Life Processes

Modes of Nutrition

We know that all living organisms require food to survive. You may wonder what is there in food which helps in the survival of organisms? Well, the answer is nutrients. Organisms consume nutrients, which enable them to carry out various body functions.

The process by which an organism consumes food is called **nutrition**, which are then utilized by the body for various functions.

Autotrophic Nutrition: The term 'autotroph' is derived from the Greek word '*Auto'* meaning self and '*trophos'* meaning nutrition.

In this mode of nutrition, organisms prepare or synthesize their own food with the help of inorganic raw materials in the presence of sunlight. These organisms are known as **autotrophs**. All green plants and some bacteria are autotrophs.

Heterotrophic Nutrition: The term 'heterotroph' is derived from the Greek words '*Heteros'* meaning different or other, and '*trophos'* meaning nutrition.

In this mode of nutrition, organisms obtain energy from the intake of complex organic substances, generally from plant and animal sources. These organisms are known as **heterotrophs**. All fungi and animals and some bacteria are heterotrophs.

Let us study about various types of heterotrophs.

Herbivores: These are the animals that feed directly on plants. For example, cow, goat, rabbit etc.

Carnivores: The animals that feed on herbivores are known as carnivores. For example, tiger, lion etc.

Omnivores: This includes the animals which eat both plants and animals. For example, humans etc.

Saprophytes: These are the organisms that feed on dead and decayed organic matter. For example, bacteria, mushroom etc.

Parasites: These are the organisms that live inside or on the body of other living organisms called the Host and obtain food from them. For example, *Cuscuta* plant that obtains food from green plants, *Ascaris* that lives in the intestine of humans etc.

Insectivorous plants: Some plants live in the areas where the soil is deficient in nitrogen. These plants trap insects and obtain nitrogen from them. These plants are called as insectivorous plants

Summary of differences between autotrophs and heterotrophs

Autotrophs	Heterotrophs
They obtain energy by preparing food from inorganic substances such as CO2 and water in the presence of sunlight.	They obtain energy from complex organic substances by consuming plants or other animals.
These organisms are called producers as they manufacture their own food.	These organisms utilize the food manufactured by producers. Hence, they are called consumers.
Green plants, algae are autotrophs.	Animals and fungi are heterotrophs.
Do You Know? Plants do not always have an autotrophic mode of nutrition. They can be parasitic, carnivorous, or saprophytic. Rafflesia is a root parasite. It draws water and minerals from the roots of other plants. Cats are purely obligate carnivores. They cannot digest fruits, vegetables, pulses, grains etc. They need a high level of protein in their diet. They lack an efficient system for digesting plant products. A cat's digestive system is specialized to suit a carnivorous eating habit.	

Autotrophic Nutrition in Plants

We know that all living organisms consume some form of nutrients to sustain life. Animals consume plants or other animals. Plants consume carbon dioxide and water from the environment to produce food.

Therefore, the process of taking in a source of energy (food) from outside the body of an organism to inside is known as **nutrition**.

Do you know what mode of nutrition is carried out in plants? Plants have an **autotrophic** mode of nutrition. The term 'autotrophic' is derived from the Greek word '*Auto'* meaning self and '*troph'* meaning nutrition.

In this mode of nutrition, plants prepare or synthesize their own food with the help of inorganic raw materials. Thus, they are known as **autotrophs.**

Let us explore how plants prepare their own food.

Photosynthesis

Energy is essential for all life processes. All living organisms require nutrition. What is the ultimate source of nutrition on Earth?

The **sun** is the ultimate source of energy on Earth. Energy from the sun is captured by plants and converted into usable form. Thus, the origin of all foods is the food prepared by plants. This food is also consumed by animals.

Autotrophs such as green plants and some bacteria prepare or synthesize their own food. They are capable of trapping solar energy with the help of a green pigment called **chlorophyll**. This trapped solar energy is then converted into chemical energy of food using CO_2 and H_2O.

Photosynthesis is the process by which chlorophyll-containing cells present in leaves synthesize food in the form of carbohydrates by using carbon dioxide, water and sunlight.

Therefore, the raw materials required for photosynthesis are CO_2 and H_2O and the products formed are carbohydrates and O_2.

Hence, the process can be represented as:

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

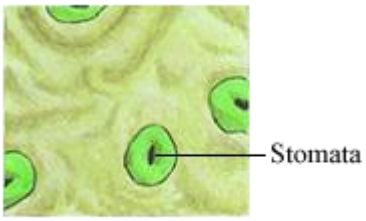
How are raw materials consumed by plants?

The raw materials required for photosynthesis are CO_2 and H_2O and the products formed are carbohydrates and O_2.

Entry of raw materials

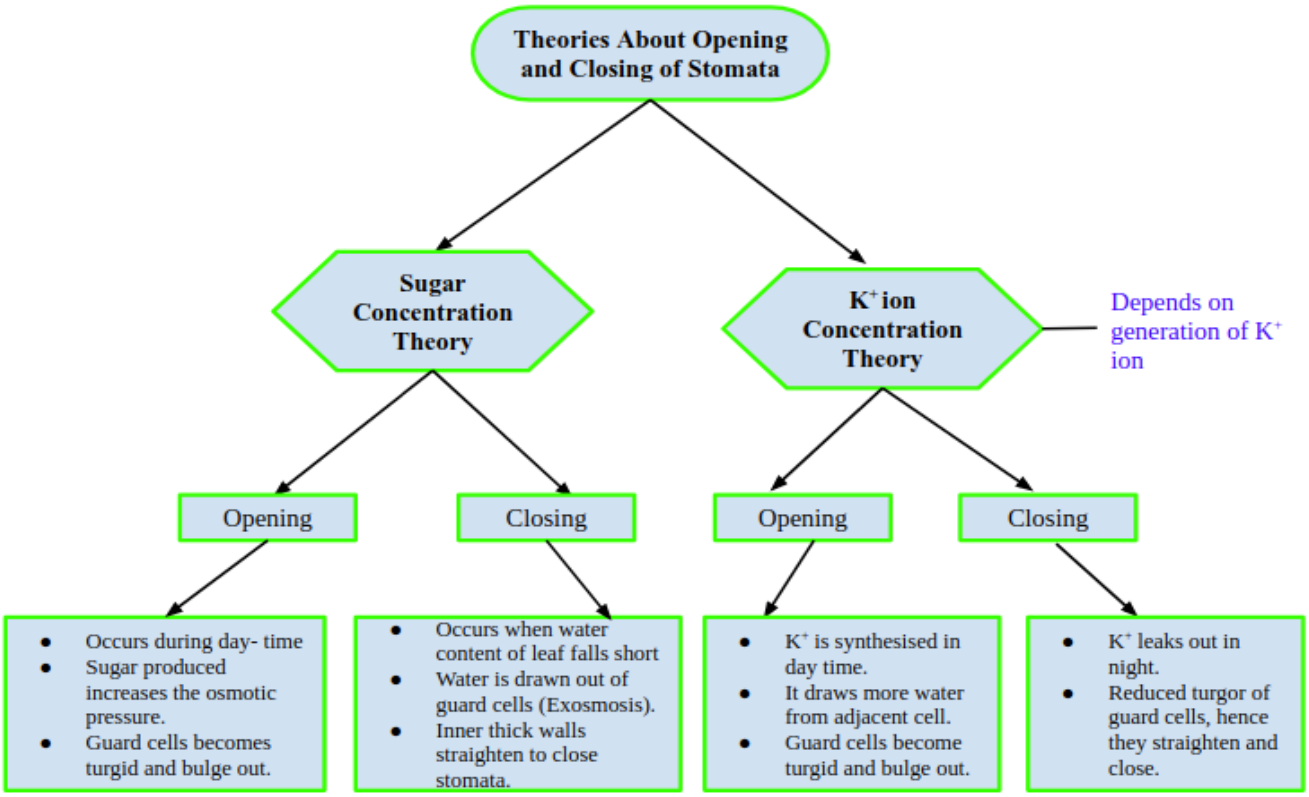
- Plants obtain water through their roots. Water is then transported to all plant parts with the help of the **xylem**.
- Exchange of gases (entry of CO_2 and release of O_2) occurs through the stomata.

Stomata are tiny pores present mainly on the surface of leaves. They are also present on the surface of young stems and roots.



Stomata consist of a stomatal opening or stoma, which is surrounded by two distinct epidermal cells known as **guard cells**. The opposing inner walls of the guard cells are thick and inelastic. The remaining walls are thin and elastic.

Theories behind Stomatal Opening and Closing



Two phases of photosynthesis

The process of photosynthesis occurs in two phases – **Photochemical Phase** and **Biosynthetic Phase**.

Photochemical Phase - A series of chemical reactions take place in the presence of light, as light behaves as catalyst is called as photochemical phase. The light reactions take place in **thylakoids** of the chloroplasts.
Light reactions – As the name suggests, this reaction takes place in the presence of

light. Light energy is absorbed by chlorophyll molecules and is utilized for splitting water molecules into hydrogen and oxygen. Additionally in this phase, assimilatory power in the form of ATP and $NADPH_2$ are produced.

Light reactions occur in the membranes of thylakoids.

Events occurring during light reactions:

- Absorption of light energy by chlorophyll molecules
- Splitting of water molecules into hydrogen and oxygen atoms
- Formation of ATP and $NADPH_2$

Reactions involved in Photolysis:-

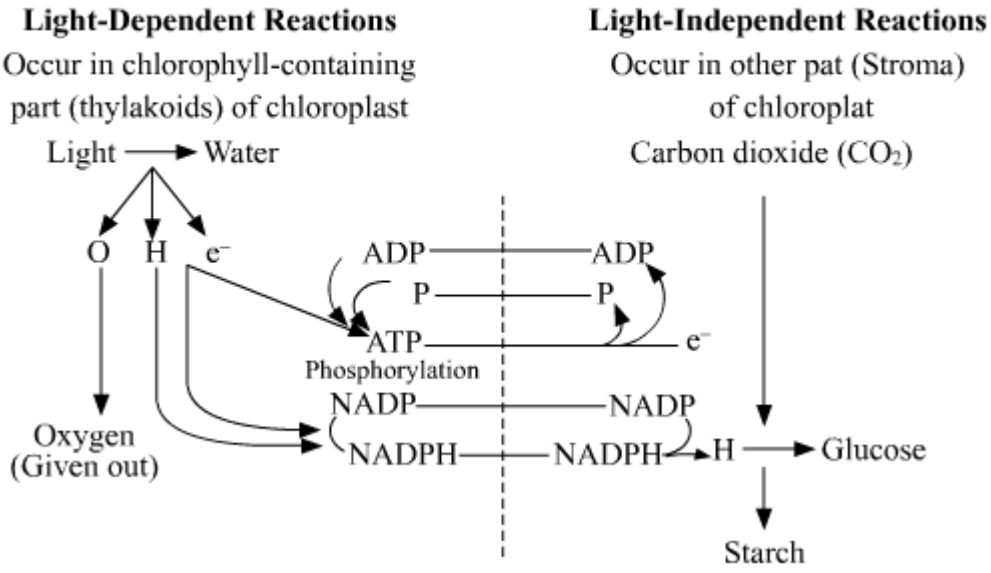
(i) $NADP^+ + e^- + H^+ \xrightarrow{\text{Enzyme}} NADPH$
(ii) $2O \rightarrow O_2$
(iii) $ADP + Phosphate \rightarrow ATP$ (Phosphorylation)

Biosynthetic Phase - It includes the reactions that are not dependent on light (but may happen during day time as well). It results in synthesis of carbohydrates, or 'food', using the energy produced through light reactions.
Dark reactions – This reaction does not require direct light and occurs in the stroma of chloroplasts. During this phase, ATP and $NADPH_2$ (formed during light reactions) are utilized for the reduction of CO_2 to carbohydrates (food).

Event occurring during dark reaction:

Reduction of CO_2 to form carbohydrates
Transformation of glucose molecules to 1 mole of Starch is called **polymerisation.**

Highly Simplified Summary of The Events in Light Reaction And Light-Independent Reaction of Photosysthesis



Some interesting facts:

- Do you know that the total amount of O_2 produced by an acre of trees per year is equal to the amount consumed by around 18 people annually!
- One tree produces nearly 260 pounds of O_2 annually.
- Hydrogen is a clean fuel. Some green algae such as *Chlamydomonas reinhardtii* are being cultured to convert water into O_2 and H_2. This mass production of hydrogen could prove to be beneficial, but is still under research.

End Results of Products Of Photosynthesis

- **Glucose:** Simple glucose is utilised by plants in the following ways:
- For consumption by plant cells
- For storage as insoluble starch
- For conversion into sucrose
- For synthesis of fats, proteins, etc
- **Water:** It can be re-utilised in the continuance of photosynthesis.
- **Oxygen:** Some of it is used in respiration of leaves and rest diffuses out.

Global warming

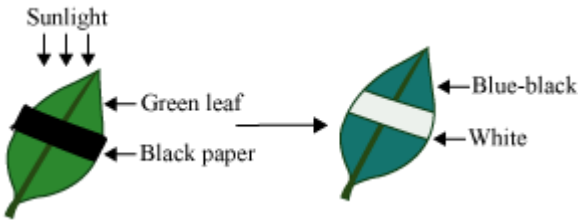
Do you know that global warming can be reduced by growing more plants?

Green plants, as we know, utilize CO_2 and water to produce food and in the process, release O_2 gas. Thus, green plants help in reducing the amount of CO_2 in the atmosphere. CO_2 is a green house gas, which is one of the reasons for global warming.

Experiments Related to Photosynthesis

We know that raw materials are utilized by plants to prepare food. **Do plants prepare food at all times? Are there any essential conditions required for photosynthesis?**

1. **Sunlight is essential for photosynthesis**



Place a healthy green potted plant in a dark room for 1-2 days. This is done to ensure that the plant consumes all its reserve food and the leaves do not contain any starch. Then, cover a portion of a leaf of this plant on both sides with two uniform pieces of black paper, fixed in position with two paper clips.

Now, expose this plant to bright light. After a few hours, remove the leaf, decolourize it with alcohol, and test the presence of food (starch) with iodine solution.

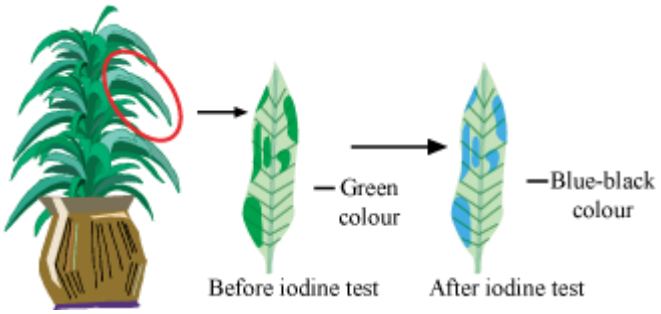
You will observe that the portion of the leaf covered with black paper does not show any presence of starch (food).

Explanation of the activity:

The food prepared by plants (carbohydrates) through the process of photosynthesis is stored as starch. This starch reacts with the iodine solution to change to blue-black colour. Only those portions of the leaf that were exposed to sunlight could photosynthesise and hence, change to blue-black colour when tested with iodine.

2. Chlorophyll is essential for photosynthesis

Place a variegated plant (i.e., a plant which has both green and non-green areas, for e.g., croton or money plant) in a dark room for 2 – 3 days. This is done to ensure that all the reserve food (starch) is utilized.



Place this plant in sunlight for six hours to allow photosynthesis to take place.

Then, pluck a leaf from this plant and trace the green areas on a sheet of paper.

Now, decolourize the leaf using alcohol and dip it in a dilute solution of iodine for a few minutes. Wash this leaf with water and compare it with the tracings of the leaf done earlier.

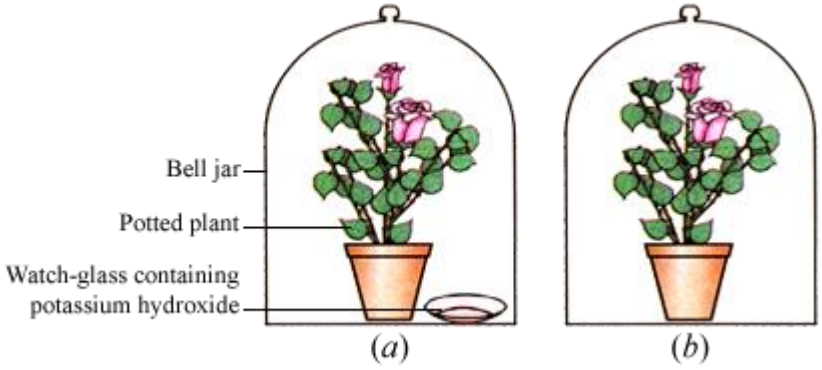
It will be observed that only the green areas of the leaf could photosynthesize.

Explanation:

The leaf is treated with alcohol so that it loses its green colour (chlorophyll pigment) and blue-black colour (in presence of starch) obtained after treatment with iodine.

The green parts of a variegated leaf contain chlorophyll. Therefore, only these parts could photosynthesize and manufacture food. Thus, the change in colour was observed only in these parts.

3. CO_2 is essential for photosynthesis



Select two healthy potted plants of nearly the same size and label them as **A** and **B.** Place them in a dark room for 2-3 days. Then, place two glass plates under both the plants. Place a watch-glass containing potassium hydroxide besides pot **A**.

Cover both the plants by inverting separate bell jars over them. Potassium hydroxide, as we know, is used to absorb CO_2. Therefore, CO_2 is not available for plant **A**.

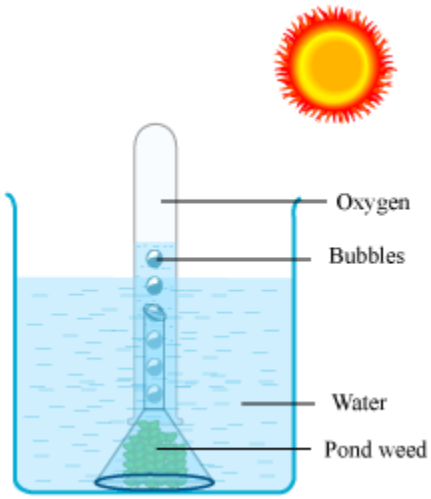
Now, seal the bottom of the jars to the glass plates with the help of Vaseline. This prevents the entry of CO_2 into the set up. Then, place the plants under sunlight for 2 – 3 hours. Test one leaf each from both plants for the presence of starch, using alcohol and iodine (as explained in the previous activity). It will be observed that plant **B** has a higher amount of starch as compared to plant **A**.

Explanation of the activity:

This happens because potassium hydroxide present besides plant **A** absorbs all the CO_2. Therefore, plant **A** is not able to photosynthesize and manufacture food. Hence, the amount of starch present in plant **B** is higher than plant **A**.

Photosynthesis in a laboratory

Place an aquatic plant (hydrilla) in a beaker filled with water. Cover the plant with a transparent funnel. Then, invert a test tube over the open end of the funnel.



While inverting the test tube, make sure it does not contain any air bubbles. Place this apparatus in sunlight and observe the changes.

It will be observed that after sometime, air bubbles (O_2) emerge in the test tube.

Human Alimentary Canal

We eat food daily, but have you ever wondered what happens to food once it enters our body? What organs form the digestive system and how is the process of digestion carried out?

Human digestive system consists of two components: alimentary canal (that include mouth, oesophagus, stomach, small intestine and large intestine), and digestive glands (that include salivary glands, liver and pancreas).

Let us explore this in detail by studying the various organs of the digestive system and the roles they play in digestion.

The Mouth

In holozoic nutrition, food is taken inside the body through mouth. This process is known as **ingestion**. Inside the mouth, teeth, tongue and salivary glands are present. Each of them play significant role in the digestion of food.

Teeth

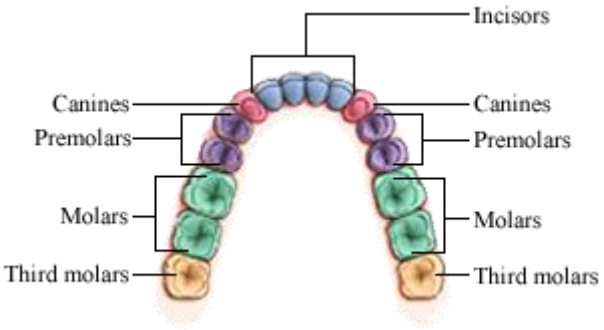
The mouth or the buccal cavity has teeth, which mechanically break down the food into smaller pieces. Teeth are rooted in separate sockets in the gums.

Do you think we have teeth from birth?

No. Babies do not have teeth. Humans grow with two sets of teeth. The first set of teeth begins to grow during infancy. This set of teeth is called **milk teeth.** These fall off between the ages of six and eight. The second set of teeth, which replaces the milk teeth, is called the **permanent teeth.** This set lasts throughout our life, unless it falls off during old age.

Look in a mirror and count your teeth. How many types of teeth do you have? Eat different food items to find out which type of teeth is being used to eat, bite, and chew these food items. Count each type. You can compare the number of teeth present in your mouth with the number of teeth others have.

If you look in a mirror, you will observe that all teeth are not similar. Have you wondered why? This dissimilarity arises from the fact that each tooth performs a different function. Let us understand the positions and functions of each type of tooth.



1. **Incisors** are the teeth present at the front portion of the mouth. There are four incisors in each jaw. They are used for biting and cutting food.

2. **Canines** are located next to the incisors. There are two canines in each jaw. They are used for tearing and piercing food.

3. **Premolars** lie next to the canines. There are four premolars in each jaw. They are used for chewing and grinding food.

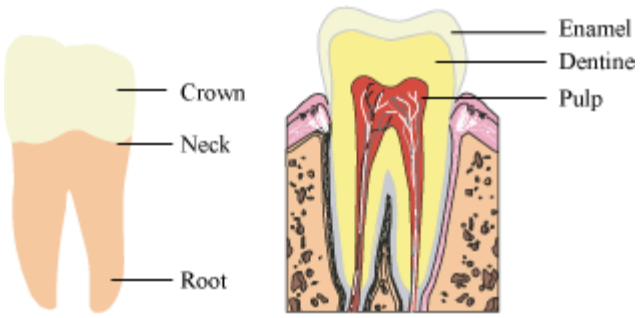
4. **Molars** lie next to the premolars at the end of the jaw. There are six molars in each jaw. They are also used for chewing and grinding food.

- In herbivores, canine teeth are absent and the incisors are sharp to cut the grass.
- In carnivores the incisors are strong and pointed while canines are enlarged.
- In omnivores, all four kinds of teeth are well developed.

Dental Formula

- **Dental formula for milk teeth** in humans is 2120/2120. It means that each half of upper jaw and lower jaw has 2 incisors, 1 canine and 2 premolars. Molars are absent in milk teeth. There are 20 teeth in the milk teeth set.
- **Dental formula for permanent teeth** in human is $\frac{2123}{2123}$. It means that each half of upper jaw and lower jaw has 2 incisors, 1 canine, 2 premolars, and 3 molars.
- **The dental formula in dogs (carnivore) is** $\frac{3142}{3143}$
- **The dental formula in rabbits (herbivore) is** $\frac{2033}{1023}$

Structure of Tooth



Structure of the tooth

The vertical section of tooth shows the following parts

- The crown – the part lying above the gums
- The neck – it connects the crown with the root
- The root – it lies buried inside the gums and supports the tooth

The white part of the tooth is called the enamel, it consists of calcium salts.

Inner to the enamel is the dentine which is a solid tissue and contains microscopic tubules/tubes.

The dentine encloses a cavity known as the pulp cavity. This cavity supplies the tooth with nerves and blood capillaries.

At the root of the tooth is a bone like material called the cement which holds the tooth firmly to the socket.

We all love to eat sweets. However, you might have heard people saying that sweets damage our teeth. Do you know if this is true? Let us understand it further.

Tooth decay

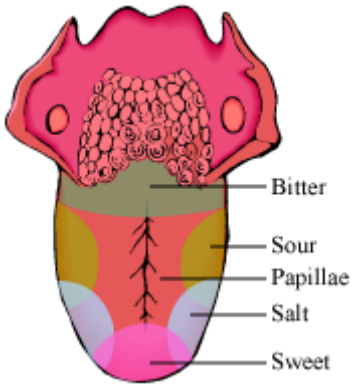
A number of bacteria are present in our mouth, though not all of them are harmful. However, irregular and improper cleaning of teeth can lead to the growth of several harmful bacteria in our mouth. These bacteria form a yellow coloured film on the tooth-surface, called **plaque**. Also, they break down the sugar present in leftover food particles and release acids in the mouth, which damage the teeth and form cavities (**caries**). The bacteria can enter the tooth pulp through these caries and cause infection. This is known as **tooth decay**. This condition can lead to severe toothache. It can also result in untimely loss of teeth. **Can you name few food items that cause tooth decay?** Tooth decay can occur because of consuming chocolates, sweets, cold drinks, and other sugar products. **How can tooth decay be prevented?**

Tooth decay can be prevented by maintaining oral hygiene, which includes the proper cleaning of teeth. Teeth must be brushed twice a day after meals using *dantun* or dental floss.

Tongue

Tongue is a muscular organ present in the buccal cavity. **What role does it play in digestion?** The tongue mixes food with saliva during chewing. It also aids in swallowing food.

How do we taste the food we eat? We are able to taste the food we eat with the help of our **tongue**. The tongue has a large number of taste buds, which tell us the taste of different types of food items. The different regions of the tongue are shown in the given figure.



What's on my tongue?

Take a sample of sugar solution, salt solution, lemon juice, and a paste of crushed *Neem* leaves. Blindfold your classmate and ask him/her to take out his/her tongue. Now, with the help of a clean toothpick, keep different samples on different areas of the tongue. Ask your friend to identify the areas of the tongue in which he/she feels sweet, salty, sour, and bitter.

An interesting fact:

Did you know that our mouth warms or cools the food according to the need of the body!

Why do you think we can feel different types of tastes?

Salivary glands

Apart from the tongue and the teeth, the buccal cavity also has salivary glands, which secrete saliva.

What is the function of saliva? The enzymes present in saliva break down or digest the starch present in the food we eat.

Let us perform an activity to test the action of saliva.

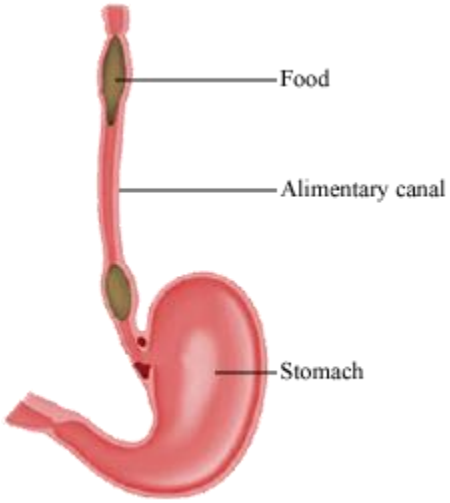
Did you know that humans produce about 1.7 litres of saliva everyday!

Pharynx

It is a common passageway for food and air. It opens into the oesophagus (which leads to the stomach) and trachea (which leads to the lungs).

The food pipe or the oesophagus

We know that the tongue helps in swallowing food. **Where does the swallowed food go from the mouth?** The swallowed food passes into the oesophagus from the mouth. The oesophagus or the food pipe runs along the neck and chest. The walls of the food pipe move to push the food down into the stomach.



Digestion in Mouth

Saliva contains enzymes salivary amylase, lysozyme, and electrolytes. Salivary amylase basically helps in starch digestion up to 30%.

$$\text{Starch} \xrightarrow[\text{pH6.8}]{\text{Salivary amylase}} \text{Maltose}$$

Two of the basic functions performed by buccal cavity are mastication of food and facilitation of swallowing.

From buccal cavity, food reaches the stomach through a process called peristalsis.

Peristalsis is the process of wave-like muscle contractions of the alimentary tract that moves food along.

What happens when food goes down the trachea instead of the oesophagus?

If food goes down the trachea or wind pipe instead of the food pipe or oesophagus, the person is not able to breathe and starts choking.

Our trachea (wind pipe) and oesophagus (food pipe) are joined near the top and separate as we go down towards the diaphragm. A thin flap of cartilage called the epiglottis usually covers the trachea while we are swallowing, so that food does not move inside the wind pipe.

However under certain conditions like swallowing too fast, talking or not chewing the food properly, some of it may enter the trachea. This may cause the airways to get partially blocked, which is called as choking. Total blockage may result in the death of the individual.

Our nervous system responds immediately to the situation by trying to eject the food. This is done by tightening the muscles between the ribs, above the oesophagus and by expanding the cavity of the throat.

Try to breathe when you are in the midst of swallowing, is it possible?

You won't be able to breathe as trachea is shut off by the epiglottis during this time.

Did you know that the human oesophagus is approximately 25 cm long?

The stomach

After the food pipe, the food enters the stomach. The stomach is a thin-walled bag. It is flattened, J- shaped, and is the widest part of the alimentary canal. It opens into the small intestine.

Digestion in Stomach

Food is stored in the stomach for about 4-5 hours. During its stay in the stomach, it is mixed with acidic gastric juices by churning movement of muscular wall and is called chyme at this stage.

Gastric juice contains hydrochloric acid. It also contains two enzymes - pepsin and rennin. The function of the acid is to convert inactivated form of pepsin into the activated form.

Small amount of protein digestion (by pepsin) occurs in the stomach.

$$\text{Proteins} \xrightarrow{\text{Pepsin}} \text{Proteases} + \text{Peptides}$$

Rennin (proteolytic enzyme) in infants helps in milk digestion.

What is the function of the stomach?

The inner lining of the stomach secretes hydrochloric acid, mucous, and digestive juices such as pepsin and rennin.

Why are they secreted? Do they have any importance? The mucous secreted by the stomach protects its inner lining. The hydrochloric acid secreted by the stomach kills the bacteria that enter the stomach through food. It also makes the medium of the stomach acidic. The digestive juices secreted by the stomach take part in the process of digestion by breaking down the food into smaller substances for example, pepsin breaks proteins into polypeptides, rennin changes soluble milk proteins into curd which is insoluble. The production of chymosin in the human body begins to diminish as one grows old.

Some interesting facts:

- Did you know that the human stomach can hold up to 1.5 litres of material?
- On an average, the stomach produces 2 litres of acid everyday.
- Food stays in the stomach for 4-5 hours.

The small intestine

The stomach empties its contents into the small intestine. The small intestine is a highly coiled, tube-like structure. It is about 7.5 metres in length. It receives secretions from the liver and the pancreas in the form of bile and pancreatic juice. Apart from this, the wall of the small intestine also secretes juices.

The secretions are poured into the small intestine. Can you say why?

When the partly digested food reaches the small intestine, the juices secreted by the small intestine complete the process of digestion. The secreted juices in the small intestines consists of maltase, sucrase, lactase, peptidase and lipase.

Digestion in Small Intestine

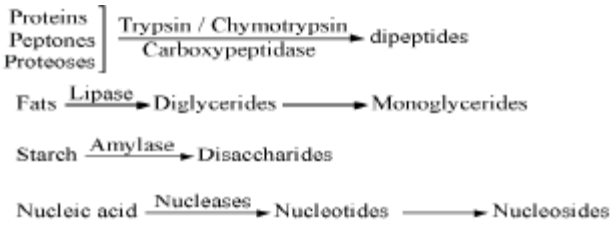
The digestion of food takes place in duodenum, which is the first part of small intestine.

The small intestine receives digestive juices from liver (bile juice) and pancreas (pancreatic juice). Small intestine itself also secretes digestive juices.

The bile juice is secreted by the liver. It does not contain any enzyme, but still is essential for digestion since it breaks the fats into smaller droplets so that the enzymes could act on them efficiently.

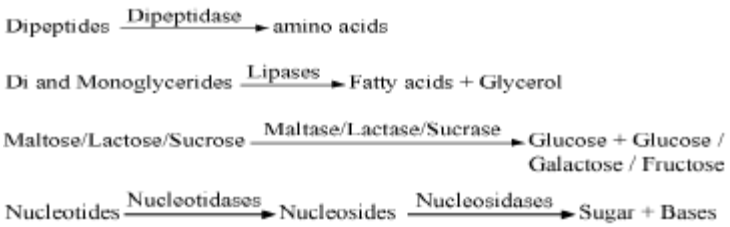
Three of the major enzymes present in the pancreatic juice are – trypsin, amylase and lipase.

Action of pancreatic juice results in:



After being partially digested, the food moves to the second part of small intestine where it is acted upon by enzymes such as maltase, sucrase, and lactase.

Action of intestinal juice results in:



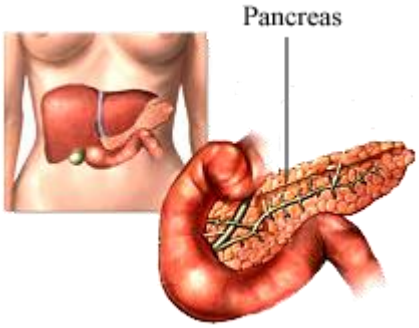
What is the function of the liver in the digestive system? The liver is the largest gland of the body. It is a reddish-brown gland situated on the right side of the upper

part of the abdomen. The main function of the liver is to secrete **bile juice**. Bile juice is stored in a sac-like structure called the **gall bladder**.

What is the function of bile? Bile takes part in the digestion of fats present in the ingested food.

What is the pancreas? Does it perform the same function as the liver?

The pancreas is a large cream-coloured gland. It is situated just below the stomach. It secretes **pancreatic juice,** which consists of protease, amylase and lipase enzymes. These juices take part in the digestion of carbohydrates, lipids and proteins by breaking them into simpler substances for example, amylase breaks starch into maltose, while lipase breaks complex fats into simple fats.



Hence, it is the small intestine where

- carbohydrates are broken down into simple sugar such as glucose
- fats are broken down into fatty acids and glycerol
- proteins are broken down into amino acids

What happens to the digested food? Nutrients from the digested food pass into blood vessels, which are present in the walls of the small intestine. This process is known as **absorption**.

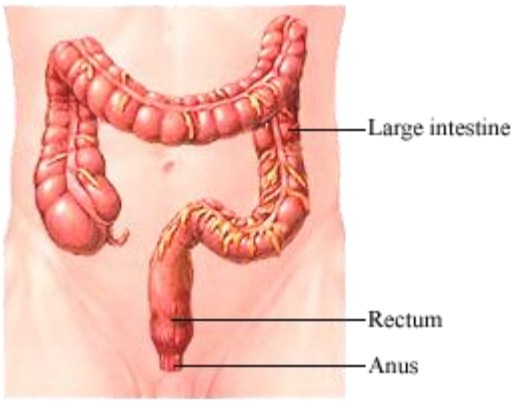
Does the small intestine have special structures that aid in the absorption of digested food?

Some interesting facts:

The human liver weighs around 1.6 kg.
Do you know that the liver is the only organ of the body which has the capacity to regenerate itself?
Do you know that pancreas also regulates the level of sugar in our blood?

The large intestine

The digested food gets absorbed into the blood vessels in the small intestine and is transported to all parts of the body by these blood vessels. This process is known as **assimilation**.



What happens to the undigested and unabsorbed food material? The undigested food material from the small intestine enters the large intestine. The large intestine is wider than the small intestine, but is shorter in length. It is 1.5 metres long.

What is the function of the large intestine? The large intestine absorbs water and remaining salts from the undigested food material.

The remaining waste material then enters the **rectum.** It is stored there in the form of semi-solid faeces. The faecal material is finally removed from the body through the **anus**. This process is known as **egestion**.

The digestion of food involves several organs and processes that occur internally. How was this discovered? Who was the first person to study the process of digestion?

The discovery of the working of the stomach was an accident. In 1822, a man named Alexis St. Martin was badly injured by a gun shot. The bullet that hit him made a hole in his stomach. The doctor treating him, named William Beaumont, was able to save his life, but was unable to close the wound properly. The doctor utilized this opportunity to study the inside of his stomach and made some wonderful observations. He found that the stomach churns the food and its walls secrete a fluid that helps in the digestion of food. He also observed that the end of the stomach opens into the intestine only after the digestion of the food inside the stomach is

completed.

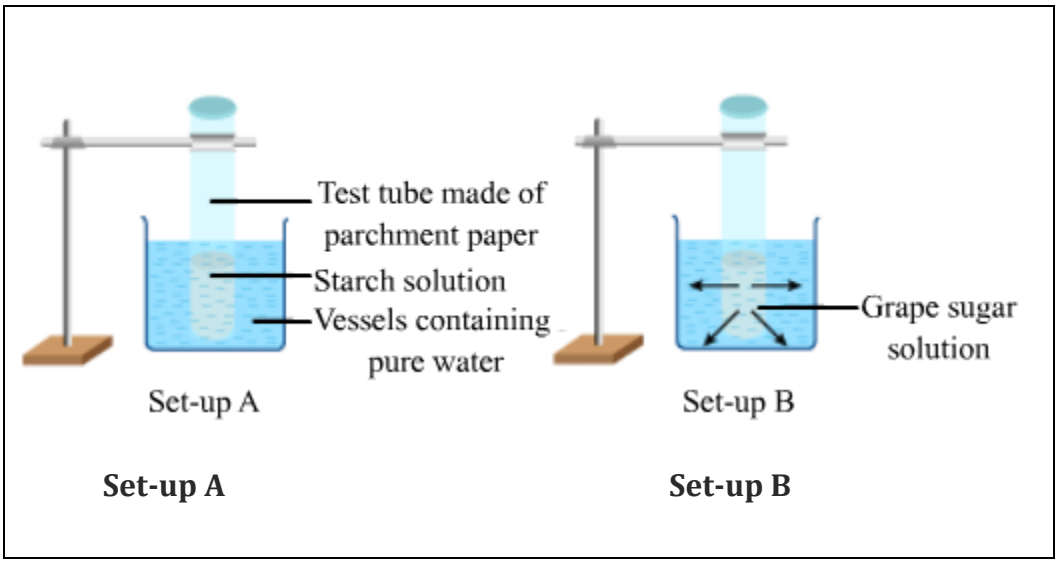
Therefore, the digestion of food starts in the mouth. The process of digestion continues in the stomach and small intestine. The absorption of nutrients occurs in the small intestine through **diffusion, active transport and facilitated transport**.

Let us understand diffusion through an activity.

Importance of diffusion

Take two tubes made of a membrane of parchment paper or bladder of a pig. Fill these tubes, one with starch paste, and the other with grape sugar solution.

Then, hang the tubes in separate vessels containing pure water (like shown below).



Experimental set-up

After 3 – 4 hours, taste the water of both the vessels.

You will notice that the water in the vessel containing sugar solution turns sweet, while the water of the other vessel shows no change.

Explanation of the activity: We know that starch is insoluble in water, while sugar is soluble. Therefore, sugar is able to pass through the membrane into the vessel turning the water sweet. On the other hand, starch does not pass through the membrane.

This activity proves that the food we eat is insoluble, so it must be converted into soluble form (or should be digested) to make it pass through the alimentary canal. In

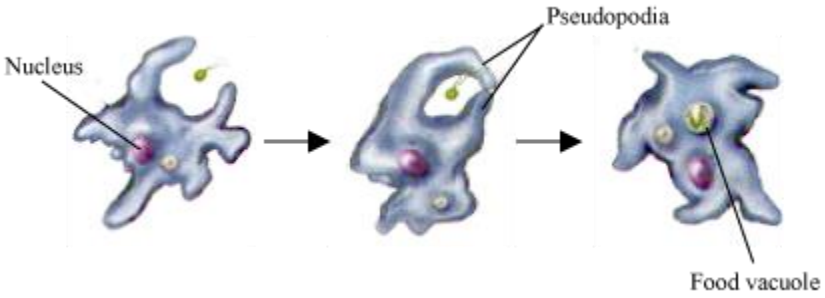
the above experiment, the parchment tubes represent the alimentary canal, while the surrounding water represents blood.

Feeding And Digestion In Amoeba

Amoeba is a single-celled organism found in puddles, lake water, pond water etc. It has a cell membrane, a round nucleus, and many small vacuoles.

We know that animals eat through their mouth. **But how does a small organism like *Amoeba* feed itself?**

Amoeba can constantly change its shape. It forms finger-like projections called **pseudopodia** (meaning false feet). Pseudopodia help *Amoeba* in moving and capturing food.



When an *Amoeba* senses its prey, it pushes out its pseudopodia around its prey and engulfs it. The food thus gets trapped in the food vacuole. An *Amoeba* feeds on algae, rotifers, protozoans, and even other small *Amoeba.*

How does the digestion of food occur in *Amoeba*?

Digestive juices such as amylase and protease are secreted inside the food vacuole in *Amoeba.* These juices act on the food and break it down into smaller components. Amylase breaks down complex carbohydrates into simple sugars, while protease breaks down proteins to simpler substances. The digested food is later absorbed by *Amoeba* for growth, maintenance, and multiplication. The waste material or undigested food is then expelled out of the body using pseudopodia.

Respiration and Its Types

We know that there is a constant exchange of atmospheric gases. Oxygen is inhaled and carbon dioxide is exhaled. If oxygen is inhaled, then it must be used for some activity in the body. Similarly, if carbon dioxide is exhaled out of the body, then it must be because it is not required. This important life process is called **respiration**.

What is the role of oxygen in the body? Why is carbon dioxide thrown out of the body?

Respiration is the bodily process of inhalation and exhalation. It is the process of taking in oxygen and releasing carbon dioxide. The process involves the consumption of oxygen and liberation of carbon dioxide and water.

The oxygen inhaled is used to burn/oxidize/break down the food (glucose). This reaction produces energy required for all activities. Water and carbon dioxide are by-products of this reaction. This process occurs inside the mitochondria and is called **cellular respiration**. It is exactly opposite to the process of photosynthesis. It can be represented as:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$$

Thus, **cellular respiration** is the process by which energy is released from the breakdown of organic substances (glucose).

Is oxygen the only molecule used to burn food and produce energy? What happens to the organisms living in regions with no oxygen?

Respiration can occur both in the presence and absence of O_2. On this basis, it can be classified into two types: **aerobic and anaerobic.**

Aerobic respiration	**Anaerobic respiration**
It occurs in the presence of O_2.	It occurs in the absence of O_2.
It involves the exchange of gases between an organism and outside environment.	Exchange of gases is absent.
It occurs in the cytoplasm and mitochondria.	It occurs only in the cytoplasm.
It always releases CO_2 and H_2O.	End products may vary.
It yields 38 ATP.	It yields 2 ATP.

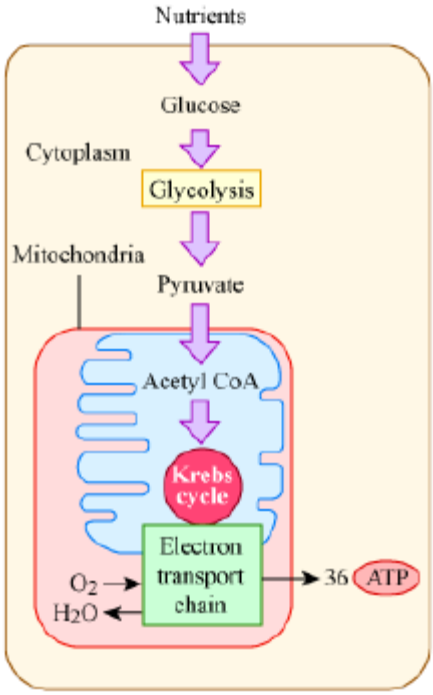
Is glucose the only carbohydrate which is broken down? Are not proteins and lipids utilized to produce energy?

Glucose is the simplest molecule that enters a series of reactions called **Glycolysis** and the **Krebs cycle** to produce energy.

Proteins and fatty acids are broken down and enter the cycle at different regions. Amino acids, depending upon the length of the carbon chain, enter the Krebs cycle at different places.

Lipids are fist converted into fatty acids and then into acetyl-CoA, which enters the Krebs cycle.

Aerobic respiration: It involves four main steps:



Step 1: The first step is called **glycolysis**. It occurs in the cytoplasm of a cell. It does not require oxygen. Here, the 6-carbon molecule glucose is partially broken down into a 3-carbon molecule, pyruvate or pyruvic acid. In this step, one glucose molecule produces 2 molecules of pyruvate.

$$\text{Glucose} \xrightarrow{\text{Glycolysis}} 2 \text{ Pyruvate}$$

Step 2: The two pyruvic acid molecules are converted into acetyl CoA, which can easily enter the mitochondria, which is the site for further reactions.

Step 3: These acetyl CoA molecules enter the mitochondrial matrix and take part in the Krebs cycle. This occurs in the presence of O_2.

Step 4: In this step, the energy released in all the above steps is converted to ATP by ATP synthase enzyme.

In aerobic respiration, a total of 38 ATP molecules are produced from one molecule of glucose.

Anaerobic respiration: It is a two step process.

Step 1: The first step, glycolysis, is the same as that of aerobic respiration.

$$\text{Glucose} \xrightarrow{\text{Glycolysis}} \text{2 pyruvic acid}$$

Step 2: Pyruvic acid is not transported to the mitochondria. It remains in the cytoplasm. It is then broken down into waste products that can be removed from the cell. This entire process occurs in the absence of oxygen.

$$\text{Glucose} \xrightarrow{\text{Glycolysis}} \text{Pyruvic acid} \xrightarrow[\text{of } O_2]{\text{In absence}} \underbrace{2C_2H_5OH + 2CO_2}_{\text{Waste product}} + 2ATP$$

Anaerobic respiration occurs in the roots of some species of water logged plants, parasitic worms, yeast, animal muscles, and microorganisms.

In some microorganisms such as yeasts, anaerobic respiration is called **fermentation**. In the process of fermentation, ethanol is formed as a by-product. This is represented in the above reaction.

Illustration of anaerobic respiration

Aerobic respiration produces large amounts of energy. **What about regions where energy is required, but oxygen is not available?** In muscle cells, when there is a lack of oxygen, anaerobic respiration occurs where pyruvic acid is converted into lactic acid. This accumulation of lactic acid causes muscle cramps.

Brewing is an industrial application of fermentation.

Do you know that brewing industries utilize yeast?

Alcoholic fermentation is the conversion of sugar into ethyl alcohol and CO_2. One of the by-products, CO_2, dissipates into air whereas the other by-product, ethyl alcohol, remains in the medium. This alcohol is processed in the brewing industry and is utilized commercially.

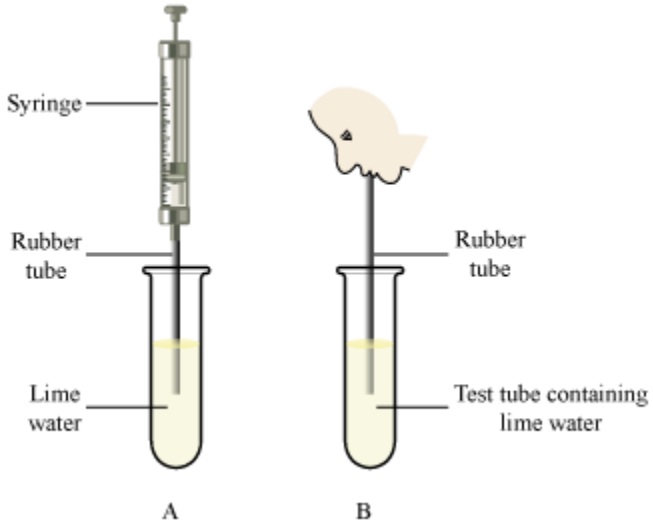
Some interesting facts:

- Do you know that fermentation predigests foods and improves the availability of nutrients present in them?

- Fermentation adds nutrients such as B-vitamin.

Is CO_2 a product of respiration? Let us find out.

Take freshly prepared lime water in two test tubes and label them as **A** and **B**. Use a syringe to pass air in test tube **A** and blow air in test tube **B** through a straw.



You will observe that limewater turns milky in both test tubes. However, it was faster in test tube **B**.

Explanation:

Limewater is the common name for saturated calcium hydroxide solution.

Its chemical formula is **$Ca(OH)_2$**.

When CO_2 is passed through lime water, it turns milky due to the formation of calcium carbonate. This reaction can be denoted as:

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

In test tube **B**, lime water turned milky faster because the air we exhale is CO_2. In comparison, the introduced air is atmospheric air in test tube **A,** which contains only 0.03% CO_2.

Exchange of gases in plants

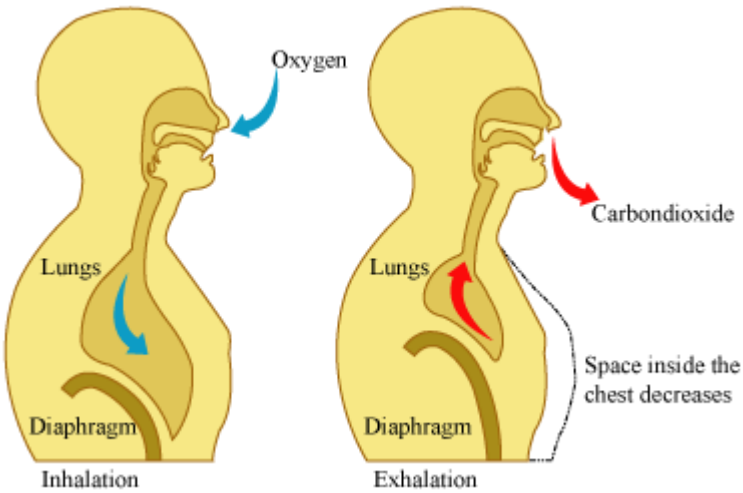
Plants exchange gases through stomata. This exchange of gases occurs through the process of **diffusion**.

When CO_2 is present in high concentration inside the plant body, it moves out into the atmosphere (where its concentration is low) and allows O_2 to enter the plants.

Respiration in Humans

How does the oxygen inhaled reach all the cells of the body? And how is carbon dioxide collected from the cells and exhaled out?
To answer these questions, we have to understand the human respiratory system.

The human respiratory system supplies our body with O_2 and also helps in removing CO_2, which is a waste product formed during cellular respiration. The intake of O_2 and exit of CO_2 involves two processes:



1) Inhalation: It involves bringing in air from outside the body into the lungs. When we breathe in, the size of our chest increases.
This happens because when air enters, the lungs expand and the ribs move outwards. Simultaneously, the diaphragm contracts and becomes flat. Thus, the size of our chest increases.

2) Exhalation: It involves removal of CO_2 from the body. When we breathe out, the size of our chest decreases. This happens because when air moves out of our lungs, the lungs contract, the ribs move back, and the diaphragm curves upwards into the chest decreasing the size of the chest.

Organs involved in respiration:
The organs of the respiratory system extend from the nose to lungs. They include the **nose, pharynx, trachea, bronchi, bronchioles and lungs**.

1) Nostrils: The air from outside first enters the nostrils, which is divided into the left

and the right nostril. These nostrils lead to open spaces in the nose called the **nasal passage**. This passage contains hair and mucus, which perform the functions of filtering, moistening, and warming the air entering the nasal passage.

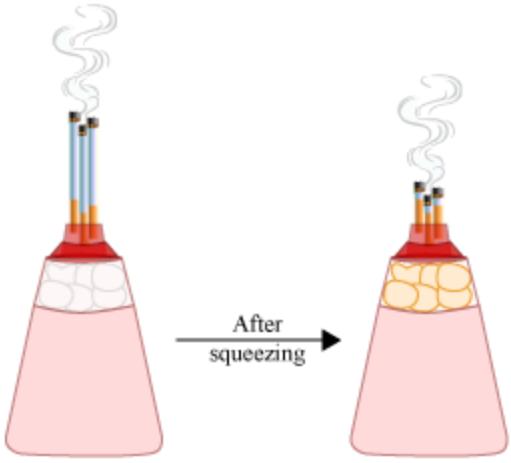
2) Pharynx: Air travels from the nasal passage to the pharynx, which is commonly known as **throat**. The pharynx is lined with a protective mucus membrane and cilia, which removes the impurities entering with air.

3) Larynx: The air from the pharynx enters the **larynx** or **voice box**. It contains two true vocal cords, which are made up of cartilage and fibres. When air passes through this area, the vocal cords vibrate and this produces different sounds. Human beings can control this vibration. Thus, they can make various sounds and are capable of speech.

4) Trachea: From the larynx, the inhaled air moves into the **wind pipe** or **trachea**. The trachea is a long narrow tube, which is lined with ciliated mucus membrane. The trachea branches into two tubes, the left and right bronchi. The cilia move the mucus containing dust particles back to the pharynx, where it is swallowed.

Do you know that tobacco contains harmful components? These components do not allow proper supply of oxygenated blood and results in many diseases.

Why is it so?
Let us perform the following activity to understand the harmful effects of smoking.



Take a clean, empty squeezable ketchup bottle.
Place a few cotton balls in the lid of the bottle and close its mouth with the help of the cap. Fit two or more cigarettes on the tip of the bottle.
Then, light the cigarette and simultaneously squeeze and release the body of the

bottle slowly, till the cigarette burns out completely. Repeat this process with two or more cigarettes.
Open the cap of the bottle and remove the cotton balls. You will observe that the colour of the cotton balls change from white to brown or black.

Explanation of the activity:
Tar, a component of cigarettes, is collected in the cotton balls. This activity shows how tar accumulates in the lungs and coats the lungs. It does not allow proper supply of oxygenated blood required by the body.

5) Bronchi and bronchioles: The air from the trachea moves into the **bronchi**, which are formed because of the division of the trachea. Each bronchus enters one of the lungs. Inside the lungs, the bronchi further divide into bronchioles. The air moves through these bronchioles.

6) Lungs: The lungs are bag-like structures situated on either sides of the ribcage. They are the chief respiratory organs in the human body. In the lungs, the bronchiole divides many times to create smaller branches. These branches ultimately terminate into tiny air-sacs known as **alveoli**. These cells are surrounded by many blood capillaries. Alveoli provide surface for the exchange of gases.

Do you know that each lung contains 300 – 350 million units called alveoli, making a total of 700 million in both lungs?
Alveoli transfers O_2 into the blood cells. Let us discuss how alveoli help in the exchange of gases.

Gases are exchanged in the lungs during respiration. Are lungs the only respiratory organs? Is the process of respiration similar in all animals?

In **aquatic animals,** gas exchange takes place by the process by **diffusion,** directly through the body wall.
However, complex aquatic animals have gills for the diffusion of gases. For example, in fishes, the water enters through their mouths and quickly moves to the gills. In the gills, O_2 gets mixed with blood. The blood then transports this oxygen to all the body cells for respiration.

Which organism exhibits faster rate of breathing – terrestrial or aquatic animals?

The oxygen source i.e., water is about 800 times denser than air. It contains less O_2 as compared to air. Since the content of O_2 in water is low, aquatic animals breathe faster to get as much oxygen as possible, resulting in a faster rate of breathing. Therefore,

aquatic animals breathe faster than terrestrial animals and also show different adaptations for better gaseous exchange.

Transportation In Plants

Transportation is a life process where substances synthesised or absorbed in one part of the body are carried to other parts of the body**.**

Water absorbed by roots is to be transported to the rest of the plant body. Food produced in the leaves is to be transported to its place of storage. Therefore, there is a requirement for a transport system in plants. How does the transport system in plants function?

The transportation system in plants moves the energy stored in leaves to different parts. It also helps in moving raw materials absorbed from the roots to various organs of the plant. However, these are entirely different pathways.

These two pathways are explained in the following discussion.

The transportation system in plants consists of two different types of conducting tissues.

Xylem conducts water and minerals obtained from soil (via roots) to the rest of the plant. **Phloem** transports food materials from the leaves to different parts of the plant body.

Transport of water

Components of the xylem tissue (tracheids and vessels) of roots, stems, and leaves are interconnected to form a continuous system of water-conducting channels, which reaches all parts of the plant.

Root hair with adhering soil particles

Roots absorb water and mineral salts from the soil. Each soil particle is surrounded by a continuous film of water, loosely held to it by a force known as capillary force. This is known as **capillary water**. Therefore, water molecules adhere to soil particles with the capillary force. The capillary water is also present in spaces between the soil particles. This capillary water, along with the minerals dissolved in it, is absorbed by the cells in the root hair.

Absorption of water from the soil

The cells in the root hair are deficient in water because they continuously supply the absorbed water to the stems and leaves. Thus, the concentration of water in the root

hair is less than the water present in soil particles. This creates a concentration gradient, which allows the root hair cells to uptake water actively. As a result, there is a steady movement of water into the root xylem creating a column of water, which is steadily pushed upwards. This upward movement of water and minerals is called **ascent of sap**.
Due to the continuous inflow of water, a pressure is developed inside the root cells. This **root pressure** helps in pushing the plant cell sap upwards through xylem vessels.

However, this pressure by itself cannot move the water over greater heights. In order to fulfil this requirement, plants utilise some other stronger force such as **transpiration pull** or **suction pressure**. Let us explore what transpiration pull is.

Some interesting facts:

- Do you know that only 1% of the water absorbed by plants is used in photosynthesis? The rest 99% is lost through transpiration.
- In one growing season, a corn plant transpires more than 200 litres of water.

The water thus absorbed by the roots and transported into the plant body plays various vital functions, some of which are:

- transportation of soluble substances from one plant part to the other,
- production of food through photosynthesis,
- cooling the plant through transpiration.

Translocation of Food

Transportation of food

The transportation of food from the leaves to other parts of the plant occurs in the vascular tissue, namely the **phloem**. This process of transporting food is known as **translocation**. The phloem also transports amino acids and other substances to storage organs of the plant (along with the growing organs) such as roots, fruits, and seeds. The phloem consists of companion cells, sieve tubes, phloem parenchyma, and fibres.

The translocation of food occurs in the sieve tubes with the help of companion cells.

Translocation in the phloem, unlike the xylem, is achieved by utilizing energy from ATP. For example, a food material such as sucrose is transported into the phloem tissue using ATP energy. As a result, the osmotic pressure in the tissue increases, causing the water to move into it. This pressure moves the material in the phloem to the tissues, which have less pressure. This is helpful in moving materials according to the requirements of the plant.

Circulatory System

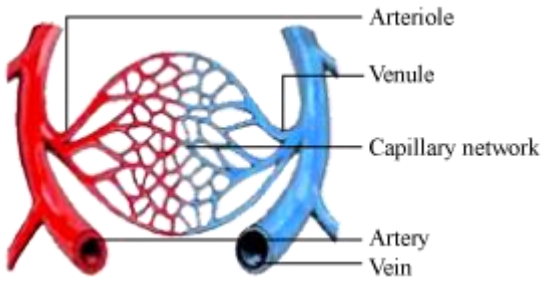
Nutrients are required for living. For example, oxygen is required by all cells in the body. **How does atmospheric oxygen reach the cells?** The waste materials that are produced are thrown out of the body. **Is there a system that transports nutrients and collects wastes materials in the body?**

The system that transports nutrients and collects waste materials for disposal in the body is the **circulatory system**. The circulatory system consists of the central organ i.e., the heart, blood vessels, and circulating fluid i.e., blood. Another system, called the **lymphatic system,** transports immune cells.

Let us explore the components of the circulatory system and how each component functions for the efficient transport of materials in the body.

Blood vessels

Arteries are tough, elastic tubes that carry blood from the heart and supply it to various organs of the body. As the arteries move away from the heart (i.e., on reaching organs and tissues), they divide into smaller vessels. The smallest vessels called **capillaries** have very thin walls. Arteries are red in colour because they carry oxygenated blood.



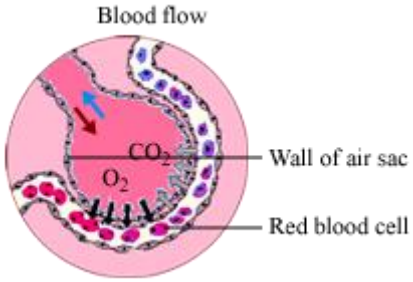
Capillaries (in organs and tissues) join together to form veins. Veins collect blood from different organs and tissues. Veins are thin-walled as compared to arteries. This is because they bring back blood from the organs to the heart and blood is no longer under pressure. These veins carry deoxygenated blood into the heart.

Components of blood:

Blood consists of red blood cells, white blood cells, and platelets (present in the blood plasma).

Blood is red because of the presence of haemoglobin. What is its function in blood?

The main function of haemoglobin molecule is to transport oxygen molecules to body cells for cellular respiration. When we breathe in, we take in O_2, which reaches the lung alveoli. O_2 then diffuses into blood of the surrounding capillaries from the alveoli, which has a high concentration of O_2. The haemoglobin pigment present in the blood gets attached to four O_2 molecules and forms oxyhaemoglobin, oxygenating the blood.



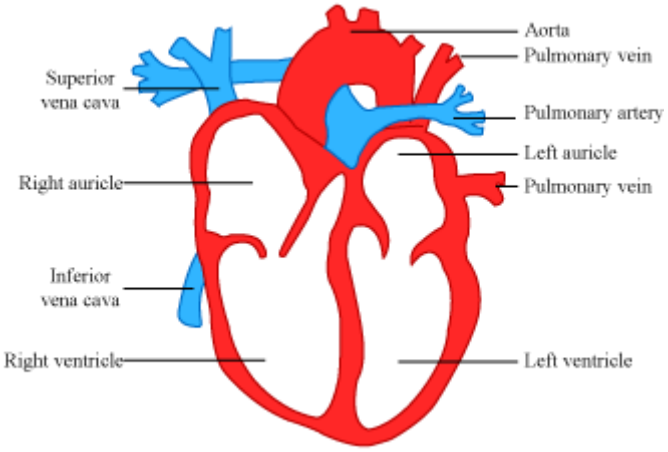
This oxygenated blood is then distributed to all the body cells by the heart.

After supplying O_2 to the body cells, the blood collects CO_2, which is produced after cellular respiration in the cells. Thus, the blood becomes deoxygenated.

The haemoglobin pigment has less affinity for CO_2. Therefore, it is mainly transported in the dissolved form. This deoxygenated blood brings back CO_2 to lung alveoli.

The lungs have a high concentration of O_2. Therefore, it diffuses into the blood. Blood, on the other hand, has more concentration of CO_2, which moves into the area of its lower concentration in the lung alveoli. Thus, the exchange of gases occurs in the alveoli. The oxygen inhaled is transported to all parts of the body while the CO_2 produced in the cells is collected from the cells and exhaled out.

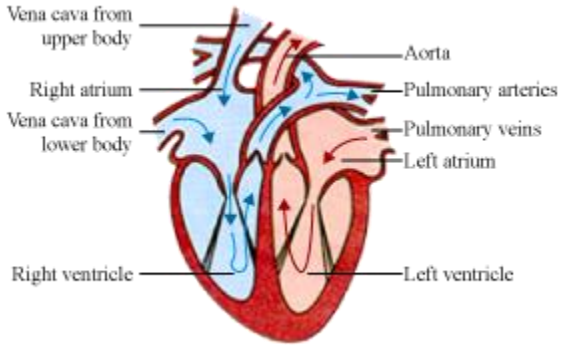
How does the heart distribute oxygenated blood?



In human beings, the heart is a muscular organ. It is divided into four chambers – right auricle, right ventricle, left auricle, and left ventricle. The walls of these chambers are made up of a special muscle called **myocardium**, which contracts continuously and rhythmically to distribute blood to all the body cells.

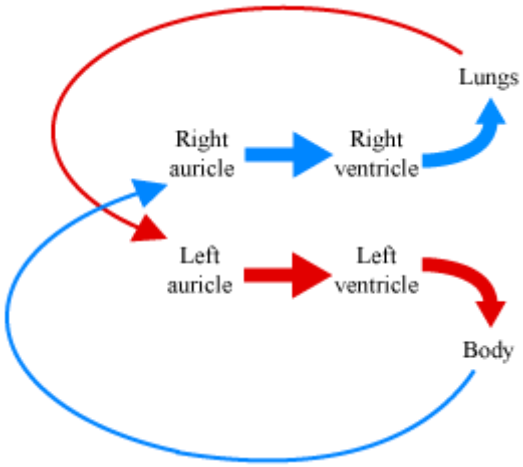
Flow of blood in the human heart

- The heart has superior and inferior vena cava. They carry deoxygenated blood from the upper and lower regions of the body respectively and supply the deoxygenated blood to the right auricle of the heart.



- The right auricle contracts and passes the deoxygenated blood to the right ventricle, through an auriculo-ventricular aperture (tricuspid valve).

- The right ventricle contracts and passes the deoxygenated blood into the two pulmonary arteries, which pumps it to the lungs where the blood is oxygenated. From the lungs, the pulmonary veins transport the oxygenated blood to the left atrium of the heart.



- The left atrium contracts and through the auriculo-ventricular aperture (bicuspid valve), the oxygenated blood enters the left ventricle.
- The blood passes to aorta from the left ventricle. The aorta gives rise to many arteries that distribute the oxygenated blood to all the regions of the body.

Since the blood goes twice through the heart, it is known as **double circulation.**

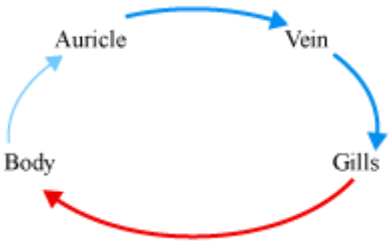
Warm-blooded animals such as mammals have this type of blood circulation.

The body temperature of cold-blooded animals is the same as that of their surroundings. In hot environments, their blood becomes warm and in colder environments, their blood becomes cold.

Therefore, they do not require energy to maintain their body temperature. Hence, cold-blooded animals such as fishes, amphibians, and many reptiles can tolerate some amount of mixing of oxygenated and deoxygenated blood. Therefore, they have two or three chambered hearts.

Two chambered heart of fishes:

Circulatory system of fishes: The oxygenated blood from the gills does not enter the heart. It is directly distributed in the entire body. Only the deoxygenated blood enters the auricle and then the ventricle. The deoxygenated blood enters the gills for oxygenation from the ventricle.



Thus, in fishes, the blood passes through the heart only once during one cycle of passage. This type of circulation is referred to as **single circulation**.

Blood pressure

Rohan visited a doctor with his grandfather.

The doctor measured his blood pressure using a sphygmomanometer. Rohan observed that the doctor placed the sphygmomanometer cuff around his upper arm

and attached a fastening belt by folding the leftover flap. Then, he placed a stethoscope at his elbow joint and inflated the squeezable ball to make the pressure go above 180mm Hg (observed in the attached column of mercury).

The doctor then released the air by opening the air valve and carefully observed the pressure drop.

Explanation of the activity:

When the sphygmomanometer is inflated, the major artery of the arm collapses and this makes us feel uncomfortable. Then, when air is slowly released, a sound is heard using the stethoscope. This sound is the systolic blood pressure. It is the pressure of blood inside the artery during contraction of ventricles of the heart. When no sound is heard any longer, it is diastolic blood pressure. The diastolic pressure is the pressure of blood inside the artery during relaxation of the ventricles. The normal systolic pressure is about 120mm of Hg and normal diastolic pressure is 80mm of Hg.

Some interesting facts:

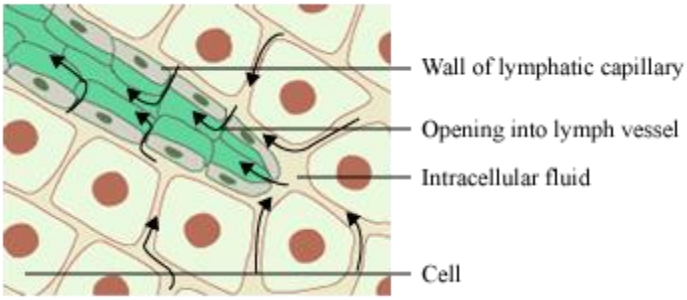
- Do you know that the pressure created by the human heart to pump blood is enough to eject blood up to a distance of around 30 feet?
- Aorta is the largest artery in the human body.

Lymphatic system

Lymph is another fluid connective tissue, which helps in the process of transportation.

In addition to blood vessels, the body contains lymphatic vessels. Some pores are present in the walls of the capillaries and through these pores, small amounts of plasma, proteins, and blood cells flow out in intercellular spaces in the tissues.

This forms the **tissue fluid** or **lymph**. It is a colourless fluid that contains less protein. The lymph enters into tiny vessels situated in intercellular spaces. These capillaries join to form the lymph vessels.



Functions of the lymph:

- It acts as a reservoir of water, salts, and digested food.
- It carries digested food and fats from the small intestine. Lymphatic vessels present in the intestinal villi absorb fatty acids.
- It contains phagocytes that can engulf and destroy bacteria and other foreign particles.

Do you know what causes a heart attack? High blood pressure, smoking, consuming food items with high cholesterol, being overweight, etc. are some causes that can result in a heart attack. Most heart attacks are caused when blood vessels that bring blood and oxygen to the heart muscles are blocked.

Excretory System in Humans

Kidneys

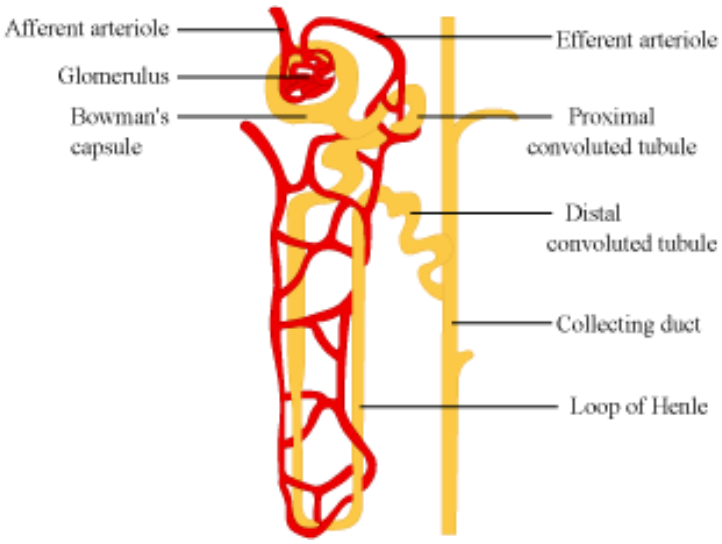
They eliminate nitrogenous wastes from the body and are helpful in maintaining the water balance of the body by removing excess fluids.

The various nitrogenous wastes such as urea, uric acid etc. are supplied from the blood to the kidneys (this is similar to the removal of CO_2 from the blood to the lungs). Thus, the basic filtration unit of the excretory system lies in the kidneys.

Structure of kidneys:

Kidneys are reddish brown bean shaped structures which are found in pairs. Each kidney is divided into two parts - an outer dark region called cortex and inner lighter region called medulla. Each kidney has several microscopic tubular structures called nephrons.

The kidneys consist of a cluster of very thin-walled capillaries. Each cluster is associated with a cup-shaped end of a tube, in which filtered urine is collected. These basic filtering units of the kidneys are called **nephrons**. Each kidney possesses a large number of nephrons (approximately 1- 1.5 million).



Structure of a nephron

The main components of a nephron are the **glomerulus**, **Bowman's capsule,** and a long **renal tube**. The blood enters the kidneys through the renal artery, which branches into many capillaries associated with the glomerulus. Water and solutes are transferred to the nephron at the Bowman's capsule.

In the proximal tubule, some substances such as amino acids, glucose, and salts are selectively reabsorbed and unwanted molecules are added in the urine. The filtrate then moves down into the loop of Henle, in which more water is reabsorbed. From here, the filtrate moves upwards into the distal tubule, and finally to the collecting duct. This duct collects urine from many nephrons.

The urine formed in each kidney then enters a long tube called the ureter. The ureters move the urine from the kidneys to the urinary bladder. The urinary bladder is under the control of the nervous system. This helps us to control the urge to urinate.

Some Interesting Facts:

- **Do you know that blood passes through the kidneys 300 times in a day?**
- **The urinary bladder can hold up to 600ml of urine!**

Artificial kidneys

Do you know what will happen if your kidneys fail?

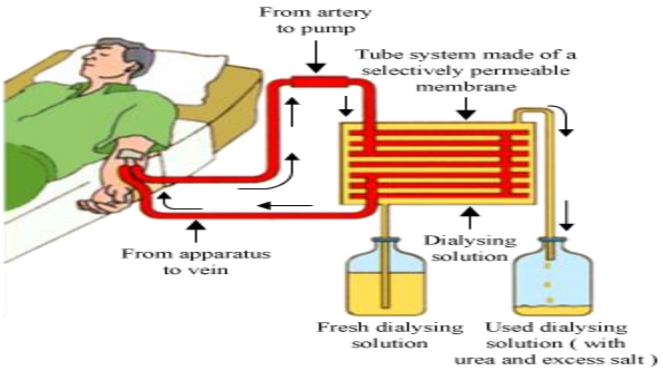
Healthy kidneys remove excess of fluid, wastes, and minerals from the body. They also make hormones that keep the bones strong and healthy. If the kidneys fail to function,

wastes may accumulate in the body, the body may retain excess fluid, and blood pressure may rise. This can even lead to death.

In such a case, an artificial kidney or hemodialysis is useful.

In hemodialysis, only a few drops of blood are allowed to flow, through a special filter that removes wastes and extra fluid. The detoxified blood is then returned to the body.

The special filter used in dialysis consists of a number of tubes with semi-permeable lining, suspended in a tank filled with the dialysis fluid.



Dialysis

What is dialysis? When is it performed? It performs the function of which organ?

Sometimes, kidney(s) stops functioning because of an infection or an injury. This leads to the accumulation of harmful wastes in the body, which can even cause death. In such a condition, blood is filtered artificially. This process is known as **dialysis**. A dialysis machine performs the function of a normal kidney, and thus helps an individual to survive.

Do you know that the human bladder can stretch to hold up to 400 mL of urine?!

Excretion in Plants

The process by which wastes are thrown out of the body is called excretion and the organs that help in excretion are called excretory organs.

Excretion in Plants

Plants do not have specialized structures for the elimination of wastes like humans have kidneys, lungs, etc. Plants use a variety of techniques to remove waste materials. Oxygen, a by-product of photosynthesis is removed through stomata. The excess

water absorbed from roots is also lost through stomata via **transpiration**. Cell vacuoles, gum, resin etc. are stored in old xylem tissues. Waste products may be stored in leaves that fall. Plant roots also sometimes excrete wastes materials.

Have you ever wondered how plants get rid off the waste products then?

Plants have specialized mechanisms for elimination of wastes. Some of these mechanisms are given below.

- Plants get rid of the wastes by combining them with inorganic salts. The insoluble crystals are formed in the product. These crystals are harmless. They get deposited on the bark, dead wood, old leaves, etc of plants.
- Some of the waste products of plants are useful for human beings and we utilize such products in our daily life. For example − tannins, resins, gums, essential oils, latex, etc.
- Stomata also serve as an excretory organ. During photosynthesis, oxygen is produced as a waste product while in respiration, CO_2 acts as waste products. Both of these gases are eliminated through stomata.

Tannins are present in tea leaves and impart a slightly bitter taste to the tea.

Resins are used for making varnishes. Latex oozes out from the stems through cuts or abrasions and is utilized in making rubber.

Excretion in Simple Organisms and Animals

Unicellular organisms like *Amoeba*, Hydra excrete the waste produced in their cells directly into the surroundings by cell membrane with he help of the process of diffusion.

Multicellular organisms have specific excretory parts for excreting wastes out of their body. Earthworm excrete with the help of excretory tubules known as nephridia. *Planaria* excrete with the help of flame cells and insects through malphigian tubules.