sits Probably Arboreal."

- Robert Louis

Respected Principals, Correspondents, Head Masters / Head Mistresses, Teachers,

From the bottom of our heart, we at SURA Publications sincerely thank you for the support and patronage that you have extended to us for more than a decade.

It is in our sincerest effort we take the pride of releasing **SURA's Guide for Biology (Science) for Class X**, based on the latest syllabus issued by CBSE. This guide has been authored and edited by qualified teachers having teaching experience for over a decade in their respective subject fields. This Guide has been reviewed by reputed Professors who are currently serving as Head of the Department in esteemed Universities and Colleges.

With due respect to Teachers, I would like to mention that this guide will serve as a teaching companion to qualified teachers. Also, this guide will be an excellent learning companion to students with exhaustive exercises including NCERT in-text and bookback questions and Exemplar questions.

In complete cognizance of the dedicated role of Teachers, I completely believe that our students will learn the subject effectively with this guide and prove their excellence in Board Examinations.

I once again sincerely thank the Teachers, Parents and Students for supporting and valuing our efforts.

God Bless all.

Subash Raj, B.E., M.S.
- Publisher
Sura Publications

All the Best

CONTENTS

Portions Deleted in Science Theory

1] **Control and coordination in animals and plants:** Tropic movements in plants; Introduction of plant hormones; Control and co-ordination in animals: Nervous system; Voluntary, involuntary and reflex action; Chemical co-ordination: animal hormones.

2] **Heredity and Evolution:** Basic concepts of evolution.

Unit-wise Mark Distribution

Unit No.	Unit	Marks
I	Chemical Substances-Nature and Behaviour	26
II	World of Living	23
III	Natural Phenomena	12
IV	Effects of Current	14
V	Natural Resources	05
	Total	**80**
	Internal assessment	**20**
	Grand Total	**100**

Design of the Paper

Topology of Questions	Total Marks	% Weightage (Approx.)
Remembering: Exhibit memory of previously learned material by recalling facts, terms, basic concepts, and answers. **Understanding:** Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	60	75
Applying: Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	12	15
Analysing: Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations. **Evaluating:** Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria. **Creating:** Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.	8	10
Total	**80**	**100**

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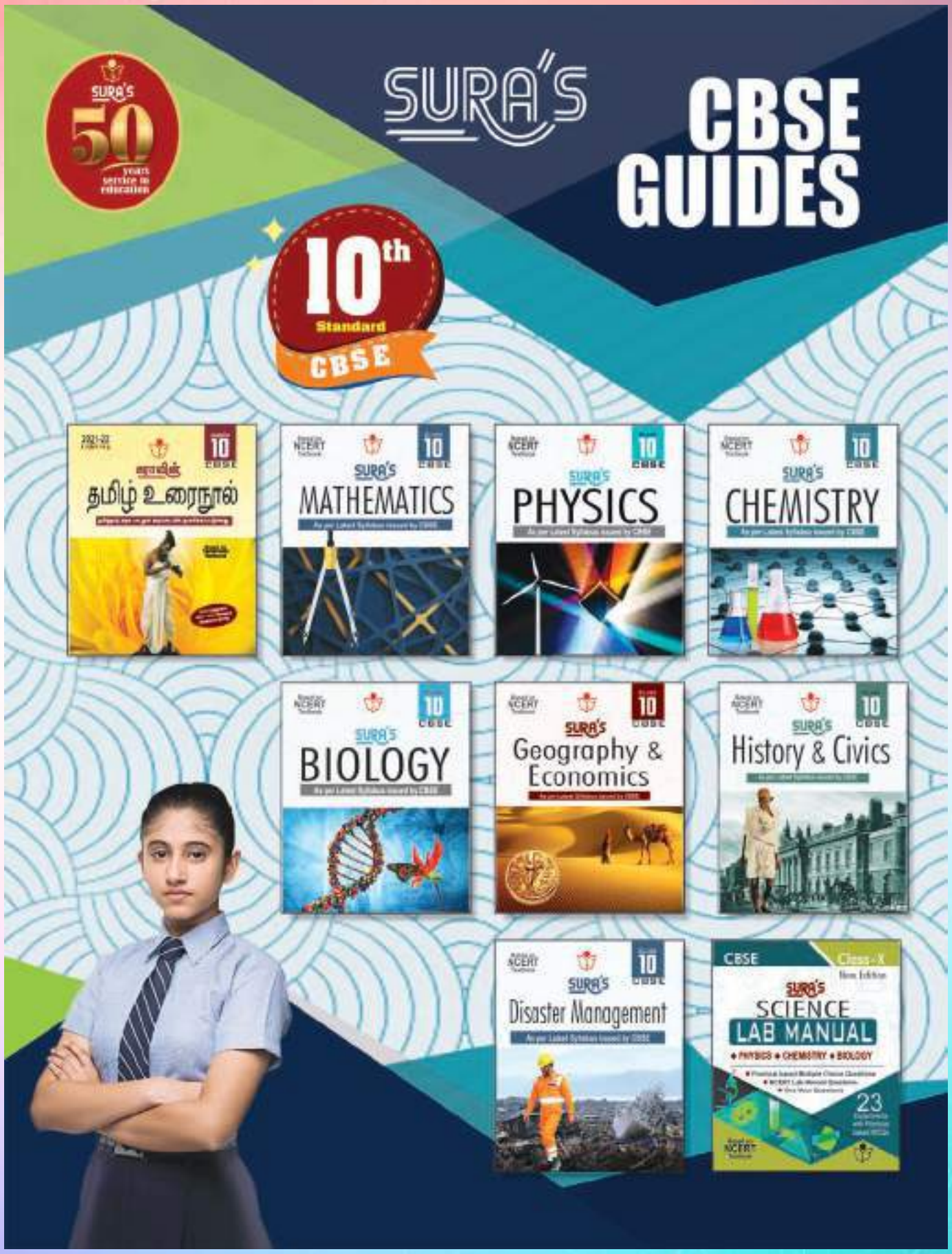


Concept Map

Life Processes

Nutrition

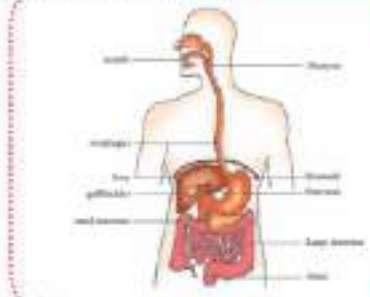
Plants

- Autotrophic nutrition in plants.

Animals

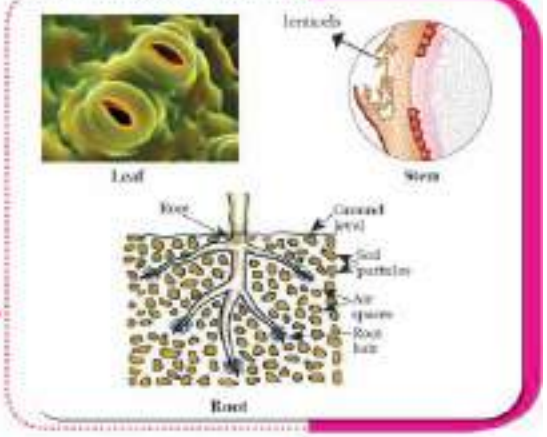
- Heterotrophic nutrition in animals
- Steps included are:
- Ingestion
- Digestion
- Absorption
- Assimilation
- Egestion

Human beings



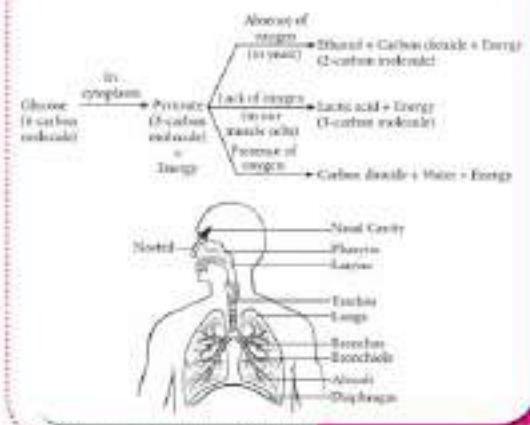
Respiration

Plants



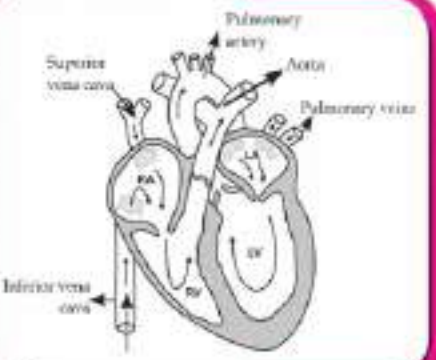
Human beings

Break-down of glucose by various pathways



Transportation

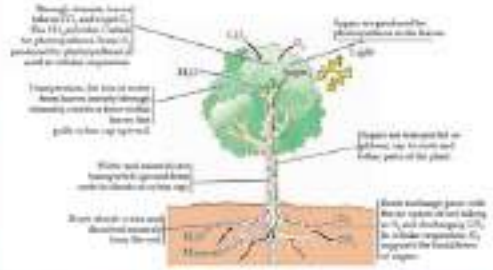
Human beings



Plants

Xylem
(Transport of water)

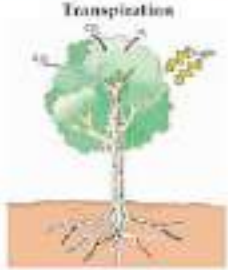
Phloem
(Transport of food)



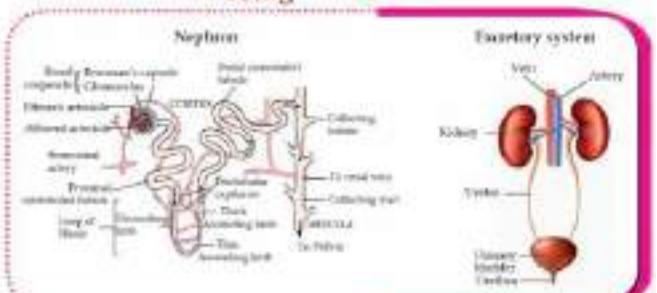
Excretion

Plants

Transpiration



Human beings



Chapter

1

Life Processes

LEARNING OBJECTIVES

In this chapter, we will learn about -

- The characteristics of living beings
- Life processes
- Energy required for life processes
- Nutrition and different modes
- Nutrition in plants, animals and human beings
- Dental caries
- Respiration in plants, animals and human beings
- Transportation in plants, human beings
- Excretion

1.0 Introduction

There are various living organisms ranging from small unicellular Amoeba to large giant whale or a tall tree. When something is living, it is said to be *alive*. Therefore, those organisms which are alive are called *living organisms*. We can say that, all plants and animals including human being are said to be living organisms. But, a question arises, how do you identify whether something is alive or dead? The solution is that there are few criteria which decide whether something is alive or dead. Let us discuss about it in detail.

One of the most important criteria is the *movement*. All the living organisms such as plants and animals move either faster or slower by themselves without any external help. However, the movements in animals are faster than that it can be observed easily while that in plant, it is slow and can be observed only with difficulty.

You must have observed that, animals can move from one place to another by jumping, flying, swimming etc., or also by moving their parts like wagging, clapping etc. For Examples, a bird moves when it is flying in the sky, a fish moves when it is swimming in water, a frog moves when it jumps into a pond. Let us now see how animals can move their body parts, a dog wagging its tail, movement of chest up and down on breathing, movement of hands on clapping. All these movements show that a bird, a fish, a frog, a dog and human beings are living organisms.

***Fig 1.0:* Fish swimming in water**

***Fig 1.1:* Frog jumping**

On the other hand, plants cannot move from one place to another like animals, but can move their body parts such as roots, flowers, leaves and shoots. The movements in plants are largely depends on the internal and external stimuli. The external stimulus includes light, water, gravity, touching etc. Plants also show their movement by growing their roots and shoots.

Note

We will be discussing about the stimuli in later chapter.

Fig 1.2: ***Plant responding to light***

Fig 1.3: ***Plant responding to touch***

Thus, the above discussion shows that the living organisms and non-living things can be distinguished with the single criterion i.e., movement.

Let us now, discuss about the various characteristics of living organisms which helps us in distinguishing it from the non-living things.

1.1 Characteristics of Living Organisms

- Living things can move by themselves.
- Living things can grow.
- Living things need food, air, water.
- Living things are sensitive and hence respond to stimulus.
- Living things can reproduce to have young ones.
- Living things respire and excrete.

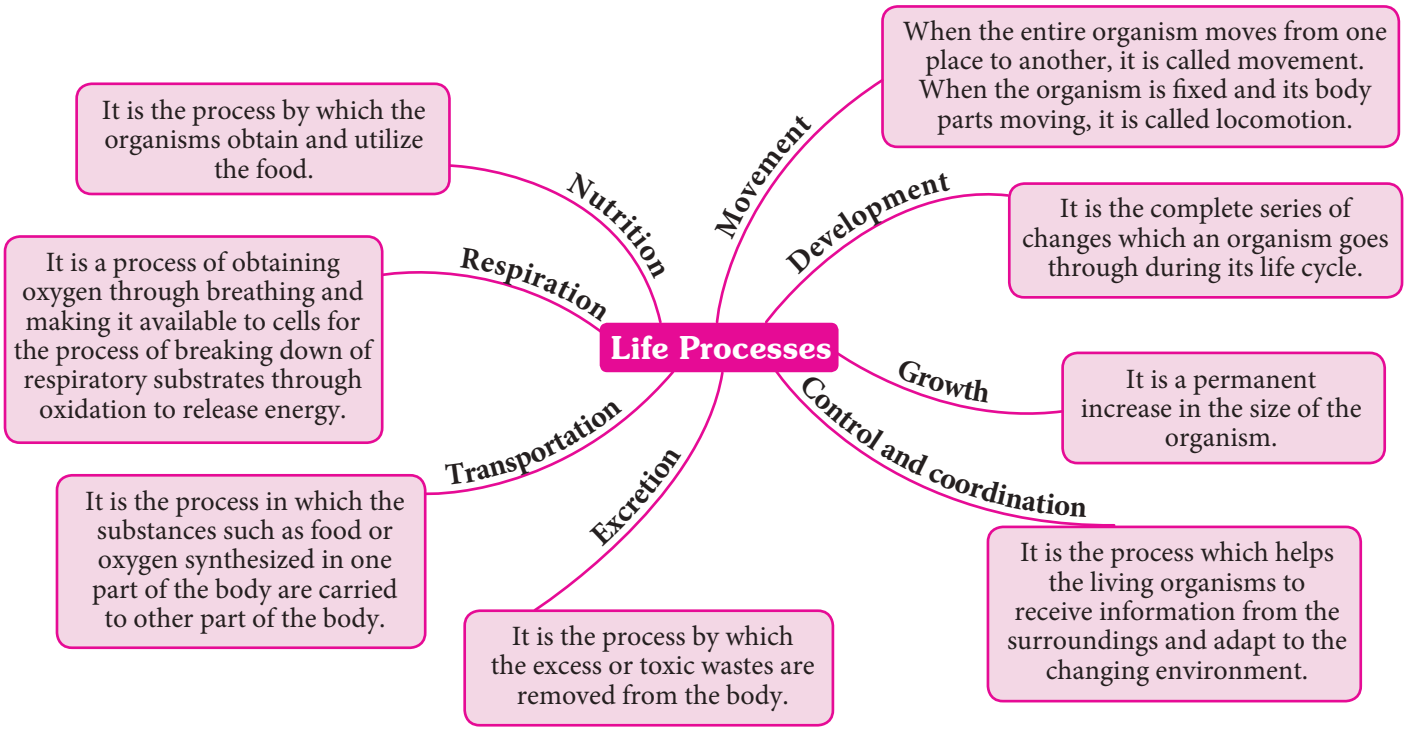
The above characteristics are seen only in living organisms and not in non-living things. Now, can you differentiate living and non-living things?

No.	Living Things	Non – living Things
1.	They have definite life span.	There is no definite life span.
2.	They can reproduce or multiply to produce offspring.	Multiplication is imposed.
3.	They have the ability to evolve in time.	These do not have the ability to evolve.
4.	They have the ability to self- repair.	The repairs can be done by outside agencies.
5.	They can perform growth, development and differentiation.	These do not have such activities.

1.2 Life Processes

There are some basic functions which are required to be done by all the organisms to maintain their life on the earth. This maintenance must continue even when the living organisms are not physically fit or active, sitting idle or also during sleeping. These basic functions are called **life processes**. Some of the life processes include nutrition, respiration, transportation, excretion, control and coordination, growth, development, movement and reproduction.

Let us now discuss about these life processes in detail.



In order to perform these functions, all the living organisms need energy.

1.3 Energy Requirement for Life Processes

Food is a kind of fuel which provides energy to the entire living organism. Therefore, the energy can be obtained from the food that the organisms eat.

Hence, we can say that, that food is the basic requirement of the entire living organism for obtaining energy.

Let us try to understand some important life processes which are needed for living organisms.

1.4 Nutrition

We know that, food is an organic substance consisting of different components such as carbohydrates, fats, proteins, mineral salts, vitamins and water. These components are known as *nutrient*. We can define nutrients as,

"These are organic as well as inorganic substance which is required for the normal growth and development, maintenance and survival of a living organism"

For example, proteins and mineral salts are nutrients for the biosynthesis of its body constituents whereas carbohydrates and fats are nutrients as a source of energy. Hence, we can say that all living organism need nutrients to build up their body and get energy. Green plants produce their own organic nutrients and obtain inorganic nutrients from outside source whereas animals intake both organic and inorganic nutrients from outside source.

Fig 1.4: ***Proteins as food***

Fig 1.5: ***Minerals and vitamins***

Thus, we can define nutrition as,

"A process of intake of nutrients and their utilization by an organism for various biological activities"

Brain Box

The *organic nutrients* such as fats, proteins, carbohydrates etc., are the nutrients obtained from the plants or animals. The organic foods obtained from plants are in the form of vegetables, fruits etc., while it is obtained in the form of milk, eggs, meat etc., from animals. The *inorganic nutrients* are the nutrients obtained from inorganic substances such as water, carbon dioxide, minerals such as Fe, Cu, Zn etc. Green plants obtain the inorganic nutrients from the soil or from the atmosphere. The inorganic elements present in the soil are called *mineral nutrients*.

Let us now discuss about the various means of obtaining food by the organism.

1.5 Modes of Nutrition

Do you think all living organisms obtain their food in the same way? The answer is No. Different organism lives in different environment and hence, they undergo various methods to derive the nutrient from their environment. The methods of obtaining food by the organism are called *mode of nutrients*.

All the organisms are classified into two major groups based on the method of obtaining nutrients or food as,

(a) Autotrophic

(b) Heterotrophic

Let us now discuss about these two modes of nutrition in details.

1.5.1 Autotrophic Mode of Nutrition

The word *'autotrophic'* is derived from a Greek word *"auto"* means *'self'* and *"troph"* means *'nutrition'* i.e., *"Self-Nutrition"*. In this mode of nutrition, the organism synthesizes its own food from the inorganic raw materials like carbon dioxide and water present in the surrounding in presence of solar energy.

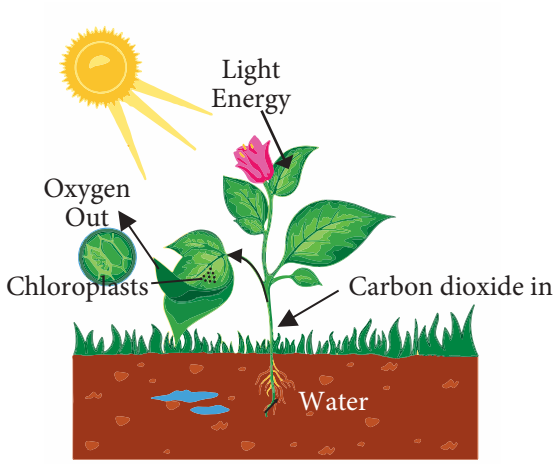


Fig 1.6: Photosynthesis

The autotrophic organism contains the green pigment called *chlorophyll*, which has the ability to trap the solar energy. This trapped solar energy along with the inorganic materials like water and carbon dioxide present in the environment helps to prepare food by the process of photosynthesis. Hence, those organisms which can prepare their own food from carbon dioxide and water are called **autotrophs** or **autotrophic organisms**. Thus, autotrophs are the **producers** of food. All the green plants including autotrophic bacteria are autotrophs.

Thus, we can define autotrophic nutrition as

"A kind of nutrition in which the organisms prepare their own food using the inorganic raw materials present in their surroundings. These organisms are called autotrophs"

1.5.2 Heterotrophic Mode of Nutrition

The word *'heterotrophic'* is derived from a Greek word *"hetero"* means *'different'* or *'other'* and *"troph"* means *'nutrition'* i.e., *"Other Nutrition"*. In this mode of nutrition, the organism cannot synthesize its own food from the inorganic raw materials like water and carbon dioxide and uses the food made by the autotrophic organism directly or indirectly.

From the above discussion, it can be concluded that all animals are heterotrophs which depend on plants or other animals for their food. Most of the Bacteria and Fungi like yeast are also heterotrophic organism.

Thus we can define heterotrophic nutrition as

"A kind of nutrition in which organisms depends on other organisms for its food. These organisms are called heterotrophic organisms or heterotrophs"

Fig 1.7a: ***Herbivores***

Fig 1.7b: ***Carnivores***

Let us now discuss the various types of the heterotrophic mode of nutrition.

1.5.2.1 Types of Heterotrophic Nutrition

Heterotrophs can obtain their food from other organism in three different ways as follows:

(a) Saprophytic nutrition
(b) Parasitic nutrition
(c) Holozoic nutrition

We will now discuss these types of nutrition in detail with examples to understand them more clearly.

(a) Saprophytic Nutrition

The word *"sapro"* means *'rotten'*. The organisms which obtain the food from dead plants and decaying animal bodies or other decaying matter are called *"saprophytes"* or *"saprophytic"* organism. The saprophytes break down the complex organic molecule present in dead and decaying matter into simpler substances outside their body and then are absorbed as the food.

It includes fungi such as Mushroom, Bread mould and many bacteria. The saprophytes also derive their food from rotting wood of dead and decaying trees, rotten leaves and household wastes like rotten bread etc. We can define saprophytic nutrition as,

"A kind of nutrition in which an organism obtain its food from dead plants like rotten leaves, dead and decaying animal bodies and other decaying organic matter"

Fig 1.8a: ***Mushroom***

Fig 1.8b: ***Bread mould***

(b) Parasitic Nutrition

The term *"para"* means *'other'*. There are some organisms which live in an **intimate association** with another living organism from which it derives food. The organism which obtains the food is called a *'parasite'* and the organism from which the food is obtained is called the *'host'*. The host may be either a plant or an animal. The parasite receives its food from the host but may or may not get benefit in return. Usually a parasite harms the host. Several Fungi such as Puccinia, Bacteria and few plants like Cuscuta (*Amarbel*) and some animals like Plasmodium, Roundworms, Liver fluke etc., causes diseases in human beings by being parasitic.

Fig 1.9a: ***Roundworm (Ascaris) in humans***

Fig 1.9b: ***Cuscuta (Amarbel) in host plant***

The parasites also include ticks, lice, Tapeworms (Taenia) and leeches.

Fig 1.10a: ***Leech***

Fig 1.10b: ***Tapeworm (Taenia)***

We can define parasitic nutrition as,

"A kind of nutrition in which an organism derives its food from the body of another living organism"

(c) Holozoic Nutrition

The word *"holozoic"* means *'feeding on solid food'*. In this mode of nutrition, the large complex organic molecules of ingested food are broken down into smaller soluble substances with the help of **digested enzymes**. These simpler substances are then absorbed into the cell.

The holozoic nutrition involves **ingestion** [taking in food], **digestion** (breaking down of complex organic food materials into simple smaller soluble molecule) and **assimilation** (absorbing soluble food molecule). Most of the animals including human beings have a holozoic mode of nutrition.

Thus, we can define holozoic nutrition as,

"A kind of nutrition in which an organism takes in the complex organic food materials by the ingestion and gets digested and absorbed into the body cell of the organism"

Let us now discuss how nutrition takes place in plants.

1.6 Nutrition in Plants

As discussed earlier, plants can make their own food by a process in presence of energy from the sunlight and green pigment chlorophyll in leaf. This process is known as *photosynthesis*. Let us discuss this process in detail.

Photosynthesis

The word *"photo"* means *'light'* and *"synthesis"* means *'building together'* or *'building up with light'*. It is the most important process by which the green plants prepare complex food and release oxygen. Hence, we can define photosynthesis as

"The process by which green plants prepare their own food from carbon dioxide and water in the presence of light energy using chlorophyll"

The overall equation for the process of photosynthesis will be:

$$6CO_2 + 6H_2O + \text{Light Energy} \xrightarrow{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Carbon dioxide — Water (From soil) — (From sun) — Glucose — Oxygen

Site of Photosynthesis

The process of photosynthesis takes place only in green plants due to the presence of green coloured pigment called *chlorophyll*. **Pigments** are the coloured organic substance which absorbs visible light. The green pigment of green plants i.e., chlorophyll absorbs visible light. It is seen only in those cells which possess the green coloured plastids called *chloroplasts*. The chloroplast is the organelle in the cells of green plants which contain chlorophyll. Thus, the site of photosynthesis in the cell of the leaf is chloroplasts. We can see chloroplasts easily by using a light microscope as shown in the fig.

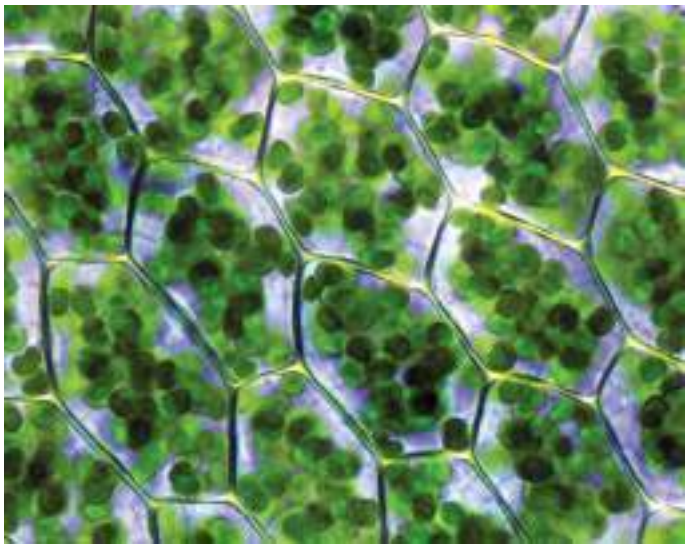


Fig 1.11: ***Chlorophyll in the chloroplasts***

Cross-section of a Leaf

The cross-section of a leaf shows three main layers namely,

a) Upper epidermis
b) Mesophyll region
c) Lower epidermis

The upper and the lower epidermis have a *waxy cuticle* to prevent water loss and also protect the inner parts. The upper epidermis is continuous while the lower epidermis is discontinuous due to the presence of *stoma*. The mesophyll region is divided into two parts as

i) Palisade mesophyll
ii) Spongy mesophyll

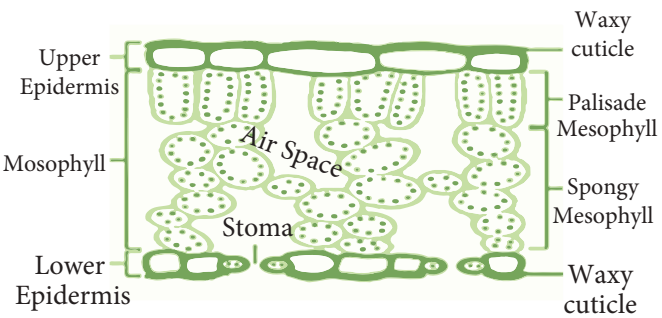


Fig 1.12: ***Cross-section of Leaf***

The palisade mesophyll part contains the organelles chloroplasts in which chlorophyll are present. The spongy mesophyll part contain many cells with air spaces between them.

Process of Photosynthesis

The process of photosynthesis requires four basic raw materials, namely

a) Chlorophyll
b) Carbon-dioxide
c) Water
d) Sun Light

We have already learnt that food is prepared in the green leaves of the plant by combining carbon dioxide and water in presence of sunlight and chlorophyll. The carbon dioxide required for preparing food is taken by the plants from air which enters the leaves through tiny pores called *stomata*. The water required is taken from soil through roots. The sunlight provides the energy required to carry out the preparation of food. The green pigment called *chlorophyll* present in green leaves help to absorb energy from sunlight. The oxygen produced as a by-product goes into the air.

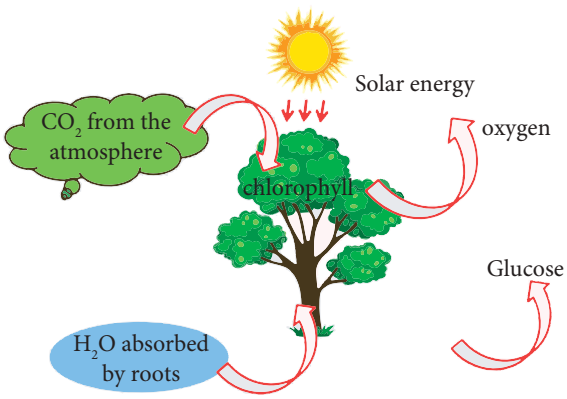


Fig 1.13: ***Process of Photosynthesis***

The food prepared by the green leaves is in the form of glucose (carbohydrates). This glucose is sent to different parts of the plant. The excess glucose or glucose which is not used immediately is converted into starch and stored in the leaves of the plant as the **internal energy reserve**. Thus, the green plants convert sunlight energy into chemical energy by making food by the process of photosynthesis. When we eat plant foods such as fruits, vegetables, food grains etc., the chemical energy stored in them is released in our body during respiration.

Note

Some of the energy derived from the food we eat is stored in our body in the form of glycogen.

Steps during Photosynthesis

a) Absorption of sunlight energy by chlorophyll.
b) Conversion of sunlight energy into chemical energy and splitting of water into hydrogen and oxygen using sunlight energy.
c) Reduction of carbon dioxide to form carbohydrates using the chemical energy.

Usually, these three steps occurs one after the other. However, it differs in few plants. For example, in desert plants, the carbon dioxide is taken in at night to prepare an intermediate product which reacts with sunlight on next day when the stomata is open.

Chlorophyll is necessary for Photosynthesis

You must have seen that most of the common plants have leaves which are totally green due to the presence of chlorophyll. But there are some plants whose leaves are partly green and partly white. This is because, the part of leaf which is green in colour contains chlorophyll and the part of leaf which is white in colour does not contain chlorophyll. The leaves which are partly green and partly white are called *"variegated leaves"*. These leaves are seen in plants such as croton and coleus.

Fig 1.14: ***Variegated leaves***

Let us now perform an activity using a plant having variegated leaves to show that chlorophyll is necessary for the process of photosynthesis in plants.

Activity – 1.1

Aim:

To demonstrate that chlorophyll is necessary for photosynthesis.

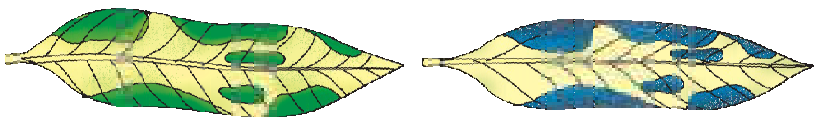
Materials Required:

Potted money plant or croton, alcohol, water, sheet of paper, beaker, water-bath.

Procedure:

- Take a potted plant with variegated leaves such as money plant or crotons.
- Keep the plant in a dark room for three days so that all the starch gets used up.
- Now, keep the plant in sunlight for about six hours.
- Pluck a leaf from the plant.
- Mark the green areas in it and trace them on a sheet of paper.
- Dip the leaf in boiling water for a few minutes.
- Then, immerse it in a beaker containing alcohol.
- Carefully place the above beaker in a water-bath and heat till the alcohol begins to boil.
- Observe the colour of the leaf and the solution.
- Note down your observation.
- Now, dip the leaf in a dilute solution of iodine for a few minutes.
- Take out the leaf and rinse off the iodine solution.
- Observe the colour of the leaf.
- Compare the colour of the leaf before and after.

Diagram:



Before the test *After the test*

Observation:

The blue-black colour appears only in those parts of leaf which were green. The blue-black colour does not appear in white parts.

Conclusion:

Since starch formation takes place only in green parts containing chlorophyll. This shows that chlorophyll is essential for photosynthesis.

Let us perform an experiment to show that light and chlorophyll are necessary for photosynthesis by green plants. In this activity leaves make "starch" as food by photosynthesis.

Activity – 1.2

Aim:

To demonstrate that sunlight is necessary for photosynthesis.

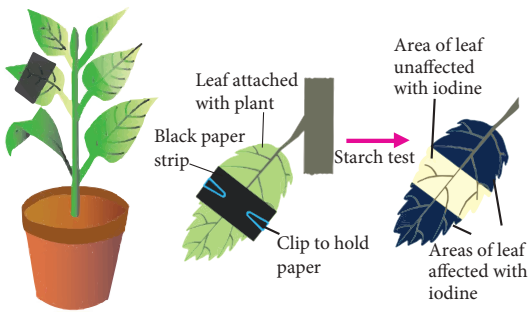
Materials Required:

Potted plant, paper clips, aluminium foil, beaker, alcohol, water bath, petri dish, iodine solution, dropper

Procedure:

- Take a potted plant and de-starch the leaves by keeping it in darkness for 2–3 days.
- Now, take a small strip of aluminium foil and fix it over a part of leaf using paper clips.
- A part of leaf can be covered using black paper too.
- Place the potted plant in sunlight for 3–4 hours.
- Detach the leaf and remove the aluminium foil.
- This leaf is now dropped inside a beaker containing alcohol.
- Place the beaker in a water bath and allow it to boil for some time to remove all chlorophyll from the leaf.
- Take this colourless leaf from alcohol and place it in a hot water to make it soft.
- Transfer the colourless leaf to a petri dish and add few drops of iodine solution with the help of dropper.
- Observe the change in the colour.

Diagram



Requirement of Sunlight for Photosynthesis

Observation

- The part of the leaf covered with aluminium foil or black paper will not show any change in the colour.
- The rest of the part changed into blue-black indicating the presence of starch.

Inferences

- The formation of starch is due to photosynthesis.
- The part of the leaf exposed to sunlight produce starch and so the leaf turned blue-black on addition of iodine solution.
- The part of the leaf covered with aluminium foil or black paper could not produce starch by photosynthesis due to absence of sunlight.
- So the closed part of the leaf will not change the colour on addition of iodine solution.

Let us now study how carbon-dioxide enters the leaf.

When you look into the lower surface of leaf through an electron microscope, you will see that there are a large number of tiny pores on the surface of the leaves. These pores are called *stomata*. You can observe that it is surrounded by a pair of guard cells. The guard cells control the opening and the closing of stomata pores. In land plants, stomata are present on the epidermal layers while in aquatic plants, it is absent. Thus in aquatic plants, the carbon-dioxide is taken in dissolved form through the surface of plant body.

Fig 1.15: The picture showing stomata on the lower surface of a leaf as seen through a microscope

When the guard cells absorb water, they swell, become curved and open the pore. On the other hand, when the guard cells lose water, they shrink, become straight and close the pore. Thus, a large amount of water is lost from the cells of the plant leaves when stomatal pore is open. So, when the plant does not require carbon dioxide, it closes the stomata. Hence, we can conclude that the gaseous exchange in plants occurs through the stomata in leaves.

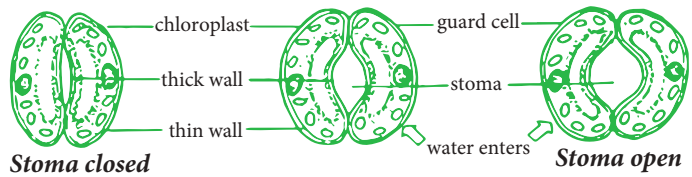


Fig 1.16: Stoma

Note

The exchange of gases occurs across the surface of stems, roots and leaves as well.

Brain Box

In broad-leaved plants, the stomata occur only in the lower surface of the leaf whereas in narrow-leaved plants, the stomata occur both in lower surface as well as in upper surface of the leaf.

Let us now perform an activity to show that carbon dioxide is important for photosynthesis.

Activity – 1.3

Aim

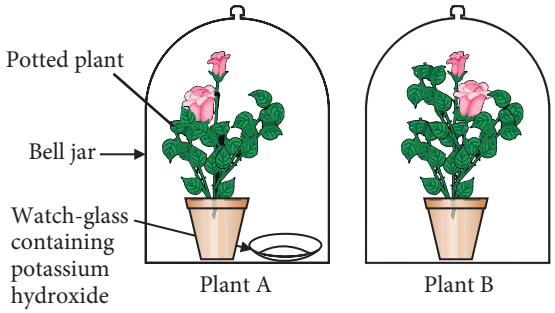
To demonstrate that carbon dioxide is necessary for photosynthesis.

Materials Required

Two healthy potted plants of same size, glass plates, bell jar, potassium hydroxide, Vaseline, iodine solution

Procedure

- Take two healthy potted plants of nearly the same size.
- Keep them in a dark room for three days.
- Then, place each plant on separate glass plates.
- Cover whole of the plant with bell jar.
- Mark it as 'A' and 'B'.
- Now, take a watch-glass containing potassium hydroxide and place in potted plant A.
- Seal the bottom of the jars to the glass plates using vaseline so that the set-up is air-tight.
- Keep the plants in sunlight for about two hours.
- Pluck a leaf from each plant and check for the presence of starch using iodine solution.

Diagram

Observation
The leaf of potted plant B turns blue showing the production of starch. The leaf of potted plant A remains colourless showing the absence of starch.
Result
This experiment shows that carbon dioxide is necessary for photosynthesis.
Conclusion
In the plant A, the carbon dioxide was absorbed by potassium hydroxide kept in a petri dish and so the plant did not get carbon dioxide and hence the process of photosynthesis did not take place.

Water is an essential raw material in photosynthesis. It acts as a *limiting factor*. This is because less than 1 % of the water is absorbed by a plant. The water required by the plants for photosynthesis is absorbed by the roots of the plants from the soil by *osmosis*. The water absorbed by the roots along with minerals such as nitrogen, phosphorus, magnesium is transported upward to the leaves to synthesize proteins and other compounds. Nitrogen is taken in the form of *nitrites* or *nitrates*. It is also taken up as organic compounds which have been prepared by bacteria from atmospheric nitrogen.

1.7 Nutrition in Animals

As we have studied earlier that the animals are heterotrophic organism and hence they obtain their food from other organisms. This shows that animals need food from an external source. Animals like big fishes eat small fishes, birds eat worms and insects and snakes eat frog. Thus, they obtain their food by eating the flesh of other animals in an orderly way. The big fish eats small fish, the birds eat worms and insects and the snake eats frog.

Fig 1.17a: Big fish eats a small fish

Fig 1.17b: Bird eats a worm

Fig 1.17c: Snake eats a frog

Have you heard that some plants can eat insects too? Two such plants are the Pitcher plant and the Venus fly-trap.

Fig 1.18: ***Venus fly trap***

Fig 1.19: ***Pitcher plant***

We, the human beings also obtain foods like fruits, vegetables, pulses, rice, wheat etc., from plants and foods like milk, egg, cheese, curd etc., from animals. We also obtain foods like chicken, fish and meat from animals.

Let us now discuss the process involved in nutrition in animals.

1.7.1 Steps Involved in Nutrition in Animals

Though, there are large ways of obtaining food, but the single–celled organism may ingest the food through any part of the surface. On the other hand, in multicellular organism, different parts of the body modify to perform different functions. There are five main steps involved in the process of nutrition in animals.

Let us see how nutrition takes place in simple unicellular animals by taking Amoeba as an example.

Nutrition in Simple Unicellular Animals

The organisms which consist of only one cell are called *unicellular organism*. Thus, the unicellular animals possess only single cell. It includes *Paramoecium*, *Euglena, Amoeba* etc. The steps involved in the nutrition of Amoeba are as follows:

a) Ingestion - Amoeba has no mouth for ingestion of food. Hence, the mode of nutrition is *holozoic*. Amoeba ingests food by using *pseudopodia*. These pseudopodia are finger-like protoplasmic projections found around the Amoeba. It helps Amoeba in locomotion and to capture food. When a food particle comes near Amoeba, it gets surrounded by the encircling pseudopodia which touch each other. The membrane closer to food particle gets dissolved and the food is engulfed along with little water surrounding it to form a food vacuole inside the Amoeba. This food vacuole can be considered as *'temporary stomach'* of Amoeba. The process of obtaining food is called *phagocytosis*.

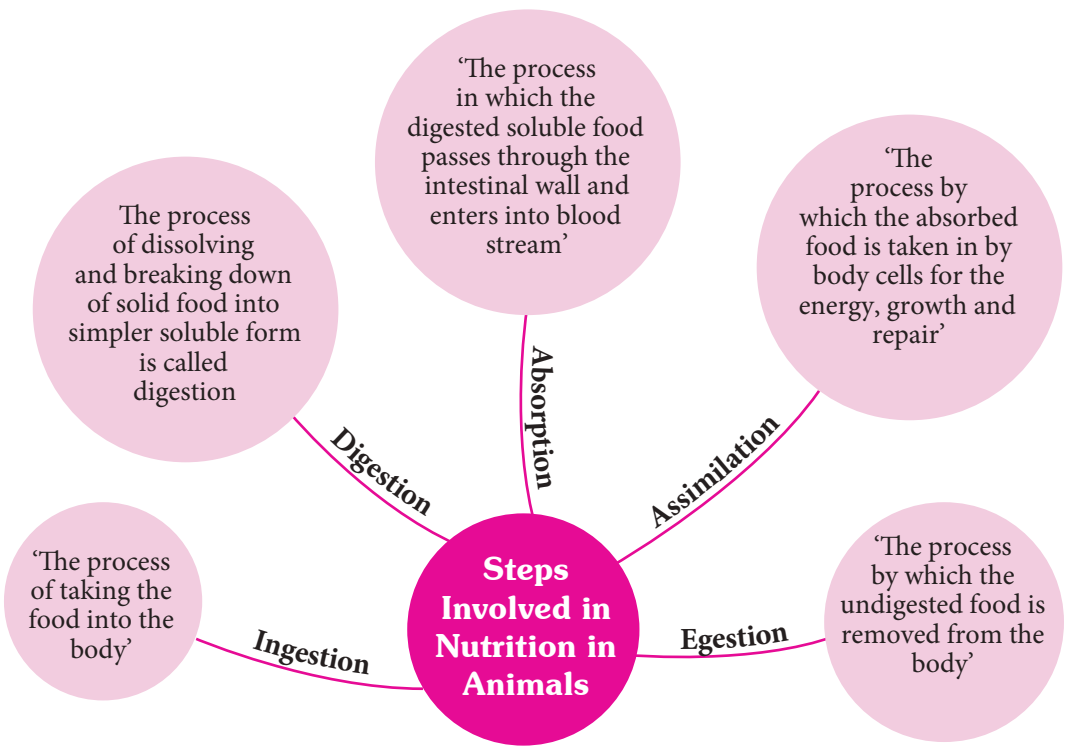


Fig 1.20: ***Human digestive system***

The word *"phagocytosis"* means *"cell feeding"*.

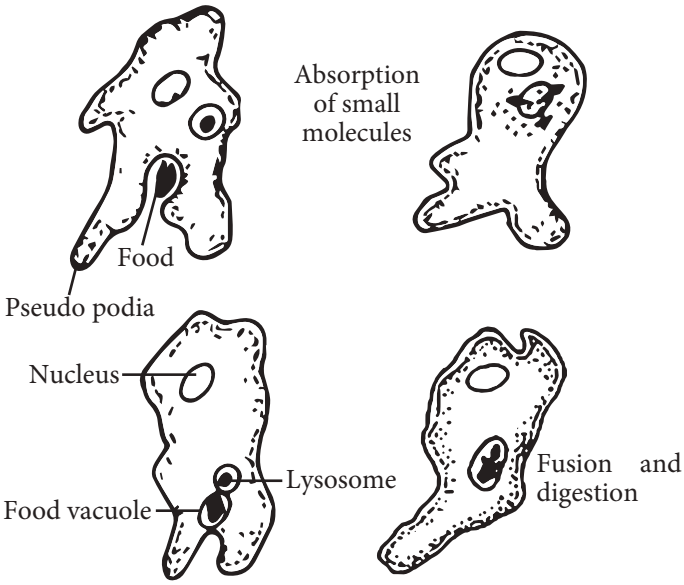


***Fig 1.21:** Phagocytosis of Amoeba*

b) Digestion -The process of digestion takes place inside the food vacuole by means of digestive enzymes. The enzymes from cytoplasm enter into the food vacuole and break down the food particles into small soluble molecules. Due to this, the food dissolves and get digested.

c) Absorption - The digested food in the food vacuole of Amoeba is directly absorbed into the cytoplasm by the process of diffusion. The digested food spreads into the entire amoebic cell and the food vacuole disappears.

d) Assimilation - Some part of the absorbed food is now used to obtain energy through respiration. The remaining part of the absorbed food is used for the growth and reproduction in Amoeba. The process of entering and using of absorbed food by the cell is called *assimilation*.

e) Egestion - Amoeba does not have any specialized part which helps it to remove the undigested food. So, when a considerable amount of undigested food is collected inside Amoeba, the cell membrane suddenly ruptures and the undigested food is thrown out of the body.

We shall now explain the process of nutrition in the complex multicellular animals such as human beings.

Nutrition in Complex Multicellular Animals

The organisms consisting of more than one cell to perform specific functions are called *multicellular organisms*. It includes human beings, rats, etc. As discussed earlier, human beings are heterotrophic and also omnivorous organisms which obtain their food from plants and animals by means of holozoic mode of nutrition. Human beings consist of a digestive system and the associated digestive glands.

Let us now discuss the alimentary canal and digestive glands associated with it.

Alimentary Canal and Digestive Glands

The digestive system consists of a long continuous canal called the *alimentary canal*. It is a long tube extending from mouth to anus. It includes, mouth (buccal cavity or oral cavity), pharynx, oesophagus, stomach, small intestine, large intestine and anus.

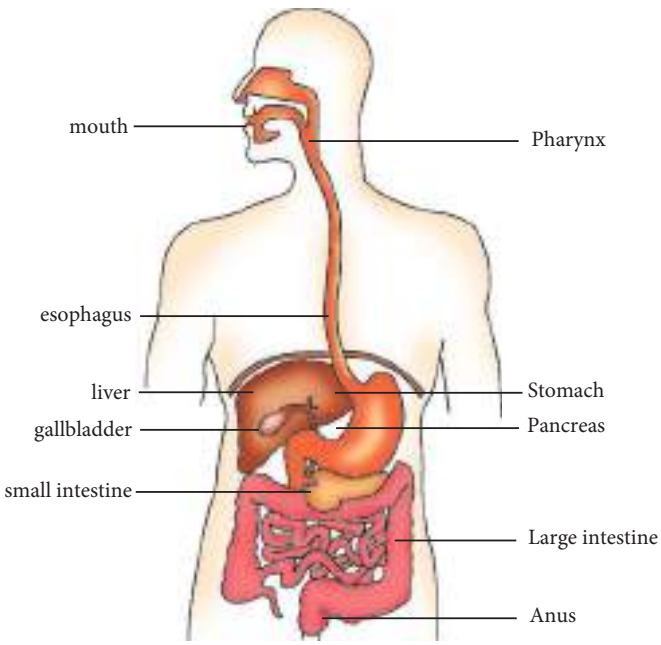


***Fig 1.22:** Alimentary Canal of man*

1. Ingestion

The process of ingestion of food takes place through the mouth. The mouth is the upper most opening guarded by two soft, movable sensitive lips which helps to hold the food.

2. Digestion

The process of digestion of food begins in the mouth or buccal cavity. It is the anterior part that lies between upper fixed jaw and lower moveable jaw. Each jaw has teeth. The buccal cavity contains teeth, tongue and salivary glands.

Fig 1.23: ***Buccal cavity***

Tongue

Tongue is a muscular and movable flat structure attached posterior to the lower jaw. The tongue bears taste buds to identify the nature of food. It moves and holds the food for mixing it with saliva.

Teeth

Teeth are hard structures made of ivory–like substance called *dentine*. The part of teeth covered by a shining substance called *enamel*. It is the **hardest** substance of the body. Each jaw has 16 teeth of four different types namely,

a) Incisors
b) Canines
c) Pre-molars
d) Molars.

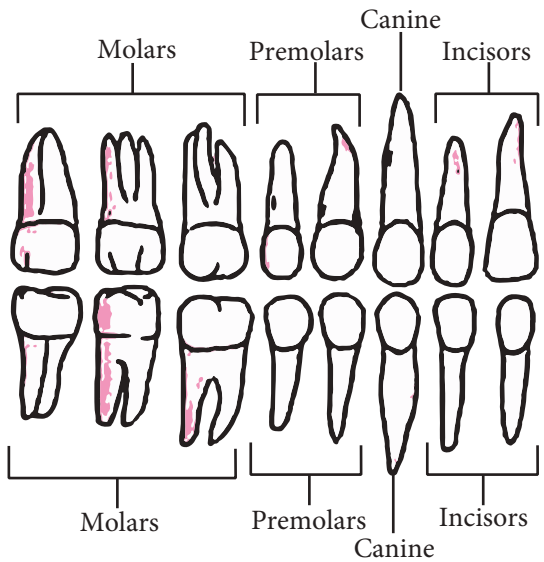


Fig 1.24: ***Types of Teeth***

The incisors are sharp with cutting edges and hence help in biting the food. The canines are pointed and hence help in tearing the food. The pre-molars and molars are broad and hence help in grinding the food.

Functions of Teeth

a) To cut the food into small pieces
b) To chew the food
c) To make the food soft for easy swallowing

Salivary Glands

The buccal cavity has three pairs of salivary glands. These are namely,

a) Parotid gland lying on the sides of the face
b) Sublingual gland lying below the tongue
c) Sub-mandibular gland (known as Sub-maxillary gland) lying at the angles of lower jaw

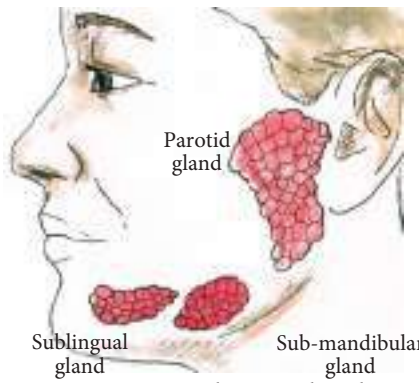


Fig 1.25: ***Salivary glands***

These salivary glands secrete about 1.0 – 1.5 *l* of saliva into buccal cavity every day. The saliva contains water, salts, mucus and an **enzyme ptyalin**. The enzyme ptyalin or **salivary amylase** acts on starch and glycogen and convert into maltose. The mucus and water makes the food soft and slippery. Thus the digestion of starch i.e., carbohydrate begins in the mouth. Since, the food remains in the mouth only for a short time and so, the digestion of food remains incomplete.

$$\text{Starch (Carbohydrates)} + \text{Glycogen} \xrightarrow{\text{Ptyalin}} \text{Maltose}$$

Function of Saliva

a) The saliva cleans the teeth
b) The saliva provides solvent for dissolving chemicals present in the food
c) The saliva keep the lips, buccal cavity and tongue moist.

Let us perform an activity to see the action of saliva on starch.

Activity – 1.4
Aim
To demonstrate the action of saliva on starch.
Materials Required
Starch solution, test tubes, dilute iodine solution
Procedure
◆ Take 1 ml starch solution (1%) in two test tubes (A and B). ◆ Add 1 ml saliva to test tube A. ◆ Leave both test tubes undisturbed for 20–30 minutes. ◆ Now add a few drops of dilute iodine solution to the test tubes. ◆ Observe the change in the colour. ◆ Now, find out the presence or absence of starch in the two test tubes by iodine solution.
Observation
a) The blue colour appears in test tube B showing the presence of starch. b) The blue colour does not appear in test tube A showing absence of starch.
Result
The experiment shows that action of saliva on starch.
Conclusion
This indicates that salivary amylase present in saliva has broken down the starch into soluble sugar.

Note

Many times we have observed that when we see or eat a food which we like, our mouth waters. This watering of mouth is due to the production of saliva.

Pharynx

Pharynx is long, funnel shaped vertical canal that acts as a passage way from buccal cavity to the oesophagus. The muscles of pharynx contract to push the food into oesophagus. The process of pushing food into oesophagus is called *swallowing or deglutition*.

Oesophagus or Food pipe

Oesophagus is a long, tubular structure which carries food from pharynx to stomach. The walls of oesophagus have muscles which contract and expand alternately. When the slightly digested food enters the oesophagus, the walls of the food pipe undergo contraction and expansion, pushing the digested food into the stomach. The movement of contraction and expansion of walls pushing the digested food into the stomach is called *peristaltic movement*.

Note

The peristaltic movements of the muscular walls of different digestive organs are responsible for the movement of food down the alimentary canal as a whole.

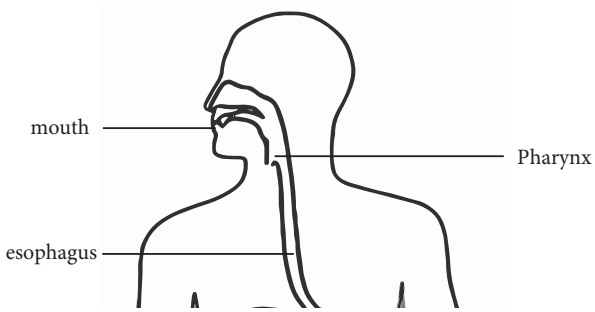


Fig 1.26: ***Oesophagus***

Stomach

It is a J – shaped large muscular organ lying on the left side of the abdomen. The partially digested food is further digested in the stomach. The food is broken down into smaller pieces and churned to form a semi-solid paste. The wall of the stomach contains glands that secrete gastric juice. The gastric juice contains hydrochloric acid, mucus, pepsin, gastric lipase and rennin.

Fig 1.27: ***Stomach***

Function of Hydrochloric Acid

a) It softens the food.
b) It makes food acidic for the function of pepsin.
c) It stops the action of salivary amylase.
d) It kills germs and bacteria to disinfect the food.
e) It converts inactive pepsinogen and pro-rennin into active pepsin and rennin.

$$\text{Inactive pepsinogen} \xrightarrow{HCl} \text{Active pepsin}$$
$$\text{Inactive pro-rennin} \xrightarrow{HCl} \text{Active rennin}$$

Function of Pepsin

The main function of pepsin is to hydrolyze proteins into soluble proteoses and peptones only in presence of hydrochloric acid.

$$\text{Protein} \xrightarrow{Pepsin} \text{Peptones} + \text{Proteoses}$$

Function of Rennin

It is active only in infants. The main function of rennin is to converts soluble milk protein casein into insoluble protein called *paracasein*. Due to this, the milk stays in stomach for longer duration.

$$\underset{\text{(Soluble milk protein)}}{\text{Casein}} \xrightarrow{Rennin} \underset{\text{(Insoluble)}}{\text{Paracasein}}$$

Function of Mucus

The main function of mucus is to protect the inner lining of stomach from corroding action of hydrochloric acid as well as from pepsin enzyme.

Note

If mucus is not secreted, hydrochloric acid results in the erosion of inner lining of stomach leading to the formation of peptic ulcers in the stomach. The Helicobacter pylori reside in these ulcers. Peptic ulcers are highly painful.

Function of Stomach

a) ***Churning of food:*** Stomach mixes the food with gastric juice.
b) ***Softening of food:*** The hydrochloric acid softens the food.
c) ***Temporary storage of food:*** The stomach stores ingested food.
d) ***Absorption:*** Stomach absorbs some soluble components such as glucose, alcohols, minerals etc., of food.
e) ***Partial digestion:*** The ingested food is partially digested by the enzymes present in gastric juice.
f) ***Regulating the passage of food into intestine:*** The stomach makes the food softer and allows the food to pass to intestine by pyloric valve.

The partially digested food then goes into the small intestine. The exit of food from stomach is regulated by a *"sphincter muscle"*.

Small Intestine

It is the longest part of the alimentary canal which includes *duodenum, jejunum and ileum*.

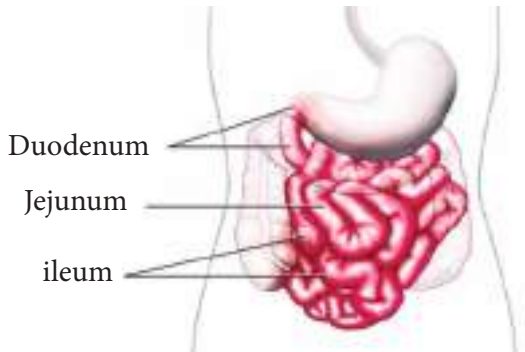


Fig 1.28: ***Small intestine***

The length of the small intestine varies in different animals, based on the type of food they eat. Though, the small intestine is very long, it is called **small intestine** because it is narrow. It is extensively coiled in the abdomen to get accommodated in small space.

It is the seat of major **digestion** and **absorption**. We all know that cellulose is a carbohydrate food which is difficult to digest. So, the herbivorous animals like cow, goat etc., which eat grass need a longer small intestine to allow the cellulose present in the grass to be digested completely. On the other hand, meat is a food which gets digested easily. So, the carnivorous animals like tiger, lions etc., which eat meat need a shorter small intestine to allow the meat to digest completely. The small intestine in human beings is the site of complete digestion food.

Small intestine receives the secretion of two glands namely,

i) Liver
ii) Pancreas

Liver

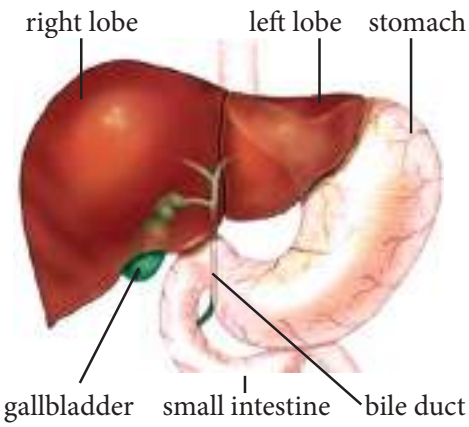


Fig 1.29: ***Liver***

It is the largest, reddish brown colour gland of the body. It has soft pear–shaped sac called *gall bladder*. The gallbladder secretes bile juice. Bile is alkaline containing bile pigments. The, bile is stored in the gall bladder. It helps to emulsify or break the fats or lipids present in the food.

Functions of Bile

i) It breaks the larger globules of fat into small globules to make the enzyme to act and digest them.
ii) It prevents putrefaction of food.
iii) The bile creates a medium for the pancreatic juice to act on food by neutralizing the acidity in the food.

Note

Bile has no enzyme and hence it has no chemical action on food.

Pancreas

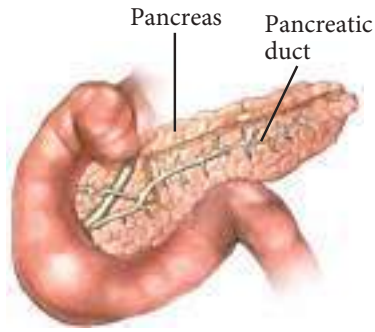


Fig 1.30: ***Pancreas***

It is the second largest gland in our body lying below the stomach. It secretes a digestive fluid called *pancreatic juice* which contains digestive enzymes such as trypsin, nucleases, pancreatic lipase and pancreatic amylase. The enzyme trypsin digests the proteins, the enzyme pancreatic amylase breaks down the starch and the enzyme lipase breaks down the emulsified facts. Pancreas produces two types of hormones namely,

a) Insulin
b) Glucagon

Insulin is essential for using glucose and storing it into glycogen. Glucagon is essential for conversion of glycogen into glucose. The alkaline medium is favourable for the action of pancreatic enzymes.

$$\text{Starch} \xrightarrow{\text{Pancreatic amylase}} \text{Maltose}$$

$$\text{Fat} \xrightarrow{\text{Lipase}} \text{Fatty acids} + \text{Glycerol}$$

$$\text{Proteins} \xrightarrow{\text{Trypsin}} \text{Peptides}$$

Secretion of intestinal juice and pancreatic glands

The intestinal juice contains a number of enzymes which complete the digestion process. The complex carbohydrates are converted into glucose, proteins which are turnover converted into amino acids. The fats are converted into fatty acids and glycerol. All these end products i.e., amino acids, glucose, fatty acids and glycerol are small and water soluble molecules. The intestinal juice includes maltase, invertase, lactase etc.

Peptides $\xrightarrow{\text{Trypsin}}$ Amino acids

Sucrose $\xrightarrow{\text{Invertase}}$ Glucose + Fructose

Maltose $\xrightarrow{\text{Maltose}}$ Glucose + Glucose

Lactose $\xrightarrow{\text{lactose}}$ Glucose + Galactose

Now let us discuss how these digested foods are absorbed.

1. Absorption

The small intestine is the main region for the absorption of digested food. All the end products of digestion are soluble in water and can be easily absorbed by the wall of intestine which contains blood capillaries. The inner surface of small intestine is specially adapted for the process of absorption of digested food by having millions of tiny, finger like projections called *villi*. The presence of villi increases the absorptive surface area of the small intestine. Thus, the presence of villi and blood capillaries in absorptive area enhances the ability of absorption by the inner wall of the small intestine. Thus, the large surface area of small intestine helps in the rapid absorption of digested food through the walls of the small intestine and enters into our blood.

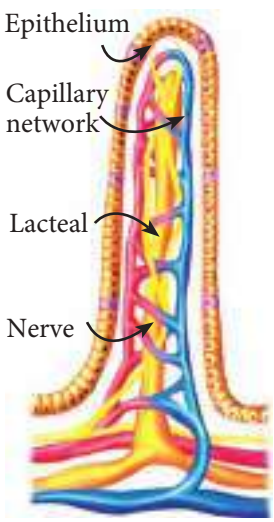


Fig 1.31: ***The structure of villi***

Note

Villi are richly supplied with blood capillaries and contain lymph vessels. The lymph opens into the larger veins carrying digested fats absorbed from the large intestine.

2. Assimilation

The process of using of digested food is called *assimilation*. The blood carries the digested food to all parts of the body where it gets assimilated by the body cells. The body cell uses the digested food to obtain energy for growth and repair of the body. When the assimilated food undergoes oxidation during respiration, the energy is released in the body cells. The digested food which is not used by the body immediately is stored in the liver in the form of glycogen. This stored glycogen can be used as a source of energy by the body whenever required.

3. Egestion

The process of egestion takes place in large intestine. It is the end part of alimentary canal. It is 1.5 – 1.8 m long and 4 – 6 cm in diameter. It receives the undigested food in the form of semifluid along with mucus and water. The wall of the large intestine absorbs most of the water from undigested food. The large intestine has three parts namely,

a) Caecum
b) Colon
c) Rectum

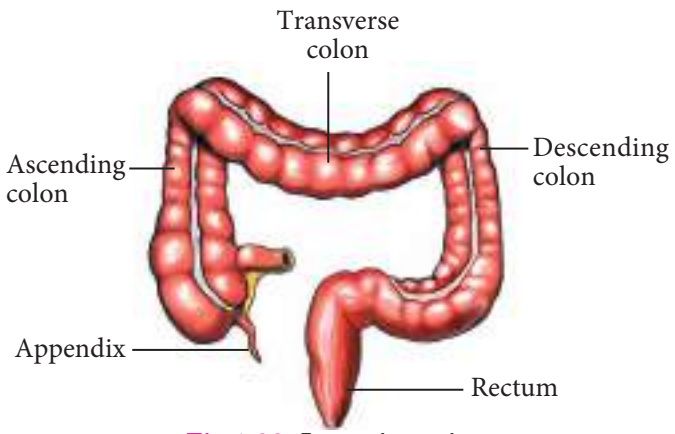


Fig 1.32: ***Large intestine***

Caecum is a small pouch with a blind tube attached to it called *vermiform appendix*. Colon is the longest part of large intestine. The colon absorbs water from the undigested food and converts it into faecal matter (solid waste). Rectum is the last part of the large intestine which stores the undigested food for some-time and then the undigested food is expelled outside as faeces or stool by the opening called *anus*. The act of expelling the faeces is called *egestion* or *defecation*. Normally, the exit of faeces is controlled by the *anal sphincter*.

Let us now describe how energy is released from the food which is absorbed and assimilated in the cells of the body.

1.8 Respiration

Most of the living beings need oxygen to obtain energy from food. This oxygen is obtained from the air. It mixes with food molecules like glucose present in the body cells to release energy slowly. The energy released is stored in the form of *ATP [Adenosine triphosphate]* molecules in the cells. The body uses this energy whenever required.

Generally, there is an understanding of respiration as intake of oxygen and release of carbon dioxide. But, respiration is a multistep, enzyme based biochemical process which breaks the organic compounds present in the body cells at releasing the energy in small packets. Thus, we can define respiration as

'The process of releasing energy from food'

When oxygen burns the food in the body cells, it releases energy and produce carbon dioxide and water as waste products. These waste products are eliminated from the body. Thus, the process of respiration involves

a) Taking in oxygen into the body cells
b) Burning food by using oxygen to release energy
c) Eliminating waste products i.e., carbon dioxide and hydrogen in the form of water from the body.

It can be expressed as,

Food + Oxygen → Carbon dioxide + Water + Energy

Also, respiration is a complex process involving intake of oxygen from atmosphere called *breathing or gaseous exchange.* The breaking down of organic compound to release energy inside the cells is called *cellular respiration*. Thus, respiration involves

a) Breathing (gaseous exchange)
b) Cellular respiration

Since, the process of respiration takes place inside the body cells to release energy, it is called cellular respiration.

Note

Respiration is essential for life because, it provides energy for carrying out all the life processes which are necessary to keep the organisms alive.

Let us now learn about breathing and respiration in detail.

Breathing and Cellular Respiration

Respiration can be divided into two separate processes namely,

a) Breathing
b) Cellular respiration

Breathing is the mechanism by which an organism obtains oxygen from the air and releases carbon dioxide. On the other hand, respiration is more a complex process which involves breathing as well as oxidation of food in the cells to release energy. Thus, we can say that

"Breathing is a physical process whereas respiration is a biochemical processes"

The breathing process involves lungs of an organism whereas the respiration process involves mitochondria in the cells. The main purpose of respiration is to oxidize simple food molecules like glucose to release energy for carrying out biological functions and maintaining the survival of an organism.

Let us now perform an activity to demonstrate that we breathe out carbon dioxide.

Activity – 1.5

Aim

To demonstrate that we breathe out carbon dioxide.

Materials Required

Lime water, test tubes, straw, pichkari

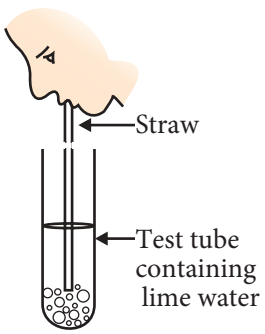
Procedure

- Take some freshly prepared lime water in two test tubes.
- Now place a straw in the test tube marked A in such a way that it touches the bottom of the limewater.
- Similarly, set the apparatus for pichkari by marking the test tube B.
- Then, blow air through the straw in one test tube and pichkari in another test tube.
- Observe the changes in both the test tubes.
- Note how long it takes for lime water to turn milky?

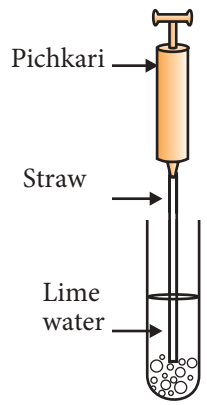
Observation

The lime water in A turns milky immediately whereas the lime water in B takes long time to turn milky.

Diagram



Test tube A



Test tube B

Result

The air we exhale is found to be carbon dioxide.

Conclusion

The lime water is a solution of calcium hydroxide. So, when it combines with carbon dioxide, it results in the formation of calcium carbonate having a white precipitate.

Note

Respiration is opposite of photosynthesis.

Storing of the Energy Released during Respiration

Do you think that all the energy released during respiration is immediately used by an organism? The answer is 'No'. Organisms do not use all the energy released during the process of respiration, but stores it in the form of ATP molecules in the body cells.

We shall now discuss about the terms ATP, ADP and inorganic phosphate.

ADP: ADP is Adenosine Di-Phosphate. These molecules have low energy content and are present inside a cell. ADP contains two phosphate group.

ATP: ATP is Adenosine Tri-Phosphate. These molecules have high energy content. ATP contains three phosphate groups in its molecule. ATP is known as **energy currency** of cells because, the energy stored in ATP is used by the body cells for various purpose like contraction of muscles, synthesis of proteins, conduction of nerve impulses etc.

Inorganic phosphate: Inorganic phosphate is a substance present within a cell which contains a phosphate group made up of phosphorus and oxygen. These are also present inside a cell. It is usually represented as 'P_i' where 'P" stands for phosphorus and 'i' for inorganic.

Let us now discuss how energy is converted into ATP.

Conversion of Energy into ATP

The conversion of energy involves two steps to be stored as ATP.

Step – 1: Conversion of ADP to ATP

The ADP molecule combines with inorganic phosphate P_i by absorbing the energy released during respiration to form ATP. It is represented as

$$\underset{\text{Low energy}}{\text{ADP}} + \underset{\substack{\text{Inorganic}\\\text{Phosphate}}}{P_i} + \underset{\text{(From respiration)}}{\text{Energy}} \longrightarrow \underset{\text{(High energy)}}{\text{ATP}}$$

Step – 2: Conversion of ATP to Energy

When the ATP molecule is broken down using water, the energy is released along with the reformation of ADP. The energy released is equal to 30.5 kJ/ mole. This energy is used to carry out all endothermic reactions taking place in the cells.

It is represented as

$$\underset{\text{High energy}}{\text{ATP}} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Low energy}}{\text{ADP}} + \underset{\substack{\text{Inorganic}\\\text{phosphate}}}{P_i} + \text{Energy}$$

Note

ADP can be converted into ATP by absorbing energy produced during respiration and ATP can be converted back to ADP by releasing energy which can be used again and again by the cells. This ensures that there is a continuous supply of energy to the organism.

1.8.1 Types of Respiration

The process of oxidation of food to release energy can take place either in the presence of oxygen or in the absence of oxygen. Based on this, respiration is classified into two types namely,

a) Aerobic respiration
b) Anaerobic respiration

Brain Box

The oxidation of food to release energy often takes place only in presence of oxygen and the oxidation of food in absence of oxygen is rare.

(a) Aerobic Respiration

In the process of aerobic respiration, the food (glucose) is completely broken down into carbon dioxide and water by oxidation. This results in production of considerable amount of energy which is stored as ATP. The breaking down of food (glucose) can be represented as follows:

$$\underset{\text{(1 molecule)}}{\text{Glucose}} \xrightarrow{\textit{Glycolysis}} \underset{\text{(Pyruvic acid)}}{\text{Pyruvate}} \xrightarrow{\textit{Oxygen (Krebs cycle)}} \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} + \underset{\text{Energy}}{38\text{ATP}}$$

Thus during this process, the respiratory substrates such as glucose are completely broken down into water and carbon dioxide by the process of oxidation.

The energy released during aerobic respiration is used by most of the living organism such as humans, dogs, cats, lions, goat, deer, birds, lizards, snakes, earthworm, frogs and insects and most of the plants.

Thus, we can conclude that all organisms which obtain energy by aerobic respiration cannot live without oxygen. This is because if there is no oxygen, they cannot get energy from the food which they eat. Since, the breakdown of pyruvate giving out carbon dioxide, water and energy takes place in mitochondria, it is said to be the site of aerobic respiration in the cells.

(b) Anaerobic Respiration

During this process of respiration, the micro-organism like yeast breaks down food (glucose) to obtain energy along with ethanol and carbon dioxide. This energy is then used by microorganism. Thus, a less amount of energy which gets stored in the ATP molecules is produced. It can be represented as follows:

$$\underset{(1\,\text{molecule})}{\text{Glucose}} \xrightarrow{Glycolysis} \underset{(\text{Pyruvic acid})}{\text{Pyruvate}} \xrightarrow{Ab.of\ O_2\,(Yeast-Fermentation)} 2\underset{\text{Ethanol}}{C_2H_5OH} + 6\underset{\text{Carbon dioxide}}{CO_2} + 2\underset{\text{Energy}}{ATP}$$

Sometimes, during this process the respiratory substances such as glucose are incompletely broken down to form the end products such as lactic acid and carbon dioxide. In anaerobic respiration, the glucose is initially broken down into pyruvic acid in the cytoplasm by the process of glycolysis. The pyruvic acid is further broken down into ethanol or lactic acid in absence of oxygen by microorganisms like yeast, bacteria etc.

Thus, we can conclude that all the organisms which obtain energy by anaerobic respiration can live without oxygen. This is because, these organisms can obtain energy by the process of anaerobic respiration. The whole process of anaerobic respiration takes place in the cytoplasm.

We know that human beings obtain energy by aerobic respiration. But do you know that anaerobic respiration takes place in our muscles sometimes.

Let us see how anaerobic respiration takes place in human beings.

Anaerobic Respiration in Human Beings

The anaerobic respiration takes place in our muscles during vigorous physical exercise. During this respiration, the glucose (food) is converted to lactic acid with the release of a small amount of energy. The sudden accumulation of lactic acid in our muscles during vigorous exercise or physical activity can cause *muscular cramps*. This is because during heavy physical activity such as running for long time or heavy exercises, we require more energy. To obtain this extra energy, the glucose is broken down partially by anaerobic respiration with the release of lactic acid. The lactic acid gets stored in the muscles. The accumulation of lactic acid in the muscles causes muscle cramps.

Fig 1.33a: ***Vigorous physical exercise***

Fig 1.33b: ***Muscular cramps***

Note

The painful contractions of muscles are called cramps.

We can get relief from the muscle cramps by taking a hot water bath or massage. This is because, the hot water bath or massage improves circulation of blood in the muscles which increases the supply of oxygen to the muscles. The oxygen breaks down the lactic acid accumulated in the muscles into carbon dioxide and water. Hence, we get relief from muscle cramps.

Anaerobic respiration also takes place in the muscles of animals like tiger, cheetah, lion, deer, puma etc. When these animals run very fast, they require more energy than normal. Thus, it is possible for these animals to get leg cramps due to the accumulation of lactic acid in leg muscles.

Fig 1.34: ***Cheetah chasing a deer***

Now, can you differentiate the aerobic and anaerobic respiration?

Differences between Aerobic and Anaerobic Respiration

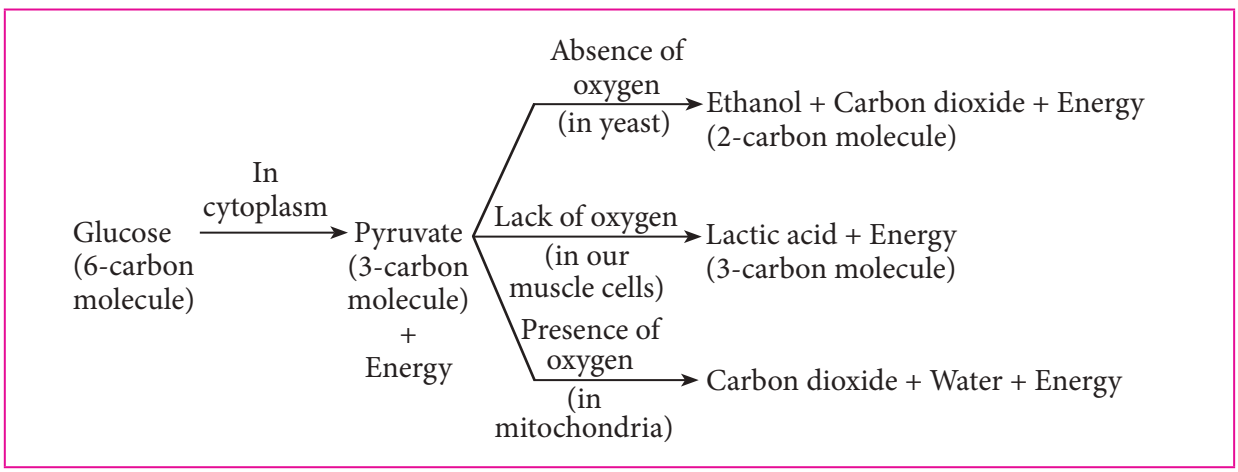
Characteristics	Aerobic Respiration	Anaerobic Respiration
Oxygen	It takes place in presence of oxygen.	It takes place in absence of oxygen.
Respiratory Substances	The respiratory substances are completely broken down.	The respiratory substrates are incompletely broken down.
Occurrence	It is common method of respiration.	It occurs in few organisms only.
Cell organelle	It takes place in cytoplasm as well as in mitochondria.	It takes place only in cytoplasm.
Energy	Considerable amount of energy is released.	Very small, less amount of energy is released.

Thus, we can conclude that

a) Anaerobic respiration in plants like yeast produces ethanol and carbon dioxide as end products.

b) Anaerobic respiration in animal muscle tissue produces lactic acid as end product.

We can schematically represent the breakdown of glucose by various pathways as follows:



Fermentation

It is an anaerobic process of breaking down of carbohydrates by micro-organism to produce alcohol, organic acids and other products along with heat and waste gases.

We shall explain an activity to demonstrate the process of fermentation.

Activity – 1.6
Aim
To demonstrate the process of fermentation.
Materials Required
Fruit juice or sugar solution, test tube, one-holed cork, glass tube

Procedure
◆ Take some fruit juice or sugar solution in a test tube. ◆ Add some yeast to the test tube. ◆ Now, this test tube is fitted with a one-holed cork. ◆ Fit a glass tube to the cork and dip the free end of the glass tube into a test tube containing freshly prepared lime water. ◆ Observe the change in lime water.
Observation
The lime water turns milky.
Result
The process of fermentation takes place due to carbon dioxide.
Conclusion
This shows that carbon dioxide is liberated from the mixture of sugar solution and yeast. The fermentation of sugar results in the production of ethanol and carbon dioxide.

Fermentation is used in many industries as follows:

Uses of Fermentation

- a. Brewing industry to produce whisky, beer, wine etc.
- b. Baking industry to make bread, cakes etc.
- c. Cleaning of hides and separating of retting of fibres like jute, hemp etc.
- d. In the production of curd and yoghurt.
- e. Softening and aromatization of tobacco, tea etc.
- f. Synthesis of vinegar, lactic acid, citric acid etc.

1.8.2 Respiration in Plants

We know that plants also use oxygen (air) for respiration and release carbon dioxide. Since, respiration in plants involve oxygen and carbon dioxide, these are called *respiratory gases*.

Let us now discuss how plants obtain oxygen in detail.

Plants obtain Oxygen by Diffusion

We know that plants have a branching shape and so have a large surface area and hence the process of diffusion is possible to supply oxygen to the cells required by the plants for respiration. The process of diffusion occurs in all main parts of the plant such as roots, stems and the leaves and plants obtain oxygen.

Let us discuss how respiration takes place in roots, stems and leaves.

Respiration in Roots

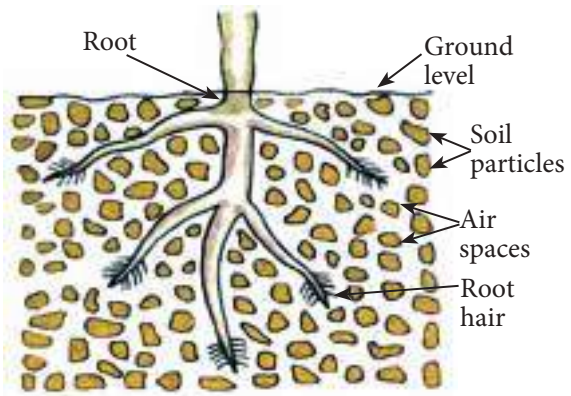


Fig 1.35: ***Respiration in roots***

Air is found in the spaces between the soil particles. We know that roots possess root hairs. The root hairs are the extension of epidermal cells of a root. The root hairs

are always in contact with air in the soil. So, the oxygen from air enters the root hair by the process of diffusion and reaches all other cells of root. The carbon dioxide produced in the cells of the roots during respiration moves out through the same hairs by the process of *diffusion*.

Now you will know why the land plants die if their roots remain water logged for a considerable period of time. This is because when you water the plants in excess, all the air present in between soil particles expel. Due to this, oxygen will not be available to the roots for aerobic respiration. This makes plants to respire anaerobically and results in the production of alcohol. This kills the plant.

Let us see how respiration takes place in stems.

Respiration in Stems

You would have observed that there are soft, hard and woody stems in a plant. The soft stems are present in small plants, i.e herbaceous plants, whereas the hard and woody stems are present in large trees. Though, both are plants, the process of respiration in them are different. The stems of herbaceous plants have stomata in them. Hence, the process of exchange of respiratory gases i.e., carbon dioxide and oxygen takes place through *stomata* and reaches all the cells for respiration. The carbon dioxide liberated during respiration diffuses out into the air through the same stomata.

***Fig 1.36:* Respiration in stems through stomata**

But the hard and woody plants do not have stomata, instead they possess *lenticels*. These are small area of bark where the cells are loosely packed for the exchange of respiratory gases to take place. The oxygen from air diffuses into the stem through lenticels and reaches all the cells of the stem for respiration and the carbon dioxide produced in the cells of the stem diffuses out into the air through the same lenticels.

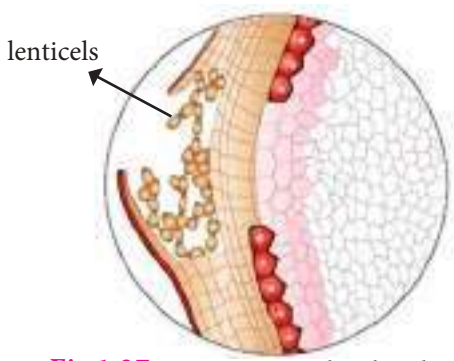


***Fig 1.37:* Respiration in hard and woody plants taking place through lenticels**

We shall now discuss how respiration takes place in leaves.

Respiration in Leaves

We know that there is no special means of transport of gases and hence, the exchange of respiratory gases i.e., carbon-dioxide and oxygen in the leaves takes place by the process of diffusion.

Let us now see how exchange of gases takes place.

The leaves of a plant have tiny pores called *stomata* and the exchange of respiratory gases takes place by the process of *diffusion* through the stomata. The oxygen from air diffuses into the leaf through stomata and reaches all the cells of leaf for respiration and the carbon dioxide produced in the cells of the leaf diffuses out into the air through the same stomata.

Note

Photosynthesis takes place only during the daytime.

Now a question arises whether stomata will be open throughout the day. The answer is that the process of photosynthesis occurs only during the day and so, oxygen is produced and carbon dioxide is used. The leaves use some of this oxygen for the process of respiration and the remaining oxygen is diffused into air. This process takes up even more carbon dioxide from air. Thus, during day oxygen diffuses out and carbon dioxide diffuses in.

The process of photosynthesis does not occur during night and hence, oxygen is not produced. So, the oxygen from air diffuses into leaves to carry-out the process of respiration and the carbon dioxide produced diffuses out into the air. Thus, during night oxygen diffuses in and carbon dioxide diffuses out.

1.8.3 Respiration in Animals

There are different methods of respiration in animals. Each animal has its own mode of respiration. Usually all animals take up oxygen from air and release carbon-dioxide. The land animals use oxygen for both breathing and respiration. Thus, the land animals have more advantage to obtain oxygen as it is surrounded by an oxygen rich atmosphere from where it can obtain required amount of oxygen.

The organism which lives on land i.e., terrestrial organisms have specialized organ to absorb oxygen directly from the air. Oxygen from air entering skin or lungs is absorbed by the blood and gets transported to various tissues of the animal. The blood carries carbon-dioxide from tissues and brings it to skin or lungs to throw it out into the atmosphere.

The organisms which lives in water i.e., aquatic organisms absorb the dissolved oxygen either directly through *skin* or through *gills*. Since the amount of dissolved oxygen in water is low as compared to the amount of oxygen in air, the rate of breathing is faster.

Human beings or terrestrial organisms absorb oxygen by *lungs* or *skin*. Insects absorb oxygen through the tiny holes called *spiracles* on their body or by the air tubes called *tracheae*. In Amoeba, the gaseous exchange takes place through the thin cell membrane by the process of diffusion. We know that, Amoeba is an aquatic animal and so, the oxygen from water diffuses into the body of Amoeba through its *cell membrane*. Since Amoeba is smaller in size, the oxygen diffused into the body spreads quickly into the whole body of Amoeba.

The skin of the earthworm is thin and moist. Hence, it absorbs the oxygen needed for respiration through its *moist skin*. The carbon dioxide released is carried back by the blood to expel from the body of the earthworm through its skin. Thus, the respiratory surface of an earthworm is its moist skin. The processes of respiration in leeches are similar to earthworms.

Fig 1.38: ***Earthworm - moist skin***

In fishes, the gaseous exchange in fishes takes place through gills. This process is also called *bronchial respiration*. The gills are the special organs of respiration in fish present either side of its head. These gills are covered by gill covers and so are not visible for our eyes.

The same process of respiration can be seen in prawns, mussels etc.

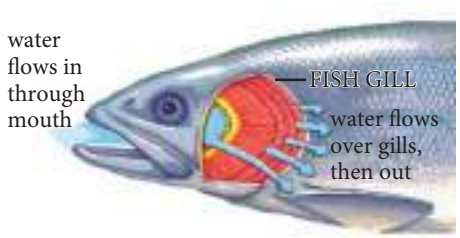


Fig 1.39a: ***Respiration in Fish***

Fig 1.39b: ***Prawns***

Fig 1.39c: ***Mussels***

1.8.4 Respiration in Human Beings

The respiration takes place through lungs in humans. A lung has numerous alveoli. Each wall of the alveoli has blood capillaries. During the mechanism of breathing, oxygen diffuses into the blood and carbon dioxide passes out of lungs. This process of respiration is called *pulmonary respiration*.

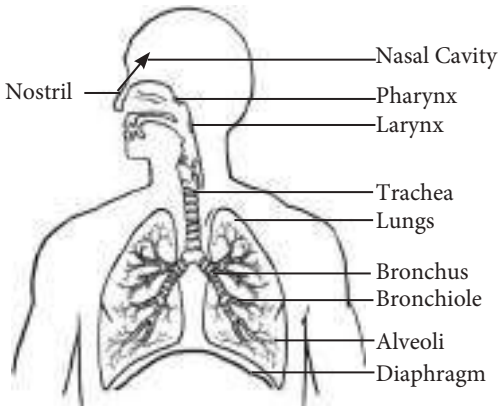


Fig 1.40: ***Human Respiratory System***

Organs Involved in Respiration

The main organs of human respiratory system include nose, nasal passage or nasal cavity, trachea, bronchi, lungs and diaphragm.

Nose

It has two holes in it called *nostrils*. It is situated at the lower end of the nose.

Nasal Cavity

The air enters through the nostrils and reaches into a pair of nasal cavities. The nasal passages found behind the nostrils. The nasal cavities are separated from the oral cavity by a hard, bony palate. The two nasal cavities are lined with fine hair and *mucus*. There are a pseudostratified epithelium cells which secretes mucus. Mucus contains lysozyme and antimicrobial agents for killing the microbes.

When the air passes through the nasal cavity, the dust particles and other impurities present in it are trapped by the hair and mucus and the clean air enters the lungs. The nasal passage is also lined with olfactory cells and hence acts as an organ of smell. The nasal chambers open into pharynx. Thus, the air enters into pharynx.

Pharynx

It is a short, vertical tube located at the back of the buccal cavity. It is a common passage for both the respiratory and digestive systems. The air from pharynx enters into trachea or wind pipe through a slit–like aperture called *glottis*. The glottis remains open except during swallowing. The glottis has a leaf–like cartilaginous flap called *epiglottis*. The epiglottis closes the glottis to check the entry of food. Now the air reaches the trachea.

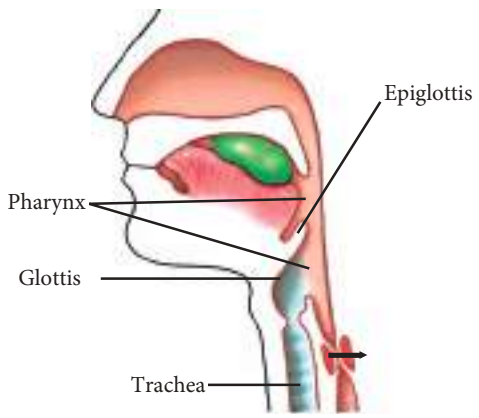


Fig 1.41: ***Air passing from Pharynx to Trachea***

Trachea or Wind Pipe

It is a thin-walled tube which extends through the neck and divides into two branches called *bronchi*. These two branches further, divide and re-divide. These bears C- shaped cartilaginous rings for support. The bronchi divide further to produce very fine tubes called *bronchioles*. Bronchioles do not have *cartilaginous rings*. These bronchioles further give rise to *alveolar sacs* or *alveoli*. The bronchi and their branches resembles bunch of grapes. The alveoli are thin walled and are surrounded by a network of blood capillaries. The large surface area fulfils the exchange of gases. Thus, the actual site of gaseous exchange is the alveoli. Actually, the pigment *Haemoglobin (Hb)* present in the red blood corpuscles (RBC's) of blood adds an efficient supply of oxygen to all the cells of the body.

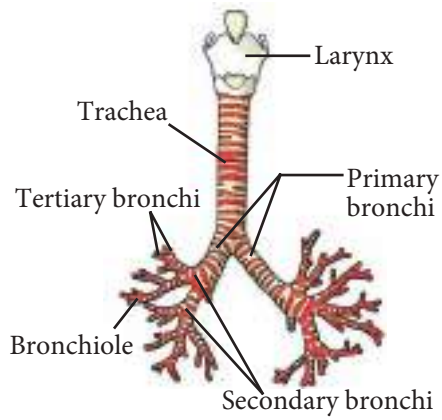


Fig 1.42: ***The picture showing wind pipe (Trachea)***

Note

Haemoglobin (Hb) is a very important respiratory pigment present in blood.

Lungs

The lungs are a pair of pinkish to greyish, conical, spongy respiratory organs. They are located in the thoracic cavity one on each side of the heart. Each lung is covered by two thin membranes called *pleura*. In between these two membranes there is a thin fluid filled space called *pleural sac*. Within the lungs, the bronchi further divides into two bronchi which further divides into smaller bronchioles. The right lung is three lobed and larger whereas the left lung is two lobed and smaller. Thus, we can conclude that thoracic cavity is air tight and the pleural sacs of the lungs are in contact with its inner lining.

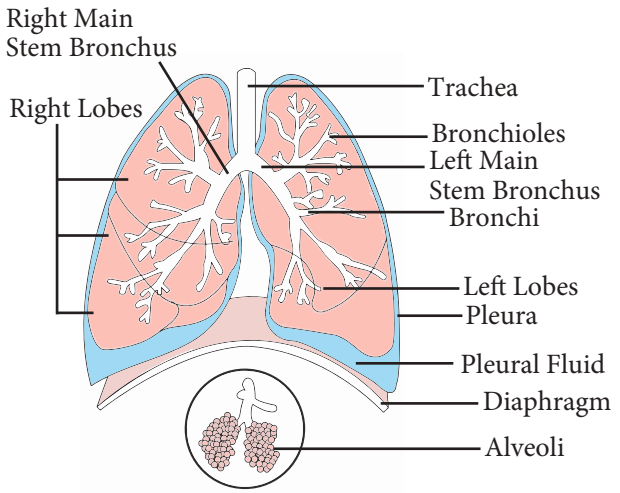


Fig 1.43: ***Lungs***

We discussed the breathing in human beings taking place in lungs. Now we will discuss how mechanism of breathing takes place in detail.

1.8.5 Mechanism of Breathing

The process of taking air, rich in oxygen, inside the body of an organism and leaving the air, rich in carbon dioxide, from the body is known as *breathing*. The process of breathing involves the movement of the ribcage and diaphragm.

We know that breathing is a continuous process which goes on throughout our life. When we breathe in air, the oxygen in the atmosphere is taken in and used by our body and when we breathe out the carbon dioxide is removed as a waste product.

The process of taking in oxygen into our body during breathing is called *inhalation*. The process of expelling carbon dioxide out from our body is called *exhalation*. Thus, both exhalation and inhalation takes place regularly.

We shall discuss how these two processes take place in the human body.

a) Inhalation

When we breathe in oxygen, the muscles between the *ribs contract* and the *rib cage* move *upwards* and *outwards*. When the diaphragm contracts, it moves downward in order to increase the space volume of the chest cavity and make it larger. Thus, when the chest cavity increases in size, it takes in air from outside into the lungs. The lungs get filled up with air and expand.

b) Exhalation

When we breathe out carbon dioxide, the muscles between the *ribs relax* and the *rib cage* move *downwards* and *inwards*. When the diaphragm relaxes, it moves upward in order to decrease the volume of the chest cavity and make it smaller. Thus, when the chest cavity decreases in size it pushes the air from the lungs to outside.

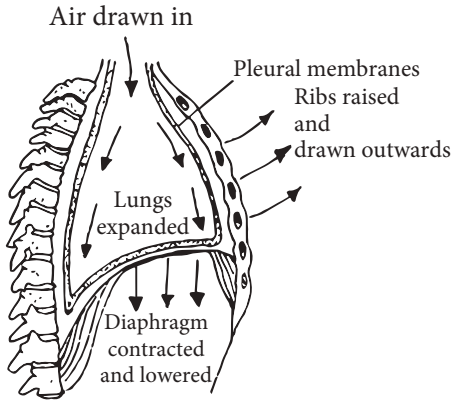


Fig 1.44: ***The diagram showing the process of inhalation***

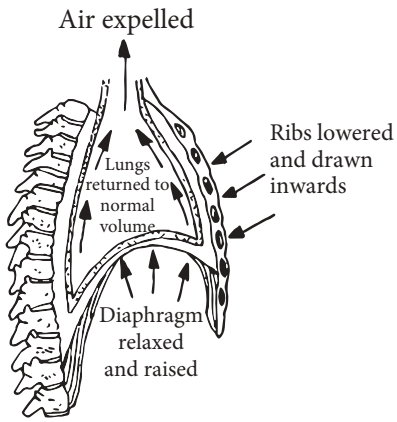


Fig 1.45: ***The diagram showing the process of exhalation***

Rate of Breathing

During breathing, the oxygen is pumped into our body and carbon dioxide is expelled outside. Though, breathing takes place on its own (involuntarily), the rate of breathing is controlled by the *respiratory centre* of the brain. The average breathing rate in an adult man at rest is about *15 – 18 times per minute*. But this rate increases with increase in physical activity. This is because, when we do some physical exercise, our body needs more energy. In order to produce more energy through respiration, our body requires more oxygen. Rapid breathing produces more oxygen to body cells which in turn produces more energy for doing physical

exercise. Thus, we breathe faster after physical exercise in order to produce more energy to compensate with the loss of energy by the body during exercise.

We have studied earlier that oxygen is required for both breathing and respiration. This oxygen is carried by the Haemoglobin (Hb) present in our blood. The normal range of Haemoglobin (Hb) in the blood of a healthy adult person is *12 – 18 g/dl*. The deficiency of Haemoglobin (Hb) in a blood of a person results in breathing problems, tiredness etc.

You would have heard that deep sea divers carry oxygen gas cylinders when they go under the sea. This is because water does not have free oxygen for us to breathe and we do not have gills to use the dissolved oxygen in water as fishes do.

Fig 1.46: ***Deep sea diver carries an oxygen cylinder***

You would also have heard about carbon monoxide poisoning. Carbon monoxide is formed when a fuel is burnt in an insufficient supply of air. We can observe this, when petrol burns in a car engine to release lot of carbon monoxide. We studied that Haemoglobin (Hb) present in our blood carries oxygen to all parts of our body. Haemoglobin (Hb) has more affinity for carbon monoxide than oxygen. Thus, when carbon monoxide gas is inhaled by a person, it binds with Haemoglobin (Hb) very strongly and prevents Haemoglobin (Hb) from carrying oxygen to the brain and other parts of the body. Thus, a person becomes unconscious and even dies due to the absence of oxygen.

Brain Box

You would have seen in hospitals where a patient having serious breathing or respiratory problems is put on 'ventilator'. It is a tube inserted directly into trachea of the patient to help him to breathe freely.

1.9 Transportation

We know that the body of an organism is made up of cells. All these cells require oxygen, water, minerals and organic food for their survival and maintenance and also to carry out their vital activities. Some of the essential substances have to be absorbed from the atmosphere at specific site while substances are prepared at one specific site. Let us discuss these points in detail with two examples.

Example – 1: Plants absorb water, minerals etc., from the soil through root hairs. This water helps plants to prepare food in leaves.

Example – 2: The animals take the digested food from the alimentary canal and supplies to all the living cells of the body by the mechanism of transportation.

Thus, we can define transportation as,

'The life process in which a substance produced or absorbed in one part of the organism is carried to other part of its body'.

This shows that an arrangement is required for an organism to carry the substance to all parts of its body. Especially, large organisms require transport system in their bodies to supply their cells with oxygen, water, food etc. Thus, these organisms require special tissues to take food, water, oxygen and other materials from one part of their body and carry it to the other part which requires them.

We shall now study how plants and animals transport the essential substances from one part of their body to another.

1.9.1 Transportation in Plants

We know that the essential substances required by the plant cells are carbon dioxide, water, oxygen and minerals. These are supplied from outside. The other substances required by all living cells are the food and hormones which are synthesized by the plant itself. Thus, the process of transportation is less elaborated in plants as compared to that in animals. Hence, it is obvious that the plants need to transport the food prepared in the leaves to be distributed to all other parts of the plants.