Chapter

1

Nutrition

When we do activities such as breathing, working, walking, etc. we need energy. At the same time when we are not doing any apparent activity also, energy is needed to maintain the working of our body. Where does the energy comes to perform all these activities? The source of energy for these activities comes from the food which we eat.

You had studied in your previous classes about how different organisms get their food. Let us recall them.

- What are saprophytes?
- What are heterotrophs?
- What are autotrophs?
- How does our body perform different functions?
- Where does

How do plants obtain food materials? What do they do with simple substances present in nature?

I . Autotrophic Nutrition

We know that autotrophs are the organisms capable of using light energy to synthesize chemical compounds. They acquire nutrients like some minerals and water from the soil as well as some gases from the air. They are capable of producing large compounds like carbohydrates, proteins, lipids etc. from these very simple substances. These carbohydrates produced by plants are utilized for providing energy in most living organisms and all animals including human beings.

Everything we eat comes from plants why don't the plants get used up? What are they using to grow and produce more plants, more seeds?

Scientists have been working for centuries to find out how plants carry out their life processes. We know that among all life processes, the process of photosynthesis makes plants the universal food provider for all living organisms.

You had studied somthing about photosynthesis in your earlier classes. Van helmant and other scientiests believed that platns gets food material not only from soil other factors are also there. What do you think are some raw materials needed for photosynthesis?

What could be the end products of the process of photosynthesis?

Let us study the process of photosynthesis in detail to find out more about this.

Photosynthesis:

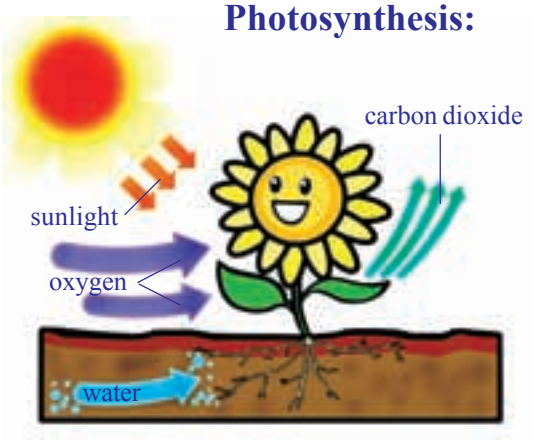

fig-1: Photosynthesis

Photosynthesis is the process by which all green plants contains the green pigment called chlorophyll, which build up complex organic molecules from relatively simple inorganic ones using light as an energy source. The process is very complex and there are several steps as well as intermediary compounds that are formed. Scientists had tried to formulate a simple equation for photosynthesis over the past 200 years. An equation that was readily accepted and is still widely used is the one formulated and proposed by C.B. Van Neil in the year 1931 which is as follows. His opinion was, "for each molecule of carbohydrate formed, one molecule of water and one molecule oxygen is also produced". This is a very simplified equation and does not reflect the complexity of the process of photosynthesis yet we shall use it for now.

$$CO_2 + 2H_20 \xrightarrow[\text{Chlorophyll}]{\text{Light}} CH_2O + H_20 + O_2$$

What would be the reaction to show that glucose ($C_6H_{12}O_6$) is being synthesized?

Write down a balanced equation to show this.

It is known that plants synthesize carbohydrates, the smaller simpler ones first and from which the more complex ones like starch and cellulose are synthesized. Plants are also capable of synthesizing all other compounds like proteins, fats etc.

Animals are not capable of synthesizing carbohydrates and they have to depend on plants for the same.

Can we state that photosynthesis is the basic energy source for most of the living world? Why, why not?

Let us find out whether plants produce carbohydrates by the process of photosynthesis.

Activity-1

Presence of starch in leaves

Let us take a leaf of a potted plant (we can select such plants that have soft thin leaves).

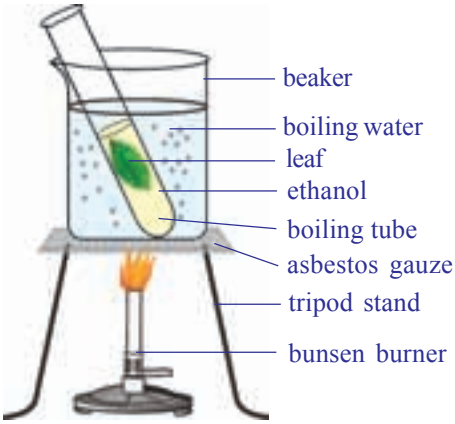

fig-2(a): Leaf boiling in ethenol

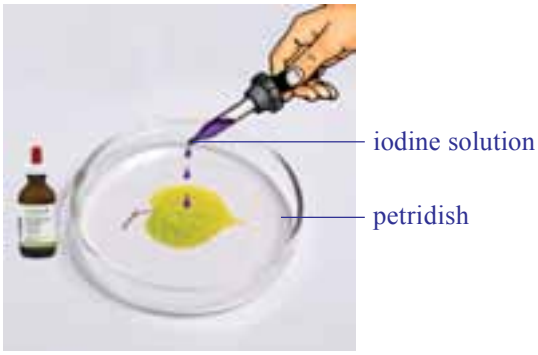

fig-2(b): iodine test

Boil the leaf in methylated spirit over a water bath till it becomes pale-white due to the removal of chlorophyll . Observe the leaf.

Spread the leaf in a dish and add a few drops of tincture iodine/ betadine solution on it. Again observe the leaf.

What do you see?

The presence of starch will be indicated by a blue-black colour.

Do you think solar energy transforms into chemical energy by the process of photosynthesis?

Materials essential for the process of Photosynthesis

What are the materials that you think would be essential for the synthesis of carbohydrates in the process of photosynthesis? (Hint: Equation proposed by Van Neil)

Do you think the equation tells us about all the materials involved?

It took scientists over 300 years to find out about them and still there are several materials involved in the process that we don't know about.

Let us study how scientists worked to find out about some of the materials required for the process of photosynthesis.

Water and Photosynthesis

In class VII we had already studied how Von Helmont found that water was essential for the increase of plant mass

He did not know about photosynthesis then. It was later found that increase in plant body mass or material occurred due to the process of photosynthesis. We shall study more about it in the following sections.

Once again read the chapter on nutrition in plants in class VII and write a note on Von Helmont's experiment focusing on how he concluded that water was important for growth in plant body mass.

Air and Photosynthesis

Let us discuss a simple experiment about Photosynthesis. We have studied some others in our earlier classes. This one helps us to find out about the role of air in the process of photosynthesis. It is interesting to learn about the experiment which was one of the several milestones in the gradual development of our understanding of Photosynthesis.

fig-3: Priestly experiment

Joseph Priestly (1733-1804) in 1770 performed a series of experiments that revealed the essential role of air in the growth of green plants (photosynthesis was still not known to scientists). Priestly, you may recall, discovered oxygen in 1774(the name oxygen was coined later by Lavoisier in the year 1775). Priestly observed that a candle burning in a closed space, a bell jar, soon gets extinguished. Similarly, a mouse would soon suffocate in a closed space of the bell jar. He concluded that a burning candle or an animal, both somehow, damage air. But when he placed a mint plant in the same bell jars, he found that the mouse stayed alive and the candle when lighted from outside continued burning in the presence of the mint plant. Priestly hypothesized as follows: Plants restore to the air whatever breathing animals and burning candles remove.

What had Priestly done to introduce the mint plant without disturbing the experimental set up?

How did he light the candle from outside?

Priestey's experiment confirms that gaseous exchange was going on and plants were giving out a gas that supported burning and was essential for the survival of animals.

But how do plants takein air and utilize carbon dioxide for photosynthesis and oxygen for respiration?

How do they make the choice?

Massive amounts of gaseous exchange occurs through the stomata present in leaves as long as they are open while plants also carry on gaseous exchange through loose tissues on stems, roots etc.

It is actually at the level of the organelles involved in the process of photosynthesis and respiration that the choice of the gas required is made.

Activity-2

Carbon dioxide is necessary for Photosynthesis

We need a destarched plant to start with. For destarching we need to keep the plant should in the dark for nearly a week for the removal of starch (or destarching) from the leaves.

Arrange the apparatus as shown in the figure.

- Take the wide mouthed transparent bottle.
- Put potassium hydroxide pellets / potassium hydroxide solution in the bottle. (Potassium hydroxide absorbs carbon dioxide)
- Insert splitted cork in the mouth of the bottle.

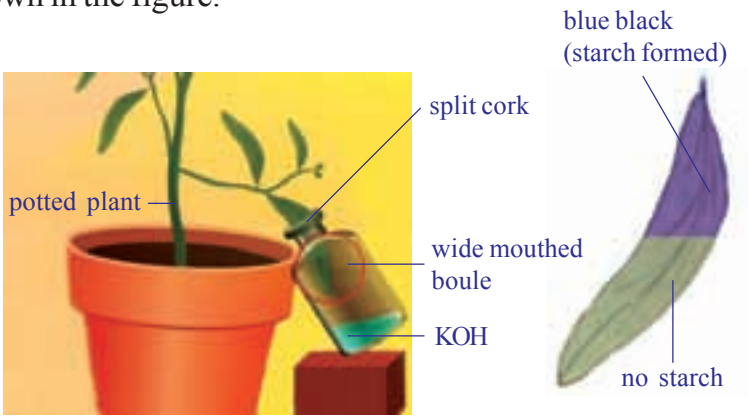

fig-3: Mohl's of leaf experiment

- Insert one of the leaves of destrached plant (through a split cork) into transparent bottle containing potassium hydroxide dioxide pellets/ potassium hydroxide solution.
- Leave the plant in sunlight.
- After a few hours, test this leaf and any other leaf of this plant for starch.
- The leaf which was exposed to the atmospheric air becomes bluish-black, and the one inside the flask containing potassium hydroxide which absorbs carbon dioxide in the bottle does not become blue-

black, showing that carbon dioxide is necessary for photosynthesis.

Ask your teacher why this experiment called Mohl's of leaf experiment. Write information in your note book.

Light and Photosynthesis

In Priestley's time, scientists didn't quite understand about energy, but later on much was discovered about it. If combining oxygen with carbon and hydrogen atoms to form carbon dioxide and water produced energy , what about the reverse? What about forming oxygen again and putting it back in the air. Eventually, scientists learned that the energy situation would also reverse. Oxygen formation would use up energy . This meant that if plants formed oxygen they had to get energy to make that possible. Where did the energy come from?

A Dutch scientist, Jan Ingenhousz (1730-1799), found the answer. He kept studying the way in which plants formed oxygen and, in 1779, noticed that this only happened in the light. In an experiment with the aquatic plant, Hydrilla, he observed that in bright sunlight, small bubbles formed around the green parts while in the dark they did not form. He also found that the gas present in the bubbles was oxygen.

It was further confirmed when Engelman in the early 20th century ingeniously detected the point of maximum photosynthesis. He used a strand of algae and exposed it to different colours of light (the colours that we see in a rainbow) He then usedoxygen sensitive bacteria and found them to crowd areas illuminated with red and blue rays of light. This lead to more studies on light and photosynthesis and the role of different coloured compounds called pigments in plants and the utilization of light energy.

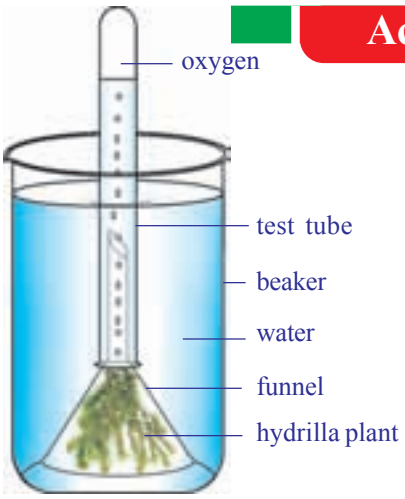

fig-4: Hydrilla experiment

Activity-3

Oxygen is produced during Photosynthesis in the presence of light

- Arrange the apparatus as shown in the figure.
- Place some water plant (Elodea or Hydrilla) in a beaker containing pond water and cover these by a short-stemmed funnel.
- Invert a test-tube full of water over the stem of the funnel. Ensure that the level of water in the beaker is above the level of stem of the inverted funnel.

Place the apparatus in the sun for at least 3 days (when you leave school keep it back in your classroom). You would see that in place of water there is air that fills in. It is actually a gas that will collect in the test-tube.

Test the gas in the test-tube by inserting a glowing incense stick which would burst into flames. This shows the presence of oxygen.

Activity-4

Sunlight is necessary to form starch

fig-5: Black paper experiment

- Take a plant with destarched leaves. Remember the process of destraching leaves.
- Cover one of its leaves with black paper on which a design is cut. Fix the paper on the leaf in such a manner that light does not enter the dark part.
- Place this plant in the sun.
- After few hours of exposure to bright sunlight, test the leaf which is covered by black paper for the presence of starch.
- It will be observed that only the parts of the leaf, which could get light through the cut out design, turns blue-black showing the presence of starch.

Chlorophyll and Photosynthesis

Ingenhousz wanted to find out more about photosynthesis and carried out several other experiments. He proposed that only green plant parts could carry out the process of photosynthesis.

What about plants having colored leaves? How is it that new leaves which look dark red in colour in several plants turn green? Do plants having reddish or yellowish leaves also carry out photosynthesis? What made plants carry out photosynthesis while even green coloured animals (like

some birds)could not? Questions like these remained challenges until scientists could isolate the green coloured substance from plant parts and study its nature.

Establishment of Ingenhousz's proposition came after several experiments till the mid 20th century when scientists could also locate the site of photosynthesis and even isolate it. Around four decades after Ingenhousz's proposition scientists could only isolate the green substance to observe its nature and find out whether photosynthesis could be carried out with it. This had become possible in the year 1817 due to the work of two scientists Pelletier and Caventou who obtained an extract of the green colored substance and named it as chlorophyll means green leaf.

It was also found that the other pigments would aid in the process of photosynthesis by passing on the energy of sunlight trapped by them to chlorophyll.

Where does Photosynthesis take place?

Try to name some parts where you think photosynthesis occurs.

Do you think the new reddish leaves of plants also carry out photosynthesis? What could be the role of their colour?

The exact location of the photosynthetic part or a part containing chlorophyll was not known till another 60 decades after Pelletier and Caventou discovered chlorophyll. It was believed to be spread in the cells of green plant parts. In 1883, Julius von Sachs, observed that chlorophyll in plant cells is not spread through the entire cell. It is found in organelles within the cell. Such organelles were named as chloroplasts. These are present in large numbers in the cells (around 40 – 100) of parts like the stomatal guard cells and ground tissues of plants .

You have studied about Chloroplast in Class IX. Let us observe the figure.

fig-6(a): T-S of leaf

fig-6(b): T-S of chloroplast

What makes chloroplast appear completely different from other cell organelles?

Do you know

If a cell is broken up, the chloroplasts also break into pieces, so it becomes a very difficult task to isolate them to study the different steps of photosynthesis.It was not until 1954, that Daniel I. Arnon was able to break up plant cells so gently that whole chloroplasts could be obtained that could carry through photosynthesis.

It has been found that the chloroplast is a membranous structure, consisting of 3 membranes. The third layer that forms stacked sack like structures called as grana is believed to be a site for trapping of solar energy while the intermediary fluid filled portion called as stroma is believed to be responsible for enzymatic reactions leading to the synthesis of glucose, which in turn join together to form starch.

Mechanism of Photosynthesis :

There are two major phases are found in Photosynthesis. They are as follows:

1. Light reaction
2. Dark reaction

1) Light Reaction (Photo chemical Phase)

In this reaction light plays the key role. A series of chemical reactions occurs in a very quick succession initiated by light and therefore the phase is technically called the photochemical phase. The light reaction takes place in chlorophyll containing thalakoids called Grana of Chloroplasts . The light reaction occurs in several steps.

Step-I : The chlorophyll on exposure to light energy becomes activated by absorbing photons. (Photon is the smallest energy of light)

Step-II: The energy is used in splitting the water molecule into its two component ions

$H_2O \longrightarrow H^+ + OH^-$

The reaction is known as photolysis, which means splitting by light

(photo means light, lysis means breaking)

Step-III: The highly reactive ions of water undergoes quick change in two different directions of OH^- and H^+ ions as described below

OH^- ions through a series of steps produce water (H_20) and Oxygen (O_2). TheWater may be used inside the plant but O_2 is released into the atmosphere. H^+ ions undergo series of changes in dark reaction. ATP and NADPH are formed at the end of the light reaction these are called as assimilatory powers.

2. Dark reaction (Bio synthetic phase)

This reaction in the phase do not require light energy and occur simultaneously with the light reaction. (time gap between the two being less than even one thousands of a second)

The term dark reaction does not mean that they occur when it is dark at night. It only means that the reactions are not depend on light. H^+ Ions produced in photolysis are immediately picked up by special compound NADP to form NADPH. In the dark phase the hydrogen of the NADPH is used to combine it with Co_2 by utilizing ATP energy and to ultimately produce glucose ($C_6H_{12}O_6$). This synthesis occurs in a number of steps using certain special intermediate compounds (mainly RUBP Ribulose bi phosphate) and enzymes. Finally the glucose to convert to starch.

During photosynthesis several events occur in the chloroplast some of them are :

1. Conversion of light energy to chemical energy
2. Splitting of water molecule
3. Reduction of carbondioxide to carbohydrates

Light is required to initiate several events while several may continue even in the absence of it. That would mean, once light energy has been captured it can help reactions to continue even in the dark. Light dependent events or reactons are called light reactions and it has been found to take place in grana, while the rest are called dark reactions and they occur in the stroma.

Plants are capable of working under a range of situations, from very lighted hot dry conditions to wet, humid dim light conditions and requirement of light and other factors varies from one plant to another.

Heterotrophic Nutrition

Each organism is adapted to its environment. The form of nutrition differs depending on the type and availability of food materials as well as how it is obtained by the organism. For example whether the food source is stationary (such as grass) or mobile (such as a deer) would allow for differences in how the food is accessed and what are the parts of body involved in acquiring the same by a cow and a lion.

There is a range of strategies by which the food is taken in and used by the organism. Some organisms break down the food materials outside the body and then absorb it. Examples like bread moulds, yeast, mushrooms etc. Others take in whole material and break it down inside their bodies. What can be taken in and broken down depends on the body design and functioning . Some other organisms dertive nutrition from plants or animals without killing them this parasitic nutritive strategy is used by a wide variety of organisms like Cuscuta, lice, leaches and tapeworms.

How do organisms obtain their nutrition

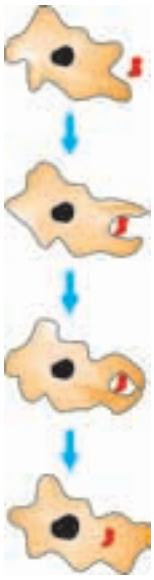

fig-7: Nutrition in Ameoba

Since the food and the way it is obtained differ, the digestive system is different in various organisms. In single celled organisms like amoeba the food may be taken in by the entire surface but as the complexity of the organism increases, different parts become specialized to perform different functions.

For example amoeba takesin food using temporary finger like extensions (pseudopodia) of the cell surface which fuse over the food particle forming food vacuole. Inside the food vacuole, complex substances are broken down into simpler ones which then diffuse into the cytoplasm. The remaining undigested material is moved to the surface of the cell and thrown out. In Paramoecium, which is also a unicellular organism the cell has a definite shape and food is taken in at a specific spot. Food is moved to the spot by the movement of cilia which covers the entire surface of the cell, where the food is ingested. (cytostome).

Parasitic nutrition in cuscuta

Dodder (*genus Cuscuta*) is a leafless, twining, parasitic plant belongs to morning glory family (Convolvulaceae). The genus contains about 170 twining species that are widely distributed throughout the temperate and tropical regions of the world. Many species have been introduced with their host plants into new areas.

fig-8: Haustoria in cuscuta

The dodder contains no chlorophyll(Cuscuta reflexa has been found to have very small amount of chlorophyll) and instead absorbs food through haustoria which are rootlike organs that penetrate the tissue of a host plant and may kill it. The slender, stringlike stems of the dodder may be yellow, orange, pink, or brown in colour. The dodder's flowers, in nodulelike clusters, are made up of tiny yellow or white bell-like, lobed corollas (united petals). Its leaves are reduced to minute scales.

The dodder's seed germinates, forming an anchoring root, and then sends up a slender stem that grows in a spiral fashion until it reaches a host plant. It then twines around the stem of the host plant and throws out haustoria, which penetrate it. Water is drawn through the haustoria from the host plant's stem and xylem, and nutrients are drawn from its phloem. Meanwhile, the root rots away after stem contact has been made with a host plant. As the dodder grows, it sends out new haustoria and establishes itself very firmly on the host plant. After growing in a few spirals around

one host shoot, the dodder finds its way to another, and it continues to twine and branch until it resembles a fine, densely tangled web of thin stems enveloping the host plant.

Nutrition in Human Beings

Human digestive system is very complex in nature where different parts are involved and perform different functions by using various digestive juices and enzymes.

Let us observe the figure of digestive system.

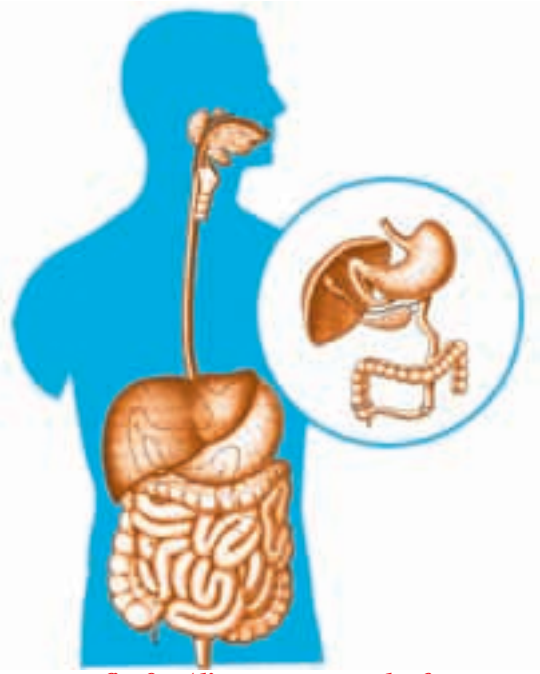

fig-9: Alimentary canal of man

The alimentary canal is basically a long tube extending from the mouth to the anus we can see that this tube has different parts. Various regions are specialized to perform different functions.

- What happens to the food once it enters our body?
- How it get digestive in the alimentary canal?

let us discuss. We eat various types of food which has to pass through the same digestive tract. The process of taking food in the body is called ingestion. Naturally the food has to be processed to generate particles which are small enough to be picked up by our body. The texture also needs to be such that it may be easily absorbed.

Steps in the passage of food through alimentary canal or gut.

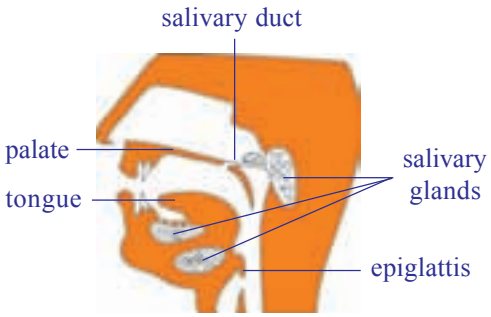

fig-10: Buccal cavity

Food is masticated by our teeth in the mouth and mixed with saliva to make it wet and slippery it helps in smooth passage through our alimentary canal to the stomach. Saliva is secreted by three pairs salivary glands located at the side of the jaw and below the tongue. They contains an enzyme amylase (ptyalin) which helps in the breakdown of complex carbohydrates to simple ones). Such process of breaking down of complex food

substances into the simple substances so that they can be used by the body with the help of enzymes is called digestion. The tongue helps in mixing the food and pushing it into the next part. The lower jaw also helps in the whole process. To know the chemical nature of saliva, let us do the litmus paper activity.

Activity-5

Litmus paper test

Before taking food into the mouth, take a litmus indicator paper and touch it to your tongue. Observe if there is any color change. Perform the litmus test again after chewing the food and swallowing it. Observe the color changes.

fig-11: Peristaltic movement

The soft food mixed with saliva passes through oesaphagus or food pipe by wave like movements called peristaltic movement to the stomach.

At the stomach food gets churned with gastric juice and HCl. It is in semi solid condition. The digestion of food goes on as most proteins are broken down into smaller molecules with the help of enzyme pepsin acting on them.

Food in the form of a soft slimy substance where some proteins and carbohydrates have already been broken down. This is called chyme. Now passes from the stomach to the small intestine as ring like muscles called as spincters relax to open the passage into the small intestine. The spincters are responsible for regulating the opening such that only small quantities of the food material may be passed into the small intestine at a time.

The small intestine is the longest part of the alimentary canal. It is the site of the complete digestion of carbohydrates, proteins and fats. It receives the secretion of liver and pancreas for this purpose. These juices render the internal condition of the intestine gradually to a basic or alkaline one.

Fats are digested by converting them into small globule like forms by the help of the bile juice secreted from liver. This process is called emulsification.

Pancreatic juice contains enzymes like trypsin for carrying on the process of digestion of proteins and lipase for fats.

Walls of the small intestine secrete intestinal juice which carry this process further that is small molecules of proteins are broken down to further smaller molecules . The same is the condition with fats. Carbohydrate digestion that started in the mouth and did not occur in the

stomach, resumes now as the medium gradually changes to an alkaline one and the enzymes for carbohydrate breakdown become active.

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Activity-6

Observation of enzymes chart

Let us observe the chart showing different enzymes and digestive juices and it functions discuss the chart in your class.

Table-

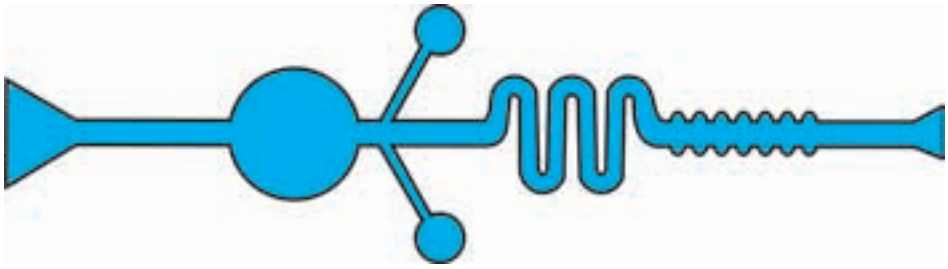
S.No.	Enzyme/Substance	Secreted by	Secreted into	Digestive juice	Acts on	Products
1	Ptyalin (salivaryamylase)	Salivary glands	Buccal cavity	Saliva	Carbohydrates	Dextrins and maltose
2	Pepsin	Stomach	Stomach	Gastric juice	Proteins	Peptones
3	Bile (No enzymes)	Liver	Duodenum	Bile juice	Fats	Emulification breaking down of largef ats into small globules
4	Amylase	Pancreas	Duodenum	Pancreatic juice	Carbhoydrates	Maltose
5	Trypsin	Pancreas	Duodenum	Pancreatic juice	Proteins	Peptones
6	Lipase	Pancreas Intestinal wall	Duodenum	Pancreatic juice Intestinal juice	Fats	Fatty acid and glycerol
7	Peptidases	Small Intestine	Small Intestine	Intestinal juice	Peptides	Amino acids
8	Sucrase	Small Intestine	Small Intestine	Intestinal juice	Sucrase (Cane Sugar)	Glucose

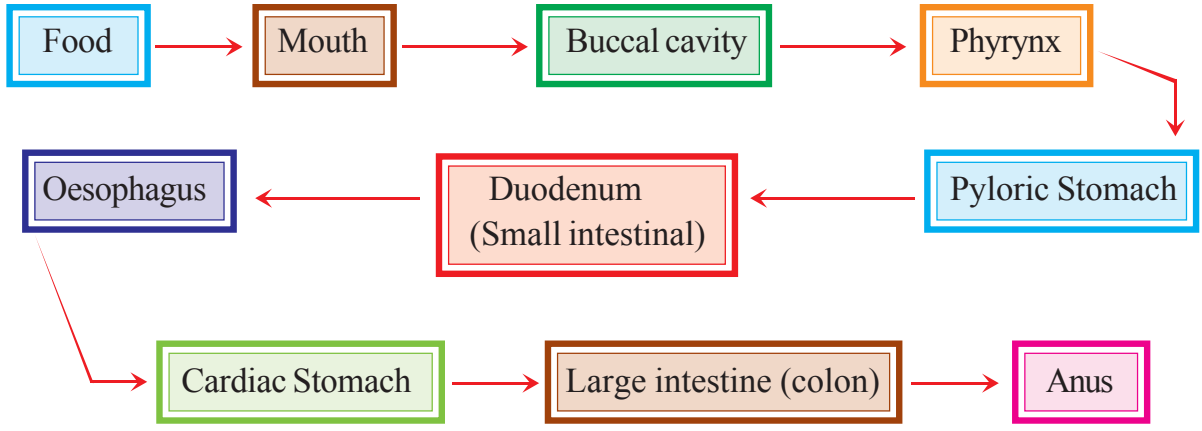
- Name the enzymes which act on carbohydrates?
- Which juice contains no enzymes?
- What are the enzymes acts on proteins?

Transport of the products of digestion from the intestine into blood (through the wall of intestine) is called absorption. Internally, intestinal wall has a number of fingers like processes called villi. The villi increase the surface area for absorption. Blood vessels and lymph vessels are present in the form a network in the villi. Products of digestion are absorbed first into the villi and from here into the blood vessels an lymph vessels. Digested food is taken up by the walls of the small intestine. They help to take up maximum amount of digested food to be sent to various parts of the body through blood. Rest of the food material passes to the large intestine. Where most of the water present is taken up from this material. This material is then expelled through the anus which is the last part of the alimentary canal. This passage of undigested material from the body by the way of anus is called defecation. Food that passes out of the anus still contains considerable amount of proteins, fats and carbohydrates, roughages are fibres of either carbohydrates or proteins

Flow chart of human digestive system

Let us observe the diagramatic representation of human digestive system.





Health aspects of the alimentary canal

The human alimentary canal usually functions remarkably well considering how badly we treat it on occasions! Sometimes it rebels, and we either feel sick or have indigestion.

Vomiting is the body's method of ridding itself of un-wanted or harmful substances from the stomach. The peri-staltic movements of the stomach and oesophagus reverse their normal direction and the food is expelled. There are many causes of vomiting, but one of the most common is over-eating, especially when the food contains a high pro-portion of fat. Vomiting also occurs when we eat something very indigestible or poisonous.

When we feel 'bilious' or 'liverish', it is often the result of having eaten 'rich' meals over several days. The liver is unable to cope with the excessive fat and we get a feeling of nausea and sometimes a headache.

Indigestion is a general term used when there is difficulty in digesting food. Healthy people can usually avoid in-digestion by: a) having simple, well-balanced meals, b) eating them in a leisurely manner, c) thoroughly masticat-ing the food, and d) avoiding taking violent exercise soon afterwards. We can learn a lot from other mammals which after a meal have a good sleep!

A more serious form of indigestion is caused by stomach and duodenal ulcers. These conditions occur more often in people who may be described as hurried or worried. Thus ulcers occur more often in busy people who get into the habit of hurrying over meals and rushing from one activity to another without sufficient rests such as doctors, school-masters, members of parliament, stock-brokers and business executives. Those who are able to relax, who are not continually tensed up, and who live at a slower pace, seldom get ulcers.

For good health it is necessary to empty the bowels regularly. If the food residues remain in the colon for too long, the bacteria present have more time to produce harm-ful substances which may be absorbed by the blood. Constipation can often be avoided by having plenty of roughage in the diet.

Food defficiency diseases

We know that food is main source to maintain biological processes in a perfect manner. Our diet should balanced one which contains proper amount of carbohydrates, proteins, vitamins, mineral salts and fats. $^{2}/_{3}$ of world population affected by food related diseases. Some of them are

suffering by consuming high calorific food. Most of them are facing various diseases dur to lak of balanced diet. It is very important to discuss about food deficiency diseases.

Eating of food that does not have one or more than one nutrients in required amount is known as mall nutrition. Poor health, willfull starvation, lack of awareness of nutritional habits, socio economic factors are all the reasons for mall nutrition in our country.

Mall nutrition is of three types 1. Calory mall nutrition, 2. Protein mall nutrition, 3. Protein calory mall nutrition. Let us observe harmfull effects of mall nutrition in children.

1. Kwashiorkor disease: This is due to protein dificiency in diet. Body parts become swollen due to accumulation of water in the intercellular spaces. Very poor muscle development, swollen legs, fluffy face difficult to eat, diarea, dry skin are the symptoms of this disease.

2. Marasmus: This is due to deficiency of both proteins and calories. Generally this disease occure when there is an immidiate second pregnancy or repeated child births. Lean and week, swelling limbs, less devoloped muscles, dry skin, diarea, etc., are the symptoms of this disease.

3. Obesity: This is due to over eating and excess of energy in take. It is a big health hazard. Obease children when grows of will be a target of many diseases like diabaties, cordio vascular, renal, gall blodder problems.

Vitamin deficiency diseases

Vitamins are organic substances. They are micro nutrients required in small quantities. Actually vitamines are not synthesised in the body, we do not generally suffer from vitamine deficiency. This is because of two sources of vitamins for our body. One is diet and other is bacteria present in the intestain synthesis and supply the vitamins.

Vitamins are classified into two groups. One is Water soluble vitamins (Becomplex, vitamin C) and other is fat soluble vitamins (vitamin A, D, E and K). Let us study the following chart showing vitamin available sources and deficiency diseases.

Vitamin	Resources	Deficiency diseases	Symptoms
Thiamine (B1)	Cereals, oil seeds, vegetables, milk, meat, fish, eggs.	Beri beri	Vomitings, fits, loss of appetite, difficulty in breathing, paralysis.
Reboflovin (B_2)	Milk, eggs, liver, kidney, green leafy vegetables.	Glossitis	Mouth cracks at corners, red and sore tongue, photophobia, scaly skin.
Niacin (B_3)	Kidney, liver, meat, egg, fish, oil seeds.	Pellagra	Dermtities, diarrhorea, loss of memory, scaly skin.
Pyridoxine (B_6)	Cereals, oil seeds, vegetables, milk, meat, fish, eggs, liver.	Anemia	Hyper irritability, nosia, vomiting, fits.
Cyanocobalamine (B_{12})	Synthesised by bacteria present in the intestain.	Pernicious anemia	Lean and week, less appetite.
Folic acid	Liver, meat, eggs, milk, fruits, cereals, leafy vegetables.	Anemia	Diarrhorea, loss of lucosytes, intestinal mucus problems.
Pantothenic acid	Sweet potatoes, ground nuts, vegetables, liver, kidney, egg.	Burning feat	Walking problems, sprain.
Biotin	Pulses, nuts, vegetables, liver, milk, kidney.	Nerves disorders	Fatigue, mental depression, muscle pains.
Ascorbic acid (C)	Green leafy vegetables, citrus fruits, sprouts.	Scurvy	Delay in healing of woonds, fractures of bones.
Retinal (A)	Leafy vegetables, carrot, tomoto, pumpkin, papaya, mango, meat, fish, egg, liver, milk, card liver oil, shark liver oil.	Eye, skin diseases	Night blindness, xeropthlmia, cornea failure, scaly skin.
Calciferol (D)	Liver, egg, butter, card liver oil, shark liver oil, (morning sun rays).	Rickets	Improper formation of bones, Knockneas, swollen wrists, delayed dentition, week bones.
Tocoferol (E)	Fruits, vegetables, sprouts, meat, egg, sunflower oil.	Fertility disorders	Sterility in males, abortions in females.
Phylloquinone (K)	Green leafy vegatables, milk.	Blood clotting	Delay in blood clotting, over bleeding.

Key words

Glucose, starch, cellulose, grana, stroma, light reaction, dark reaction, heterotrophic nutrition, haustoria, Alimentary canal, salivary glands, peristaltic movement, amylase, ptyalin, pepsin, chyme, sphincter, digestion, pancreas, enzymes, villi, bile juice, lipase, fat, liver, emulsification.

What we have learnt

- Autotrophic nutrition involves the intake of simple inorganic materials like some minerals, water from the soil as well as some gases from the air and using an external energy source like the sun to synthesis complex high energy organic material.
- Photosynthesis is the process by which living plant cells containing chlorophyll, produce food substances [glucose & starch] from Carbon dioxide and water by using light energy. Plants release oxygen as a waste product during photosynthesis.
- Photosynthesis process can be represented as

  $6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6H_2O + 6O_2$
- The materials required for photosynthesis are light: Carbon dioxide, Water, green color pigment chlorophyll.
- Chloroplast are the sites of photosynthesis light reaction takes place in the grana region reaction which is independent of light takes place in the storma region.
- The end product of photosynthesis are Glucose water and Oxygen.
- During photosynthesis the important events which occurs in the chloroplast are
  a) Conversion of light energy
  b) Splitting of water molecule
  c) Reduction of carbon dioxide to carbohydrates
- Heterotrophic Nutrition involves the intake of complex material prepared by other organisms.
- The form of nutrition differs depending on the type and availability of food material as well as how it is obtained by the organism.
- In single celled organisms the food may be taken in by the entire surface but as the complexity of the organism increases different parts becomes specialized to perform different funchoru.

- The large complex food molecules such as carbohydrates, proteins , liquids are broken down in to simple molecules before they are absorbed and utilized by the animals this process of breaking down of complex molecules in to simple molecule is called digestion.
- In human beings the food eaten is broken down in various steps with the helps of enzymes secreted by digestive glands which are associated with the alimentary canal and the digested food is absorbed in small intestine to be sent to all cells in the body.
- The digestive system includes the alimentary tract and several associated organs. The functions of system are as follows :
  a) Ingestion: Taking of food into the body
  b) Digestion: Breaking up of complex food substances into the simple substances. So that they can be used by the body which will be carried out by specific enzymes.
  c) Absorption: The passage of digested food through the walls of alimentary tract (particulars in small intestine) into circulatory system.
  d) Defecation: The passage of undigested material from the body by the way of anus.

Improve your learning

1. Write ddifferences between (AS1)
   a) autotrophic nutrition - heterotrophic nutrition
   b)
   c)
   d)
2. Give reasons (AS1)
   a) Why photosynthesis is considered as the basic energy source for most of living world?
   b) Why is it better to call the dark phase of photosynthesis as a light independent phase?
   c) Why is it necessary to destrach a plant before performing any experiment on photosynthesis?
   d) Why is it not possible to demonstrate respiration in green plant kept in sunlight?
3. Give examples (AS1)
   a) Digestive engime
   b) Organisms having heterotrophic nutrition
   c)
   d)
4. Where do plants get each of the raw materials required for photosynthesis?(AS1)
5. Explain the necessary conditions for autotrophic nutrition and what are its by products?(AS1)
6. With the help of chemical equation explain the process of photosynthesis in detail? (AS1)
7. Name the three end products of photosynthesis? (AS1)

8. What is the difference between light reaction and dark reaction? (AS1)
9. Most leaves have the upper surface more green and shiny than the lower ones why? (AS1)
10. Explaint he structure chloroplast with a neatly labeled diagram. (AS1)
11. What is the role of acid in stomach? (AS1)
12. What is the function of digestive enzyme? (AS1)
23. How is the small intestine designed to absorb digested food explain with neatly labeled diagram? (AS1)
24. How do fats digested in our bodies? Where does this process takes place? (AS1)
25. What is the role of saliva in the digestion of food? (AS1)
26. What will happen to protein digestion as the medium of intestine is gradually rendered alkaline? (AS1)
27. What is the role of roughages in the alimentary track? (AS1)
28. How do non green plants such as fungi and bacteria obtain their nourishment? (AS2)
29. If we keep on increasing Co_2 concentration in the air what will be the rate of photosynthesis? (AS2)
30. What happens to plant if the rate of respiration becomes more than the rate of photosynthesis? (AS2)
31. Why do you think that carbohydrates are not digested in the stomach? (AS2)
32. What process you follow in your laboratory to study presence of starch can leaves? (AS3)
33. How would you demonstrate that green plant release oxygen when exposed to light? (AS3)
34. Visit a doctor and find out keeping in view of digestion. Prepare a chart and display in your classroom. (AS4)
    i) Under what condition does a patient need to become a drip of glucose.
    ii) Till when does a patient need to be given a glucose.
    iii) How does the glucose help the patient to recover.
35. If there were no green plants, all life on the earth would come to an end! Comment? (AS5)
36. Draw a neatly labeled diagram of stomatal apparatus found in leaf, and it's role in photosysthesis? (AS5)
37. Draw the label diagram of human digestive system? List out the parts where peristalasis takes place. (AS5)
38. Draw the flow chart showing the passage of the food through different parts of the elementary canal? (AS5)
39. Almost all the living world depends on plants for food material. How do you appreciate the process of making food by the green plants? (AS6)

40. Even a heard solid food also becomes smooth slurry in the digestive system, engimes release at a perticular time. This mechanism is an amazing fact. Prepare a cartoon on it. (AS6)
41. What food habbits your going to follow after reading this chapter? Why? (AS7)

Choose the correct answer

42. How do following organisms take the food? ( )

    a) Yeast b) Mushrooms c) Cuscuta

    d) Leeches e) Amoeba f) Tapeworm

43. The rate of Photosyntesis is not affected by: ( )

    a) Light Intensity b) Humidity C) Temperature d) Carbondioxide Concentration

44. A plant is kept in dark cupboard for about forty eight hours before conducting any experiment on Photosynthesis in order to : ( )

    a) Remove Chorophyll from leaves b) Remove Starch from leaves

    c) Ensure that no photosynthesis occurred d) Ensure that leaves are free from the Starch

45. The digestive juice without enzyme is ( )

    a) Bile b) Gastric juice c) Pancrtatic juice d) saliva

46. In single celled animals the food is taken ( )

    a) By the entire body surface b) Mouth c) Teeth d) Vacuoles

47. Which part of the plant takes in carbondioxide from the air for photosynthesis ( )

    a) Root hair b) Stomata c) Leaf veins d) Sepals

Fill in the blanks

48. The food synthesized by the plant is stored as _____
49. _____ are be sites of photosynthesis.
50. Pancreatic juice contains enzymes for carrying the process of digestion of _____ and _____
51. The finger like projections which increases the surface area in small intestine is called_____
52. The gastric juice contains _____ acid.

Chapter

2

Respiration - The energy releasing system

Using food to carry out life processes is key to life for all living organisms be they multi cellular or unicellular. In the chapter on nutrition we have discussed how the body draws out nutrients from the food taken in. Respiration is the process by which food is broken down for release of energy. Respiration leads to final utilization of food. Food is to be burnt down for obtaining energy for day to activities. When oxygen is plentiful respiration normally takes over. Cells of the living body are using food and working constantly to help our body function properly. They require the presence of gas, food material and some chemicals for that.

The term 'respiration' which had come from a Latin word respire meaning 'to breathe', refers to the whole chain of processes from the inhalation of air to the use of oxygen in the cells. To begin with, we shall study the relation of gases and the process of respiration.

Discovery of gases and respiration

Levoiser

The term respiration came into use, a century after the word breathing was used, way back in the 14th century. It was used much before people knew that air is a mixture of gases. They hardly knew anything about all the life processes that took place internally in a living body. Respiration which was used as a medical term, usually referred to as a process involving passage of air and production of body heat.

It was not until 18th century when Lavoisier and Priestley did a comprehensive work on properties of gases, their exchange and respiration that we came to know something about how the process of gaseous

exchange goes on, in our body. You have already studied about some of Priestley's experiments in earlier classes (You have an account of it in the chapter on nutrition as well). Revise the account and answer the following-

- Can it be said that Priestley's experiment helped us to find out more about composition of air? How?

Lavoisier also carried out several experiments to understand the property of gases.

In his early experiments, it is clear that Lavoisier thought that the gas liberated on heating powdered charcoal in a bell-jar kept over water in a trough was like fixed air(in those days carbon dioxide was known as fixed air). The next series of experiments deals with the combustion of phosphorus in a bell-jar. From them Lavoisier showed that whatever it was in the atmospheric air which combined with the phosphorus, was not water vapor. His final words are that the substance which combines with the phosphorus is "either air itself, or another elastic fluid contained, in a certain proportion, in the air which we breathe". This was the respirable air, a component of air that also helped in burning.

Prestley

- What was produced by combustion according to Lavoisier?
- What did Lavoisier find out about air from his experiments?
- What conclusion can be drawn from Lavoisier's experiments?

Lavoisier noted that there was a profound difference between the air in which combustion of a metal had been carried out and the one which had served for respiration. The air that we breathe out precipitated lime water while that after heating metal did not.

From this he deduced that there were two processes involved in respiration, and that of these he probably knew only one. He therefore carried out another experiment by which he showed that about one-sixth of the volume of 'vitiated air'(a term used then to show air from which the component needed for burning had been removed) consists of chalky-acid gas(fixed air). Therefore, to re-create common air from vitiated air, it was not enough merely to add the appropriate amount of eminently air needed for burning or respirable air; the existing chalky acid gas must also be removed.

He drew immediately the logical conclusion regarding the process of respiration. Either eminently respirable air is changed in the lungs to chalky acid air; or an exchange takes place, the eminently respirable air being absorbed, and an almost equal volume of chalky-acid air being given up to the air from thelungs. He had to admit that there were strong grounds for

believing that eminently respirable air did combine with the blood to produce the red color.

Lavoisier's findings lead way to several other researchers.

- Which gas do you think is Lavoisier talking about when he says chalky acid gas?
- Which gas according to him is respirable air?
- What steps in the process of respiration does Lavoisier mention as an inference of his experiments?

A few lines from a textbook of Human Physiology, written by a renowned chemist, John Daper around mid-19th century goes like this- 'The chief materials which a living being receives are matter that can be burnt, water and oxygen gas; and out of the action of these upon one another, all the physical phenomena of its life arise. What the body expels out is water, oxide of carbon, phosphorous, sulphur and others.'

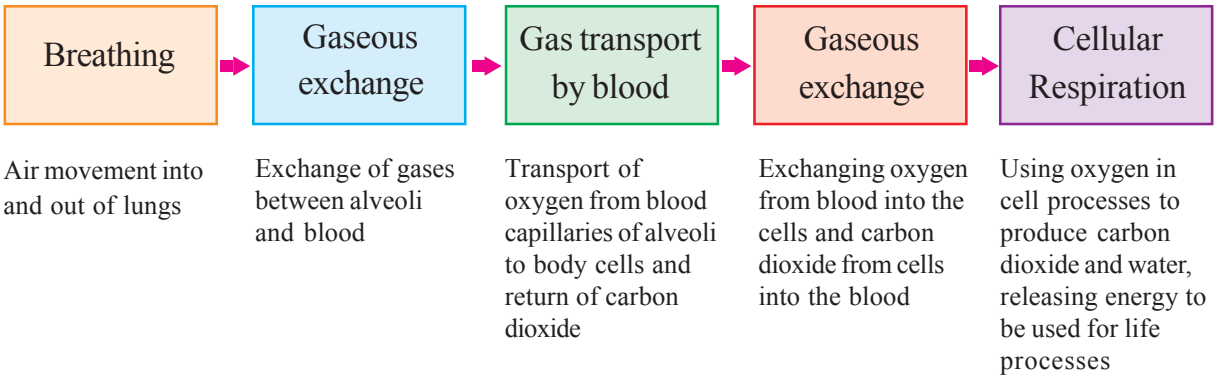
Thus we can see that the role of major compounds and elements in the process of respiration was known by mid19thcentury. The events involved were not very clearly understood, but, people believed that there was some relationship of the heat produced in the body and the process of respiration.

- It is a common observation that our breath is warmer than the air around us; does respiration have anything to do with this?

Let us study the events involved in respiration in human beings to figure it out.

Events / Steps in Respiration

There are no strict demarcations of events involved in the process of respiration. It is a very complex process of several biochemical and physical processes. But for a general understanding on what goes on, we shall study under the following heads.



Breathing

In the previous classes we had done experiments to find out what was there in the air we breathe out.

We had seen that in a set up with lime water, it turned milky quite fast as we breathe out into it as compared to a similar set up in which normal air was passed with the help of a syringe or pichkari in lime water. (Experimental set up to test the presence of Carbon dioxide in exhaled air). Arrange apparatus as shown in figure and try to do the experiment once again to find out what happens.

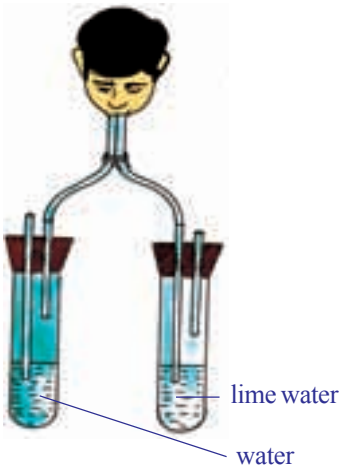


fig-1: Respiratory gases

- What does this experiment indicate?
- Which gas turns lime water milky?
- Which gas do you think might be present in greater quantities in the air we breathe out as compared to air around us?
- We are also aware of the fact that water vapor deposits on a glass pane if we breathe out on it.
- Where does this water vapor come from in exhaled air?

We shall have to study the pathway of air in our body through our respiratory system and the mechanism of breathing respiration to find that out how the exhaled air comes to contain more of some components and less of some others (Fig showing the respiratory system/pathway). By "respiratory system" we usually mean the passages that transport air to the lungs and to the microscopic air sacs in them, called alveoli (where gases are exchanged between them and blood vessels) and vice versa.

Pathway of air

Let us observe the path way of air from nastril to alveolus.

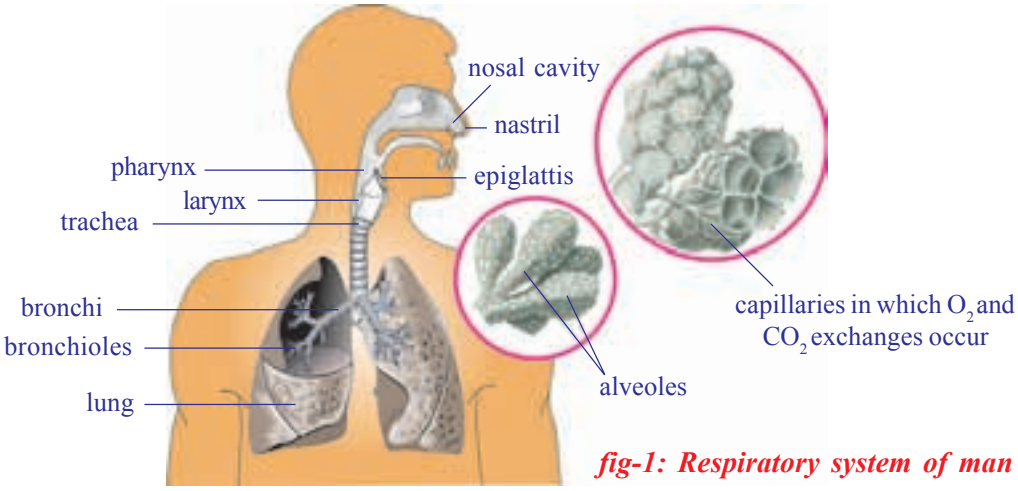


fig-1: Respiratory system of man

Nostrils: Air usually enters the body through the nostrils

Nasal cavity: Air is filtered. The moist surface of the lining of the nasal cavity, and the hairs growing from its sides, remove some of the tiny particles of dirt in the air. In addition, as the inhaled air passes through the nasal cavity, its temperature is brought close to that of the body, and it takes up water vapor so that it becomes more moist than before.

Pharynx: Warming and moistening goes on in this common passage of digestive and respiratory system. Epiglottis, a flap like muscular valve controls movement of air and food towards their respective passages.

Larynx: This stiff box contains our vocal cords. When air passes out of the lungs and over the vocal cords, it causes them to vibrate. This produces sounds on the basis of our speech, song etc.

Trachea: Wind pipe channeling air to lungs. Touch your neck to feel the tube like structure.

Bronchus: At its lower end the trachea or the wind pipe divides into two bronchi-one leading to each lung.

Bronchioles: The bronchi further divide into smaller and smaller branches called bronchioles.

Alveolus: These finally terminate in clusters of air sacs called alveolus in the lungs which are very small and numerous. Gaseous exchange takes place here as blood capillaries take up oxygen and expel carbon dioxide here.

Blood: Carries oxygen to each and every cell of the body.

The whole passage from nostrils to alveolus is moist and warm.

Do you know?

Their interior of lung is divided into millions of small chambers, thus tremendously increasing the moist surface available for transfer of gases between air and blood. The linings of the lungs are much folded and so their total surface is enormous. If all alveoli of our lungs are spread out they will cover an area of nearly 160 m^2.

Think and discuss

- What will happen if the respiratory tract is not moist?
- Are both lungs similar in size?
- Why alveolus are so small and uncountable in number?

Epiglottis and passage of air

Epiglattis diverts air to lungs

fig- : Breathing

Epiglattis diverts food mass away from opeing of larynx

fig- : Swalowing

From the nasal cavity the air goes into the pharynx. There is a tricky problem here. From the pharynx there are two passageways, beginning with nearly same opening and ending into separate ones, one to the lungs and one to the stomach. It is important that air goes in one and food in the other. It is also important that food *does not* enter the tube through which air goes to the lungs. The traffic is kept properly channeled by a flap like valve, the ***epiglottis*** that protects the tube to the lungs, arresting entry of food. Observe the following figures and discuss in your class how epiglottis works while breathing or swallowing

This valve is partly closed when we swallow food; it deflects food down to the stomach and keeps it out of the trachea or wind pipe which is the route to the lungs. The epiglottis opens more widely when we take a breath, and air enters the lungs. Nervous regulation is important in guiding the function of epiglottis and passage of food and air. Let us try to do an activity to feel what happens when we swallow food.

- Why we are advised not to talk while eating food ?

Activity-1

Keep your palm around an inch away from your nose; feel you breathing out; do not remove it until you have finished the activity. Breathe steadily for 1-2 minutes. Now take a piece of any fruit, chew and before swallowing it keep the fingers of the other palm on your neck, now swallow it.

- What did you notice? What happens to your breath as you try to swallow?
- What is helping you to swallow without deflecting it to the wind pipe?

Mechanism of respiration in human being

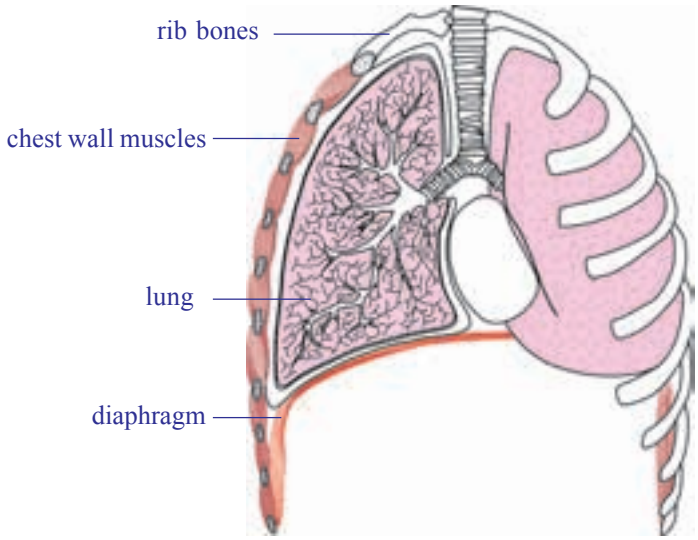


fig- : Movement of diaphragm

We know that breathing is the process of inhaling and exhaling. All of us know that the organs involved are mainly the lungs. You can't see your lungs, but it's easy to feel them in action. Put your hands on your chest and breathe in very deeply. You will feel your chest getting slightly bigger. Now breathe out the air, and feel your chest return to its regular size. You've just felt the power of your lungs! The lungs themselves can neither draw in air nor push it out. Instead, the chest wall muscles and another flexible flattened muscle called **diaphragm** works the lungs in moving air into and out of them. See how the diaphragm works in the figure.

- What is the role of diaphragm and ribs in respiration? Are both active man and woman?

The chest wall is made up of the ribs, muscles, and the skin. The ribs are attached at an angle to the spine (if you run your finger along one of your ribs, you will notice that it extends downward from the spine). When we inhale, the chest wall moves up and out. This increases the volume of the chest cavity.

fig- : Movement of rib cage at inhalation, exhalation

The diaphragm may be imagined as the "floor" if you think of the chest cavity as a "room." When the diaphragm is relaxed, it is in the shape of a dome - with the convex side of the dome extending into the chest cavity. When the diaphragm contracts it flattens out a bit or the dome moves downward. As a result, the volume of the chest cavity is increased.

When the volume of the chest cavity is increased, its internal pressure decreases and the air from the outside rushes into the lungs. This is **inspiration** (inhalation).

Then the reverse occurs. The chest wall is lowered and moves inward, and the diaphragm relaxes and assumes its dome shape. These changes increase the pressure on the lungs; their elastic tissue contracts and squeezes the air out through the nose to the external atmosphere. This is **expiration** (exhalation).

Do you know?

Our lungs are spongy and elastic in nature. They are not of the same size. The lung towards left is slightly smaller making space for your heart! Lungs are protected by two membranes called pleura. A fluid filled between these membranes that protect the lungs from injury and also aid in the expansion of the spongy and elastic lung muscle, as they slide one over the other.

You must have noticed that your own breathing is slow and shallow when you are at rest, and deeper and faster when you exercise hard. Indeed, patterns of breathing show a great range, for they are coordinated with moment-by-moment needs of the body for supply of oxygen and removal of carbon dioxide.

What other situations affect your breathing?

It has been found that all movements of breathing stop at once when the nerves leading from the brain to the respiratory muscles are cut.

- What can be concluded from this?
- What happens during the process of breathing?
- Which gas needs to be removed from our body during exhalation? Where does the extra amount of gas come from?
- What is the composition of inhaled air?
- When compare with inhaled air is there any difference in composition of exhaled air?

Gaseous Exchange (alveoli to capillaries)

Gaseous exchange takes place within the lungs, by diffusion from the alveoli to blood capillaries and vice versa.The carbon dioxide in the blood is exchanged for oxygen in the alveoli. These tiny air sacs in the lungs are numerous and only one cell thick. They are surrounded by capillaries that are also only one cell thick. Blood, dark red in colour flows from the heart through these capillaries and collects oxygen from the alveoli. At the same time, carbon dioxide passes out of the capillaries and

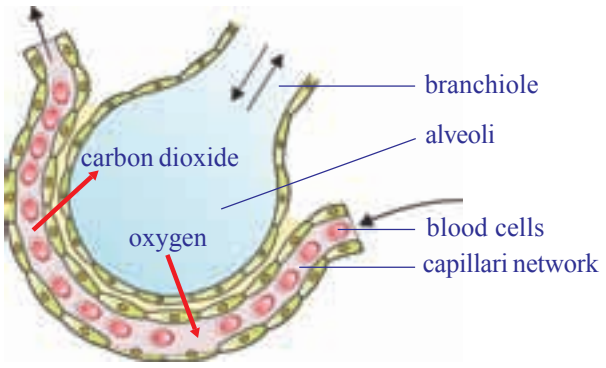


fig- : Diffussion path way for gaseous exchange between lung and blood capillaries

into the alveoli. When we breathe out, we get rid of this carbon dioxide. The bright red, oxygen-rich blood is returned to the heart and pumped out to the body.

As a result of gaseous exchange, the composition of inhaled and exhaled air is different. See the table given below.

Gas	% in inhaled air	% in exhaled air
Oxygen	21	16
Carbon dioxide	0.04	4
Nitrogen	79	79

Approximate values are given in the table

- Why does the amount of Oxygen vary between exhaled and inhaled air?
- What has raised the percentage of carbon dioxide in exhaled air?

Do you know?

The total lunge capacity of human being is nearly 5800ml. Normally at rest who inhale or exhale approximately 500ml of air. 1200ml of air remains in lungs after complete exhalation. Recall the activity of lung capacity performed by you in class VII in the chapter Respiration in Organisms.

Transportation of gases

Till the lungs and the alveoli it is air that enters our body and we know that air is a mixture of gases. The relative amount of gases and their combining capacity with hemoglobin and other substances in blood determine their transport via blood in the body.

When oxygen present in the air is within normal limits(around 21%) then almost all of it is carried in the blood by binding to hemoglobin, a protein (quite like chlorophyll, the only major difference being it has iron in place of magnesium as in chlorophyll) present in the red blood cells. As oxygen is defused in the blood, it rapidly combines with the hemoglobin to form oxy hemoglobin. Not only can hemoglobin combine with oxygen, but the reverse can also happen to yield a molecule of hemoglobin and oxygen.

Carbon dioxide is usually transported as bicarbonate, while some amount of it combines with hemoglobin and rest is dissolved in blood plasma.

$$Hb + O_2 \longrightarrow HbO_2$$

$$HbO_2 \longrightarrow Hb + O_2$$

Do you know?

If hemoglobin is exposed to air at sea level, nearly every molecule combines with oxygen to form oxy hemoglobin. At a height of 13 km (about 8 miles) above sea level, the concentration of oxygen is much lower about one fifth as great as at sea level.

fig- : Mountaneer

Under these conditions only about half as many molecules of oxygen combine with hemoglobin to form oxy hemoglobin. this is important, because blood cannot carry enough oxygen to the tissues if hemoglobin is combined with few oxygen molecules. In fact, human life is impossible at such an altitude without a supplementary supply of oxygen. Provision for such a supply is built into modern aircraft, which have pressurized cabins that maintain an enriched air supply. When we go down we will face another type of problems.

Gaseous exchange (capillaries to cells and back)

In the capillaries over the tissues, hemoglobin meets a very different environment. The tissue cells are continually using oxygen, hence, the concentration of oxygen is quite low in them. It might be only one third of that in the lungs. As the concentration of oxygen is so low, oxy hemoglobin releases the oxygen molecule which enters the cells. In the reactions that occur within cells in our bodies, carbon dioxide and water are produced and energy is released to be used up for different purposes. The cells expel them into blood capillaries.

Cellular respiration

The term cellular respiration refers to the pathway by which cells release energy from the chemical bonds of food molecules that enter them and provide that energy for the essential processes of life. All living cells must carry out cellular respiration. It can be in the presence of oxygen that is aerobic respiration or in its absence that is anaerobic respiration (fermentation). Cellular respiration in prokaryotic cells like that of bacteria occur within the cytoplasm. In eukaryotic cells cytoplasm and mitochondria are the site of

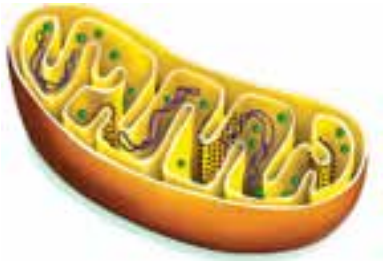


fig- : Mitochondria

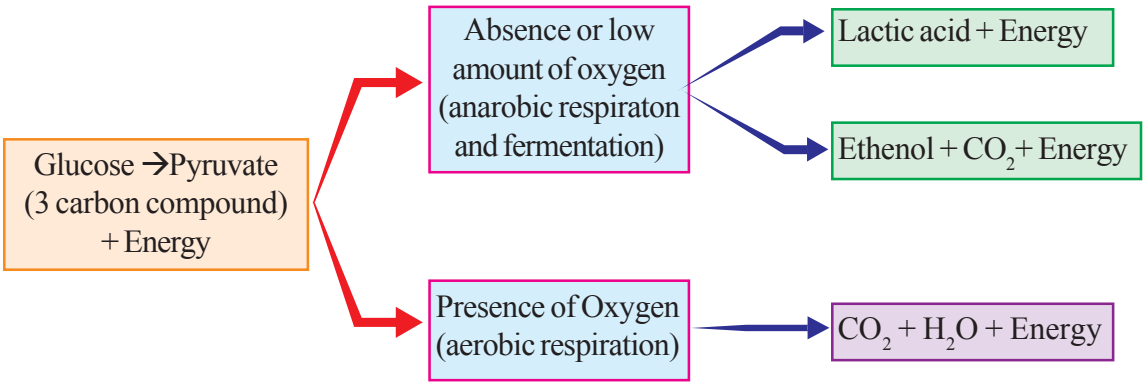
nature of the molecule from one stage to the next is slight, in any step small amount of energy is released. The complete breakdown of a sugar molecule with the release of all its available energy involves a series of different chemical reactions.

Each small Parcel of chemical energy from the breakdown of sugar is stored up in a special compound, known as ATP. The energy currency of these cells is ATP (adenosine triphosphate) an energy rich compound that is capable of carrying energy wherever needed within the cell.

Each ATP molecule gives 7200 calories of energy. This energy is stored in the form of phosphate bonds. If the bond is broken the stored energy is released.

- Do cells of alveoli or lungs also require oxygen to carry out cellular respiration? Why/Why not?

In short at cellular level we could have the following pathways starting with glucose(as an example, remember that there are other components of food as well)



Do you know?

Glucose is the most commonly used sugar for deriving energy in plants, animals and in microorganisms. In all these organisms glucose is oxidized in two stages. In the first stage it is converted into two molecules of pyruvic acid. In the second stage if oxygen is available pyruvic acid oxidized to CO_2 and water, large amount of energy is released. If oxygen is inadequate or not available pyruvic acid is converted into either ethanol or lactic acid and very little amount of energy (nearly one tenth that produced in adequeate amount of oxygen) is released.

Can energy be released without oxygen?

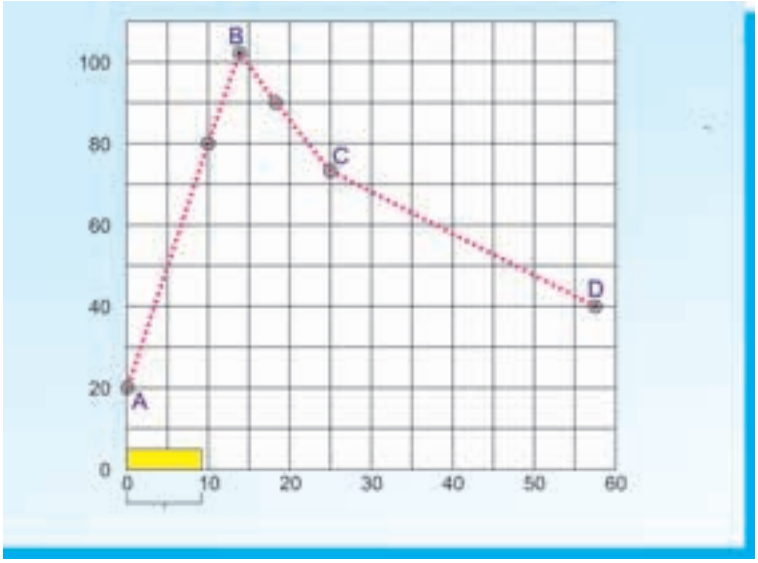
- After undergoing strenuous exercise we feel pain in muscles, does adequate oxygen reach the muscles?
- What is being formed in the muscles?

fig- : Athelet (Strenus excercise)

When you sprint a hundred yards, you do a considerable amount of muscular work. But you do not start a race by standing on the track and panting for a few minutes to stoke up with oxygen first. In fact you can run the race with very little extra breathing. The fastest sprinters do not breathe at all when running a hundred yards. After you have reached the tape, however, you feel very different. Depending on your state of training, and on how hard you ran, you will pant for some minutes after the race, until your breathing gradually returns to normal.

These facts could be linked up with what we have learned so far about ATP. It might be that the race was run on the energy produced when the ATP already present in your muscles was being converted to ADP. Unfortunately this pleasantly simple idea is inadequate, because we only carry sufficient A TP in a muscle to last for about half a second when doing vigorous exercise. There must be some other explanation for the way in which we can pro- duce energy first and then use up oxygen later.

One approach in the study of this problem was to analyze the blood of a person during and after exercise. For obvious reasons the athlete taking part in the experiment had to stay still where the apparatus was. He pedaled a stationary bicycle, or ran on a tread mill (moving as fast backwards as the athlete moved forwards). Some results are shown in the graph. Vigorous exercise lasted for nine minutes (shown by the bar at the base of the diagram) and regular blood samples were taken and analyzed. One particular compound in the blood, lactic acid, was found to vary greatly in its concentration as you can see from the graph.



Graph showing effects of vigorous excercise on the concentration of lactic acid in blood.

Observe the graph of lactic acid accumulation in the muscles of an athelete and answer the following questions.

(Graph showing varying amount of lactic acid in the muscles)

x - axis = Time in minutes

y - axis = Concentration of lactic acid in blood mg/cm^3

a. What was the concentration of lactic acid in the blood to start with?

b. What was the greatest concentration reached during the experiment?

c. If the trend between points C and D were to continue at the same rate, how long might it take for the original lactic acid level to be reached again? (Hint: extend the line CD until it reaches the starting value.)

d. What does high level of lactic acid indicate about the condition of respiration?

Accumulation of lactic acid results in muscular pain. If we take walk, brisk walk, slow jogging, running for same distance we feel that there an increase in pain levels this is because of lactic acid accumulation.

It seems as if the lactic acid was being produced rapidly by the active muscles, and then only gradually removed from the blood after exercise. What is surprising is that the athlete needs a great length of time to recover. The simplest explanation we can produce at-this stage is that the sugar in the working muscles was being changed to lactic acid. The energy stored in lactic acid molecules is less than that in sugar molecules, and if the acid comes from the sugar then the energy released could be used to rebuild ATP from ADP and phosphate.

During a 100m race a well-trained athlete can hold his breath all the time it is not until afterwards that he pants. In this case, the muscles are using the energy released during the anaerobic breakdown of glucose. It is not until afterwards that the athlete obtains the oxygen needed in order to remove the lactic acid. Therefore, when we under-take strenuous exercise we build up what is called an **oxygen debt** which has to be repaid later. In a longer race athletes have to breathe all the time, so some lactic acid is removed while they are running, and they can go on for longer before becoming exhausted. The presence of lactic acid in the blood is the main cause of muscle fatigue, but if the body is rested for long enough the tiredness goes.

Anaerobic respiration

We have found that living things produce carbon dioxide and give out energy. If these processes are caused by an oxidation process, what happens

if the oxygen supply is cut off? If human muscles can go on releasing energy when they are short of oxygen, what can cells of other living organisms do?

Let us find out by doing some experiments.

Activity 2

Some experiments on yeast

To test this idea we can see whether it is possible to detect any rise in temperature and the production of carbon dioxide, when living organisms are kept away from a supply of oxygen.

Yeast grows rapidly if it is supplied with glucose in solution. Indeed, wild yeasts are normally found growing on the skins of fruits like grapes and apples, from which they derive their food supplies. Our immediate problem is to remove the oxygen from the glucose solution and yeast.

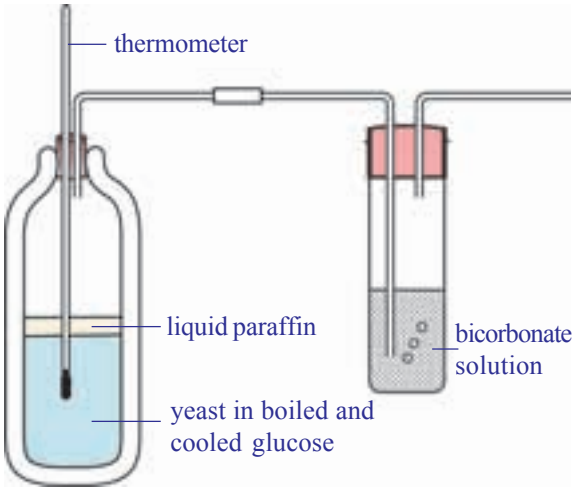


fig- : Testing for production of heat and CO_2 under anaerobic respiration

1. You can remove dissolved oxygen from glucose solution by boiling it for a minute, and then cooling it without shaking. Now put in some yeast; the supply of oxygen from the air can be cut off by pouring a 1 cm layer of liquid paraffin on to the mixture.
2. Arrange for any gas produced by the yeast to escape through a wash-bottle containing bicarbonate/indicator solution (or lime- water).

If you wish to check that the oxygen has been removed from the mixture, add a few drops of diazine green (Janus Green B) solution to the yeast suspension before you pour the liquid paraffin(wax) over it. This blue dye turns pink when oxygen is in short supply around it.

We have not described any control experiments - try working them out for yourself. You may prefer to carry out the 'carbon dioxide production' part of the experiment on a smaller scale, using test-tubes. If you do, then warm them to about 37° C in order to speed up the test.

- What happens when a baker prepares a dough by mixing yeast in it?

Fermentation

Let us recall mida dough and yeast powder activity that you performed in class VIII in the chapter 'The story of micro organisms'. Why valume of

the dough was increased? Which gas released in that reaction.

If yeast and sugar solution are left to stand without oxygen for some days, they develop a characteristic smell, caused by a new compound, ethanol, which has been manufactured by the yeast from the sugar. The ethanol can be separated from the yeast-glucose mixture by the process of fractional distillation since ethanol boils at a lower temperature (70°C) than the sugar solution.

Quite like aerobic respiration this is a process of producing energy when the short supply of oxygen.

- Respiration is an energy releasing pathway, do you agree? Justify your answer.

Respiration versus combustion

Lavoisier around the late 18thcentury, through a series of carefully performed experiments, came to the opinion that respiration was a process like combustion. He wrote in a compilation of 1783, "respiration is a combustion, very slow indeed and oxygen here not only combines with carbon but also with hydrogen." Robinson also stated that respiration is a type of combustion and combustion is the source of heat in animals.

Activity 3

Observing changes during combustion of sugar

Take a small amount of glucose on a tin foil/or any small container or arrange apparatus as shown in the figure and heat it over a flame. Does it melt? What happen if you keep it for some time? Does it catch fire?

When glucose burns, carbon dioxide and water are produced and energy is released as heat.

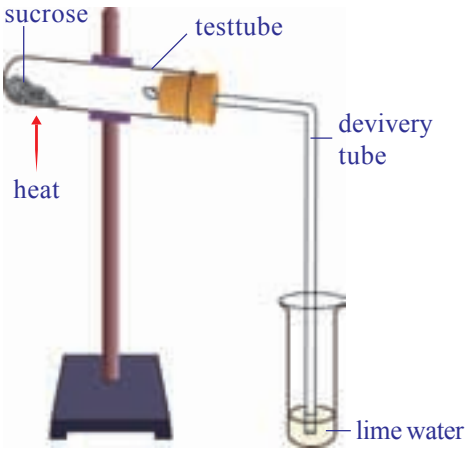


fig- : CO_2 - a by product of energy release

We know that combustion of glucose gives us carbon dioxide, water and energy while from the respiratory equation we get the same products. But essentially the processes must differ due to following reasons.

1. Glucose must be burnt at high temperature in the laboratory to liberate energy, if it happened in our cells,all cells would be burnt.
2. Once glucose starts burning we can't stop the process easily, but living cells are able to exercise control over the sort of burning of glucose in the presence of Oxygen.

3. Water normally stops combustion from taking place while cells contain a lot of water and respiration still goes on.

What can you conclude from this?

Heat production by living organisms

Heat production was a feature of burning glucose or sugar as you observed earlier. Living animals and plants usually produce energy in the form of heat.

We feel worm when we where swatter in winter season. We know that swatter prevents loss of heat energy produced by the body. Does this suggest any way in which our bodies lose heat to the surroundings?

- What are the other ways in which our body loses heat?

Heat is constantly lost from the body surface thus it must be continuously generated within our bodies to replace what has been lost, and keep the body temperature constant.

- Is the rate of heat production always the same?

In the course of vigorous activity, a greater amount of heat is generated; we know that we feel hot after some form of strenuous exercise such as running in a race.

Try to take your temperature when you first get up in the morning and after jogging for some time.

- What difference do you find?
- Where does the heat come from?

Evolution in energy releasing system

Exchange of gasses is a common life process in all living organisms, but it is not same in all. Single celled organisms Amoeba or multi cellular organisms like hydra and planarians obtain oxygen and expel carbon dioxide directly from the body by the process of diffusion. In multy cellular animals special organs are evolved. Animals either terrestrial or aquatic adopted different types of respiration and different types of respiratory organs mostly due to the habitat in which they live. Body size, availability of water and the type of circulatory system are some of the reasons for the animals to develop different types of respiratory organs.

We will see tracheal respiratory system in insects like cockroach, grasshoper etc. Tracheal respiratory system consists of series of tubes called trachea. This is divided into fine branches called tracheoles which carry air directly to the cells in the tissues.

Some aquatic animals like fishes have developed special organs for

respiration which are known as gills or branchiae. Blood supplied to gills through capillaries which have thin walls which gases are exchanged. This is called bronchial respiration. Fish keeps its mouth open and lowers the floor of the oral cavity. As a result water from outside will be drawn into the oral cavity. Now the mouth is closed and the floor of the oral cavity is raised. Water is pushed into the pharynx and is forced to gill pouches through internal bronchiole apertures. Gill lamellae are bathed with water and gas exchange takes place.

Respiration through skin is called cutaneous respiration. This type of Respiration is seen in earth worms and leeches. Frog an amphibian can respire through cutaneous and pulmonary respiration processes.

Respiration in Plants

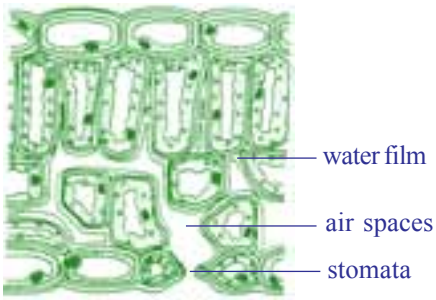


fig- : Leaf as a respiratory organ

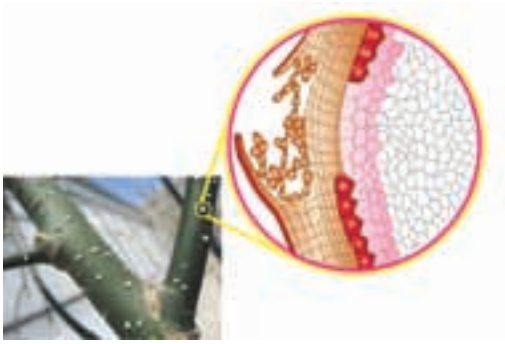


fig- : Lenticells on stem

You already know about stomata in leaf where gaseous exchange takes place in most plants. There are other areas on the plant body as well through which gaseous exchange take place like surface of roots, lenticels on stem etc. (Fig showing stomata and lenticels). Some plants have specialized structures like breathing roots of mangrove plants as well as the tissue in orchids that help Oxygen is also required by plants to produce energy and carbon dioxide is released.

Conduction within the plant

Inside the plant these openings lead to a series of spaces between the cells which form a continuous network all over the plant. The spaces are very large in the leaves, much smaller in other parts of the plant. The air spaces are lined with water and the oxygen in the air spaces dissolves in this and passes through the porous cell walls into the cytoplasm where the sugar is broken down into carbon dioxide and water with the liberation of the energy. The carbon dioxide passes out into the air spaces by a similar method.

The whole system works by diffusion; as the oxygen is used up by the cells a gradient develops between the cells and the air in the spaces, and similarly between the air in the spaces and the air outside the stomata and lenticels, so oxygen passes in. In the same way, as more carbon dioxide is

given out by the cells a gradient occurs in the reverse direction and it passes out.

Aeration of roots

Most plants can aerate their roots by taking in the oxygen through the lenticels or through the surface of their root hairs (as their walls are very thin). They obtain this oxygen from the air spaces between the soil particles. But plants which have their roots in very wet places, such as ponds or marshes, are unable to do this. They are adapted to these water-logged conditions by having much larger air spaces which connect the stems with the roots, making diffusion from the upper parts much more efficient.

fig- : Arial roots

The most usual adaptation is to have a hollow stem. Next time you are by a pond or marsh cut the stems of some of the plants which are growing there and see how many are hollow compared with a similar number of species of plants growing in normal soil. The problem of air transport is more difficult for trees and not many survive with their roots permanently in water. An exception is the mangrove tree of the tropics which sends up aerial roots above the surface and takes in oxygen that way.

To know more about respiration in plants we should perform the following activities.

Activity-5

Take a handful of moong or bazra seeds. Soak the seeds in water a day before to perform your experiment. Keep these soaked seeds in a cloth pouch and tie with a string tightly. Keep the cloth pouch in a corner of your class room. Next day collect the sprouts/ germinated seeds from the pouch, keep it in a glass bottle/plastic bottle(around 200 ml capacity). Take a small injection bottle, fill three fourth of the bottle with lime water. Tie a thread to the mouth of the small bottle; insert it in the bottle carefully and let it hang by the thread. Close the plastic bottle tightly. Make a similar set with sprouted seeds. Keep this set undisturbed for one or two days. During this time observe the color of lime water in both the sets. In which set does the color change faster? Why?

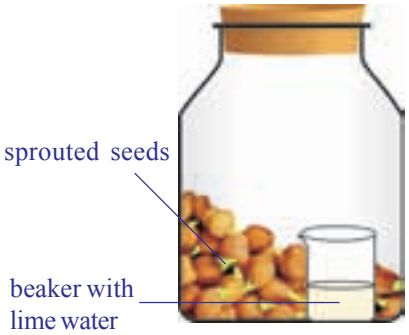


fig- : Evoluved CO_2 in respiration

Activity 6

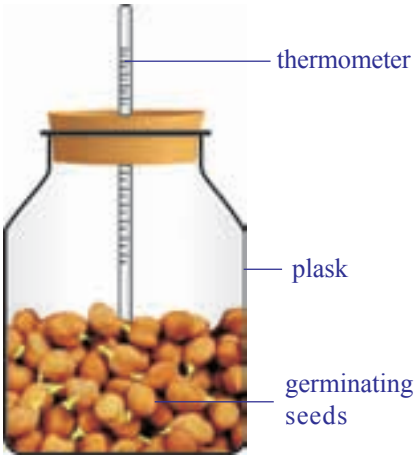


fig- : Heat evoluved during respiration

Take sprouts which were prepared for above activity in a thermos flask. Remove the lid and prepare a cork (with thermocol, or rubber or any other material) through which you can bore a hole to insert a thermometer. Take care that the bulb of the thermometer should dip in the sprouts. Close the flask with this tight fitting cork. Record the temperature every two hours. You are advised to do this for at least 24 hours.

- Make a graph by using your observations.
- Is there any increase in temperature?
- Does the temperature increase steadily or does it abruptly increase at a time of the day?
- Where does the heat come from?

Photosynthesis versus Respiration

Plants carry out photosynthesis, which means that they produce their own food from atmospheric CO_2 using light energy from the sun. This process is a complex series of steps involving the conversion of light energy into chemical energy, which is then used to synthesize sugars from carbon dioxide. This is a process of synthesis or an anabolic process which occurs in the chloroplasts.

The equation below summarizes the photosynthetic process

$$CO_2 + H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} (CH_2O)n + O_2$$

Sugar

Once produced, the sugars can then be used for the process of respiration to provide energy to run all life processes.

Respiration as we know is not just the exchange of gasses. It is the process of breakdown of complex food molecules or a catabolic process to produce chemical or potential energy.

This can be summarized by the equation

$$(CH_2O)n + O_2 \longrightarrow CO_2 + H_2O + \text{Energy}$$

Photosynthesis and respiration appear to be opposing reactions, but both have very different biochemical pathways and are essential for a plant's metabolism.

Photosynthesis takes place in the chloroplast to produce sugars, starches and other carbohydrates for the plant's metabolic needs. Cellular

respiration occurs in mitochondria where these carbohydrates are "burned" to produce chemical energy to do work at the cellular level. During daytime, the rate of photosynthesis is usually higher than that of respiration while at night it is just reverse in most plants. Temperature, humidity, light intensity etc. seem to affect the ratio of photosynthesis and respiration in plants.

Key words

Aerobic respiration, Anaerobic respiration, Alveolus, Trachea, Bronchi, Bronchioles, Epiglottis, Pyruvate, Anabolic, Catabolic.

What we have learnt

- By "respiratory system" we usually mean the passages that transport air to the lungs and to the microscopic air sacs in them, called alveoli (where gases are exchanged) and vice versa.
- The term 'respiration' refers to the whole chain of processes from the inhalation of air to the use of oxygen in the cells.
- Lavoisier found that the air that we breathe out precipitated lime water while that after heating metal did not. He also found that something even beyond lungs occurred to produce carbon dioxide (he knew it as fixed air) and body heat.
- Air passes from nostrils to nasal cavity to pharynx, larynx, trachea, and bronchi, bronchioles to alveoli and blood and back through the same route.
- Gas exchange in the lungs takes place in the tiny air sacs called alveoli in the lungs. The lungs have millions of alveoli and each lies in contact with capillaries. Oxygen and carbon dioxide diffuse readily across a combination of the alveolar wall, the capillary wall and a thin layer that lies between them.
- Diaphragm is a muscular tissue present at the floor of the chest cavity.
- During inspiration (inhalation) the volume of the chest cavity is increased as the diaphragm contracts and dome flattens out, its internal pressure decreases and the air from the outside rushes into the lungs.
- During expiration, the chest wall is lowered and moves inward, and the diaphragm relaxes and assumes its dome shape. These changes increase the pressure on the lungs; their elastic tissue contracts and squeezes the air out through the nose to the external atmosphere.
- Air is filtered in the nasal cavity and the whole length of the trachea.

- The moist surface of the lining of the nasal cavity, and the hairs growing from its sides, remove some of the tiny particles of dirt in the air. In addition, as the inhaled air passes through the nasal cavity, its temperature is brought close to that of the body, and it takes up water vapor so that it becomes more moist than before.
- Pharynx is a common passage of digestive and respiratory system. Epiglottis, a flap like muscular valve controls movement of air and food towards their respective passages.
- Larynx is a stiff box like structure containing our vocal cords. When air passes out of the lungs and over the vocal cords, it causes them to vibrate. This produces sounds on the basis of our speech, song etc.
- Trachea is the wind pipe channeling air to lungs.
- At its lower end the trachea or the wind pipe divides into two bronchi-one leading to each lung.
- The bronchi divide into smaller and smaller branches called bronchioles.
- These finally terminate in clusters of air sacs called alveolus in the lungs which are very small and numerous. Gaseous exchange takes place here as blood capillaries take up oxygen and expel carbon dioxide here.
- Aerobic respiration occurs in adequate supply of air producing a lot of energy, carbon dioxide and water.
- Anaerobic respiration and fermentation occurs in inadequate supply or absence of oxygen to produce energy.
- Cells may resort to the breakdown of 3 carbon compound, pyruvate, aerobically or anaerobically depending upon the availability of oxygen. Usually in multicellular organisms cells fail to carry on the process of anaerobic respiration for long.
- Respiration is not essentially a process of combustion differ due to following reasons
  - Glucose must be burnt at high temperature in the laboratory to liberate energy, if it happened in our cells, all cells would be burnt.
  - Once glucose starts burning we can't stop the process easily, but living cells are able to exercise control over the sort of burning of glucose in the presence of oxygen.
  - Water normally stops combustion from taking place while cells contain a lot of water and respiration still goes on.
- Photosynthesis and respiration appear to be opposing reactions, but both have very different biochemical pathways and are essential for a plant's metabolism.
- Photosynthesis takes place in the chloroplast to produce sugars, starches and other carbohydrates for the plant's metabolic needs.
- Cellular respiration occurs in mitochondria where mainly these carbohydrates are "burned" to produce chemical energy to do work at the cellular level.

Improve your learning

1. Distinguish between (AS1)
   a) inspiration and expiration
   b) aerobic and anaerobic respiration
   c) respiration and combustion
   d) photosynthesis and respiration
2. State two similarities between aerobic and anaerobic respiration. (AS1)
3. Food sometimes enters the wind pipe and causes choking. How does it happen? (AS1)
4. Why does the rate of breathing increase while walking uphill at a normal pace in the mountains? Give two reasons. (AS1)
5. Air leaves the tiny sacs in the lungs to pass into capillaries. What modification is needed in the statement? (AS1)
6. Plants photosynthesize during daytime and respire during the night. Do you agree to this statement? Why? Why not? (AS1)
7. Why does a deep sea diver carry oxygen cylinder on her back? (AS1)
8. How are alveoli designed to maximize the exchange of gases? (AS1)
9. Where will the release of energy from glucose in respiration take place? Mala writes lungs while Jiya writes muscles. Who is correct and why? (AS1)
10. What is the role of epiglottis and diaphragm in respiration?(AS1)
11. How gasses exchange takes place at blood level? (AS1)
12. Explain the mechanism of gasses exchange at branchiole level. (AS1)
13. After a vigurus excercise or work we feel pain muscles. What is the relationship between pain and respiration? (AS1)
14. Raju said stem also respire along with leaves in plants. Can you support this statement? Give your reasons. (AS1)
15. What happen if diaphragm is not there in the body? (AS2)
16. If you have a chance to meet pulmonologist what questions your going to clarify about pulmonory respiration? (AS2)
17. What procedure you followed to understand enorobic respiration in your school laboratory? (AS3)
18. What are your observations in combustion of sugar activity? (AS3)
19. Collect information about cutanous respiration in frog. Prepare a note and display them in your classroom. (AS4)
20. Collect information about respiratory diseases (because of pollution, tobboco) and discuss with your classmates. (AS4)
21. What is the pathway taken by air in the respiratory system? Illustrate with a labeled diagram.(AS5)
22. Draw a block diagram showing events in respiration. Write what you understood about cellular respiration. (AS5)

23. How you appreciate the mechanism of respiration in our body? (AS6)
24. Prepare an article on enorobic respiration to present school symposium. (AS7)
25. Prepare a cartoon on discussion between hemoglobin and chlorophil about respiration. (AS7)

Fill in the blanks:

1. Exhaled air contains _____ and _____.
2. A flap like muscular valve controls movement of air and food is _____.
3. Energy currency of the cell is called _____.
4. Lenticells are the respiratory organs exsists in _____ part of plant.
5. Mangroove trees respire with their _____.

Choose the correct answer:

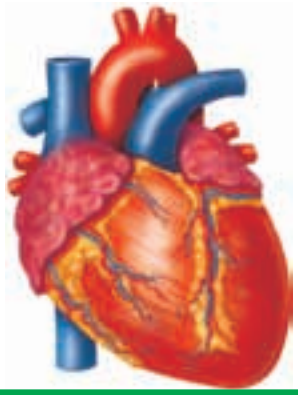
1. We will find vocal cords in ( )
   a) larynx b) pharynx c) nasal cavity d) trachea
2. Cluster of air sacs in lungs are called ( )
   a) alveolus b) bronchi c) braonchioles d) air spaces
3. Which of the following is correct ( )
   a) the diaphragm contracts - valume of chest cavity increased
   b) the diaphragm contracts - valume of chest cavity decreased
   c) the diaphragm expands - valume of chest cavity increased
   d) the diaphragm expands - valume of chest cavity decreased
4. Respiration is a cetabolic process because of ( )
   a) breakdown of complex food molecules b) conversion of light energy
   c) synthesis of chemical energy d) energy storage
5. Energy is stored in ( )
   a) nucleus b) mitochondria c) ribosomes d) cell wall

Annexure

Pranayama - The art of breathing

It is wonder to know that only human beings have to learn how to breath. Our lungs are devided into lobes. At each breath we will inhale or exhale only 500ml of air. Where as our lung capacity is approximately 5800ml. So most of the time breathing takes place in the upper lobes only. This means we are not using our lungs to their fullest capacity. Even after complete expiration approximately 1200ml of air remains in our lungs. So we can make use of 4600ml of lung capacity for breathing.

To improve the breathing capacity the Saint Patanjali developed *Yogabyasa*. The art of breathing in Yogabyasa is called *Pranayama* prana means gas, ayama means journey. In Pranayama practice air is allowed to enter three lobes of lungs inorder to increase the amount of oxygen to defuse into blood. More amount of oxygen available to brain and tissues the body will be more active. It is very important to practice Pranayama regularly to make our life healthy and active. All people irrespective of age and sex should practice Pranayama under the guidance of well trained Yoga Teacher to improve the working capacity of lungs.



Chapter

3

Transportation - The circulatory system

fig-1: Pulse

Have ever observed a doctor holding the wrist of the patient and looking at his watch for a minute? What is that is that he is trying to find out from the watch and the wrist of the patient? You may wonder to know that he is counting the heart beat of the patient. Don't you think that is crazy, holding the hand to count the heart beat?

Activity-1

You could try to find out for yourself, what the doctor was doing. Keep your index and middle fingers on your wrist below the thumb as shown in the fig-1.

What did you feel?

You feel something pushing your fingers rhythmically up and down. Now let us count the Rhythm also called the pulse, for a minute. Now stand up and jog for one minute standing at the same place. Note the pulse for a minute.

1. What did you observe? Is the pulse rate same in both conditions?

Table-1

S.No	Name of the person	Pulse at rest/minute	Impulse after jogging /minute

Activity-2

Now observe the pulse rate of students of your class.

We see that pulse rate varies from person to person and situation to situation. So it is not constant where you are afraid or excited the pulse rate goes up. There is a relationship between the pulse rate and the beat of our heart. Now let us try to find out more about this relationship.

fig-2: Matchstick stethoscoap

Try to observe your pulse rhythm in other ways as well such as climbing stairs, running, etc.

Take your shirt button insert a matchstick and place it on your wrist as shown in the fig-1.

1. What did you find?
2. When do you think that our pulse rate goes up?
3. What does the pulse rate show?

Do you know?

newborn (0–3 months)	infoants (3-6 months)	infants (6–12 months)	children (1-10 years)	children over 10 years & adults, including seniors citizens	well- reainedd adults athlets
100-150	90-120	80-120	70-130	60-100	60-100

Activity-3

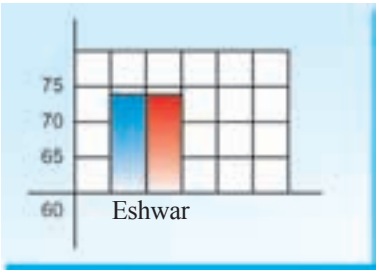
Let us repeat the work lennak

Make a paper tube 10 inch long and one inch in diameter. Keep one end of it on the chest of your friend on a point in the centre around 6 inches from his or her neck. Keep your ear at the other end. Listen carefully and count the beats for a minute.

Also find your friend's pulse rate. Note observations of at least 10 students of your class in the following tabular form.

Table-1

S.No	Name of the student	Heart beat at rest/min	Pulse rate at rest/min
1	Eswar	72	72



x-axis: Name of the student
y-axis: Heart beat, pulse rate per minute

Let us plot histogram between persons and heart beat and pulse rate as shown in the sample graph. Here blue bar indicates heart beat, red bar indicates pulse rate.

- What is the relationship between the heart beat and the pulse?
- Can we say, the pulse rate is always equal to the heart beat?

So there is relation between pulse rate and heart beat.

Now try to understand the structure and method of working of this vital organ the heart. It is the beat of the heart which makes us alive. Heart is located between the two lungs protected by ribcage. The size of your heart is approximately the size of your fist.

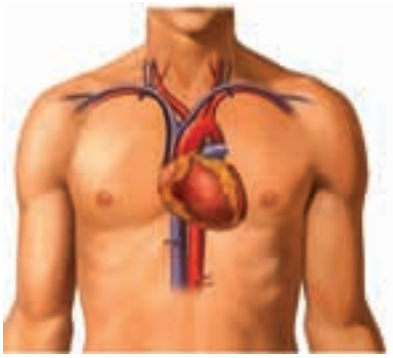


fig-4: Location of Heart

fig-5: Heart

Lab Activity

Aim: Observation of the internal structure of the mammalian heart.

Material required: Since the structure of all the mammalian hearts is similar, we take the sheep's or goat's for our observation. For this we need the following materials.

Freshly collected specimen of heart of sheep/goat from the butcher. Soda straws, Sharp and long blade / scalpel, Tray and a jug of water. Dissection scissors and forceps or *3D model* of heart.

Procedure for observation:

- Before coming to the class wash the heart thoroughly so that, blood is completely drained from the chambers.
- Take the soda straws and insert them into the stumps of the blood vessels.

Note your observations as you proceed.

How many layers are covering the heart?

(Now remove the layers covering the heart, and observe)

What is the shape of the heart?

How many large blood vessel stumps are attached to the heart?

Which end of the heart is broader and which end is narrow?

Observe the arrangement of blood vessels (coronary vessels) on the wall of the heart.

(In case you don't have a model or a goat's heart, look at the figures given carefully for observation)

Internal structure of the heart

- Keep the heart in the tray in such a way that a large arch like tube facing upwards. This is the ventral side.
- Now take a sharp blade or scalpel and open the heart in such a way that the chambers are exposed. Take the help of the fig-6.

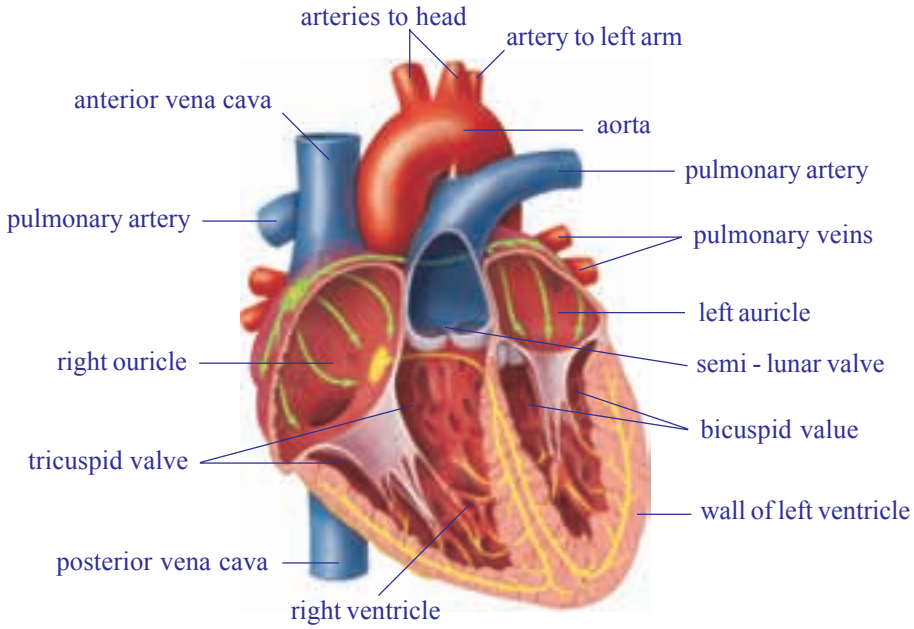


fig-5: Internal structure of heart

Now observe the internal structure. Observe the wall of the heart.

- Is the thickness of the wall of the heart uniform throughout?
- How many chambers are there in the heart?
- Are all the chambers of the same size?
- What other difference could you observe between the chambers?
- Are all the chambers connected to each other?
- How are they connected to each other? How are they separated?

You can observe white colored structures in the lower part of the heart. Note down the size shape and to which parts they are attached. Can you guess the function of these structures?

Write a note on your observations of the heart. Compare your notes with the description given below.

The heart is a pear shaped structure, triangle in outline, wider at the anterior end and narrower at the posterior end.

The heart is covered by two layers of membranes. The membranes are called pericardial membrane. The space between these two layers is filled with pericardial fluid, which protects the heart from shocks.

The heart is divided into four parts by grooves.

Two upper parts are called ***atria***, and the lower ones are called ***ventricles***.

The blood vessels which are seen in the walls of the heart are coronary vessels which supply blood to the muscles of the heart.

In our observation we found that the heart has four chambers in it. On left side two chambers are present, one in anterior and the other is the posterior. On right side also two chambers are present, one upper (anterior), and one lower (posterior).

The walls of the ventricles are relatively thicker than atrial walls.

There are ***six blood vessels*** attached to the heart. Of these six two blood vessels are rigid and the four are less rigid.

The rigid vessels are called arteries which originate from the heart and supply blood to various organs in the body. The larger artery is the ***aorta.***

The relatively smaller one is pulmonary artery which carries blood from the heart to the lungs.

The less rigid vessels are the ***veins,*** which bring blood from body parts to the heart.

The vein which is at the anterior end of the right side of the heart is superior venacava, which collects blood from anterior parts of the body.

The vein which is coming from posterior part of the heart is ***postcaval vein***, collecting blood from posterior part of the body.

The left atrium receives two pulmonary veins, which collect blood from lungs.

The left atrium and ventricle are smaller when compared to that of right atrium and ventricle.

The two atria and the two ventricles are separated from each other by muscular partitions called septa. The openings between atria and ventricles are guarded by valves.

In the right atrium we can observe the openings of ***superior and inferior venacavae***. In the left atrium we can observe the openings of ***pulmonary veins***, that bring blood from lungs.

From the upper part of the left ventricle a thick blood vessel called ***aorta*** arises. It supplies oxygenated blood to the body parts. From the upper part of the right ventricle pulmonary artery arises that supplies de-oxygenated blood to the lungs. After careful examination we can observe valves in the pulmonary artery and aorta as well.

The blood vessels and circulation

Let us study how we came to know about their function and structure. The blood vessels and circulation.

It was not until 16th century that we really came to know how our blood vessels functioned. In 1574, an Italian doctor, ***Girolamo Fabrici***, was studying the veins in the leg. Henoticed that they had little valves in them. If the blood moved in one direction, the valves folded in toward the walls of the vessel, so that the blood could pass without trouble. If the blood moved in the opposite direction, the valves opened and closed off the vein.

This meant they were one-way valves. They permitted the blood to move when a person is standing upright. The blood can't move downward.

When a person moves his legs, or just tightens his leg muscles, those muscles squeeze against the veins and force the blood in those veins to move upward against the pull of gravity (because that's the only way to go). If a person keeps his leg muscles relaxed, the blood isn't moving much, but at least it isn't being pulled down by gravity. The valves won't allow that.

The important thing was that the blood in the leg veins could only move toward the heart. Fabrici paid no attention because everyone thought that the blood leaving the left ventricle always moved away from the heart. He missed the importance of his own discovery.

fig-7: William Harvey

But then, ***William Harvey (1578-1657),*** an Englishman who, after he became a doctor, went to Italy for further education and studied under Fabrici.

Harvey dissected the hearts of dead people and studied the valves between each atrium and its ventricle. He noticed that they

were one-way valves. They allowed the blood to flow from the atrium to the ventricle without any trouble.

When the heart contracted, however, none of the blood in the ventricle could flow back into the atrium. Instead, all the blood was pushed out into the arteries.

Harvey began thinking about the valves his teacher, Fabrici, had discovered in the leg veins. They were one-way, and they forced the blood to move toward the heart.

He checked that by tying off and blocking different veins in animals he experimented on. The veins always bulged on the side of the block away from the heart. It was as though the blood were trying to flow toward the heart and to accumulate just below the block because it simply couldn't flow away from the heart. This was true of all veins.

In the arteries, the blood bulged on the heart side of any block he put in, as though it were trying to flow away from the heart and couldn't move in the other direction.

Harvey now saw what was happening. The heart pushed blood into the arteries, and the blood returned by way of the veins. It did this for both ventricles. The blood had a double circulation. If one started from the right ventricle, it left by way of the arteries to the lungs, and returned by way of the veins to the left atrium and from there into the left Ventricle.From the left ventricle, it left by way of the arteries to the rest of the body and returned (in a "greater circulation") by way of the veins to the right atrium and from there into the right ventricle. Then it started all over.

Harvey also showed that it was impossible to suppose that the blood was used up in the body and that new blood was formed. He measured how much blood the heart pumped in one contraction and counted the number of contractions.

fig-8: Marcello Malpighi

He found that in one hour, the heart pumped out a quantity of blood that was three times the weight of a man. The body couldn't use up blood and form new blood at such a rate. The same blood had to circulate and be used over and over again.

Harvey still had some problem. The smallest arteries and veins that could be seen had to be connected by vessels too small to see. Were they really there?

In the 1650s, scientists had learned to put lenses together in such a way that objects too small to see with the naked eye could be magnified and made visible. Marcello Malpighi (1628-

1694), with the microscope, he could see tiny blood vessels that were invisible without one.

In 1661, four years after Harvey's death, Malpighi studied the wings of bats. He could see blood vessels in their thin membranes and, under the microscope; he could see that the smallest arteries and veins were connected by very fine blood vessels.

He called these blood vessels "capillaries" from the Latin word for "hair", because they were as thin as the finest of hairs.

With the discovery of capillaries, the idea of the circulation of the blood was complete, and it has been accepted ever since.

Now we know that blood circulates in the blood vessels. But how did the scientists find out that blood moves in blood vessels? Is it possible to demonstrate the movement of blood in vessels without damaging the vessels?

fig-9(a): Try like this

Let us repeat the classical experiment to demonstrate the movement of blood in veins conducted by William Harvey in early 17th century, when there was no compound microscope or other modern equipment.

1. Tie a tornquit just above the elbow of a person, whose blood vessels are prominent in the hand.
2. Ask him/her to hold the fist with a piece of cloth rolled in the hand. Now the blood vessels can be seen more prominently.
3. Find undivided blood vessel, where we have to work for the next few minutes.
4. At the end of the vessel furthest from the elbow apply steady pressure, so as to close its cavity.
5. Now apply pressure from elbow towards the palm slowly and observe the changes in the blood vessels. (Take the help of the figures given in the text.)

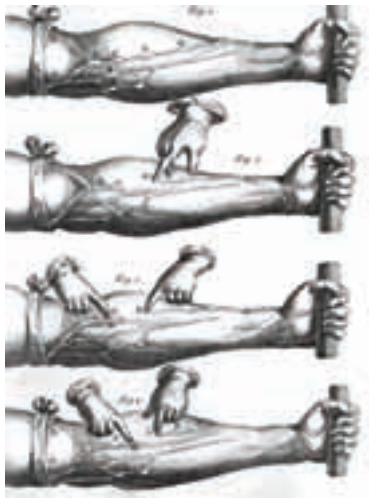


fig-9(b): Harvey's demonstration

Arteries and veins

There are two types of blood vessels one arteries and other is veins. Arteries carry blood from the heart to body parts. Where as veins carry blood from body organs to heart. Let us observe the structural and functional differences of arteries and veins.

fig-10: Arteries, veins, capillari

Do you know?

Blood capillaries

Blood capillaries are the microscopic vessels made of single layer of cells. They allow diffusion of various substances. The leucocytes (WBC) can squeeze out of the capillary wall. They establish continuity between arterioles and venules.

Complete the following table with the details of arteries and veins based on fig-10.

table-

Blood vessels	Darw figure	Thickness of the wall	Layers of the wall	Lumen size	Capacity to retain the shape

Observe the structural and functional differences of arteries and veins.

table-

Artery	Vein
Move away from the heart.	Move towards the heart.
Distributes blood to the body organs.	Collects blood from body organs. blood pressure is low.
Blood pressure is high.	Valves are present.
Valves are absent.	Carry de-oxygenated blood, except pulmonary vein.
Carry oxygenated blood, except pulmonary artery.	They start in blood capillaries.
They end in capillaries.	They can be seen sub-cutaneously.
They are deep seated.	They collapse when there is no blood in it, or cut across.
They do not collapse when there is no blood init or when cut across.	Veins further devided into venules.
Arteries further devided into atrerioles.	

Let us do the following activities to observe arteries and veins.

Sit on a table with one leg dangling and the other resting on it so that the back of one knee rests on the knee of the other. After a time you will see and feel the leg which is on top give a series of small movements with each heart beat. If you do it for long you will reduce the blood flow to the leg and so develop 'pins and needles'.

Swing your arm round several times to fill the veins with blood, hold the arm vertically downwards and gently press your finger along a prominent vein-stroking it in the reverse direction to the blood flow, i.e., towards the hand. Can you see the swllings where you have pushed blood against the valves?

Think and discuss

- Artery walls are very strong and elastic. why?
- Why we compare arteries is rather like tree which devides into smaller and smaller branches.
- The lumen size or valve size is bigger in vein when compare with artery. Why?

Arterioles of arteries and venules of veins join with microscopic vessels called capillaries.

The cardiac cycle

The human heart starts beating around 21st day during the embryonic development (refer reproduction chapter). If it stops beating, it results in the death of the animal.

One contraction andone relaxation of atria and ventricles is called one cardiac cycle.

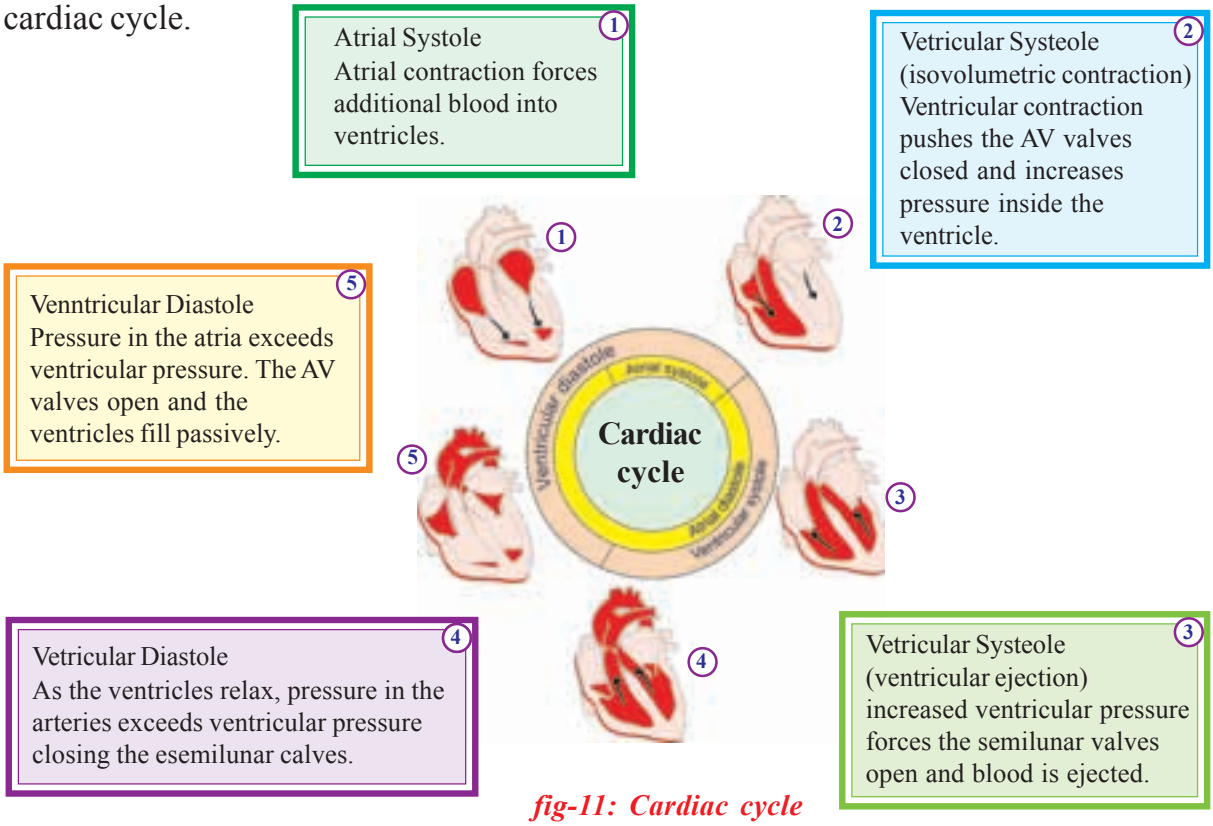


fig-11: Cardiac cycle

To start with all the four chambers of the heart are in relaxed state (joint diastole). Blood from venacavae and pulmonary veins enters the right and left atria respectively. Now the atrias contract, forcing the blood to enter into the ventricles. The ventricles start contracting and atria start relaxing.

On ventricular contraction due to pressure the blood moves into the aorta and pulmonary artery. The aperture between the atria and ventricles is closed by valves. When the valves are closed forcibly, we can listen to the first sharp sound of the heart ***lubb.***

When the ventricles start relaxing the pressure in the ventricles is reduced. The blood which has entered the arteries tries to come back into the ventricles. The valves which are present in the blood vessels are closed to prevent backward flow of blood into the ventricles. Now we can listen to a dull sound of the heart **dupp.** The auricles fill up with blood and are ready to pump them into the ventricles.

The sequential events in the heart which are cyclically repeated are called **cardiac cycle.** The **cardiac cycle** includes an active phase **systole** and a resting phase the **diastole** of atria and ventricles. The whole process is completed in approximately 0.8sec.

The time needed for atrial contraction is 0.11-0.14 seconds. The time needed for ventricular contraction is 0.27-0.35 seconds.

Hence naturally the blood is pumped in to the blood vessels at regular intervals. The tissues will not receive the blood continuously, but in the form of spurts. So when we keep our finger at the wrist, where the artery is passing into the hand we feel the pressure of blood moving in it. This is the ***pulse***. ***The rate of the pulse will be equal to the number of heart beats.***

Do you know?

Name of the animal	Weight of the body	Weight of the heart	No. of beats/min
Blue whale	1,50,000 kg	750 kg	7
Elephant	3000 kg	12 - 21 kg	46
Man	60-70kg	300 gm	76
Coaltit (Bird)	8	0.15 gm	1200

Significance of circulation

Evolution of the transport (circulatory) system

When the unicellular organisms separated themselves from the sea with the formation of the limiting membrane, the problem of transportation arose. The nature has found the solution, by creating a microscopic ocean which has its own currents.

In unicellular organisms like Amoeba the protoplasm shows natural movements. These movements are called Brownian movements, because of which the nutrients and oxygen are distributed throughout the protoplasm equally.

This simplest intracellular transportation system, present in unicellular animals has been retained in multi cellular animals including humans. The protoplasm of any cell in our body is mobile and protoplasmic currents exist even in the nerve cells.

The multi cellular animals have to develop more complicated system for transportation of materials.

The parazones like sponges, use sea water for transportation. Since the natural water currents are not reliable, the sponges create their own currents by beating of flagella that are present in their body.

The cnidarians which are better evolved than sponges (e.g. ***Hydra and jelly fish***) have developed blind sac like gastro vascular cavity, which has taken up the function of digestion and transportation of nutrients to each and every cell of the body.

In platyhelmenthes (e.g. ***Fasciola hepatica***) the digestive system is highly branched and supplies digested food to all the cells directly. In these animals the excretory system collects wastes from each cell individually. In these organisms most of the body is occupied by digestive and excretory systems.

In animals belonging to Nemathelmenthes the pseudocoelom has taken up the function of collection and distribution of materials.

The Annelids, the first Eucoelomate animals have developed a pulsatile vessel, to move the fluid and the transporting medium is blood.

The Arthropods have developed a pulsatile organ to pump the blood, the heart. The blood instead of flowing in blood vessels floods the tissues, directly supplying the nutrients to the tissues. Oxygen is directly supplied to the tissues directly by the respiratory system.

Such type of transportation system which supplies nutrients to the

tissues directly is called open type of circulatory system.eg. Arthropods, many moluscs and lower chordates.

The other type of transportation system where the blood takes the responsibility of delivering the materials, which flows in the blood vessels Is called closed type of circulatory system. Such type of closed circulatory system is present in annelids echinoderms, ***cephalopod*** mollusks (e.g**.** ***Octopus***) and all the higher animals.

Do you know?

The human circulatory system can move one ml of blood from heart to a foot and back which is approximately 2 meters, in about 60 seconds.

It would take more than 60 years for the substance to move across this distance by diffusion.

fig-12: Limphatic system

Lymphatic system

As blood flows through some amount of fluids and certain solid materials are constantly flowing out of them at different junctions. Such materials are collected and sent back into blood circulation. In latin lymph means water.

Have you ever observed what happened to your feet after overnight journey, in sitting position without moving? We feel that our foot wear is a little tight. In elders it will be clearer; the lower part of the legs will be swollen. This stage is called edema. Why do our legs swell?

We know that blood circulates in the blood vessels, pushed by the heart. From the heart it flows into the arteries and finally into the capillaries. To supply nutrients to the cells (tissues), the liquid portion of the blood with nutrients flows out of the capillaries. This is called tissue fluid.

The tissue fluid which is present in the tissues should be transported into the blood vessels again. Some portion of the tissue fluid enters into the venules, which in turn form the veins, which carry blood to the heart. What about the remaining tissue fluid? To transport the tissue fluid in to the main blood stream, a separate system is present. That is called lymphatic system.

Lymph is the vital link between blood and tissues by which essential substances pass from blood to cells and excretory products from cells to blood. The lymphatic system is a parallel system to venous system which collects tissue fluid from tissues and transports it to the venous system.

Blood is substance which contains solid and liquid particles. Lymph is the substance that contains blood without solid particles. Tissue fluid is the substance which contains lymph present in the tissues.

We shall read about this as the system of **lymph circulation** in detail in higher classes. The muscles which are attached to the skeleton (skeletal muscles) act as pumps when they contract and help in pushing the lymph flowing in lymphatic vessels and the blood flowing in veins towards the heart.

The valves that are present in the lymphatic vessels and veins stop the rivers flow of blood.

Single /double circulation

We know that blood flows in the blood vessels. To keep the blood moving the heart pumps it continuously. The blood that is pumped by the heart reaches the body parts and comes back to the heart. But course taken by the blood is not the same in all the animals. Let us observe the fig-13(a) & (b). Start from any point in the fig-13(a) & (b). Move in the direction of arrow. Note down the parts which are in the way in cyclical form.

fig-13(a): Single circulation

fig-13(b): Double circulation

Compare the two flow charts and answer the following.

- How many times did your pointer touch body parts in fig-13(a) & (b)?
- How many times did your pointer touch the heart in fig-13(a) & (b)?
- How many times did your pointer touch the respiratory organs in fig-13(a) & (b)?

From your observation it is clear that in fig 1 blood flows through heart only once to complete one circulation.

If blood flows through heart only once for completing one circulation it is called single circulation.

If the blood flows through the heart twice for completing one circulation it is called double circulation.

Blood pressure (B.P)

In class 9th we studied about blood and it's components, blood grouping, etc., in the chapter animal tissues. Now we will discuss some other points related to blood.

Generally you have heard the word B.P. What is B.P.? To move the blood through this network of vessels, a great deal of force is required. The force is provided by the heart and is at its highest when the ventricles contract, forcing the blood out of the heart and into the arteries. Then there is a drop in the pressure as the ventricles refill with blood for the next beat.

fig-14: Sphygmomanometer

BP is always measured in the upper arm artery. BP varies throughout the body, so a standard place must be used so that a person's blood pressure can be compared over a period of time. Doctors measure the blood pressure (BP) with a device called sphygmomanometer.

There are two pressure readings. One measures the strongest pressure during the time blood is forced out of the ventricles. This is called systolic pressure. For a healthy young adult it will be 120 mm of Hg. The second reading is taken during the rest period, as the ventricles refill with blood. This is called diastolic pressure. It will be 80mm of Hg.

BP will change according to the activity in which the person is engaged, such as resting, walking and running. ***People who have high BP during rest period are said to have hypertension.***

Coagulation of blood

Another important part in the story of blood is coagulation. Only because of this character animals servive when they met seviour injurius.

How does the blood clot?

When there is an injury blood clots in 3-6 minutes. Chemistry involved in blood coagulation. You know that when you cut yourself, the blood flows out of the wound for only a short time. Then the cut is filled with a reddish

solid material. This solid is called a blood clot. If blood did not clot, anyone with even a slightly wound bleeds profusely.

- When the blood flows out, the platelets release an enzyme called thrombokinse.
- Thrombokinse acts on another substance present in the blood called pro-thrombin converting it into thrombin.
- Thrombin acts on another substance called fibrin, that is present in dissolved state converting it into insoluble fibrin.
- The blood cells entangle in the fibrin fibers forming the clot.
- The fibrin fibers are attached to the edges of the wound and pull them together.

This straw colored fluid portion after formation of the clot is *serum*.

Discuss with your teacher about vitamin K in relation to coagulation of blood.

fig-15(a): Blood in the blood vessel

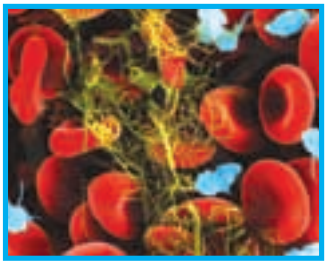


fig-15(b): Clot formation

Normally the blood that oozes from a wound clots in 3-6 minutes. But in some people due to vitamin K deficiency it takes more time. Due to genetic defect the blood may not coagulate. This type of defect is called haemophilia. Haemophilia is common diffect where the marriages between very close relatives. See annexure.

HOW MATERIALS TRANSPORT WITH IN THE PLANT

There is a vast transport system to continual supply of essential nutrients and oxygen to perform metabolic activities, and a means of the excretory substances which are found in each cell of animal body.

Is there anything in plants which corresponds to a blood circulatory system?

In previous classes we studied about Van Helmont experiments on plants get water which contain minerals from soil through their roots. The water absorbed by roots and food prepared by leaves are supply to the remaining pats of the plant

fig-16: Transportation

by vascular bundles having xylem and phloem.

In the root the xylem tissue was situated towards the centre while in the stem it was arranged in bundles near the outside.

How water is absorbed?

We know that roots absorb water with minerals from soil, what is the mechanism behind this?

Are roots directly contact with water?

How is water absorbed?

Activity-4

Obsorption of root hairs

To perform this activity you need to germinate bajra or mustard seeds.

Examine some mustard seedlings which have been grown on wet filter paper. Observe the mass of fine threads coming from the root by hand lens. These are root hairs through which water enters the plant. Gently squash a portion of the radical between slide and cover slip in a drop of water and examine under a microscope. Note the thinness of the walls of the root hairs. It is not completely understood how the water enters the root hairs and passes inwards from cell to cell until it gets into the xylem vessels, but there is no doubt that osmosis plays an important role.

Every living cell acts as an osmotic system, the cytoplasm lining of the cell wall act as the semi permeable membrane. Observe the following figure, how roots penetrate into soil? you will see that the root hairs grow out into the spaces between the soil particles and that the hairs are surrounded by moisture.

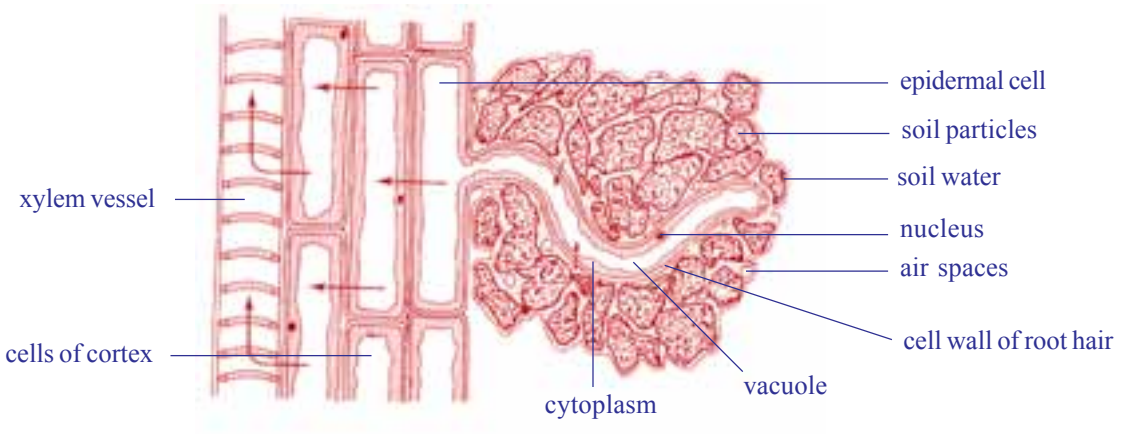


fig-17: L-S of root showing relationship of root hair to soil water

The soil water is an extremely dilute solution of salts, more dilute than that of the cell sap in the root hair; therefore water will pass into the vacuole of the root hair by osmosis. The entry of water dilutes the contents of the root hair vacuole so that it becomes weaker than its neighbour.

Therefore water passes into the neighbouring cell which in turn becomes diluted, finally water enters the xylem vessels. As there are vast numbers of root hairs and root cells involved, a pressure in the xylem vessels develops which forces the

water upwards. This total pressure is known as root pressure. Root pressure is not the main cause of movement of water in xylem ,but it is certainly one factor. The other factor is also there. You will learn about those reasons in further classes in detail.

Activity-5

What is root pressure

Take a regularly watered potted plant and cut the stem portion 1 cm above the ground level. Then connect a glass tube by means of strong rubber tubing as shown in the figure. The size of glass tube should be equal to the size of the stem. Take care while joining tube and stem being bound tightly, water cannot escape from the tube. Now, pour some water in the glass tube until water level can be seen above the rubber tube. Mark the level of water (M_1) in the tube. Keep your arrangement a side for 2 to 3 hours. Then observe and mark the water level (M_2) in the tube.

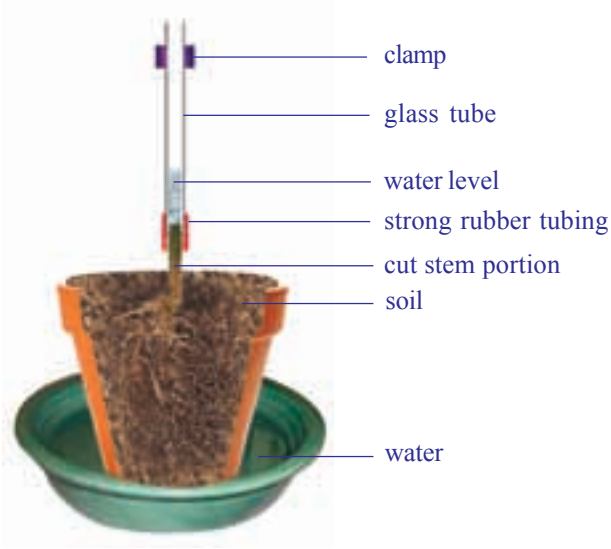


fig-18: Root pressure

- Is there any increase in the water level?
- What is the role of xylem in this action?

The difference between M_2 and $M\text{-}_1$ indicates the level of water raised in the stem. Because of the root pressure the water level increases in the tube.

The mechanism by which the water travels through the plant

We have seen that there is a push from below due to root pressure on the columns of water in the xylem vessels, but this is seldom large and at

some seasons it is nil. How does the water reach the top of a tree like a giant redwood 120 m high?

fig-19: Transpiration

Let us recall the activity that you performed in lower classes. (fig leaf covered by polythene cover) Why inner sides of cover become moist? Where do these droplets of water or water vapour come from?

We knew that this type of evaporation of water through leaves is called transpiration. Water evaporates through stomata of leaves and lenticels of stem.

when the leaves transpire there is a pulling effect on the continuous columns of water in the xylem vessels. The top ends of these vessels are surrounded by the leaf's mesophyll cells which contain sap, so the water is continuous from the xylem vessels to the walls of the mesophyll cells from which it evaporates into the air spaces causing the pull. The water column does not break because of its great tensile strength. This is a property of water you dem-onstrate every time you drink through a straw.

Now we have a picture of the water-conducting system of a tree. Water is absorbed by osmosis from the soil by the root hairs and is passed into the xylem vessels which form a continuous system of tubes through root and stem into the leaves; here the water evaporates and passes into the atmosphere. The evaporation creates the main pull from above root pressure gives a variable and minor push from below. The result is a continuous column of moving water, the transpiration stream.

Is there any relation between transpiration and rain fall?

The amount of water passing through a plant is often considerable. For example, an oak tree can transpire as much as 900 liters of water per day. It follows therefore that areas of forest significantly affect the degree of saturation of the air above them, so that when air cur-rents bring air which is already nearly saturated to a forest area, it becomes fully saturated and comes down as rain; this is why forest areas often have a higher rainfall than areas nearby.

Transport of mineral salts

You will recall that mineral salts are necessary for plant nutrition (micro, macro nutrients) and that they are obtained from the soil in sol-ution through the root hairs. The salts are in the form of electrically charged ions. Sodium chloride (NaCl) is in the form of Na^+ and Cl^-, and Magnesium

Sulphate ($MgS0_4$) occurs as Mg^{2+} and $S0_4^{2-}$. But they are *not* ab-sorbed into the root hairs by the simple process of diffu-sion, but it must involve the use of energy by the cytoplasm we will discuss those issues in further classes. Once absorbed, the ions travel in the water in the xylem vessels and pass to the growing points of the plants where they are used for growth. They may also pass laterally from xylem to phloem.

Transport of manufactured food

Food such as sugar is synthesised in the green parts of plants, mainly the leaves, but this food has to be trans-ported to all the living cells, especially those which are actively growing and those which store food.

The veins of a leaf consist of xylem and phloem, and these tissues are continuous with those of the stem. The following experiments provide evidence that food is trans-ported in the phloem cells.

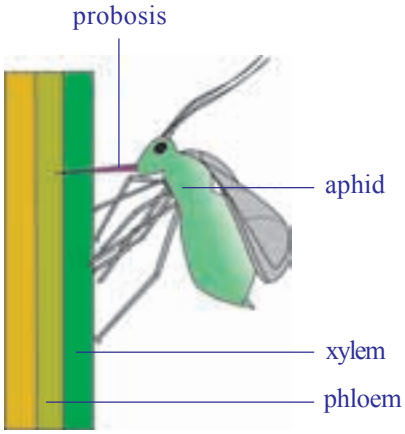


fig-20: Aphid extracting food material from plant

Phloem sieve tubes are extremely small and the analysis of their contents is not easy, Biologists studied about food transportation in plants with the help of aphids (greenfly). When you see aphids clustering round the young stems of plants they are feeding on the plant juices. To obtain this juice an aphid pierces the plant tissues with its long needle like organ "prob-oscis". It can be shown that when a feeding aphid is killed and the stem carefully sectioned, the proboscis only pene-trates as far as a phloem sieve tube. This proboscis also provides a ready-made means of obtaining the juice for analysis! The experiment can be done in this way. An aphid is killed while in the act of feeding and the body is then carefully cut away, leaving the hollow proboscis still inserted into the phloem. It is found that because the contents of the phloem sieve tubes are under slight pressure the fluid slowly exudes from the cut end the proboscis in the form of drops; these drops are then collected and analysed. The fluid is found to contain sugars and amino acids.

Not surprisingly, aphids absorb so much sugar from the phloem that they cannot assimilate all of it and it passes out of the anus as a sticky syrup called honey-dew. Leaves which have been attacked by aphids often feel sticky as a result.

You may notice that sometimes barks of the tree damaged more than a half, even though treeis alive. How is this possible?

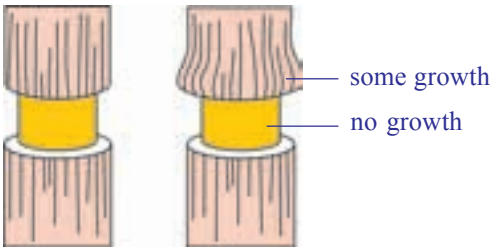


fig-21: Removing ring of bark

Further experiments to illustrate the conduction of sugars by the phloem have been done by removing a ring of bark from a shoot to expose the wood. Re-moves all tissues from the cambium outwards, including the phloem. After a few days, when the tissues above and below the ring were analyzed it was shown that food had accumulated above the ring, but was not present below it. If left for some time, the stem increased in thickness im-mediately above the ring, but no growth occurred below it. So any damage to the phloem all around the stem will prevent food from passing down to the roots and the tree will eventually die. This is a fact of great economic importance because certain mammals scratching the bark of trees to get at the food stored in the phloem, especially during hard winters when food is scarce. Voles do this to young saplings at ground level and rabbits can do much damage to older ones. Foresters find it economically worthwhile to enclose new plantations with wire netting to pre-vent rabbits from entering.

Foresters also encourage predators such as foxes, bad-gers, hawks and owls as they help to keep down the popu-lation of voles and rabbits. Grey squirrels too do great damage, particularly to beech and sycamore, and for this reason, in some parts it is impossible to grow these trees as a crop. Observe barks of trees in your surroundings for evidence of bark having been gnawed off saplings and trees. Note the species of tree, the position of the damage, whether the damage is recent or old, and the size of tooth marks if these are visible. From these observations you could find out which species had caused the damage. Also look out for the effect of such damage on the tree as a whole.

Key words

Circulation - movement in a cycle; specifically, movement of blood throughout the body, Right atrium - the upper right chamber of the heart, Left atrium - the upper left chamber of the heart, Right ventricle the lower right chamber of the heart, Left ventricle - the lower left chamber of the heart, Pulse, Artery, Vein, Stethoscope, Aorta, Capillary, Systole, diastole, Cardiac cycle, Blood pressure, Lymph, Single circulation, Double circulation, Coagulation of blood, Sphygmomanometer, Prothrombin, Thrombin, Fibrinogen, Fibrin, Root hair, radical, root pressure, plant nutrients, xylem, phloem, vascular bundles.

What we have learnt

- The pulse rate is equal to heart beat. We can count the heart beat without the aid of any instrument.
- We can prepare our own stethoscope just by rolling a paper.
- The heart is covered with two pericardial membranes Filled with pericardial fluid which protects it from shocks.
- Six blood vessels are attached to the heart. The two rigid blood vessels are arties which supply blood to body parts Aorta and lungs and pulmonary artery.
- The less rigid vessels are various, which bring is blood from body parts – superior veins from lungs.
- Heart has four chambers two upper atria, two lower ventricles.
- Atrium and ventricle of the same side are connected by atrium ventricular aperture.
- Atria an separated from each other by inter atrial septum ventricles by inter. Ventricular septum.
- The atrio ventricular apertures are guarded by walls. There are walls in the aorta and pulmonary artery also.
- The right side of heart receives blood from body and send to lungs.
- The right side of the body receives blood from lungs and send it to body parts.
- The arteries carry oxygenated blood except pulmonary artery. The veins carry deoxygenated blood except pulmonary veins.
- One contraction and relaxation of heart is called cardiac cycle.
- If the blood goes to heart only once before it reaches all the body parts called single circulation. If it go twice it is called double circulation.
- Vitamin K deficiency leads to delayed coagulation of blood.
- Plants obserob soil water throwgh roots by the process of osmosis.
- Water travels throwgh xylem vessels and food material travels throwgh phloem vessels.
- There is a relation between tranportation and transpiration in plants.
- Biologists studied about in tubes with the help of aphids.

Improve your learning

1. The more cells animals have the more dependent they are upon some type of specialized transport system. Why? (AS1)
2. What is the relationship between blood and plasma? (AS1)
3. Which type of blood vessels carry blood away from the heart? (AS1)
4. What are the three main type of blood vessels in the body? (AS1)

5. Which is the largest artery in the body? Why it is big in size? (AS1)
6. Which blood vessel carries blood for oxygenation? (AS1)
7. Name the structures which are present in veins and lymph ducts and absent in arteries. (AS1)
8. What is the use of platelets? (AS1)
9. Write differences between; (AS1)

   a) systole - diastole b) veins - arteries c) xylem - phloem
10. Explain the way how plants get water by osmosis through root hair? (AS1)
11. What is root pressure? How it is useful to the plant? (AS1)
12. Phloem is a food source for some animals. How can you justify this statement? (AS1)
13. Read the given para and name the parts of the heart. (AS1)

    We have observed that the heart is divided into four chambers by muscular structure. Any structure that divides two chambers is known as ***septum***. Now let us try to name the septa present in the heart.

    a) The septum that divides the two atria can be named as *inter atrial septum*

    b) The septum that divides the two ventricles can be named as_____.

    c) The septum that divides the atrium and ventricle can be named as_____.

    The holes that connect two chambers are called ***apertures***. Let us try to name the apertures which connect the atria and ventricles.

    d) The aperture that is connecting the right atrium and right ventricle can be named as_____.

    e) The aperture that is connecting the left atrium and left ventricle can be named as _____.

    Any structure that closes an aperture, and allows one way movement of materials is called as ***valve***. Now let name the valves that are present in the chambers of the heart.

    f) The valve that is present between left atrium and left ventricle can be named as_____.

    g) The valve that is present between right atrium and right ventricle can be named as _____.
14. If the valves in veins of the legs fail to stop fail flow of blood what could be the consequences of this failure? (AS2)
15. What will happen cell sap of root hair cells contain high concentration of ions? (AS2)
16. John prepare stethoscope with paper cup and string. Write down the procedure of preparation. (AS3)
17. In lab activity why you are advised to wash hands with antibacterial loation. (AS3)
18. How can you prove that the water transport through the xylem? (AS3)
19. What is your inference about experiments with aphids? (AS3)
20. Draw a block diagram to explain single and double circulation. (AS5)
21. Prepare a block diagram showing from water absorption by roots to transpiration by leaf . (AS5)
22. What you want to compare with the transportation of in blood vessels? (AS6)

23. How do you feel about transportation of water in huge trees? (AS6)
24. Prepare a cartoon on heart beating? (AS7)

Choose the correct answer

25. After reading this lesson what precausions you would take in menuring potted plant. (AS7)
26. The term cardiac refers to which organ in the body?

    a) heart b) vein c) lymph d) capillary

27. Blood on which side of the human heart is low in oxygen?

    a) left vetricle b) right ventricle c) left atrium d) right atrium

28. Which structures of the heart control the flow of the blood?

    a) arteries b) veins c) valves d) capillaries

29. Which of the following opinion is correct

    a. Ravi said, xylem and phloem cells arranged one upon the other to form a tube like structure.
    b. John said, xylem and phloem are not separate tube like structures.
    c. Salma said, xylem and phloem cells connect together to form a tube like structure.
    d. Hari said, because of its shape they said to be tube like structures

30. An aphid pierces its proboscis into the …… to get plant juices

    a) Xylem b) phloem c) cambium d) vascular bundle

Fill in the blanks

31. The …….. in above cells and the …….. in below cells causes to continues column of moving water.
32. If we remove all tissues from the cambium outer wards …… will not occur.

Annexure-I

The rhesus factor

There is another antigen of red blood cells which is present in 85% of the people of Britain, this is known as the rhesus factor, as it was first discovered in rhesus monkeys. People who have this are said to be rhesus positive (Rh+). Those who do not have this factor are termed rhesus negative (Rh-). Normally they do not carry an antibody to this factor in their plasma. However, if Rh+ blood is transfused into the blood of a Rh- person,

antibodies will be formed and these are capable of destroying Rh+ red cells. Under certain circumstances this is a potential hazard for babies.

If a Rh+ man marries a Rh- woman, some of the children are likely to be Rh+. At birth there is always some mixing of blood between the circulation of mother and baby and this may occasionally happen during pregnancy. So, if a child is Rh+ some of its blood will leak into its mother's circulation and cause antibodies to form in her blood. If the mother has more children, not all will necessarily be Rh+, but if they are, the amount of antobody in her blood often increases with each pregnancy, and in some instances the antibodies in her blood may pass into the boby's blood in sufficient quantities to produce very serious anaemia and even death. Fortunately these cases are in frequent, and when they do occur, the baby is gicen a complete transfusion soon after birth so that its blood is replaced by blood containing no antibodies to the rhesus factor. It is now possible for this transfusion to be carrried out before birth. Another recentlyu developed techniwqye is for the mother to be gicen an injection shortly aftrer the birth of her first child which prevents the Rh+ cells from stimulating the production of the harmful antibody.

Annexure-II

Thalassemia

Thalassemia is a group of inherited blood disorders characterized by mild to severe anaemia caused by haemoglobin deficiency in the red blood cells. In individuals with thalassemia, the production of the oxygen-carrying blood pigment haemoglobin is abnormally low. There are two main types of thalassemia: alpha thalassemia and beta thalassemia. In each variant a different part of the haemoglobin protein is defective. Individuals with mild thalassemia may be practically symptoms, such as anaemia, enlarged liver and spleen, increased susceptibility to infection, slow growth, thin and brittle bones, and heart failure.

Facts about Thalassemia

- Thalassemia is a serious Inherited Blood Disorder.
- 4.5% of world population (250 million) is thalassemia minor.
- There are over 35 million Indians are carriers of the abnormal Gene for Thalassemia.
- It is estimated that about 100,000 infants are born with major Haemoglobinopathies every year in the world.
- 10,000 – 12,000 Thalassemic children are born every year in our country.
- Survival depends upon repeated blood transfusion & costly medicines.
- Thalassemia can be prevented by awareness, pre-Marital / pre-conceptual screening followed by antenatal diagnosis is required.

Treatment

Thalassemia major should be diagnosed as early as possible in order to prevent growth restriction, frail bones and infections in the first year of life. The infant's haemoglobin levels and development should therefore be monitored closely. If Hb is lower than 70% or the child shows signs of poor growth and development, regular transfusion is the treatment of choice. According to the WHO, the aim of this treatment is to retain a median haemoglobin value of 115 – 120 g/*l*. This can usually be achieved by carrying out transfusions of concentrated red blood cells at intervals of every three to four weeks.

Today thalassemia major can be cured by stem cell transplantation. A prerequisite is usually that the affected individual who has siblings with identical tissue type (HLA type) a transplantation of blood stem cells referred to as a "bone marrow transplant", can be carried out.

Chapter

4

Excretion - The wastage disposing system

There is no factory which manufactures a product without generating any waste. This is true of our body which is a cellular factory too. It is true for other organisms as well. Wastes are generated at regular intervals from the bodies of most organisms. This raises questions like

- Where are the wastes produced?
- How are they produced?
- What are the substances present in them?
- Does the composition vary in the same organism in different situations?

Try to think and discuss about such questions and make a note of it.

Living beings need energy for their survival and to perform activities either of building up of body material (anabolism) or its breakdown (catabolism), collectively called as metabolic activities. Organisms use different substances for metabolic activities. Different products are generated as a result of these metabolic activities. Can you name different products generated by the following life processes?

Table-1

Life processes	Products
Photosynthesis	
Respiration	
Digestion	

- What products would the organism be able to take up for other activities?
- What products which would cause harm to the body, if they are not removed?
- What happens if products that are harmful are not removed from our body every day?

We have already learnt that different kinds of materials are produced out of various metabolic activities. Some of these may be harmful for the organism are removed from their body or packed and stored in some other forms. These are the wastes in the body of an organism. We have already discussed how organisms get rid of gaseous wastes generated during photosynthesis or respiration. Other metabolic activities generate nitrogenous wastes that need to be removed. Salts and excess water and several other materials have to be removed. Excretion (In latin ex means out, crenere means shift) is a biological process involved in separation and removal of wastes from body. Now let us study how excretion takes place in human being.

Excretion in Human Beings

A number of reactions take place during various metabolic activities. Many useful substances and energy are produced. At the same time many other things happen such as, toxic wastes may be produced, water content may increase, ionic balance in the body may be disturbed. The waste products include carbon dioxide, water, nitrogenous compounds like Ammonia, Urea, Uric acid, bile pigments, excess salts etc. The most poisonous of all waste products of metabolism is Ammonia. Where are these waste material produced? Where are they present?

Now let us observe the test reports of Blood and Urine of a person given in table-2 and find out the components present in both Blood and Urine.

mmoles/L means millimoles per litre, mg/dl means milligram per deci litre.

1. What are the substances present in blood?
2. What are the substances present in urine?
3. What are the substances present in the blood and urine in common?
4. Which substances are present above the normal limits both in the blood and urine?
5. What happens if some materials above normal limits?

DEPARTMENT OF BIOCHEMISTRY

SPECIMEN:PLASMA/SERUM (BLOOD)

TEST/METHOD	RESULT	UNITS	RANGE
GLUCOSE FASTING	82	mg/dl	60-100 (GOD POD)
SODIUM	137	mmoles/L	135-145
POTASSIUM	4.10	mmoles/L	3.5-5.0
CHLORIDES	101	mmoles/L	95-106
UREA	29	mg/dl	15-40
CREATININE	2.8.	mg/dl	0.6-1.5
URIC ACID	7.50	mg/dl	3.0-5.0
TOTAL CHOLESTEROL	221	mg/dl	150-200
TRIGLYCERIDES	167	mg/dl	60-200
CALCIUM	9.40	mg/dl	8.0-10.5
PHOSPORUS	4.50	mg/dl	3-4.5
BILURUBIN(TOTAL)	0.70	mg/dl	0.1-0.8
TOTAL PROTEINS	7.20	g/dl	6.0-7.5
ALBUMIN	4.60	g/dl	3.0-5.0

DEPARTMENT OF BIOCHEMISTRY

SPECIMEN: URINE

TEST/METHOD	RESULT	UNITS	RANGE
24 hrs.Protein	90	mg/day	<100 mg
24 hrs Creatinine	2.7	mg/day	1-2
24 hrs.Calcium	305	mg/day	Up to 200
24hrs.phosphorous	0.8	mg/day	upto 1g
24hrs.uric Acid	800	mg/day	upto 600
ELECTROLYTES:			
Sodium	140	mmol/L	125-250
potassium	50	mmol/L	25-100
Osmolality (calculated)	180	mosm/L	100-600
Glucose	65	mg/dl	50-80
Chlorides	128	mmol/L	120-130
Urea	35	gm/day	20-30

6. Keeping in view the question no: 4, list out what substances are need to be removed from body?

By studying the structure and function of the excretory system we will able to understand this better.

Excretory System in Human being

In human beings excretion mainly occurs through a urinary or excretory system consisting of a pair of kidneys, a pair of ureters, urinary bladder and urethra, as shown in the fig-1. Now let us observe external and internal features of a kidney in goat / sheep, which is similar to Human kidney in function.

Lab Activity

Aim: Studying the external and internal features of a kidney

Materials required: Freshly collected specimen of sheep/goat's kidney from the butcher or 3D Model of a kidney, Sharp blade/scalpel, Tray and a jug of water.

Procedure for observation: Before coming to the class wash the kidney thoroughly so that, blood is completely drained from it. Put the kidney in the tray and observe it carefully. Note your observations in your observation book. With the help of sharp blade take the longitudinal section here your advised to do this activity in the guidance of your teacher. (see fig-1) of kidney and observe internal structure.

fig-1: Kidney of goat

- Draw what you have observed and compare it with fig-1
- What is the shape of kidneys?
- What is the colour of kidney?
- What is the shape of the kidney?
- Do you find any attachments on upper portion of kidney?
- Is the Internal structures similar to fig-2
- What is the colour of the outer part in L.S of kidney?
- In L.S of kidney where do you find dark colour portion?
- How many tubes coming out from kidney fissure?

fig-2: LS of Kidney of goat

Don't forget to wash your hands after completing desection with antibacterial loation.

Now let us know the structure of human excretory system and its functions

1. Kidneys

In Human being there are a pair of bean shaped, reddish brown structures in the abdominal cavity attached to dorsal body wall (Fig) one on either side of the back bone. The right kidney is placed slightly lower than the left kidney. Think why it is soap?

The size of the kidney is 10 cm in length, 5-6 cm in breadth, and 4 cm in thickness. Each kidney is convex on the outer side and concave on the inner side. The position of the right kidney is lower than the left kidney due to the presence of liver above.

Let us recall the last question in your lab activity. The inner side of each kidney has fissure or hilus for the entry of a ***renal artery***, exit of a ***renal vein*** and the ***ureter***. Renal artery brings oxygenated blood loaded with waste products and renal vein carries deoxygenated blood. The waste products generated in various organs of the body or filtered and removed in the kidneies.

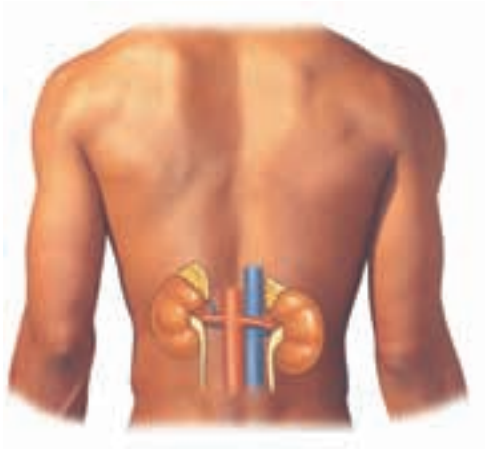


fig-3: Location of kidneies

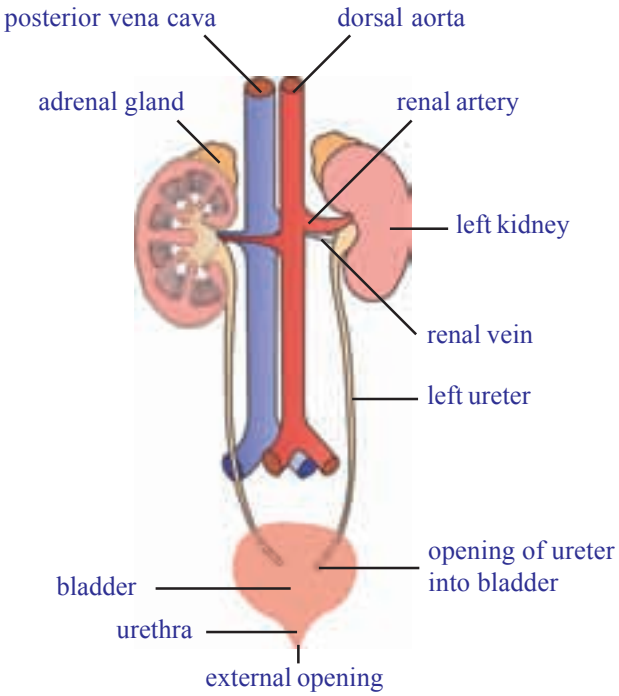


fig-4: Excretory system

Internal structure of the kidney:

Let us observe L.S of the kidney to know more about internal structure. It shows two distinct regions. Dark coloured outer zone called the cortex and pale coloured inner zone called medulla. Each kidney is made up of approximately more than one million (1.3 to 1.8 million) microscopic and thin tubular functional units called nephrons or uniferous tubules.

- Why the nephron is considered to be the structural and functional unit of the kidney?

Structure of nephron:

Each nephron has basically two parts. One is Malpighian body and other is renal tubule.

Malpigian body: It consists of a blind cup shaped broader end of nephron called Bowman's capsule and bunch of fine blood capillaries called glomerulus. The Bowman's capsule and glamerulous together called a malpigian capsule or renal capsule. Glomerulus develops from afferent arteriole. It gives rise to an efferent arteriole.

- Think why the diameter of the efferent arteriole is less than that of afferent arteriole?

Because of the narrower out let (efferent arteriole) pressure exerts in the glomerulus.It functions as a filtration unit. Bowmans capsule which accommodates one glomerulus,is lined by a single layer of squamous epithelial cells called podocyte cells. There are fine pores between podocyte cells to allow passage of materials filtered out of glomerulus.

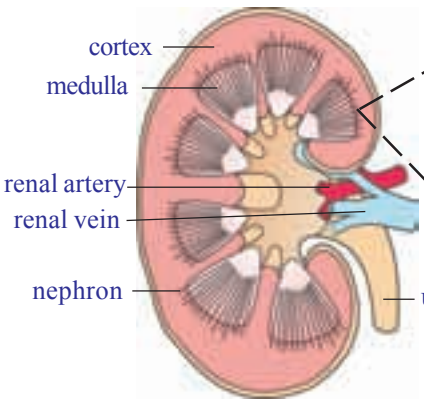


fig-5: Internal structure of kidney

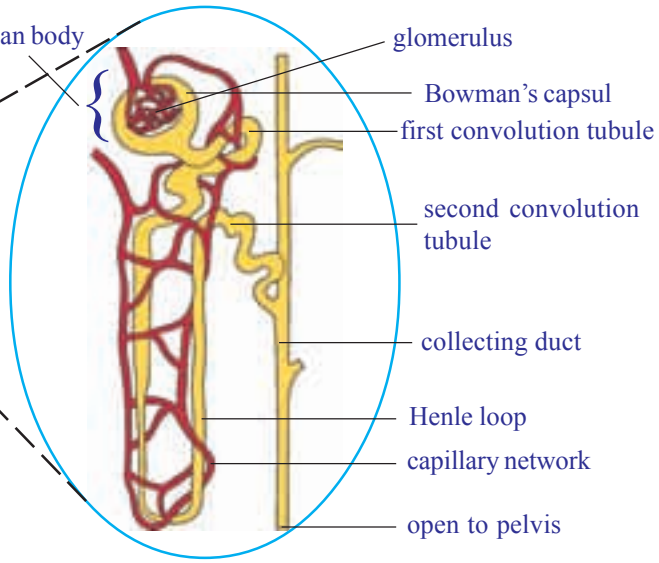


fig-6: Structure of nephron

Renal tubule: It has three parts. First or proximal convoluted tubule (PCT), Loop of Henle, which is U shaped, second or Distal convoluted tubule (DCT).

Distal convoluted tubules open into a collecting tube. Collecting tube form pyramids and calyces which open into the pelvis. Pelvis leads into the ureter.

All parts the renal tubule are covered by a network of peritubular

(around tube) capillaries formed from efferent arteriole. The pieritubular capillaries join to form renal venule.

Mechanisms of urine formation

Formation of urine involves four stages *i. Glomerular filtration, ii.Tubular reabsorption, iii. Tubular secretion and iv.Concentration of urine*

i) Glomerular filtration:

Blood flows from renal artery to glomerulus through afferent arteriole. Observe the figure of Glomerular filtration in nephron and try to answer the following questions.

- Which arteriole has more diameter, afferent or efferent?
- What are the substances that are filtered into the glomerular capsule?

ii) Tubular Re-absorption:

Glomerular filtrate is also called primary urine which almost equal to blood in chemical composition except the presence of blood cells. It passes into proximal convoluted tubule. Useful substances in primary urine are reabsorbed into peritubular net work. The amount of water asborption depends upon amount of excess water present in the body and the amount of dissolved wastes to be excreted.

- If you drink more water will you pass more urine?
- What are the substances reabsorbed into peritubular net work from proximal convoluted tubule (PCT)?

iii) Tubular secretion:

After reabsorption in PCT region, the urine travels through the loop of Henle into DCT. Here some other wastes like extra salts ions of k^+ Na^+ Cl^- and H^+ secrets from peritubular capillaries in to DCT. It occurs mostly in the distal convoluted tubule, which is also surrounded by peritubular capillaries. This maintains a proper concentration and pH of the urine. Smaller amount of tubular secretion also takes place in the area of proximal convoluted tubule

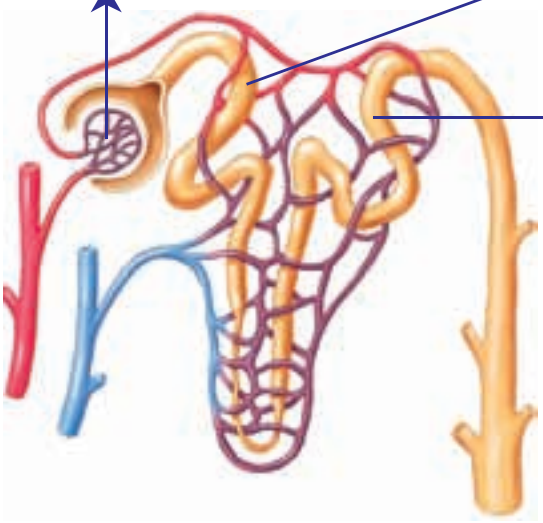
- What are the substances that secretes into DCT?

Do you know?

After the age of 40 years the number of functioning nephrons usually decreases by about 10% in every 10 years.

i) Glomerular filtration: Blood flows inside the glomerulus under the influence of pressure due to the narrowness of efferent arteriole. As a result it undergoes pressure filtration or ultra filtration. Waste molecules, nutrient molecules and water are filtered out and enter the Bowman's capsule.

ii)Tubular reabsorption: The peritubular capillaries around PCT reabsorb all the useful components of primary urine such has glucose, amino acids, vitamin C, Potassium, Calcium, Sodium, Chlorides and 75% of Water. Selective reabsorption also occurs in the region of distal convoluted tubule.



iii) Tubular secretion: Tubular secretion is the active secretion of waste products by blood capillaries into the urinary tubule. It ensures removal of all the waste products from blood, *viz.,* urea, uric acid, creatinine, salt ions like K^+, Na^+ and H^+ ions.

fig-7: Mechanism of urine formation

iv) Concentration of urine:

75% of water content of the nephric filtrate is reabsorbed in the region of proximal convoluted tubule. 10% of water passes out of filtrate through osmosis in the area of loop of henle. Further concentration takes place in the area of collecting tubes in the presence of hormone called vasopressin. The hormone is secreted only when concentrated urine is to be passed out. Think why is it not secreted when a person drinks a lot of water? Absence of vasopressin hormone produces dilute urine. Hormone action, maintains osmotic concentration of body fluids. Deficiency of vasopressin causes excessive, repeated, dilute urination (Diabetes insipidus).

- Why more urine is produced in winter?
- What happens if reabsorption of water does not takes place?

Now let us discuss remaining parts of excretory system.

2. Ureters

There are a pair of whitish, narrow distensible and muscular tubes of 30cm length. Each ureter arises from hilus of the kidney. It moves downward and obliquely opens into the urinary bladder. Ureter carries urine from the kidney to the urinary bladder. The movement of urine in the ureter is through peristalsis.

3. Urinary bladder

It is a median, pear shaped and distensible sac that occurs in the pelvic part of the abdomen. It stores urine brought by two ureters. The storage capacity of urinary bladder is 300 - 800ml.

4. Urethra

It is a tube that takes urine from urinary bladder to outside. The opening of urinary bladder into urethra is guarded by a ring of muscles or sphincter. Urethra is 4 cm long in females and about 20cm long in males. Its opening is separate in females but is in common with the reproductive tract in males (urino-genital duct).

Micturtion

The urine is temporarily stored in the bladder. There are two sets of circular sphincter muscles in the bladder. When the bladder is filling up both these muscles are constricted, so the exit is closed. However as the pressure of the urine increases the walls of the bladder are stretched and this triggers off an automatic reflects action which causes the upper sphincter to relax. But the lower sphincter in contrast is under the control the will, and so urine can still be retained untill this muscle is relaxed too. Control of urination is not possessed by very young children but is gradually learn.

Urge for micturition occurs when urinary bladder is filled with 300 - 400 ml of urine. The stretched bladder stimulates nerve endings to develop the reflex. However urine can be retained in the urinary bladder till it gets filled up to the maximum capacity of 700 - 800ml. At this time the urge becomes painful and leads to voluntary micturition. Total amount of urine excreted per day is about 1.6-1.8 litres. It's quantity increases with larger intake of fluids and decreases with lesser intake.

Think and discuss

Why do some children pass urine during sleep at night until 15 or 16 years of age?

Composition of urine

It is a transparent fluid produced by urinary system. Urine has amber color due to presence of urochrome.Composition of normal urine varies

considerably depending on several factors for instance taking a protein rich diet will result in more urea in the urine. This is because the proteins get de-aminated in the liver with subsequent urea formation. Even sugar can appear in a normal person after a heavy intake. If other conditions are constant, a large intake of liquids or water-rich food increases the volume of water in the blood, hence more urine is excreted.

Urine contains 96% of water 2.5% of organic substances (urea, uric acid, creatine, cratinine, water solution vitamin, hormones, and oxalate etc) and 1.5% of inorganic solutes (sodium, chloride, phosphate, sulphate, magnesium, calcium, iodine). Itis acidic in the beginning but becomes alkaline on standing due to decomposition of urea to form ammonia.

- What happens if both kidneys fail completely?

Complete and irreversible kidney failure is sometimes called endstage renal disease (ESRD). If kidneys stop working completely, our body is filled with extra water and waste products. This condition is called uremia. Our hands or feet may swell. You feel tired and weak because your body needs clean blood to function properly. Is there any solution to this problem? Let us know about artificial kidney.

Dialysis (Artificial kidney)

Kidneys are vital organs for survival. Several factors like infections, injury, very high blood pressure, very high blood sugar or restricted blood flow to kidneys. This leads to accumulation of poisonous wastes in the body and leads to death. Dialysis machine is used to filter the blood of a person whose kidneys are damaged. The process is called haemodialysis. In this process blood is taken out from the main artery, mixed with an anticoagulant, such as heparin, and then pumped into the apparatus called dialyzer. In this apparatus blood flows through channels or tubes. These tubes are embedded in the dialyzing fluid. The membrane separates the blood flowing inside the tube and dialyzing fluid (dialyses), which has the same composition as that of plasma, except the nitrogenous wastes.

As nitrogenous wastes are absent in dialyzing fluids, these substances from the blood move out freely, there by cleaning the blood of its wastes. This process is called dialysis. This is similar to function of the kidney but is different as there is no reabsorption involved .The cleaned blood is pumped back to the body through a vein after adding anti-heparin. Each dialysis session lasts for 3 to 6 hours. This method has been using for thousands of uremic / kidney failure patients all over the world.

- Is there any long term solution for kidney failure patients?

Do you know?

The first kidney transplantation was performed between identical twins in 1954 by Dr. Charles Hufnagel a Washington surgeon. In India first kidney transplantation was done on 1st December 1971 at the Christian Medical college, Vellore, Tamilnadu.

Dr. Charles Hufnagel

Kidney transplantation

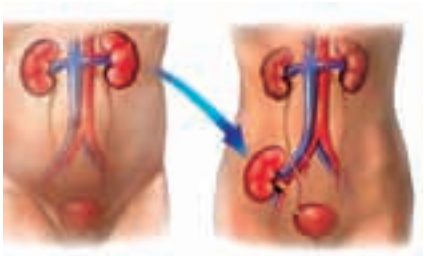


fig-8 Kidney transplantation

The best long term solution for kidney failure (acute renal failure) is Kidney transplantation. A functioning kidney is used in transplantation from a donor preferably a close relative. The kidney that you receive must be a good match to your body, to minimize the chances of rejection of transplanted kidney by the immune system of the host. Modern clinical procedures have increased the success rate of such complicated technique.

- Where the transplanted kidney fixed in the body kidney failure patient?
- What about the failure kidneys?

Based on the picture given here discuss with your teacher about kidney transplantation.

Organ donation - A gift for life

So many patients are waiting for suitable Organ Donors with severe Diseases. In hyderabad where there are kidney transplantation facilities minimum 25 patients per hospital are waiting for kidney donors. Daily 10 - 100 people met with accident in our State. Out of them some people get Brain Dead. If we collect organs from Brain Dead patients in time, we can save minimum 5 people's life. But lack of awareness on Organ Donation those who are willing to donate organs and those who need organs do not get proper information even facilities are there. Medical personals from government and private hospitals are not informing about Brain Dead Patients. If they inform it will be very useful to patients those who are waiting for Organ Donation.In Hyderabad, Organ Transplantation facility is available only in two government hospitals (NIMS and Osmonia) and in more than 10 corporate hospitals. We can transplant organs like Kidney, Liver, Heart, Lungs, Pancreas, Skin, Bone, Intestines and Eye (Cornea)

from brain dead patients. The process of transplantation of organs from brain dead patients to another is called cadaver transplantation. If you are willing to donate organs and get organs. Those who need organs must register their names in transplantation facility hospitals. Those who are willing to donate their organs have to sign in an application form at transplantation facility hospital. Some voluntary organisation also working on this corner.

Collect information about voluntary organisation for organ donation and make a report on them.

There is very less awareness among people about organ donation. Society needs much awareness in organ donation, so that we can save many lives who are in need of different organs for their survival. Instead of living in their memories, let them live in others for one more life. We must show humanity, after all we are humans.

We can live even after death

Five organs of 18 year old youth donated

Dc correspondent, Hyderabad, 20 June 2013

Five organs of 18 year old H.S. YASWANTH KUMAR were donated by his father H V Shiva kumar to the organ donation wing of jeevandan scheme on Thursday. Yaswanth had met an accident on June 15 while he was travelling in a shared Autorikshaw from Jagadgirigutta. He was rushed to Nizam Institute of Medical Sciences (NIMS). The Nuero surgeons at NIMS declared him brain dead. Jeevandan counsellors obtained the consent of Mr. Shiva kumar, who agreed to donate Yaswanth's kidneys, two heart valves, liver. These organs were retrieved and sent to various Hospitals for Transplantaion. Dr. Swarnalatha in-charge of Jeevandan scheme, said in a statement. Think how much great yaswanth's parents are?

Other path ways of excretion (*accessory excretory organs*)

You have learnt about kidney, chief excretory organ of our body. What are the other excretory organs of human body**?** Lungs, skin, liver have their own specific functions but carry out excretion as a secondary function.

Lungs: In respiratory process lungs remove carbon dioxide and water.

Skin: This contains large number of sweat glands richly supplied with blood capillaries, from which they extract sweat and some metabolic wastes. Since the skin sends out plenty of water and small amount of salts, it serves as an excretory organ. Sebaceous glands in skin eliminate sebum which contains waxes, sterols, hydrocarbons and fatty acids.

fig- :Lung, Skin

Think and discuss

People in cold countries get very less/no sweat, What changes occur in their skin and in other excretory organs?

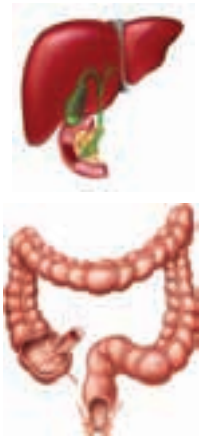


fig- : Liver, intestine

Liver: It produces bile pigments (bilerubin ,bileverdin and urochrome) which are metabolic wastes of haemoglobin of dead R.B.Cs. Urochrome is eliminated through urine. Bileverdin and bilerubin are excreted through bile along with cholesterol and derivatives of steroid hormones, extra drug , vitamins and alkaline salts. Liver is also involved in urea formation.

Intestine: Excess salts of calcium magnesium and iron are excreted by epithelial cells of colon (large intestine) for elimination along with the faeces.

Small amount of nitrogenous wastes are also eliminated through saliva and tears.

Excretion in other organisms

Different organisms use varied strategies in excretion. Specific excretory organs are absent in unicellular organisms. These organisms remove waste products by simple diffusion from the body surface the surrounding water. Fresh water organisms like *Amoeba, Paramecium* possess osmoregulatory organelle called contractile vacuole. Thus collects water and waste from the body, swells up, reaches the surface and bursts to release its content to outside. The main execretion takes place through body surface (osmosis).

Table-

Name of the phylum organism	Excretory system
Protozoa	Simple diffusion from the body surface in to the surrounding water
Porifera and coelenterates	Water bathes almost all their cells
Platyhelminthis and Nematoda	Flame cells
Annelids	Nephridia
Arthropoda	Green glands, Malphigian tubules
Mollusca	Meta nephredia
Echinodermata	Water voscular system
Reptiles, Birds and Mammals	Kidneys

Multicellular organism possesses different excretory organs for removal of waste materials from the body. Structural and functional complexity of excretory organs increases from sponges to humans. Sponges and coelenterates do not have specific excretory organs as water bathes which have in almost all their cells. Excretory structures appear for the first time in Flatworms (Flatyhelminthis).They are flame cells.

Now let's see how this vital process takes place in plants

Excretion and release of substance in plants

Do plants excrete like animals?

We are amazed to answer such type of questions. You are aware that a variety of end products are formed during metabolism and these nitrogenous wastes are important. Plants does not have specific organs to excrete these wastes. Plants break down waste substances much slower than animals. Hence accumulation of waste is also much slower. Green plants in darkness and plants that do not possess chlorophyll produce carbon dioxide and water respiratory waste product. Oxygen itself can be thought as a waste product generated during photosynthesis, and exits through stomata of leaves and lenticels of stem.

How plants manage /sent out waste products from its body?

Plants can get rid of excess water by a process like transpiration and guttation. Waste products may be stored in leaves, bark, and fruits. When these dead leaves, bark, and ripe fruits fall off from the tree then waste products in them are got rid of. Some of the plants waste gets stored in the fruits in the form of solid bodies called Raphides. E.g. yam. However several compounds are synthesized by the plants for their own use especially for defense. Several plants prepare chemicals and store them in roots, leaves, seeds for protection against herbivores. Most of the chemicals are unpleasant to taste and hence herbivores usually do not prefer to eat such plants. Some of the chemicals are toxic and may even kill the animal that eats them.

Think and discuss

Why weeds and wild plants are not affected by insects and pests?

Some of the plants secrete chemicals when injured. These chemicals seal the wound and help the plant to recover from an injury. Some of the plants release attractants for other organisms which will help the plants

for pollination, seed dispersal or even in their nutrition. For example, plants having root nodules secrete chemicals to attract rhizobia into the surroundings of the roots and form a symbiotic relationship with the rhizobium. These compounds are called secondary metabolites.

- Why plants shed their leaves and bark periodically?

The biochemical substances produced in plants are of two types. Primary metabolites and secondary metabolites. The materials like carbohydrates, fats and proteins are primary metabolites and the materials which do not require normal growth and development are secondary metabolites. e.g.: Alkaloids, Tannins, Resins, Gums, and Latex etc. Though plants produce these chemical for their own use. Man found the usage of these chemicals for other benfits.

Alkaloids:

These are nitrogenous by- products and poisonous. These are stored in different parts of the plants. Common alkaloids in plants and their uses are given below.

Table-

ALKOLOID	PLANT	PART	USES
Quinine	Cinchona officinalis.(cinchona)	Bark	Antimalarial drug
Nicotine	Nicotiana tobacum(Tobacco)	Leaves	insecticide
Morphine, Codeine	Papaver somniferum	Fruit	Pain killer
Reserpine	Roulwofia serpentine	Root	Medicine for Snakebite
Caffeine	Coffea Arabica (coffee plant)	Seed	Central nervous system Stimulant
Nimbin	Azadirachta indica(neem)	Seeds, Barks, Leaves.	Antiseptic
Scopolamine	Datura strmonium	Fruit, flower	sedative

Papaver

Roulwofia

Coffea Arabica

Tobacco

Datura

- Name the alkaloids which are harmful to us?

Tannins: Tannins are carbon compounds. These are stored in different parts of the plant and are deep brown in colour. Tannins are used in tanning of leather and in medicines e.g. Cassia, Acacia.

Resin: Occur mostly in Gymnosperms in specialized passages called resin passages. These are used in varnishes- e.g.Pinus

Cassia

Acacia

Pinus

Gums: Plants like Neem, Acacia secretes a sticky substance called gum when branches are cut. The gum swells by absorbing water and helps in the healing of damaged parts of a plant. Economically, gums are valuable being used as adhesives and binding agents in the preparation of the medicines, food, etc.

Latex: Latex is a sticky, milky white substance secreted by plants. Latex is stored in latex cells or latex vessels. From the latex of *Hevea braziliensis* (Rubber plant) rubber is prepared. Latex from *jatropa* is the source of bio-diesel.

Neem

Jatropa

Rubber plant

Do you know?

Chewing gum is a type of gum for chewing made dates back 5000 years. Modern chewing gum originally made of chicle, natural latex from plant

Whenever pollen grains enter in our body cause allergy due to the presence of nitrogenous substances. These allergens cause skin allergy and asthma.

- Do roots secret?

Brugamans, a botanist proved from his experiments that the roots not only absorb fluid from soil, but returns a portion of their peculiar secretions back into it. We can see such instances in plants like apple where a single apple crop for 4 or 5 years in the same soil will be perfect failure. It will not gave proper yielding even if you use lot of fertilizers.

- Why do we get peculiar smell when you shift the potted plants?

Excretion Vs Secretion

Excretion and secretion are the same in nature. Since both are involved in passage or movement of materials. Both processes move and eliminate unwanted components from the body. Excretion is the removal of materials from a living being, while secretion is movement of material from one point to other point. So secretion is active while excretion is passive in nature. Humans excrete materials such as tears, urine, Carbon dioxide, and sweat while secretion on other hand, includes enzymes, hormones, and saliva. In plants too we find excretion through roots into its surroundings and falling off leaves and bark. Secretions occur in the plant body in form of latex, resins, gums etc.

Key words

Creatine, creatinine, specimen, tubular fluild, peritubular, podocyte, hyper-osmotic interstial fluids, glomerulus, PCT, DCT, efferent arteriole, calyces, micturation, urochrome, dialyser, heamodialysis, anticoagulant

What we have learnt

- Due to metabolism several harmful execratory products are formed and process of removing toxic waste from the body is called execretion.
- The human execratory system comprises kidneys, ureters, urinary bladder and urethra.
- Each kidney composed of a large number of uriniferous tubules or nephrons, which are structural and functional units of kidney.
- A nephron comprises glomerulus,bowman's capsule,proximal convoluted tubule(PCT),Henle's loop, Distal convoluted tubule(DCT),and collecting tubule.
- Formation of urine involves four stages. Glomerular filteration, tubular reabsorption, tubular secretion, and concentration of urine.

- Kidneys remove nitrogenous waste from body, maintains water balance (osmoregulation), salt content, PH, and blood pressure in human body.
- Dialysis machine is an artificial kidney which filters the blood to remove the metabolic waste. Kidney transplantation is permanent solution to renal failure patients.
- Different animals have different excretory organs e.g. amoeba-contractile vacuole, platyhelminthis-flame cells, annelida-nephridia, arthropoda-malphigian tubule, reptiles, birds and mammals-kidney.
- In plants there are no special organs for excretion. Plants store different waste materials in leaves, bark, roots, seeds which fall of from the plants.
- Plant metabolites are two types i) primary metabolites eg: proteins carbohydrates and fats. ii) secondary metabolites eg: alkolides, tannins, latex and resins. These are economically important to us.
- Excretion is the removal of material from living beings where as secretion is movement of materials from one point to other.

Improve your learning

1. What is meant by excretion? (AS1)
2. How are waste products excreted in amoeba? (AS1)
3. Name different excretory organs in human body and excretory material generated by them? (AS1)
4. Deepak said that"Nephrons are functional units of kidneys" how will you support him? (AS1)
5. How plants manage the waste materials? (AS1)
6. Why do some people need to use a dialysis machine? Explain the prinsple involved in. (AS1)
7. What is meant by osmoregulation? How is it maintained in human body? (AS1)
8. Do you find any relationship between circulatory system and excretory system? What are they? (AS1)
9. Give reasons (AS1)

   A.Allways vasopressin is not secreted.

   B.When urine is discharged, in beginning it is acidic in nature later it become alkaline

   C. Diameter of afferent arteriole is bigger than efferent arteriole

   D.Urine is slightly thicker in summer than in winter?
10. Write differences (AS1)

    A. Functions of PCT and DCT B. Kidney and artificial kidney

    C. Excretion and secretion D. Primary metabolites and secondary metabolites
11. There is a pair of bean-shaped organs P in the human body towards the back, just above the waist. A waste product Q formed by the decomposition of unused proteins in liver is brought into organ P through blood by an artery R. The numerous tiny filters S present in organ P clean the dirty blood goes into circulation through a vein T. The waste substance Q other waste salts and excess water form a yellowish liquid U which goes from organ P into a bag like structure V through two tubes W. This liquid is then thrown out of the body through a tube X. (AS1)

(a) What is (i) organ P and (ii) waste substance Q.

(b) Name (i) artery R and (ii) vein T

(c) What are tiny filters S known as?

(d) Name (i) liquid U (ii) structure V (iii) tubes W (iv) tube X.

12. The organ A of a person has been damaged completely due to a poisonous waste material B has started accumulation in his blood, making it dirty. In order to save this person's life, the blood from an artery in the person's arm is made to flow into long tubes made of substance E which are kept in coiled form in a tank containing solution F. This solution contains three materials G,H and similar proportions to those in normal blood. As the person's blood passes through long tubes of substance E, most if the wastes present in it go into solution. The clean blood is then put back into a vein in the person for circulation. (AS1)

    (a) What is organ A?

    (b) Name the wastes substance B.

    (c) What are (i) E, and (ii) F?

    (d) What are G, H and I?

    (e) What is the process described above known as?

13. Imagine what happens if waste materials are not sent out of the body from time to time? (AS2)
14. To keep your kidneys healthy for long period what questions will you ask a nephrologist/urologist? (AS2)
15. What are the gum yielding trees in your surroundings? What procedure you should follow to collect gum from trees? (AS3)
16. Collect the information about uses of different kinds alkaloids, take help of Library? (AS4)
17. Draw a neat labeled diagram of L.S of kidney? (AS5)
18. Describe the structure of renal tubule with neatly labled diagram. (AS5)
19. Draw a block diagram showing the path way of excretory system in human being. (AS5)
20. If you want to explain the process of filtration in kidney what diagram you need to draw. (AS5)
21. Listout the things thats makes you amazing in excretory system of human being. (AS6)
22. You read about 'Brain dead' in this chapter. What discussions would you like to take why you think so? (AS6)
23. We people have very less awareness about organ donation, to motivate people write slogans about organ donation? (AS7)
24. After learning this chapter what habbits you would like to change or follow for proper functioning of kidneys? (AS7)

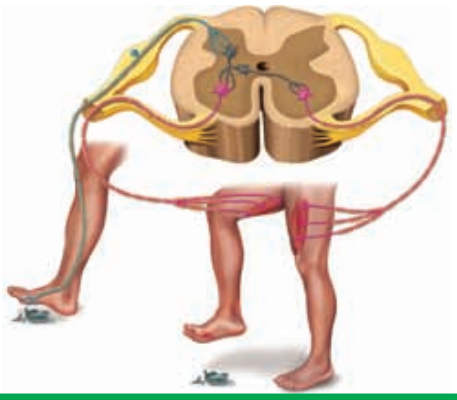
I. Fill in the blanks

1. Earthworm excreats it's waste material through _____.
2. The dark coloured outer zone of kidney is called _____.
3. The process of control of water balance and ion concentration with in organism is called_____.

4. Reabsorption of useful product takes place in _____ part of nephron.
5. Gums and resins are the _____ products of the plants.
6. Bowman's capsule and tubule taken together make a _____.
7. The alkaloid used for malaria treatment is _____.
8. The principle involved in dialysis is _____.
10. Rubber is produced from _____ of Heaveabraziliensis.

II. Multiple choice questions

1. The excretory unit in the human excretory system is called
   (A) Neuron (b)nephron (c)nephridia (d)flame cell
2. The excretory organ in cockroch
   (a) malphigian tubules (b) raphids (c) ureters (d) nephridia
3. Which of the following is the correct path taken by urine in our body?
   (a) kidney ureters bladder urethra bladder (b) Kidney ureters bladder urethra
   (c) Kidney ureters bladder urethra (d) Kidney bladder ureters urethra
4. Malphigian tubes are excretory organs in
   (a) Earth worm (b) House fly (c) flat worm (d) Hen
5. Major component of urine is
   (a) Urea (b) sodium (c) water (d)creatine
6. Special excretory organs are absent in
   (a) Birds (b) amoeba (c) sponges (d) a and b
7. Which of the following hormone has direct impact on urination?
   (a) Adrenal (b) vasopressine (c) FSH (d) estrogen
8. Amber colour to urine due to
   (a) urochrome (b) bilerubine (c) bileverdine (d) chlorides
9. Sequence of urine formation in nephron is
   (a) Glomerular filtration, Tubular reabsorption, Tubular secretion
   (b) Tubular reabsorption, Tubular secretion, Glomerular filtration,
   (c) Tubular secretion, Glomerular filtration, Tubular reabsorption
   (d) Tubular reabsorption, concentration of urine, Tubular secretion
10. Part of the nephron that exists in outer zone of kidney.
    a) Loop of the henle b) PCT c) DCT d) Bowman's capsule
11. After having lunch or dinner one can feel to pass urine, because of a
    a) stomach pressures on bladder b) solids become liquids
    c) water content in food material d) spincter relaxation



Chapter

5

Control and coordination

Reaching for a pencil, grasping a doorknob, walking or running, driving, to name but a few physical actions, all involve well-coordinated movements made with well-balanced postures. In fact, whenever we move the three basic functions, movement, balance, and coordination work together to produce purposeful motions of body parts. This is actually quite a feat, because moving is a complex process for the body.

Even standing upright is a difficult challenge of balancing on just two feet with a narrow base. Yet it is common for us not only to stand upright easily and apparently effortlessly, but also to perform many other functions, walking, running, etc. while keeping our balance.

- What other functions do you think need coordination and balance?

All our functions are carried out by an effort of several systems working together. For example, while movement, we hardly ever use just the skeletal system or muscular system alone, several other systems also have their own roles to play. Even within the muscular system, several muscles work in a sequence or at once.

- What triggers movements of the muscles?

It is a kind of pathway involvingthe way that our organs, tissues and cells pick up signals of change from their surroundings and respond to them that triggers different functions in our body as well as by our body. For example, it is but usual to move to a side of the road when we hear or see a car approaching.

Responding to stimuli

- What helps us to respond to such signals?
- Why does the living body respond to such signals?

We can think of a response as an effect of a change in the environment of the organism or signals of change or 'stimuli'.All living organisms respond to stimuli. The cat may be running because it has seen a mouse. Plants grow out into the sunshine. We start sweating when it is hot and humid.

The ability to react to particular stimuli in a particular situation must be of great importance in ensuring the survival of the organism.

There is a sequence of events that brings about responses and they start from detecting changes in environment (both external and internal) or stimuli, transmission of the information, processing of the same and finally directing and executing the appropriate response.

Let us do some activities to find more about response to stimuli.

Activity-1

Holding a falling stick

Take a long scale or stick at least around ½ meter. Keep your fingers in holding position as shown in fig- . Ask your friend to hold the stick / scale near the end and let the other end be suspended between your fingers.

Let there be a very small gap between your thumb and stick/ scale and the stick/scale and fore finger around a centimeter. Now let your friend allow it to fall. Try holding it.

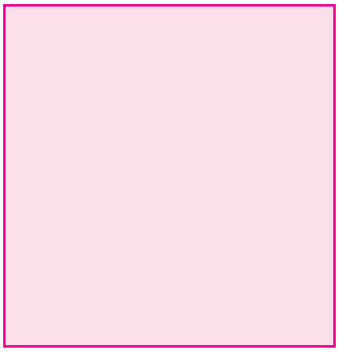


fig-1: Holding stic

- Could you holdit exactly at the point where it was suspended between your fingers?
- Mark the point where you caught the stick.
- How far up was this point from the end suspended between your fingers?
- Why did this happen?
- How fast do you think the process was?

Responses are brought about by rapid changes in some muscles and such changes are usually related to changing stimuli. Rapidity of response indicates an efficient communication system linking those parts that pick up stimuli to those that elicit a response.

- What makes this kind of communication possible?

Integrating pathways - Nervous coordination

fig-2: Galan

The Greeks believed that all functions of the body were controlled by the brain since damage to that organ produced remarkable changes in behavior. As to how such control could be exercised they had very little idea, though Galen, a Greek physiologist (A.D. 129-200) made one notable observation. One of his patients, having suffered a blow on the neck when falling from his chariot, complained of loss of feeling in the arm while still retaining normal muscular control of its moment. Galen concluded that nerves were of two kinds – those of sensation and those of action. According to him the blow in the neck had damaged the nerves of sensation but had not affected those of action.

- Why do you think Galen Drew such a conclusion?

The functioning of nerves as integrating systems was little known till late 18thCentury. Then, physiologists began to study the mechanisms of nerve functioning and find how signals were transmitted by making the connection between recent work on electricity and the propositions on working of the nervous system made till then.

Now we know more about how nerves from different sections of the brain and spinal cord control responses of different areas of the body. We alsoknow the probable pathways that are taken for information transmission but we still know very little about the working mechanisms of the nerve cell.

The Structure of a Nerve Cell

Activity-2

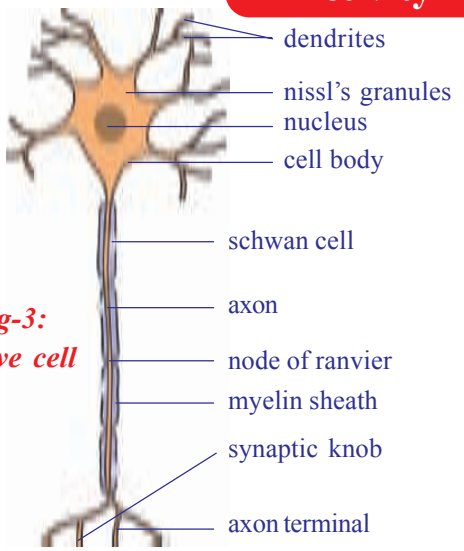


fig-3: Nerve cell

Observe the permanent slide of nerve cell under microscope and try to find out parts, compare with the following diagram.

Each nerve cell consists of a head. This has a prominent nucleus. There are fine projections mainly of two types extending from the head of the nerve cell. The small projections are dendrites while a long one that extends to different parts of our body from different nerve heads is the axon. Usually several axons together are present within a covering or sheath of an

uncontinuous largely fatty material to form the nerve fiber which is called a myelinated fiber. Axons not having the sheath are non-myelinated fibers. The covering also forms a partition between adjacent axons. The nerve cell body lies either in our brain or spinal cord or very close to the spinal cord in a region called dorsal or ventral root ganglion. In the brain or spinal cord, it is difficult to make out the difference between dendrites and axons on the basis of their length, often, the presence of the sheath helps us to find that out but several axons here do not have the sheath.

We know that the nerve cell is the basic unit of nervous system. Our nervous system contains about 10 billion of them, which communicate with each other in a specific manner. Dendrites of one nerve cell connect to the other or to the axons of the other nerve cell through connections called as a 'synapse'.

fig-4: Synapse

Synapse is the connections between neurons. Synapse is a functional region between two neurons where information from one neuron is transmitted or relayed to another neuron. Though these are regions of minute gaps and essentially neurons do not have any protoplasmic connection between them yet information is passed from one nerve cell to the other through these gaps either in the form chemical or electrical signals or both. These synapses are mainly found on the brain, spinal cord and around the spinal cord. Beyond these areas the axon carries the signals to respective areas in our body.

Pathways: From stimulus to response

In the holding stick activity you observed that there is coordination between eye and finger. Different pathways are taken by nerves to bring about this coordinated activity.

On the basis of pathways taken, nerves are classified mainly into three different types.

Afferent nurons:

Afferent (or ferrying towards) which carry messages towards the central nerves system (spinal cord or brain) from nerve endings on the muscles that sense the change in surroundings called as stimulus detectors. These arealso called as '***sensory***' nerves.

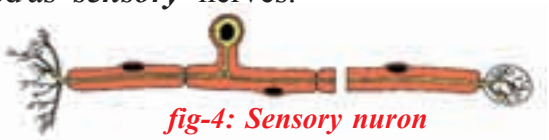


fig-4: Sensory nuron

Efferent nuron:

Efferent (or ferrying away) which carry messages from the central nervous system to parts that shall carry out the response or the effectors (nerve endings). They are also called as *'motor'* nerves.

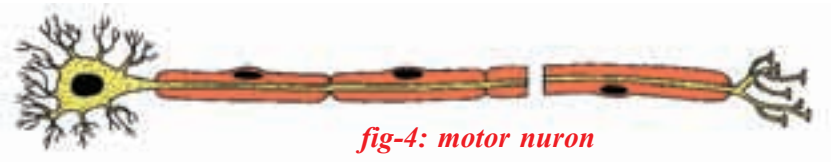


fig-4: motor nuron

Association nerves:

Association nerves, which link together the afferent and efferent nerves.

- Which organ of your body was the detector and which the effector in Activity-1?

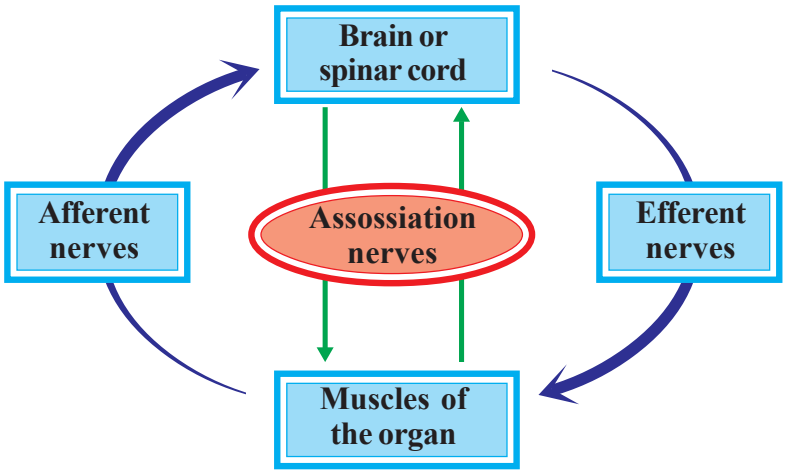


fig-5: Different nerve pathways

- What do you think was the information carried on the afferent and efferent nerves respectively?

Activity-1 showed a response on which you had some control or it was voluntary(recall the use of the term where you studied voluntary and involuntary muscles). We know that our body would also need to respond to certain situations on which we may not have a control. Such responses are called as reflexes.

A simple activity shall help us to understand this better.

Activity-2

fig-6: Knee jerk

Knee Jerk Reflex

Cross the legs, in a seated position, so that the lower half of the uppermost leg hangs freely over the other. Strike the area below the kneecap sharply, while firmly grasping the front part of the thigh with the other hand. Note the changes in shape of the thigh muscles.

Note that although we are fully conscious, we cannot prevent the thigh muscles from contracting. Such a response

is said to be involuntary. Now the same thigh muscle can operate in a voluntary manner, as when we kick a football.

Do you think most of the functions in our body go about in an involuntary manner? Why /Why not?

Do you know ?

The existence of the knee jerk was first noted in 1875. At first it was doubted whether a nervous reflex was involved at all. But it was discovered that if, in an anaesthetized monkey wherespinal nerves supplying the limb were cut, the knee jerk reaction would not occur. Clearly a nerve pathway was involved.

During actions which are involuntary and have to be carried out in very short intervals of time, the pathway that nerves follow is a short one; it does not go up to the brain while voluntary pathways are usually longer passing through the brain. Now let us see what pathways actually are.

The reflex arc

Not until the end of the nineteen century was thereflex understood in terms of pathways. Picking up informationof a stimulus to generating a response involves a pathway from detectors to brain or spinal cord or a set of nerve cell heads near spinal cord to the effectors. Such a single pathway going upto the spinal cord from detectors and returning to effectors is a reflex arc.

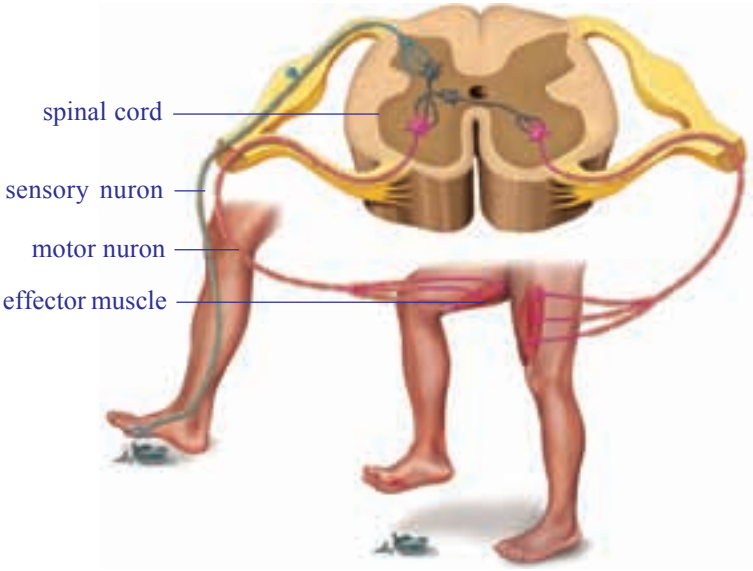


fig-7: Reflex arc

If you accidentally touched a very sharp surface with a finger, several such arcs would operate to cause the muscles of the arm to withdraw the finger. Observe the figure, how our leg muscle respond when will step on a shorp edged object.

- What other effectors would act under these circumstances?
- What does this tell us about the association of nerves?

In fact, many of you will have experienced what happens when you do things consciously and otherwise. Say for example, when you are

performing an action such as running upstairs. If you start to think about where your feet are going you often stumble. The interesting thing is that the same effectors in the leg muscles can be made to perform very special movement under the control of the conscious mind (voluntarily). Hence in a football game, the muscles of the leg operate both by reflexes and voluntarily. Most actions of our body are actually controlled together by voluntary and involuntary pathways.

Do you know ?

Nerve transmission from stimulus to a response can occur at a maximum speed of about 100 meters per second..

- Think of any action and try to make a sketch of the reflex arc.

The voluntary and involuntary actions in our body are controlled by nervous system as a whole.We may study our nervous system on the basis of areas from which nerves originate and then spread out to the whole body as mainly two divisions the central nervous system (CNS) and peripheral nervous system (PNS)

Central Nervous System (CNS)

Central nervous system includes brain and spinal cord. It coordinates all neural functions.

Brain

Proportionate to the body size, the human brain is the largest of all animals. The brain is present in the hard bony box like structure called cranium. It is covered by three layers called the meninges. The meninges are continuous and cover the spinal cord as well. The space between the inner layers is filled with fluid called cerebro-spinal fluid. It serves as a shock-absorbing medium and protects the brain against shocks/jerks along with the meninges and cranium. Mainly the nerve cell bodies together with capillaries form a mass called as grey matter while the myelinated axons or those covered by fatty sheaths form white matter. The grey matter is usually present on the periphery while white matter is present towards the center. This is mainly due to the fact that there is a small area from where the

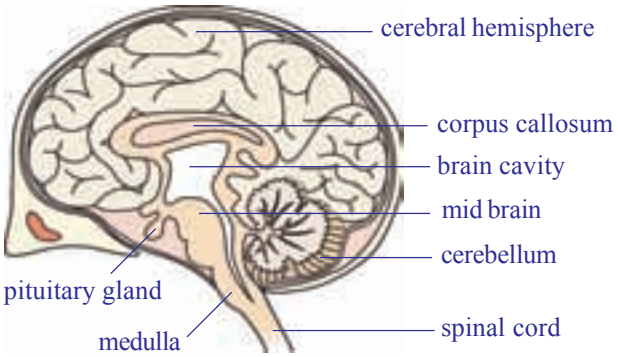


fig-8: Brain

myelinated axons leave the brain. As we have already studied, the function of the brain as a control center was known nearly 2000 years back by Greek physiologists.

Brain has the following divisions –

1. Forebrain – cerebrum, diencephalon
2. Midbrain – optic lobes
3. Hindbrain – cerebellum, medulla.

Functions of the various parts of the brain

Part of the brain	Functions
Cerebrum	i) Seat of mental abilities, controls thinking, memory, reasoning, perception, emotions and speech. ii) Interprets sensations and responds to cold, heat, pain and pressure.
Diencephalon	i) Relay centre for sensory impulses, such as pain, temperature and light. ii) Reflex centre for muscular activities. iii) Centre for certain emotions such as anger. iv) Centre for water balance, blood pressure, body temperature, sleep and hunger. v) The hypothalamus controls the pituitary gland, which functions as the master gland.
Midbrain	It relays motor impulses from the cerebral cortex to the spinal cord and relays sensory impulses from the spinal cord to the thalamus, reflexes for sight and hearing.
Cerebellum	i) Maintains posture, equilibrium and muscle tone. ii) Coordinates voluntary movements initiated by cerebrum.
Medulla oblongata	i) Contains centre for cardiac, respiratory and vasomotor activities. (**Vasomotor** refers to actions upon a blood vessel which alter its diameter) ii) Coordinates reflexes like swallowing, coughing, sneezing and vomiting.

Do you know ?

The brain weighs approximately 400g. Through the brain comprises little more than 2% the body's weight, it uses 20% of the whole body energy.

fig-9: Leonardo Davinci

Spinal Cord

Spinal cord extends from the back of the hindbrain to the back of the stomach or lumber region, through the neural canal of the vertebral column. It is cylindrical in shape. Unlike the brain, the white matter is towards periphery while grey matter is towards the center of the spinal cord. The myelinated axons leave the spinal cord from both sides of the vertebral column.

fig-10: Spinal cord

The role of the spinal cord in nervous control was studied largely by the experimentalists of the sixteenth and seventeenth centuries. They found that the Greeks concept of control by the brain was erroneous. Animals were shown to have the ability to respond to stimuli even when the brain was removed. Leonardo da Vinci (1452-1519) and Stephen Hales (1677-1771) both record the survival frogs those brain had been destroyed. The animal still produced muscular moments if its skin was pinched or pricked. Both observers further record that the animal died as soon as spinal cord was damaged by pushing a needle down it.

Such evidence suggested that the spinal cord was not simply a trunk road for instructions from the brain, but might be a control center in its own right.

- What according to you would be the function of the spinal cord?
- Are all functions of our body under direct control of the brain and spinal cord? Why do you think so?

Do you know ?

Scientists have been able to trace out the nerves that originate from brain called as cranial nerves and those that originate from spinal cord called spinal nerves. There are 12 pairs of cranial nerves which arise from the brain. There are 31 pairs of spinal nerves.

Peripheral nervous system

Figure- shows you that nerves attached to the spinal cord have two types of connection or root – some to the back or dorsal side and some to front or the ventral side of cord. The experimental work of two men, Charles

Bell in Scotland and Francois Magendie in France, in the early nineteenth century, showed these roots to have different functions. If the dorsal roots of an experimental animal were cut the animal made no obvious reaction. If, however, the ventral roots were even lightly touched, the muscles to which the nerve was connected switched violently. The ventral root evidently controlled muscular activity, the dorsal root did not.

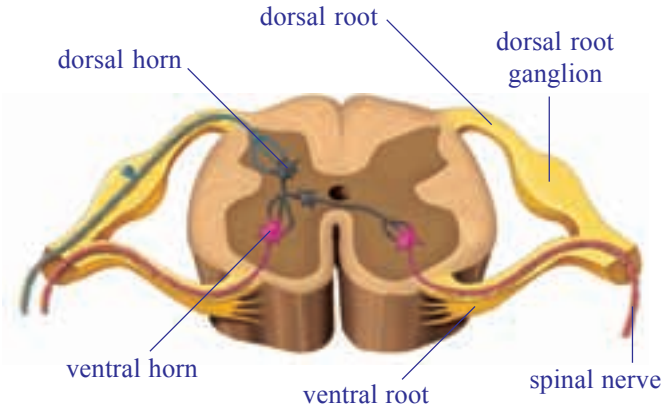


fig-11: Peripheral nerves system

In 1822 they suggested that dorsal root carried messages of sensation inwards while the ventral pathway carried outwards the instruction for muscular contraction.

- Which root according to you gets signals from afferent nerves?

The peripheral nervous system (PNS) is a vast system ofthe dorsal and ventral root nerve cell heads and the network ofspinal and cranial nerves that are linked to the brain and the spinal cord on one end and muscles on the other.

- What do you think the end of these nerves act as at the muscular end?

The PNS can either involuntarily control several functions of regions like our internal organs, blood vessels, smooth and cardiac muscles, when it is called autonomic nervous system or have voluntary control of muscles of some areas of skin and the skeletal muscle.

We can take up an example to see how certain involuntary function controlled by autonomic nervous system takes place in our body. A very evident observation is the reduction and expansion of the pupil of our eye

When we enter a dark room we cannot see anything immediately. Slowly we are able to see the things around us in the room. This is because of increase in diameter of pupil, which allows more light in. When we come out of the dark room into broad day light the diameter of the pupil decreases allowing less light to enter into the eyes. Both these functions occur under the influence of the autonomic nervous system.

Several functions in our body as we have seen are controlled by nerves while many of them and others are controlled by other ways as well. You may have heard about people having diabetes and know that they have to take insulin tablets or injections when the level of sugar in their blood

rises? Let's find out what insulin is how we came to know about it. This would also give us an idea of controls other than nerves in our body.

Do you know ?

Research in the past two decades has brought out an interesting fact. Other than central nervous system and peripheral nervous system, there is a system of neurons present in our digestive tract that can function even independently of either CNS or PNS. It has been nicknamed as a small brain and the system is called as enteric nervous system.

Coordination without nerves

The Story of insulin

In 1868 Paul Langerhans, Professor of Pathology at the University of Freiburg in Germany, working on the structure of the pancreas, noted certain patches of cells quite different in appearance from the normal tissue cells of the organ and richly supplied with blood vessels. They became known has the Islets of the Langerhans (Islets stands for islands), but their function remained unknown. Many others interested in the function of pancreas had found that its removal from the body of an experimental animal would lead to the development of diseases similar to a well-known human ailment 'sugar diabetes'. This is a condition in which the amount of free sugar in the blood and in the urine is abnormally large. It's cause in man was unknown but evidence pointed to the pancreas as a possible point of origin.

fig-12: Paul Langerhans

fig-13: Pancreas

The next stage was reached when it was found that tying up the pancreatic duct that emerged from the duodenum(a part of the small intestine) would cause the pancreas to degenerate but the Islets of Langerhans would remain normal. Moreover, an animal so treated would not develop diabetes. Here was really strong evidence that the level of blood sugar is in some way linked with the islet cells. By 1912, workers were convinced that the islets

produced a secretion which they passed into the blood. In latin insula means an island. The name insulin was coined for the secretion, even though it had not been isolated.

Ten years later in Toronto, Banting, Best, and Macleod finally succeeded in extracting insulin from degenerate animal pancreases whose ducts to the intestine had been tied. When given by intravenous injection to a dog with no pancreas, this substance kept it alive and healthy with a low level of blood sugar. Insulin is now produced in large quantities for the treatment of human sufferers from sugar diabetes, to whom it is administered by injection into the skin.

Insulin thus is a chemical that acts as it reaches blood from the cells that produce it.

Other chemical co-ordinators

The evidence that events occurring in one part of the body could be affected and indeed controlled by substances circulating in the bold was now overwhelming. In 1905 the English physiologist starling had coined the term hormone (Greek, hormao – to impel) for such secretions. The glands secreting hormones were termed ductless glands, since they have no tube or duct to carry away their products, which pass straight into the blood. In this way they different from glands such as the liver and pancreas, whose secretions pass down ducts which are connected to other organs.

The human body contains many other ductless glands (endocrine glands).Glands do not produce their hormones at a steady rate. The adrenal gland, for example, normally has a low output.

What will you do if a dog is after you? What will be your first reaction? Have you ever observed any change in your body when you are afraid?

Try to note the body language of humans / animals when they are fighting / scared.

fig-14: Cock fight

Nobody wants to fight a dog. The first thing we do is running away from the place.

If we observe our body, when we are afraid, the rate of heart beat increases; the breath rate will be faster; blood pressure increases; the hair on the body becomes erect and we get goose bumps. The other things we might not observe are pupil dilation, skin becomes more sensitive, and rarely the bladder and the rectum may be emptied. We come to normalcy only after we reach a safe spot.

In the previous lesson we have studied about nerve co-ordination, where in nerves carry stimuli from sense organs to central nervous system and orders to effectors organs-the muscles. But in the above situation the action of the nervous system is limited. All the changes in the body are carried out under the influence of a chemical called Adrenalin hormone, released by Adrenal gland which is an endocrine gland. The various actions of the body are controlled by hormones and co-ordinated by nervous system. So in this type of conditions nervous system and endocrine system work together to bring about control and co-ordination.

Ask your teacher why Adrenalin hormone is also called fight and flight hormone.

The whole system of ductless glands is called the endocrine system. Information about a few of the endocrine glands is given in the accompanying table.

Try to make a list of functions that you think are controlled both by the nervous and the endocrine system.

Feedback mechanism

Recall the fight or flight behavior of cat and dog. The amount of adrenalin hormone increases in the blood sharply in a frightening situation, getting anger or excited.

- Have ever observed the duration of anger?
- Why does anger come down?
- What may happen if anger persists for a longer period?

Anger is always short lived factor. You know that increased levels of adrenalin are responsible for anger. When the levels of adrenalin in the blood come down slowly we come to normal state. If the adrenalin levels persist for a longer period of time, regular metabolic activities are disturbed.

Increase in adrenalin levels leads to anger, decrease in adrenalin levels leads to normal position.

- What will happen if it is continued for longer periods of time?

If the sugar levels in the blood rise than normal position they are detected by the cells of pancreas, which respond by producing more insulin in to blood. If the sugar levels come back to normal level secretion of insulin is automatically reduced.

So it is necessary that the hormones are secreted by the glands in our body in precise quantities which are required for the normal functioning

Table: Endocrine glands

Name of the gland	Location	Hormone secreted	Response of body to hormone
Pituitary	Floor of brain	1. Somatotrophin	Growth of bones
		2. Thyrotrophin	Activity of thyroid gland
		3. Gonadotrophin	Activity of ovary and testis
		4. Andrenocotropic hormone	Stimulates secretion from andrenal cortex
		5. Luteinising hormone	In males - secretion of testosteron.
			In female - Ovulation, development of corpus luteum and secretion of progesterone.
		6. Follicle stimulating hormone	In male - spermatogenesis
			In female - growth of graafian follicles, estrogen secretion, milk production and secretion.
Thyroid	Neck	Thyroxin	General growth rate and metabolic activity
Ovary	Lower abdomen	Oestradiol	Growth of the uterus and skeleton of the pelvis Control of the 28 days menstrual period.
Testis	Scrotal sac	Testosterone	Growth of hair on face, muscular development, deepening of voice, normal sexual behavior and development of sex organs.
Adrenal	Attached to	Adrenalin	Increase in heart-beat rate. Rise Kidneys in blood sugar. Dilation of the coronary artery. Dilation of the pupil of the eye. Narrowing of the skin capillaries.

of the body. This means that there should be some mechanism to regulate the production and release of hormones in the body.

The timing and amount of hormones released by endocrine glands is controlled by the feedback mechanism, which is inbuilt in our body. None of the systems, whether nervous or chemical are totally exclusive of each other.

Autonomus nervous system

You know that medulla oblongata is the region that regulates heartbeat, breathing etc. the system that helps to bring about such activities of internal organs is called autonomous nervous system. Normally such involuntary activities take place by the coordinated efforts of the medulla oblongata and autonomous nervous system.

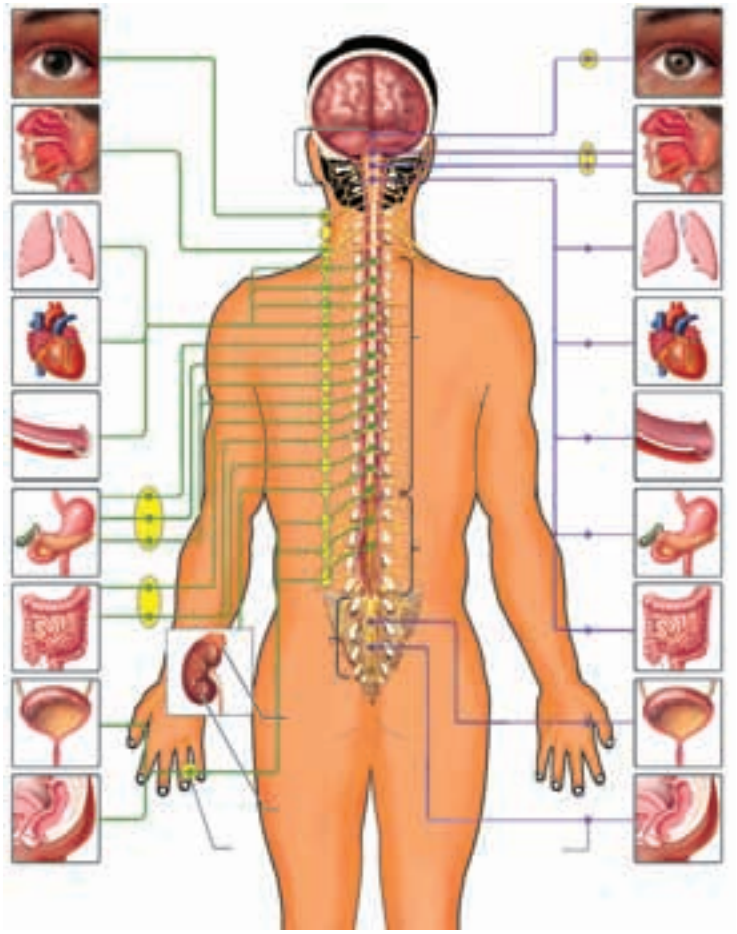


fig-15: Autonous nervous system

Now let see the autonomous nervous system influences the life activities. Observe the following figure and record your observations.

- To which organs of the body do the nerves go from the ganglions near the vertebral column?
- Which are the organs that receives nerves starting from the brain?
- Which are the organs whose activities are influenced by the sympathetic system?
- Which are the organs whose activities are influenced by the para sympathetic system?
- What you understand about the functions of para sympathetic system?
- What you understand about the functions of sympathetic system?

Ganglia near the vertebral column are connected the spinal cord by various nerves. The sympathetic system is formed by the chain of ganglia or either sides of the vertebral column and the associated nerves. The para sympathetic system is formed by the nerves arising from the ganglia of the brain and the posterior part of the spinal cord. These together constitute the autonomous nervous system. It is the part of the peripheral nervous system consisting of twelve pairs of cranial nerves and thirty one pairs of spinal nerves.

Control mechanisms in plants

How do plants respond to stimuli?

So far we have studied how control mechanisms work in our body. Do plants also have control systems? Let us find out by doing a small activity.

Activity-4

Touch the leaves of Mimosa pudica (athipathi, touch me not) plant and observe how leaves respond. The plant folds up its leaves when we touch them.

fig-16: Mimosa pudica

Do you know ?

Mymosa pudica leaves has pad like swellings at the base. This is called pulvini. Here cells contain lot of water and large inter cellular spaces. Due to water pressure pulvini hold the leaf erect. Touch me not plant shows nastic movement by touch. This is called thigmo nasty. When we touch the leaves an electrical impulse is generated. This impulse acts on plant hormone. Because of this hormone water in the pulvini cells which are closer to the leaf vein migrate to other side of the cells then pulvini loss its firmness leaves become fold. After 20 to 30 minutes water come back pulvini get firm and leaves become erect.

Try to give examples of situations where you may see plants responding to a certain stimulus.

You may have seen tendrils of plants growing towards a support, why do you think this happens? Would you say it is responding to a stimulus?

Both plants and animals react to various stimuli around them. But the method of responding to stimuli is not similar in plants and animals. Most higher animals can respond to stimuli because they have a nervous system and an endocrine system, but plants do not have a well-defined nervous or endocrine system. They do have some mechanism of control that are controlled by some chemicals or hormones.

Plants can sense the presence of stimuli like light, heat, water, touch, pressure, chemicals, gravity etc. The hormones present in the plants called as phyto hormones (phyto means plant) control responses towards the stimuli mentioned above. Phyto hormones coordinate the activities of the plant usually by controlling one or the other aspect of the growth of the plant. So plant hormones are called growth substances. Some major plant hormones and their action are given in the following table.

Major plant hormones and their action:

Abscisic acid closing of stomata; seed dormancy

Auxins cell elongation and differentiation of shoots and roots,

Cytokinins promote cell division, promotion of sprouting of lateral buds, delay the ageing in leaves, opening of stomata

Ethylene ripening of fruit

Gibberellins germination of seeds and sprouting of buds; elongation of stems; stimulation of flowering; development of fruit, breaking the dormancy in seeds and buds.

Activity-5

Take a glass jar and fill with soil. Sow a bean seed near the wall of the jar. This helps you to observe how root and shoot are growing. After 4 or 5 days you will notice that seed germinate. Keep the jar under the sun. Observe how root and shoot grow. Then tilt the glass jar and keep the plant horizontally. Observe the direction of growing of root and shoot for more than a week.

- Does the shoot take a horizontal tilt after a week?
- Which part of the shoot may have grown more and which part less to bring about this effect?

Observe the plant growing towards light and how auxins acts on bending of stem to show a response to the sunlight.

More auxin collects on the lighted side of the stem. So cells on that side grow faster. On opposite side cells grow slow to make the stem bend.

Collect bending and straight portions of tender stem. Take transverse sections of both stems, observe them under microscope.

fig-17: Bending towards sun

- Do you find any difference in the shape of epidermal cells?

Charles Darwin and his son Francis Darwin performed some experiments on photo tropism. They covered the terminal portion of the tip of stem(coleoptile) with a cylinder of metal foil. Exposed the plant to light coming from the side. The characteristic bending of the seedling did not occur. If, however light was permitted to penetrate the cylinder bending occurred normally. They stated that when seedlings are freely exposed to a lateral light some 'influence' is transmitted from upper to the lower part causing the material to bend.

In 1926, the Dutch plant physiologist W. Went succeeded in separating this 'influence' from the plant that produced it. Went cut off coleoptile tips from oat seedlings. He placed the tips on a slice of agar and left them for about an hour. He then cut the agar into small box and placed a block off centreon each stump of the decapitated plants. They were kept in the dark during the entire experiment. Within one hour he observed a distinct bending away from the side on which the agar block was placed.

Agar block that had not been in contact with coleoptile tip produced either no bending or only a slight bending toward the side on which the

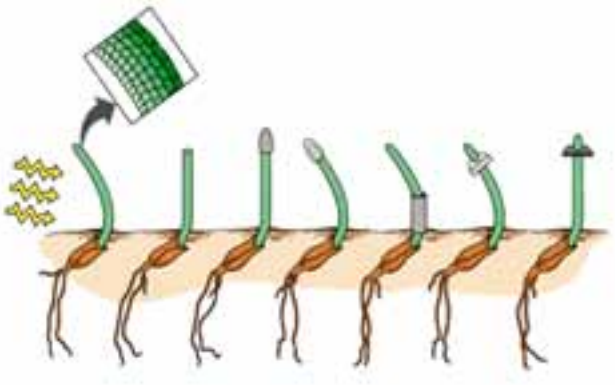


fig-18: Went experiment

block had been placed.

Went interpreted these experiments as showing that the coleoptile tip exerted its effect by means of chemical stimulus rather than a physical stimulus such as an electrical impulse. This chemical stimulus came to be known as auxin. In this way the first plant hormone auxin (greek word auxein means to increase) was discovered by Went.

Tropic and nastic movements in plants

The above experiments show that movement of individual parts of plants is possible when they are subjected to external stimuli. This type of response is called tropism or tropic movement. Sometimes the direction of stimuli determines direction of movement, at times the direction of movement is not determined by direction of stimuli. This type of response is called nastic movement.

Let us observe the growth of a creeper plant near window. The shoots of creeper bend towards sunlight. Such type of response of a plant to light is called photo tropism (photo means light, tropism means movement).

We know that roots always grow downwards. This means that plant respond positively for gravitational force. This is called geotropism.

If we observe plant which grow near a rock or wall side. You notice that all roots are growing in one direction, away from the rock or wall where water is available in the soil. This type of response to water is called hydrotropism.

A very interesting thing in plants is movement in tendrils. All plants shows positive response to photo tropism but in creepers like cucumber, bitter guard etc. the stem is weak and thin which cannot grow upwards. Tendrils play a vital role to make the plant erect. Tendrils are thin thread like growths on the leaves or stems of climbing plant. They grow towards support and wind around them. This type of response to make contact or touch is called thigmo tropism.

fig-19: Tendrils

If you taste the carpel of a flower it is sweet. Let us recall butterflies fluttering on flowers for this nectar. Ripen stigma

secretes sugary substance. This chemical substance stimulates the pollen grain which falls on the stigma. Pollen grain responds to this stimulus as pollen tubes grow pollen to reach the ovule for fertilization. This type of response to chemicals is called chemo tropism.

Key words

Response, stimuli, neuron, axon, synapse, afferent or sensory nerves, efferent or motor nerves, association nerves, central nervous system, brain, spinal cord, cerebrospinal fluid, peripheral nervous system, insulin, endocrine glands, hormones, feedback mechanism, plant hormones, tropic movements, nastic movements

What we have learnt

- Nervous system and endocrine system are the two systems that control and coordinate various functions in the body.
- The responses of the nervous system can be classified as reflex, voluntary and involuntary actions.
- The human nervous system is studied under two divisions: The central nervous system and the peripheral nervous system.
- The central nervous system consists of brain and the spinal cord while the peripheral nervous system is further divided into somatic nervous system and autonomic nervous system.
- The autonomic nervous system has two parts – sympathetic and parasympathetic, which cause physical reactions opposite to each other.
- Nerve cell is the structural and functional unit of nervous system.
- Synapse is a gap across which signals are transmitted from one neuron to the other.
- Hormones produced in one part would move to another part to achieve the desired effect.
- A feedback mechanism regulates the action of the hormones.
- Directional movements in plants in response to specific stimuli like light chemicals etc. are called tropic movements.
- Plant hormones are usually growth effectors or inhibitors. Some growth effectors are Auxins and Gibberellins while growth inhibitors are like Abscisic acid.

Improve your learning

1. Fill in the missing sections in the following flowchart. (AS1)
2. Do you think body's team work maintains functioning of our body? Justify your answer with an example. (AS1)
3. Give an example of coordination in your body where both hormonal and nervous controls function together. (AS1)
4. Consider that you are passing by a garbage disposal area and you immediately cover your nose. Arrange the events below in a logical order by marking them from 1 to 5 to trace the events that happen in the nervous system from detection of foul smell (stimulus generation) to covering your nose (response). (AS1)
   (i) At the end of the axon, electrical impulse releases chemicals
   (ii) Stimulus received on the dendritic cells of a neuron sets off chemical reaction that creates an electrical impulse
   (iii) Electrical impulse transmitted through cell body and axon
   (iv) The chemicals cross the synapse and reach the next neuron. Similarly, the electrical impulse crosses several neurons
   (v) Finally, the impulse is delivered from neuron to the gland that helps in recognition of the foul smell and muscle cells that help in covering the nose

   _____

   _____
5. What is a synapse? How it is useful in transpering information? (AS1)
6. Distinguish between (AS1)
   a) Stimulus and Response
   b) Afferent and Efferent nerves
   c) Central nervous system and peripheral nervous system
   d) Receptor and effector
6. How does Phototropism occur in plants? (AS1)
7. Give an example and explain how plants may immediately respond to a stimulus. (AS1)
8. Suggest an experiment to show how roots grow away from light in most plants. (AS1)
9. Give an example to show how hormones can influence visible changes in your body. (AS1)
10. Gibberellins and auxins promote growth in plants while abscisic acid arrests the same. Some situations are discussed here state which hormones would be needed and why? (AS1)
    a. A gardener wants large dahlias he should use along with nutrients and other things _____ hormone.

b. In a drarf plant the branches have to be thickened one would use _____ hormone.

c. Seeds are to be stored for a long time _____ hormone can help.

d. Cutting the apex or tip of plants so that there are several lateral buds _____ hormone can be used.

c) The part of the brain that helps you in colving puzzle is _____

10. What proceduce you follow to understand the effect of plant growth hormones (in agar medium) in the terminal portion of the tip of stem (coleoptile)? (AS3)

1. Draw a picture representing connection between axon-axon, axon-dendrite. Why they connect like that? (AS5)
2. Draw neatly labled diagram of Brain and write few points how it is protected. (AS5)
3. The axon of nerve cell in hand is shertons then the axon of nerve cell in leg. Do you support this statement? Why? (AS1)
4. What will happen to the potted plant kept near window in the room? (AS2)
5. You are walking in the traffic suddenlyyou heard a loud sound. How coordination takes place in this situation among respected organs? Draw a block diagram to explain this situation. (AS5)

11. Fill up the blank with suitable word. (AS1)

1. The largest region of the brain is _____
2. A pont of contact between two neuron is _____
3. _____ phyto hormon is resposeible for cell clongation and differention of shoots and roots.
4. Thryoxin resposible for _____
5. Maintains posture is maintain by _____ part of brain.
5. Make a model of neuron using suitable meterials.
6. Draw and lebled diagram of brain.
7. Collect the information about cranial nerves. Spinal nerves from internet or from your school library.
8. Obserb different actions performed by your classmet for a period of 45 minutes. Out of those action which are control voluntary and involuntary pathways.
9. Organs responed for the external stimuly by a fraction of second. How do you feel about such controlling mechanism of human body?

12. State wheather the following actions are voluntary action, simple action or conditioned reflex.

i) Blinking ii) Cleaning the table iii) Palying on the key board

iv) Salivarioning when food is put in the mouth.

v) We close our ears when we hard un bearble sound.

9. A person loss of control on emotions, which part of brain stops it's function.
   a. cerebrum b. diencephalon c. mid brain d. cerebellum
10. Leaf movement if mimosa helps to
    a. reduce photosysthesis b. protect from greazers
    c. releasing phyto hormones d. regulate it's growth
11. Diabetes is related to this gland.
    a. Thyroid b. pancreas c. adrinal d. pitutary

1. How does a neuron differ from an ordinary cell in structure? Write notes.
2. Is the structure of neuron suitable for transmission of impuleses? Analyse.
3. Man is the most intelligent animal. What could be the fact that helped us to reach such a conclutssion?
1. Take a small potted plant cover base portion of the plant titely and hang the part of upside down. Observe the plant for a weak. Based on your observation how can you support phototropism. (AS3)
2. Take a cockfether touch smoothly at different parts of your body. Findout which portion of the body has high sensation. Is this similar during sleeping? (AS3)
3. What happens if all functions of the human body is controlled only by brain? (AS2)
4. If you visit a doctor what doubts you wood like to clarify about pancreas? (AS2)
5. Collect information the actions controlled by spinal cord by using reference books from your school library. (AS4)
6. Read the following sentences and compare with endocrine glands. (AS4)
   Pheromones are chemical substances secreted by organisms. These act as chemical signals secreted by exocrine glands. Pheromones are used as signals by the members of same species. Honey bee secretes pheromones that attract other bees to the location of food.
7. Its very interesting to watch a creaper entwined its tendril to the support. Is not it? How you express your feelings in this situation? (AS6)
8. Hormones release at a speicific place, specific time for a specific function. Prepare a cartoon on hormones with a nice caption. (AS7)

Chapter

6

Reproduction - The generating system

In plants and animals reproduction is necessary for continuation of life by the production of offsprings (young ones).

- Do you think reproduction occurs only for continuation of life?
- How does an organism grow? How does repair of worn out parts take place? Is there any form of reproduction involved in the process?

You have learnt that offsprings are produced from parents either by fusion of gametes or without it. The process of reproduction where fusion of gametes are not involved is asexual reproduction and where fusion of gametes take place is called sexual reproduction. Current hypotheses suggest that asexual reproduction may have short term benefits when rapid population growth is important or in stable environments, while sexual reproduction offers a net advantage by allowing more rapid generation of diversity, allowing adaptation to changing environments..

Organisms are capable of giving rise to off springs is often more than a single way either involving the gametes or without them. Organisms also reproduce differently in different situations. For example paramecium (the slipper animalcule) would divide asexually by fission in favourable conditions while during unfavourable conditions; two paramecium may come in contact and undergo a nearly sexual form of reproduction.

During rainy season you may have wondered how swarms of insects are suddenly appear. Most insects have life cycles spanning a few days to a few months.

Let us study some modes of reproduction involving a single parent, without involving gametes. These are as weknow asexual modes of reproduction.

Asexual mode of reproduction

Sequence of pictures showing a growing paramoecium colony diminishing to cyst like structures

Fission

Single celled organisms, such as paramecium and bacteria, which reproduce by splitting in two or more offsprings. This usually occurs in a symmetrical manner. When they split into two it is binary fission, when more it is multiple fission. This is often the only mode of reproduction for these organisms.

fig-1: Fission in paramecium

Budding

A growth on the body that grows to forms nearly identical copy of parent and then separates from the parent and becomes independent. As for example in yeast.

fig-2: Budding in yeast

Fragmentation

Some animals can grow from a separate piece of parent animal. This can be from any part of the body. This happens in only the simplest animals, such as some flatworms, moulds, lichens, spirogyra etc. grow in this manner. These animals may also reproduce sexually.

fig-3: Fragmentation

Parthenogenesis

Now a days we are able to develop seed less fruits like bananas, grapes etc .This is a process of reproduction there is a shift from sexual to asexual mode of reproduction. In nature also this process occurs which we have utilised in growing organisms of our choice which have more desirable characters

fig-4: Seedless fruit

In this process generally the egg develops with out meiosis and fertilization. So the offsprings are diploid. Parthenogenesis may occur in species that also show sexual reproduction. In addition some animals known as rotifers in which all reproduction is Parthenogenetic. There are no males known in these species. In another type of Parthenogenesis meiosis does occur and the egg(monoploid) can develop whether fertilized or not. The monoploid offsprings develop into males. The diploid into females.

This strange kind of reproduction occur in bees, ants and wasps. Here one finds asexual and sexual reproduction on almost simultaneously.

Ask your teacher about plants which possess Parthenogenesis.

Regeneration

Many fully differentiated organisms have the ability to give rise to new individual organisms from their body parts. That is, if the individual is somehow cut or broken up into many pieces, many or these pieces grow into separate individuals.

fig-5: Regeneration in planaria

Vegetative propagation

Natural propagation

fig-6: Bryophyllam

Leaves: As in bryophyllum where small plants grow at the edge of leaves.

Stems: Aerial weak stems like runners and stolons, when they touch the ground, give off adventitious roots. When the connection with the parent plant is broken, the portion with the newly struck roots develops into an independent plant. Some examples for propagation by stem are from stolons, bulbs, corms, tuber, etc.

Bulbis *Tuber* *Stolon* *Corms* *Root*

fig-7

Stolons - Vallisneria, strawberry, Bulbs - Alluimcepa or onion, Corms - Colacasia, tuber - potato, Root - Dahlia, radish, carrot etc.

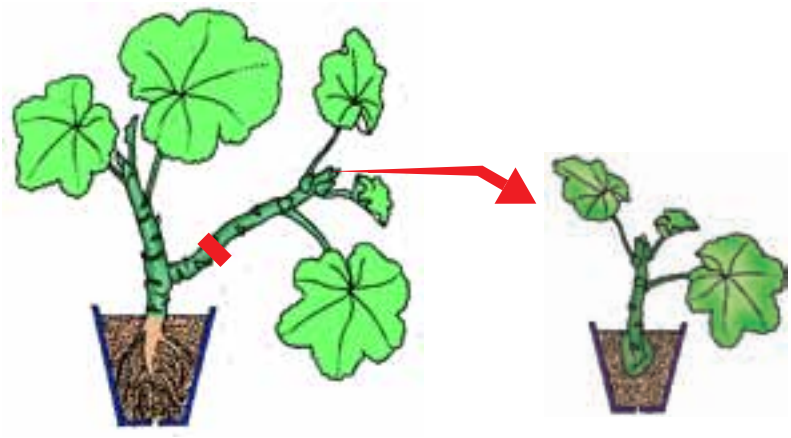


fig-8: Cutting

Artificial propagation

Cutting:

Some plants grow individually when a piece of the parent plant having bud is cut from the existing plant. The lower part of this cutting is buried in moist cell. After few days the cut parts having buds grow as an individual plant.

Layering:

A branch of the plant with at least one node is pulled towards the ground and a part of it is covered with moist soil leaving the tip of the branch exposed above the ground. After some time, new roots develop from the part of the branch buried in the soil. The branch is then cut off from the parent plant, the part which has developed roots grows to become a new plant.

fig-9: Layering

Grafting:

Two plants are joined together in such a way that two stems join and grow as a single plant. One which is attached to soil is called stock and the cut stem of another plant without roots is called scion. Both stock and scion are tied with help of a twine thread and covered by a polythene cover. Grafting is used to obtain a plant with desirable characters.

Let's discuss now, why grafting method is used when other methods of propagation is available.

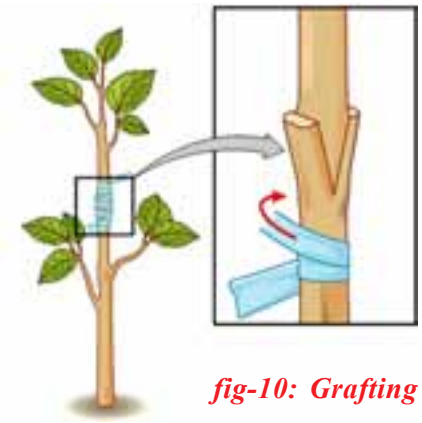
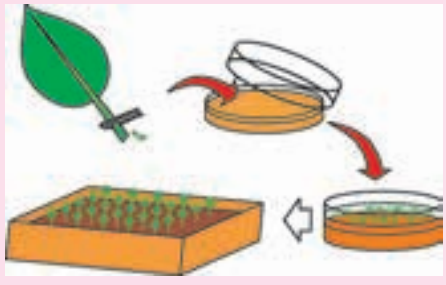


fig-10: Grafting

If you have two varieties of fruit yielding trees in your garden. One tree has the character of giving big sized fruits but less in number. The taste of the fruit is pretty good. The other one gives a large number of fruit but they are neither big in size nor tasty.

- Which one is beneficial to you and why?
- You must wish to have a plant with all the characters, don't you?

Do you know?



The cutting, layering and grafting are the traditional methods for the artificial propagation of plants. Examples of plants produced in this manner are Banana, Pineapple, Orange, Grape, Rose, etc.For commercial purposes; they are being replaced by the modern methods of artificial propagation of plants involving tissue culture. In tissue culture, they just put a few plant cells or plant tissue in a growth medium with plant hormones in it and it grows into new plants.Thousands of plants can be grown in very short interval of time.

I. Grafting enables us to combine the most desirable characteristic of the two plants (scion and stock) in its flower and fruits.

II. By grafting method, a very young scion (shoot part of a plant) can be made to flower and produce fruits quite fast when it is grafted to the stock.

III. Grafting can be used to produce varieties of seed less fruits.

Collect information from your school library or internet and collect information about advantages and disadvantages of artificial vegetative propagation and submit it in the class room.

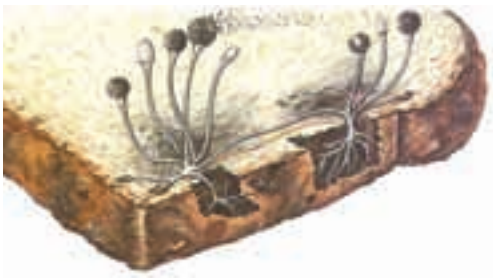
Sporeformation:

Generally we may notice that Whitish threads and blackish powdery like substance on rotten fruits, bread slices and other food materials. When you touch it the blackish powder sticks on your fingers. This is the reproductive substance produced by a fungi called Rhyzopus. You have already learnt about this in the chapter The story of micro organisms in class VIII.

The Rhyzopus parent plant produces hundreds of microscopic reproductive units called spores. When the spore case (also called sporangia) of the plant bursts, the spores spreads into air. These air-borne spores land on food or soil, under favourable conditions like damp and warm conditions, they germinate and produce new plants. Most of the fungi like rhizopus, mucor etc., bacteria and non-flowering plants such as fern and mosses reproduce by the method of spore formation.

Activity- 1

To examine rhizopus or common mould under the microscope, it is best to grow your own in a controlled environment. Use a soft bread that is preservative free or a roti, many fruits or vegetables such as potatoes or oranges will also work. A good sample of mould may take up to two weeks to form, so be sure to plan ahead for this project. (Please note: this should not be done by those with allergies to mould or with severe asthma.)



Ryzopus growing on bread

Ryzopus under microscope

Ryzopus sporongium

fig-11

Leave the bread in the open for about an hour so it is exposed to contaminants in the air. Place the bread in a plastic bag, sprinkle water over it so it is damp and seal the bag, leaving some air inside. Place the bag in a dark, warm place, away from other food items. A kitchen cupboard close to the stove may be one option. Or you could place it next to a window, with a bowl or plate covering it from the light. Mould will grow best in a moist environment. Mould should start forming in 2-3 days, but will take a week or more to get a good sample depending upon whether.

Check on the piece of bread every few days, and add more water if it is becoming dried out. Avoid opening the plastic bag as much as you can. If you touch the bread, be sure to thoroughly wash your hands afterwards. When sufficient mould has formed, you can prepare a slide and examine it under the microscope. You would find whitish thread like growth with masses of black, grey and green fine dotted structures (See Figure). The black dotted structure is that of bread mould. Take a part of the bread or roti to school in a matchbox and ask your teacher to help you to make a slide and observe under the microscope.

Material required: Mould sample, plain glass slide, cover slip, water, disposable gloves.

Procedure:

1. Place a drop of water in the centre of the slide, using an eyedropper if you have one, or the tip of a clean finger.
2. Using a toothpick, scrape some of the mould off, and place it on the drop of water.
3. Take the cover slip and set it at an angle to the slide so that one edge of it touches the water drop, then carefully lower it over the drop so that the cover slip covers the specimen without trapping air bubbles underneath.
4. Use the corner of a tissue paper or blotting paper to blot up any excess water at the edges of the cover slip.
5. View the slide with a compound microscope, starting with a low objective.

The common bread mould plant consists of fine thread like projections called hyphae and thin stems having knob like structures called Sporangia (sporangium in singular). Each sporangium contains hundreds of minute spores. When the sporangium bursts, the tiny spores are dispersed in air.

Try to give some more examples of organisms which reproduce through spore formation.

fig-12: Fern sporophill

Sporophill:

Fern plants also produce spores. Collect a fern leaf which is called sporophyll. Observe the leaf carefully. Lower side of the leaf you found that clusters of sporangia. Gently rupture the sporangia with a needle and observe spores by using magnifying lens.

What about Mushrooms! Discuss in your class.

Sexual reproduction

As you studied earlier, sexual reproduction is a way of reproduction where fusion of gametes takes place by a process called fertilisation. Fertilisation may take place either outside the body of the mother (external fertilisation) or inside the mother's body (internal fertilisation). As a matter of fact, the eggs of land animals are fertilised inside the body of the mother, after fertilisation the eggs start dividing and growing into the embryo.

External fertilisation is most common in animals like most fishes and amphibians. The female lays a vast number of eggs in water and male release some millions of sperms onto them in water. As the chance of fertilisation is controlled by nature it becomes necessary to give rise to vast number of eggs and sperms.

While talking of mammals, especially in human beings special reproductive organs have been developed in males and females. Recall in class 8th we studied that testes, sperm ducts (vas-deferens) and penis including prostrate and Cowper's glands are male reproductive organs, where as ovary, oviduct, uterus and vagina are the female reproductive organs. The union of sperm and eggs take place inside the mother's body. As we studied in class VIII this type of fertilisation helps to exchange some of the characters of parents to the child.

Reproduction of aplacental mammal - Man

We will study human reproduction as an example of reproduction in the placental mammals. The process begins, as with other animals that reproduce sexually, with the sperms of the male and ovum (egg) of the female.

Male reproductive system

In the male human the two testes are located in an out pocketing of the body wall called the scrotum .The male reproductive cells, the sperms, are produced in very large numbers (hundreds of millions) in a series of small, highly coiled tubes in each of the two testes. Observe the following

picture of male reproductive system to know other parts of the male reproductive system are essential for the transport of the sperm cells.

The development of the male reproductive organs is regulated by the male sex hormone called testosterone.

You know that Secondary sexual events are controlled by the male sex hormones, which are secreted by the testes. The production of sperms by the testes has begun when these events occur.

Men produce sperm, from the age of about 13 or 14 years, and can go on doing so most of their lives, although their power to do so decrease as they grow older.

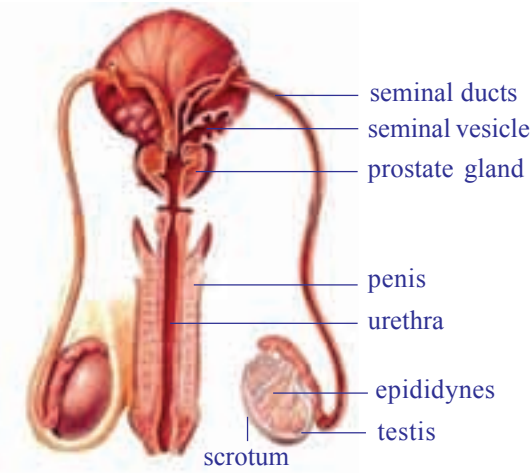


fig-13: Male reproductory system

Do you know?

Some bacteria and other microorganisms have been found that are capable of changing the sex of the organism in which they grow. A species of wasp has lost its sexual ability to reproduce and has reverted to asexual mode.

Female reproductive system

The two ovaries, where ova are formed, are located deep in the female's body. Observe the following picture of female reproductive system to know how it works.

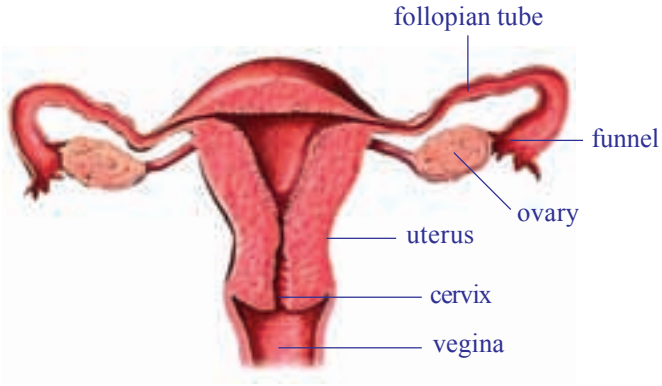


fig-14: Female reproductory system

The ova develop in tiny cellular structures called **follicles,** which at first look like cellular bubbles .As a follicle grows, it develops a cavity filled with fluid. Each follicle contains a single ovum. When an ovum is mature, the follicle ruptures at the surface of the ovary and the tiny ovum is flushed out. This release of the egg or ovum is called **ovulation**.

Generally the ovum enters the widened funnel of an **oviduct**, a tube that extends from the neighborhood of an ovary to the muscular, thick-

walled **uterus.** Fertilization occurs as the ovum passes through the oviduct (fallopian tube) thus begins a new life, with the union of a sperm with the ovum, or egg.

As the egg passes from the oviduct to the uterus, we encounter one of the most marvelous control mechanisms that man and other mammals possess, the uterus at the time of fertilization is beautifully adapted to receiving the developing embryo, providing it with food, and disposing of its wastes. A few days prior to this time, the uterus was in no such condition. Then it was small, its tissues were thin, and its supply of blood vessels was poor. Now that the fertilized egg, or zygote, is about to enter, the uterus is much larger. Its inner wall is thick, soft, and moist with fluid; its blood supply is greatly increased. It is, so to speak, just waiting for an embryonic occupant.

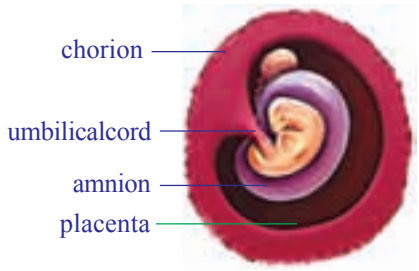


fig-15: Human embryo

Shortly we shall return to this transformation and see something of how it occurs and how it is timed for the arrival of the fertilized ovum. But now let us see what the transformation does for the developing embryo.

The human fertilized ovum undergoes mitosis and cell division (We will discuss about this in next section of this chapter) as it moves down the oviduct and finally attaches to the soft tissues of the uterus. Once attached, the embryo sinks into the soft inner uterine wall. Then certain cells of the embryo develop into the four membranes that help to nourish, protect, and support it.

The **chorion**, the outer membrane surrounding the embryo .During the development of the embryo, tiny finger like projections grow from the surface of the chorion into the soft tissues of the uterus. Gradually, small pools of rapidly moving blood form around these finger like projections in the uterine wall. These tissues of the chorion and the adjacent part of the uterine tissue make up the placenta.

Placenta is a tissue formed by the cells from the embryo and the mother. It is formed around 12 weeks of pregnancy and becomes an important structure for nourishment of the embryo. Under normal conditions there is never a direct blood flow between mother and young. The blood systems of the two are separated by thin embranes made up of cells that allow an exchange, by diffusion, of oxygen, carbon dioxide, nutrients, and waste materials. Another embryonic membrane, the **amnion,** grows around the

embryo itself. The cavity within the amnion becomes filled with fluid called amnotic fluid. The embryo develops in this fluid-filled cavity, which keeps it moist and protects it from minor mechanical injury.

The last of the four membranes to form is the allantois, which originates from the digestive canal of the embryo. The edges of the amniotic folds come together around the stalks of the allantois and yolk sac and form a tube, which leads from the embryo to the placenta. This tube is called the **umbilical** cord. It contains the very important blood vessels that connect the embryo with the placenta.

Thus the embryo develops until it is ready to be born. From the 3 months of pregnancy the embryo is called fetus. Pregnancy lasts, on the average, 9 months, or 280 days. This period is called gestation period.

Let us observe the chart showing monthwise developmental stages of human embryo.

fig-16: Developmental stages of human embryo

Do you know?

The average length of pregnancy varies by species: it is 63 days for the domestic cat and dog, 330 days for the horse, 280 days for the cow, and 20-22 days for the rat and mouse.

Birth

As pregnancy progresses, the fetus, which is the name we give an embryo after it has taken on a characteristic form, grows and the uterus increases in diameter. Usually, at about

the ninth month after fertilization, near the end of human pregnancy, the head is turned down toward the opening ·of the uterus. At birth the head usually comes out first. Sometimes the feet come first; this makes the delivery more difficult. We still do not understand how the child- birth mechanism, or labor, is triggered. This is a complex problem.

Childbirth begins when the muscle layers of the uterus start to contract and relax , these actions are felt as labor pains. At first, muscular activity of the uterus is just strong enough to move the baby slowly toward the vagina the outer canal of the female reproductive tract. Generally, at this stage, the sac (amnion) around the baby breaks, and its fluid contents are released. This is a good sign that labor is well on its way. Then the contractions of the muscles become stronger and more frequent, and the baby is pushed through the vagina and into the outer world.

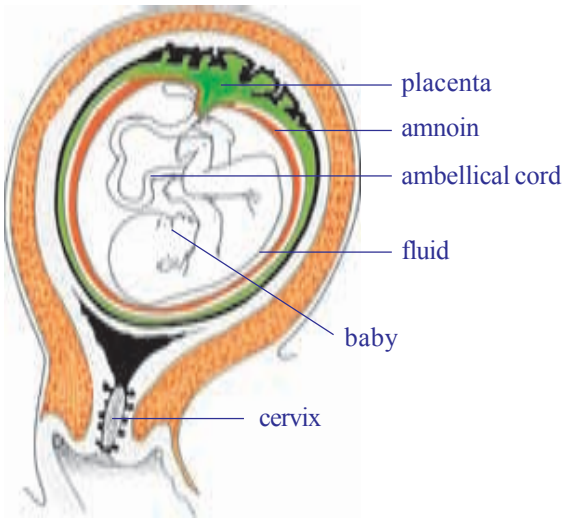


fig-17: Shortly before birth

The umbilical cord leading from the baby to the placenta, is tied off and cut by the doctor. (The small piece of cord remaining attached to the baby shrivels and falls off within a few days. The navel marks the place where it once entered the body.) After the birth of the baby, the muscular contractions of the uterus continue until they push out the tissues of the placenta, which are commonly called the "afterbirth." During the last part of pregnancy, a watery lymph like fluid called **colostrum** accumulates in the mammary glands, which have gradually been enlarging and undergoing a transformation. For the first few days after the baby is born, the mammary glands secrete only colostrum. This is very important feeding to the newly born baby which gives immunity. Following this, milk is secreted. After childbirth, and when milk secretion has stopped, the female reproductive cycle begins again. However, ovulation, fertilization, and new pregnancy sometimes start during the period of milk secretion.

Teenage mother ship an unwanted sign:

Giving birth to baby is a complex biological process. The body of a girl is physiologically suitable to give birth to a child is only after 18 years of age. Illiteracy, poverty, superstitions etc are prime causes of child

marriages. According to the statistics of department of family welfare every year 21 percent of teanage mothers die during delivery. Malnutrition also a reason for pre and post natal deaths. So girls are advised not to accept marriage before 18 years of age.

Sexual reproduction in plants

There are approximately 275,000 species of flowering plants. With few exceptions, all of them give rise to seeds enclosed in fruits. Most of the plants with which you are familiar are flowering plants. Their variety is quite remarkable. They range in size from trees weighing many tons to tiny water plants about the size of a grain of rice. A stunted willow growing in the wastes of the Arctic, a giant cactus in the Arizona desert, an orchid plant perched high up on the branch of a jungle tree- all are flowering plants. Now let us examine the essentials of process of sexual reproduction as it takes place in flowering plants.

The structure of a flower

What is a flower - the characteristic structure possessed by all these plants? Most biologists believe it is a specialized branch or stalk of the plant bearing groups of highly modified leaves at its tip. Variations in floral structure are almost endless. Indeed, it is impossible to speak of a typical flower. We can, however, imagine an idealized or generalized flower, which will illustrate basic features common, in one form or another, to many diverse groups of plants.

You have already learnt about flower and its part in lower classes. In such a flower there are four different kinds of structures attached at successively higher levels of the flower stalk Try to write about those parts and its functions.

Spals: .....

Petals: .....

Stamens: .....

Filament: .....

Anther: .....

Pistil: .....

Stigma: .....

Style: .....

Overy: .....

fig-18: Structure of flower

How a flower functions

Let us trace the series of events or the steps in the sexual reproduction of a flowering plant beginning with a newly opened flower and ending with the development of mature fruits containing seeds .

An anther, when fully developed, usually consists of two elongated sacs generally called pollen sac containing pollen grains. These grains develop from uninucleate cells, which are monoploid spores produced by meiosis.

Activity-

Take permanent slide of pollen grain from your lab, observe under microscope. Draw picture what you observe and compare with the diagram given below.

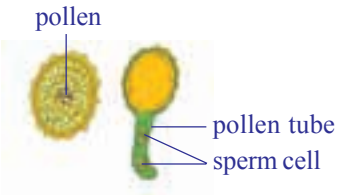


fig-20: Pollen grain

As development proceeds, the nucleus in each one of these cells divides to form two daughter nuclei. At this stage in pollen grain formation, the wall of each anther splits, forming openings through which the pollen grains can be shed. Pollination is completed when pollen is transferred to stigma, by wind, water or an insect.

Cells on the surface of stigma secrete a sticky nutrient fluid containing sugars and other substances. As pollen grain germinate on stigma, each one produces a slender thin walled pollen tube. This grows down through the tissues of the stigma, style, and ovary until it reaches the ovule. Observe the figure for more details.

As the pollen tube develops, the two nuclei of the pollen grain move down into it. One of these nuclei divides again to form two some-what elongated sperms .The other nucleus is usually located near the tip of the pollen tube, with the two sperms following along behind. The pollen tube, as it reaches the ovule, grows through a small channel leading into the interior of the ovule What happens then? In order to find out, we must look into the structure of the ovule.

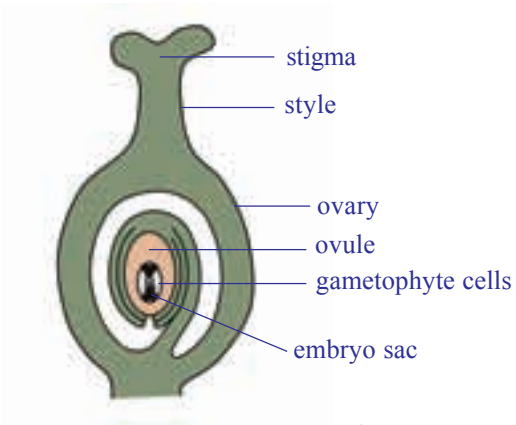


fig-21: Structure of ovule

An ovule is an egg-shaped structure attached by a stalk to the inside of the ovary. Depending upon the species of plant involved, an ovary may have one, two, several, or even thousands of ovules. At the center of each ovule is a microscopic embryo sac filled with food and water. The embryo

sac, composed of gametophyte cells.

The majority of flowering plants have an embryo sac consisting of seven cells, two of which are important to our discussion. One is a large central cell containing two nuclei. These are called the polar nuclei. The other cell is the egg. It is located at the end of the embryo sac closest to the opening through which the pollen tube enters .Soon after the tip of the pollen tube enters the embryo sac, the end of the tube ruptures and releases the two sperms into the sac.

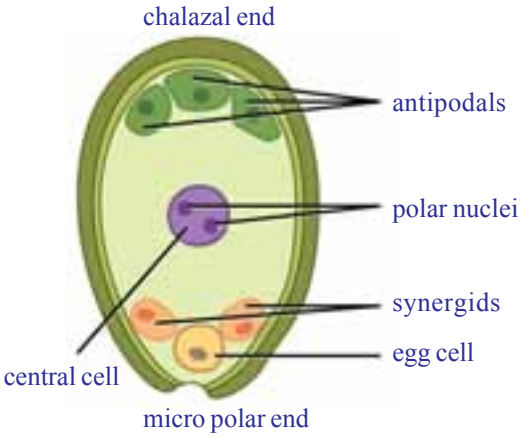


fig-22: Female gametophyte

One of the two sperms fuses with the egg to form a zygote. The zygote will develop into an embryonic plant within the ovule. By the time the egg cell has been fertilized, the two polar nuclei have combined to form a single fusion nucleus .Now the *second* sperm deposited in the embryo sac by the pollen tube moves to the center of the embryo sac and unites with the fusion nucleus. Fertilization .of the fusion nucleus stimulates the formation of a new tissue - the endosperm- in which foods are stored as development of the ovule proceeds.

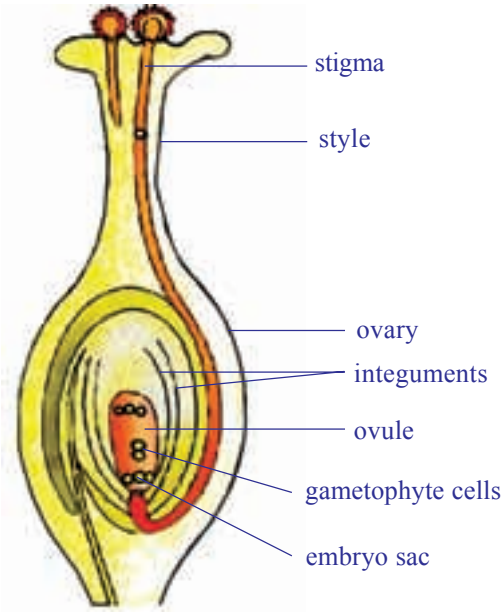


fig-23: Fertilisation

Union of one sperm with the egg, and the second sperm with the fusion nucleus, is called double fertilization. As far as we know, double fertilization occurs only in flowering plants. After double fertilization, the ovule increases rapidly in size as a result of the formation of endosperm tissue and the development of the new embryo. The embryo consists of one or more cotyledons an epicotyl and a hypocotyl. Both the epicotyl and hypocotyl are parts of a rod like axis attached to the cotyledons.

The cotyledons digest and absorb the endosperm and make the stored food it contains available for the growth of the epicotyl and hypocotyl. The cotyledons of some flowering plants, beans for example, digest, absorb, and store the foods from the endosperm as the ovule is maturing into a seed. As a consequence, the cotyledons become greatly enlarged

because of full of stored food and the endosperm disappears more or less completely. I n many other flowering plants (such as corn or castor bean), the endosperm tissue continues to grow as the ovule matures into a seed.

Thus, in a corn grain, most of the seed is endosperm, and the embryo is located at one side . As an ovule matures into a seed, there are other changes in addition to the formation of an embryo and the accumulation of stored foods. The protective coverings, which surround the embryo sac, are transformed into a seed coat. The seed coats of many seed plants are tough, and they protect the enclosed embryonic plant from injury.

Depending upon the plant species involved, the walls of the fully formed fruit may be dry, resistant structures, or soft and fleshy. The outer covering of the corn grain, for example, is made up of the tough ovary wall fused to the seed coat of the single seed of the grain .Examples of fleshy fruits include the tomato, orange, and peach. In the tomato, the ovary wall and the central tissues to which the seeds are attached are juicy and edible. I n the case of the orange - typical of citrus fruits including the lime, lemon, and grapefruit- the outer wall of the fruit becomes leathery. The edible part, the pulp, is made up of juicy multicellular outgrowths of the inner layer of the ovary wall. The cell sap squeezed from these structures is orange juice, a rich source of sugars and vitamin C. In the peach, the inner layers of the ovary wall become transformed into hard stony tissues, the stone. The outer layers by contrast remain soft and juicy.

Do you know?

Some bacteria and other microorganisms have been found that are capable of changing the sex of the organism in which they grow. A species of wasp has lost its sexual ability to reproduce and has reverted to asexual mode.

fig-24: Walther flamming

Cell division

Living organisms originate from its parent cells. It is very interesting to understand how cells multiply. As a matter of fact we shall admit that continuation of life starts from cells either those of the general body or the gametes or sex cells (having only half of genetic material as the parent).

By the end of 19th century a German biologist Walther Flemming Examined many kinds of animal and plant cells and selected those hat showed the details of dividing cells most clearly. He observed that cell nucleus passes through an orderly

series of changes. Which he called Mitosis. His most important discovery was chromosomes appeared double in number. Finally the cell divided into two halves with equal number of chromosomes which are similar to its parent cell. They are diploid in nature.

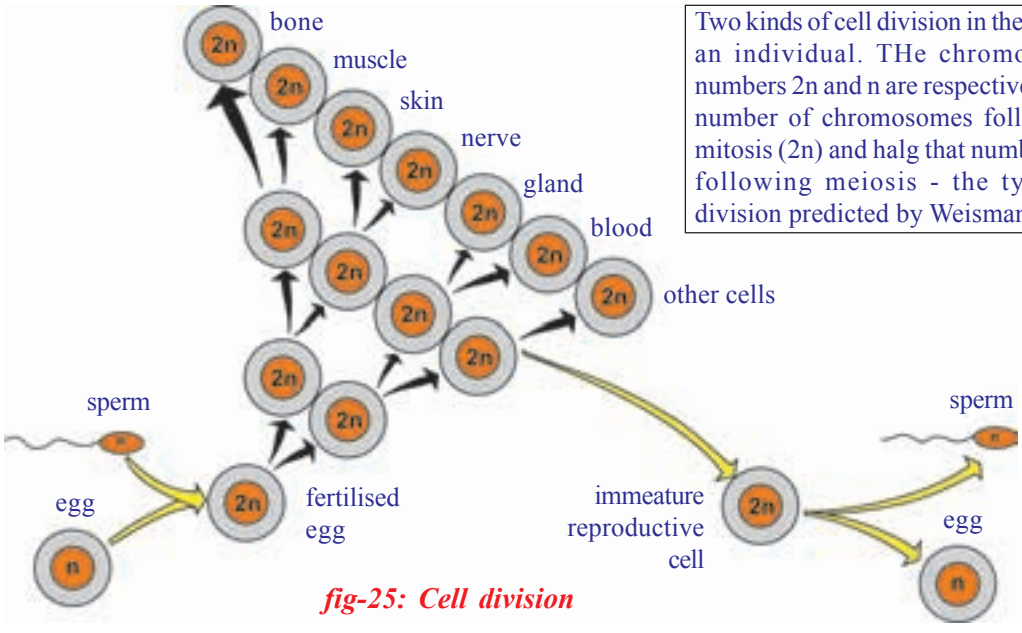
But the chromosomes always remain same. Biologists also began to wonder about this. Let us assume that when cells divide , the daughter always have the same number of chromosomes as the parent cell. Let us assume that cell division is always preceded by mitosis. In case of man this will mean that egg cells and sperm cells like other cells, must receive 46 chromosomes. But if this were so , then the union of egg nucleus and sperm nucleus , which takes place at fertilization would produce a total of 92, if it continues this would be 184, 368 and so on. But the situation is not like that.

fig-24: August weismann

August Weiseman (1834-1914) a biologist hypothesised that

1. In successive generations, individuals of the same species have the same number of chromosomes.
2. In successive cell division , the number of chromosomes remain constant.

August Weiseman was a scientist with poor eye sight, it was difficult for him to use a microscope to study cells. But there were other things that he could do. Science is not advanced only by the collection of data. Someone must think about and interpret the data. August Weiseman's poor eyesight forced him to spend time thinking. Think how great he was! Later scientists proved that another type (see fig-28- Meiosis) of division



Two kinds of cell division in the life of an individual. THe chromosome numbers 2n and n are respectively the number of chromosomes following mitosis (2n) and halg that number (n) following meiosis - the type of division predicted by Weismann.

fig-25: Cell division

takes place in sex cells called meiosis where the chromosome number is halved. Let us observe the flow chart showing cell division in fig-25.

History of cell division

In 1852 a German scientist, Robert Remak (1852–1865), published his observations on cell division, based on his observations of embryos. He stated that binary fission of cells was the means of reproduction of animal cells. This view was widely publicized not by Remak but by Rudolf Virchow (1821–1902), unfortunately without crediting Remak. Virchow is also usually given the credit for the phrase *Omnis cellulade cellula, (All cells from cells)* indicating the importance of cell division in the creation of new cells.

How a cell divides is still quite a mystery as we battle cancer now. What happens during cell division could only be understood better when scientists came to know what is present inside the nucleus of the cell. In 1879 Walther Flemming (1843–1905) reported that there were string like structures in the nucleus which split longitudinally during cell division. He named the process as mitosis(mitos- means fine threads) as the dividing structures resembled threads.

A decade later these thread like structures were named as chromosome(coloured bodies) as repeatedly in efforts to see them scientists were trying to use dyes to stain the nucleus and found that these were stained most often. Wilhelm Roux (1850–1924) proposed that each chromosome carried a different set of hereditable elements and suggested that the longitudinal splitting observed by Flemming ensured the equal division of these elements.

Combined with the rediscovery of Gregor Mendel's 1866 paper on heritable elements in peas, these results highlighted the central role of the chromosomes in carrying heritable material later called as the genetic material as well. The scheme of mitotic division was confirmed in 1904 by Theodor Boveri (1862–1915). The chemical nature of the genetic material was determined in a series of experiments over the next fifty years, culminating in the determination of the structure of its constituent the deoxyribonucleic acid (DNA) in 1953 by James Watson and Francis Crick.

Most cells of the body divide by a process of mitosis where the number of chromosomes in the daughter cells remain same, while to produce gametes a specialized layer of cells called germ cells divide by a process called Meiosis where the number of chromosomes is reduced to half.

Cell division in Human beings

Cells as we know are the structural and functional units of life of any multicellular organism. Cell division is the process (where one cell divides into two genetically identical daughter cells), that transforms a human fertilized egg into a baby in nine months and into an adult in the next 20 years. Cell division and function in a multicellular organism are highly regulated. It occurs only when there is a need for it.

Cells in some organs, such as heart and brain of an adult never divide. On the other hand bone marrow cells actively divide to produce red blood cells, which have a short life span in the body. Skin cells fall somewhere between these two extremes. For example, if you cut your finger and bleed, soon a blood clot forms to stop the bleeding. This brings in various chemicals to the site that stimulate skin cells to divide and heal the wound. Cell division ceases as the wound is completely healed. In contrast, cancer cells do not respond to such growth regulating factors and keep dividing at the expense of normal cells, thus ultimately killing the host. So it becomes important to understand the processes involved in cell division. The cell cycle will help us understand this better.

Cell cycle

Human cells, either normal or cancer cells in culture usually divide every 20 to 24 hours. The actual process of cell division called 'Mitosis' is completed in 40 to 60 minutes (this is the time of active division). The period between two cell divisions is called 'Interphase'. This is actually the period when the genetic material makes its copy so that it may be equally distributed to the daughter cells during mitosis. Interphase can be divided into three phases.

G1 phase: This is the period between the completion of mitosis and the beginning of DNA replication (Gap 1 phase).

S phase: This is the period of DNA synthesis (Synthesis phase).

G2 phase: This is the time between the end of DNA replication and the beginning of mitosis. (Gap 2 phase)

M phase: This is mitatic cell division phase.

To understand the functional relationship between these phases, PotuRao and Johnson (see

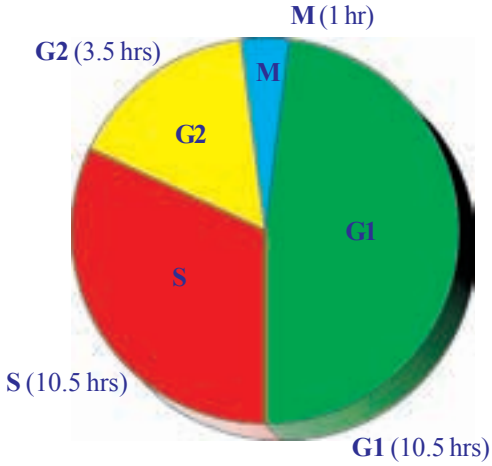


fig-26: Interface

annexure) did some elegant experiments nearly 4 decades back, using the cell fusion technique. That is combining two cells in experimental conditions. These experiments have, for the first time, provided evidence that the progression of cells through the cell cycle is sequential and unidirectional and are controlled by a series of chemical signals that can diffuse freely between nucleus and cytoplasm. These experiments are considered to be a 'mile stone' in the cell cycle studies.

Using the cell fusion technique Johnson and Rao revealed for the first time the structure of interphase(GI, S and G2) chromosomes that are not ordinarily visible under the microscope.

Activity-

Observe different stages of meiotic cell division

Take permanent slides which shows different stages of meiotic cell division from your lab kit. Observe carefully under microscope. Draw diagrams what you observe, and compare your observations with the following chart

Stage	Description
1. Prophase	1. Chromosomes contract, spiral and become visible even in light microscope and nucleoli become smaller (material to chromosomes). 2. Chromosomes split lengthways to form chromatids, connected by centromeres. 3. Nuclear membrane breaks down. 4. Centrosome, containing rod-like centrioles, divides and forms ends of spindle (probably animal cells only). (Note: No pairing of chromosomes as in meiosis).
2. Metaphase	1. Chromosomes move to spindle equator, centromeres attached to spindle fibres. 2. Centromeres split, separating the chromatids.
3. Anaphase	1. Spindle fibres attached to centromeres contract, pulling chromatids towards poles
4. Telophase	1. Chromatids elongate, become invisible, (replication at this stage to become chromosomes). 2. Nuclear membranes form round daughter nuclei. 3. Cell membrane pinches in to form daughter cells (animals) or new cell wall material becomes laid down across spindle equator (plants) 4. Nucleus divides into two and division of cytoplasm starts.

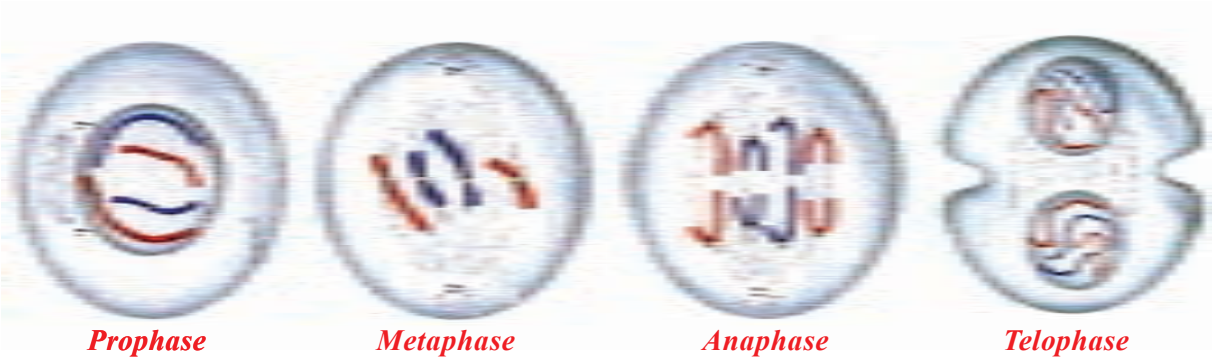


fig-27: Mitosis

Division of cytoplasm is called Cytokinesis which finally brings about formation of two daughter cells. While observing cells in tissues undergoing division, it is not easy to differentiate between the different stages of division.

Unlike mitosis which is a continuous process for division in most cells, meiosis occurs only during the formation of gametes for sexual reproduction. During meiosis the parent cell (containing two sets of chromosomes) divides twice, though the chromosomes divide only once. Thus the four daughter cells have just half the number of chromosomes as the parent cell that is are haploid (containing only one set of chromosome). Thus this division is reduction division.

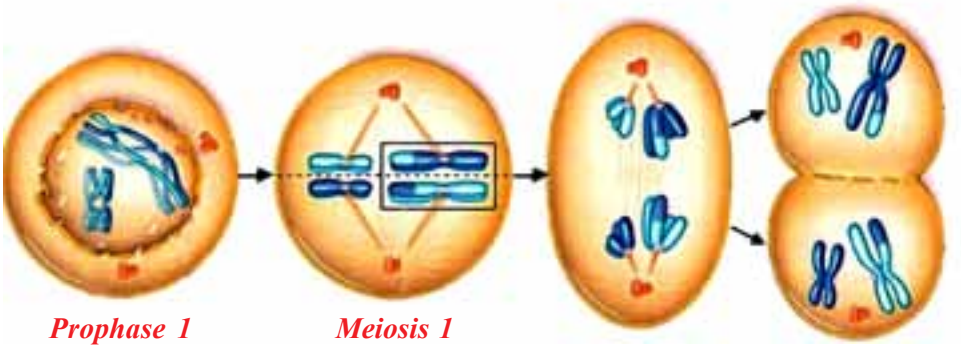


fig-28: Meiosis

- What difference do you find in mitosis and meiosis? Write in a tabular form.
- What would happen if the daughter cells did not have half the chromosome number as the parent?
- How would it affect progeny formed by sexual reproduction?

Reproductive health

- Why did the government of India fix legal marriage age of boys and girls?

- Do you feel that it is a social responsibility to control birth after having one or two children?
- What do you understand by the term Healthy Society?
- Do you support unsafe sex? Why?
- Will you encourage pre mature sex or child marriage?

As we have seen, the process of sexual maturation is gradual, and takes place while general body growth is still going on. Therefore, some degree of sexual maturation does not necessarily mean that the body or the mind is ready for sexual acts. Further, it is not fit for having and bringing up children. How do we decide if the body or the mind is ready for this major responsibility? All of us are under many different kinds of pressures about these issues. There can be pressure from our friends for participating in many activities, whether we really want or not. There can be pressure from families to get married and start having children. There can be pressure from government and voluntary organisations to avoid having children. In these situations, making choices can become very difficult.

fig-29: Red ribbon 1st December AIDS Day

In the lesson why do we fall ill, we learnt that the diseases can be transmitted from person to person in a variety of ways. Since the sexual act is a very intimate connection of bodies, it is not surprising that many diseases can be sexually transmitted. These include bacterial infections such as Gonorrhoea and syphilis, and viral infections such as AIDS (Acquired Immunodeficiency Syndrome) spread due to the human immunodeficiency virus byunsafe sexual contacts, using infected devices, infected blood transfusion, from an infected mother to child.

Andhra Pradesh has the highest number of HIV patients in the country. According to official statistics, the state had 5 lakh of the 24 lakh HIV positive patients in the country during 2011-12.

Andhra Pradesh is followed by Maharashtra (4.19 lakh), Karnataka (2.45 lakh). All other state together account for 6.66 lakh HIV patients.

Earlier Maharashtra, Karnataka and Tamilnadu were in the first three places but this year AP leapt to the top spot, officials said. While one in every 300 adults is suffering from HIV elsewhere, in Andhra Pradesh one in every 100 adults is a HIV patient, that is almost one percent.

The prevalence of HIV is 1.07 percent among males and 0.73 among female in the state, which again is higher thatn in other states. Its prevalence among adults (15-49 years) 0.90 percent, pregnant women 1.22 percent, female sex workers 11.4 percent and homosexuals 23.6 percent in Andhra Pradesh. Among the affected districts Hyderabad leads with 61,389 HIV

patients. It is followed by Guntur (55,254) and East Godavari (50,325).

Illiteracy, poor health, unemployment, migration, non-traditional sex practise and trafficking are some of the factors contributing to the spread of HIV in the state, according to experts.

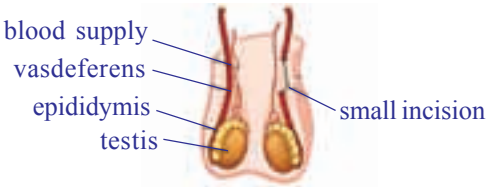
The government established Anti Retroviral Therapy (ART centres) to supply medicine to HIV patients. Medical and health, family health departments AIDS control projects implementing various programmes like ASHA (.....), Red Ribbon Express, etc., to create awareness in society on the risks and symptoms of AIDS.

The sexual act always has potential to lead to pregnancy. Pregnancy will make major demands on the body and the mind of the woman, and if she is not ready for it, her health will be adversely affected. Therefore, many ways have been devised to avoid pregnancy.

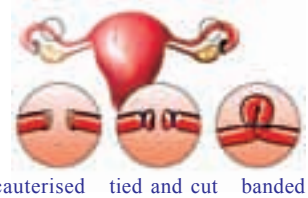
Birth control methods

The prevention of pregnancy in women by preventing fertilisation is called contraception. Any device or chemical (drug) which prevents pregnancy in woman is called a contraceptive. All the birth control methods can be of various types and used by any of the partners as preferable. Physical devices such as condoms and diaphragm (cap) are used. This prevents reaching of sperms to ova for fertilisation. This device not only prevents fertilisation but also transmitting some sexually transmitted diseases (STD) like gonorrhoea, syphilis and AIDS. No other method of contraception provides protection against sexually transmitted diseases. Chemicals in the forms of pills are induced either orally or inserting into female reproductive organ vagina. It contains hormones which stop the ovaries from releasing ovum into the ovi- ducts. Nowa days pills for males are also available. These pills kill the sperms and hence are called spermicides.

copper - T



vasectomy - cut ends of vas deferens are sealed



vasectomy - cut ends of follopian tubes are sealed

fig-23: Birth control methods

The use of intra-Uterine device called Copper-T, loop etc. are also very effective in preventing pregnancy. If a woman uses a copper-T as a method of contraception for avoiding unwanted pregnancies, then copper-T cannot protect her from acquiring sexually transmitted diseases provided her partner has such a disease. Surgical methods of birth control are available for males as well as females. In males a small portion of vas-deferens (sperm ducts) is removed by surgical operation and both ends are tied properly. This method is called vasectomy. In females a small portion of oviducts (fallopian tube) is removed by surgical operation and the cut ends are tied. This prevents the ovum from entering into the ovi ducts. This method is called Tubectomy.

Stop female foeticide

Who knows today's girl child may become a great scientist, a famous doctor, a top class engineer, a dedicated administrative officer, a world renowned economist, a wonderful teacher of an unmatched world leader of tomorrow. Stop female foeticide! Save the girl child.

Due to reckless female foeticide the male female child sex ratio is declining at an alarming rate in some sections of our society. Our government has already enacted laws to ban parental determination of sex of foetuses. In spite of laws it's a social responsibility of us to prevent female foeticide.

If we follow the simple life styles as cited below one could avoid many sexually transmitted diseases.

- Avoid sex with unknown partners/multiple partners
- Always use condoms during coitus
- In case of doubt, go to a qualified doctor for early detection and get complete treatment if diagnosed with disease.

We know that if health is lost, everything is lost. It's our responsibility to be healthy and to make others realise the importance of health. Sound health is to sound mind. To be an ideal citizen of India we should have knowledge of reproductive health not only to control high population growth but to create a healthy society. Our nation is the first nation in the world to initiate various action plans at national level towards attaining a reproductively healthy society.

Key words

Progeny, cyst, fragmentation, regeneration, vegetative propagation, artificial propagation, parthenogenesis, cutting, layering, grafting, stock, scion, desirable characters, tissue culture, amniotic fluid, placenta, umbilical cord, mitosis, meiosis, chromatid, chromosome, feoticide, HIV-AIDS, vasectomy, tubectomy.

What we have learnt

1. Reproduction is necessary for perpetuation and continuation of life.
2. Reproduction is of mainly two types keeping in view of fusion of gametes- Sexual and Asexual.
3. In sexual reproduction only half of each parent's gene are passed to the next generation.
4. Fission, budding, fragmentation, regeneration, spore formation are the ways of asexual reproduction.
5. Several plants may be grown from vegetative parts like stems, roots, leaves etc and is called vegetative propagation.
6. Vegetative propagation may be of natural or manmade, has got some economic importance.
7. Tissue culture is a modern technique of growing plants. It helps to grow more plants in less time and place.
8. In grafting we can acquire desirable characters of plants.
9. Sexual reproduction in higher animals is done through specialised organs, distinctively male and female reproductive systems.
10. Cells divide for growth of the individual to repair and replace the wear out cells and also for the formation of gametes.
11. Cell division is of two types-a) Mitosis-or somatic cell division B) meiosis- or reproductive cell division.
12. Cells of the body may be either those that constitute the general body of an organism are called somatic cells and that take part in the formation of gametes are called germ cells.
13. G-1, G-2, S and M are the stages seen in cell division in a cyclic manner.
14. The longest phase is the synthesis phase in cell cycle where duplication of genetic material takes place.
15. At the end of mitosis two daughter cells are formed with the no. of chromosomes same to that of their parents. It runs through Prophase, Anaphase Metaphase and Telophase.
16. Division of cytoplasm is called Cytokinesis.
17. During meiosis the parent cell divides twice and four daughter cells are formed.
18. Reproductive health is important to possess sound mind in a sound body.
19. One should be aware of the facts related to transmission of sexually transmitted diseases.

20. There is no cure for AIDS. Prevention is the only way to avoid it.
21. Now days various methods of contraception is available to control child birth.
22. It is our responsibility to build a healthy society.
23. Determination of sex before birth is illegal. Stop female foeticide.

Improve your learning

1. Why do fish and frog produce a huge number of eggs each year? (AS1)
2. Give examples and explain what is meant by external fertilisation? (AS1)
3. Write differences between. (AS1)
   a) mytosis-meiosis b) male gametophyte-female gametophyte
4. Explain the process of fertilisation in plants. (AS1)
5. What are the different modes of asexual reproduction? Cite them with examples. (AS1)
6. In what ways do sexual reproduction differs from asexual one? State at least three reasons.(AS1)
7. How are sperm cells adapted for their function? (AS1)
8. The menstrual cycle prepares the uterus for a fertilised egg. How long is an average menstrual cycle from start to finish? (AS1)
9. When the foetus is growing inside the uterus it needs nutrients. What provides these nutrients? (AS1)
10. What does the mother's blood take away from the baby and into the placenta? (AS1)
11. What is the job of the amniotic sac? (AS1)
12. What are the advantages of sexual reproduction? (AS1)
13. How does reproduction help in providing stability to population of species? (AS1)
14. Write the differences in between mitosis and meiosis. (AS1)
15. What happens to the wall of the uterus during menstruation? (AS2)
16. "All unicellular organisms undergo only mitotic cell division during unfavourable conditions"- Do you support this statement? Why?(AS2)
17. Vicky's father wants to grow a single plant having two desirable characters colourful flowers and big fruits What method will you suggest her and why?(AS3)
18. Uproot an onion plant and take a thin section of its root tip. Stain it and observe under microscope. Draw as you see and identify the stages of the cell division.(AS3)
19. Visit a nearby village and collect information how farmers grow sugarcane, flowering plants like chrysanthamum, primerose and vegetables like stem tubers, plump gourd (dondakaya) etc. Make a report and submit in class. (AS4)
20. Collect information from school library or using internet what vegetative methods are followed in your district as well as in your state to propagate various plants of economic importance. Represent it with a graph. (AS4)
21. Make a flow chart in correspondence with cell cycle describing different stages of mitois.(AS4)

22. Draw neat labelled diagrams of male and female reproductive systems. (AS4)
23. Draw different stages shown in Mitosis and note down its distinct characters.(AS5)
24. Prepare a flow chart to explain the process of sexual reproduction in plants. (AS5)
25. Draw a neatly labled diagram to explain plant fertilisation. Write few points on pollen grain. (AS5)
26. What would be the consequences if there is no meiosis seen in all organisms?(AS6)
27. How will you appreciate cell division that helps in perpetuation of life? (AS6)
28. What precautions will you take to keep away from various sexually transmitted diseases?(AS7)

Choose correct answer:

29. The part of the female reproductive system produces the eggs?
    a) Ovam b) Epididimis c) Cervix d) Follopian tube
30. The term that we use to describe a sperm cell fusing with an egg cell?
    a) Fragmentation b) Fermentation c) Fertilisation d) Fussion
31. Which part of the male reproductive system produces the sperm cells?
    a) Vas difference b) Epididimis c) Blodder d) Scrotum
32. How does the sperm break through the egg cell membrane? Choose the option you think is right.
    a) Tears a hole in the membrane b) Dissolves the membrane with chemicals
    c) Bites through the membrane with teeth d) Squeezes through gaps in the membrane
33. Why are egg cells larger than sperm cells? Choose the option you think is right.
    a) Egg cells have more cells in them b) Have food store to help growth after fertilisation
    c) Have thicker cell membranes d) Have larger nuclei
34. Which of these things will affect the way a foetus grows? Choose the option you think is right.
    a) Chemicals in cigarette smoke b) Alcohol c) Drugs d) All of the above
35. Which of the following is the correct description of the human life cycle? Choose the right option.
    a) Babyhood, childhood, adolescence, adulthood b) Childhood, babyhood, adulthood, adolescence
    c) Adolescence, babyhood, adulthood, childhood d) None of these

Annexure

Dr. Potu Narasimha Rao

Dr. Potu Narasimha Rao, a renowned scholar and an eminent cytologist came from a poor family in Muppala village of Guntur district. He completed his graduation in Agriculture and did his MS at IARI, New Delhi. Later, he went to USA for doing his research. He did his research work on the cytogenetics of tobacco plant. During his research, a cell line called Hela, isolated from a human tumour was established in 1952. He worked on this cell line and received his PhD in 1963. He switched his attention then from plant cytogenetic to the field of cancer cells in culture medium. He conducted research in cell kinematics and studied extremely on the "triggering factor" of cell division i.e mitosis.

He found that human cells either normal or cancer cells in culture media usually divide every 20 to 24 hours. But actually normal mitosis is completed in 40 to 60 minutes. The period in between two cell divisions is called interphase. The interphase further consists of 3 phases G1, S and G2 phases.

To understand the functional relationship between these phases, Dr.Rao and his research associate Dr. Johnson did some elegant experiments on cell fusion technique. His researches revealed that the cell cycle is sequential Unidirectional and controlled by a series of chemical signals. His experiments are considered to be a milestone in the cell cycle studies.This study threw a new hope of rays for the budding scientists to carry out researches on cell division.

Legend: A: G1 PCC; B: SPCC; C: G2 PCC. The highly condensed and darkly stained chromosomes are of mitotic HeLa cells (cells of cancerous tissue of the patient Henrietta Lacks), with permission from Spurling, K. and Rao, P.N., mammalian cell fusion V. Replication Behaviour of Heterochromatin as Observed by Premature Chromosome Condensation. *Chromosoma* (Berlin) 45; 121-131 (1974).

Chapter

7

Coordination in life processess

Human body is a wonderful machine. It is a complicated structure than it appears. Did you ever imagine the complexity of your body? Different life processes in living organisms like respiration, digestion, blood circulation, excretion, nervous system etc., are inbuilt in our body at their specific places and carry out their specific functions. We have studied each of the processes in detail nearly in isolation except in the chapter on 'Control and Coordination'. There we studied how several functions of our body go on in a coordinated manner. In this chapter, we shall study one of the life processes to show how complex the relation between different systems are and how the processes are integrated in the living body.

Let's recall the parts of the digestive canal or gut, that are involved in the digestive process where the food is broken down at different stages.

- Write down the parts of the gut where the journey of food starts from mouth to anus.
- Which life \ processes would be involved in the breakdown of food in the stomach?
- If any of those processes fail to function, what effect would it have on our body?

Every process is dependent on other to keep the body in good condition. To understand this concept we analyze how digestive system is coordinated with other systems as an example. We shall study the digestive system from feeling hungry to utilization of food , illustrating the interconnected processes going on in our body.

Feeling Hungry

- Why do we feel hungry?
- What is the cause of sensation of hunger?
- How do we know that we need food?

Activity-1

Let us observe the following table. Identify and *tick* the causes for hunger in your point of view- and discuss with your group.

Table 1

Smell of food	Taste of food	Sight of food	Being tired and exhausted	Need of food	Thought of food

- What factors stimulate hunger?
- What would be the resultant of stimulation of hunger?
- Which system do you think would send the signals to make us realize that we are hungry?

Well, a major cause for feeling hungry is the secretion of the hormone "Ghrelin" in the stomach when it goes empty. Ghrelin is secreted from certain cells in the wall of the stomach. Hunger contractions (hunger pangs) start to occur in the stomach due to hunger generating signals that reach the brain from the stomach due to the secretion of this hormone. It is believed that the Diencephalon in fore brain and vagus nerve (10^{th} cranial nerve) plays an important role in carrying these signals(See figure for location of vagus nerve) to the brain. Hunger pangs continue up to 30- 45 minutes. Increase in ghrelin levels results in sensation of hunger and motivation to consume food.

- Is the sensation of hunger controlled by Central Nervous system or is it by Peripheral nervous system?
- What kinds of controls are exercised during sensation of hunger? Are they hormonal or nervous or both?
- Can you suggest any 4 systems involved in the process of generating hunger sensation?

When you feel your stomach is full and there is no need of food any more, another hormone ***leptin*** is secreted that suppresses hunger.

Usually we take food at a particular time. Every day regularly at that time, we feel hungry. You have experienced this in your school during lunch hour. You also notice that there is a relation between hunger pangs and lunch bell.

Outcome of sensation of hunger

We find that different organ systems are involved together in the digestive process of the mouth.

Let us find more about how the organ and organ systems are involved. Feeling hungry leads us to consume food. Sometimes you may have often experienced that stale food is out rightly ejected even before intake.

- What plays a major role to identify stale food?
- If you are having a tasty dish don't you think the smell of it increases your appetite?

Taste and smell are intimately entwined. This close relationship is most apparent in how we perceive the flavors of food. Anyone with severe cough and cold can attest, food "tastes" different when the sense of smell is impaired. Actually, what is really being affected is the flavor of the food, or the combination of taste and smell. That's because only the taste, not the food odors, are being detected. Taste itself is focused on distinguishing chemicals that have a sweet, salty, sour, bitter, or umami taste (umami is Japanese for "savory"). However, interactions between the senses of taste and smell enhance our perceptions of the foods we eat.

The following activity helps us to observe how are taste is affected by the sense of smell.

Activity-2

Chewing, zeera(fenugreek), sounf(fennel seeds), potato and apple

First close your nose with your fingers. Pop in some zeera in your mouth and chew it for some time. After that, chew some sounf. Could you recognize the taste? How long has it taken to know the taste? After some time wash your mouth and repeat the activity by chewing a piece of an apple followed by a potato(remember to close your nose).

- What are your observations?

To conclude, if you want to taste the food material, the food should dissolve in saliva. On the other hand, we can taste the food that is in the

form of liquid only. We know that different types of taste buds are present on the tongue. You have also learnt about different types of papillae (taste buds) on the tongue for different tastes in ninth class. Let us recall them. Only after the dissolved food enters into the cup like taste buds, the sense of taste is carried to the brain for analysis. Then only we will know the taste of the food material.

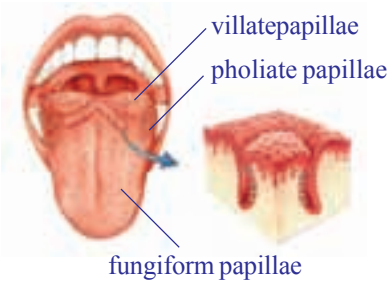


fig-1: Papillae on tongue

- Could you know the taste of both or did it taste the same? Why?

Taste and smell are closely related.

When we smell, the air borne substances get dissolved in the watery film of nasal mucus. The chemoreceptors which are other wise called olfactory receptors present in the nose and the tongue trigger signals in the form of nerve impulses to the brain where the smell and taste is detected.

- What happens when we put a food material in our mouth?
- Name the parts in the mouth that help us to taste food.

Let's find out more about the role of these parts.

Activity-3

Take a pinch of asafoetida powder / garlic and rub it on hand kerchief/ tissue paper.

Close your eyes and smell it. Then try to identify taste of different types of food materials with the help of your friend.

- How many food materials you have identified correctly?
- Do you think that there is a relation between smell and taste?
- Can you say that a particular food is tasty just by looking at it?

Sometimes mouth starts watering just by hearing the name like tamarind/lime/mango etc.,

Now let us summarize the result of the activities with the help of your answers. In general, we prefer the food material, which is attractive to our eyes, and flavor to nose, then we taste it.

Therefore, when we eat, without our knowledge, we use our sight, nose and tongue for selecting food for ingestion.

Russian scientist Pavlov has conducted an experiments and found that even the thought of food will water your mouth (conditioned reflexes). You have discussed about Pavlov experiment in the chapter animal behavior in class 9^{th}.

Taste is something connected to the tongue and the palate.

Do you know

Taste and temperature.

Is temperature effects our tasting ability? If you want to taste a food material, the temperature of the food should be nearer to our body temperature. If the food is too hot or too cold, we cannot find the taste properly. Try to drink a glass of warm water; we do not feel the actual taste of water. The same is the case of cool drinks or ice creams. We will be able to taste them when we keep them in our mouth for some time till it reaches to our body temperature.

Activity- 4

Sugar crystals over tongue

Place some sugar crystals on your tongue keep your mouth opened and see that your tongue doesn't touch the palate. Record the time from the moment you placed the crystals on your tongue till you got the taste by using stop watch.

Now repeat the test by placing the sugar crystals on the tongue and pressing it against the palate. Record the time from placing sugar crystals to getting the taste .Or put a drop of sugar solution on your tongue by using dropper.

- Which way helped you taste faster ? Why?

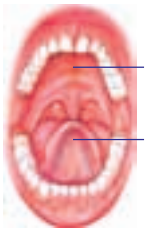
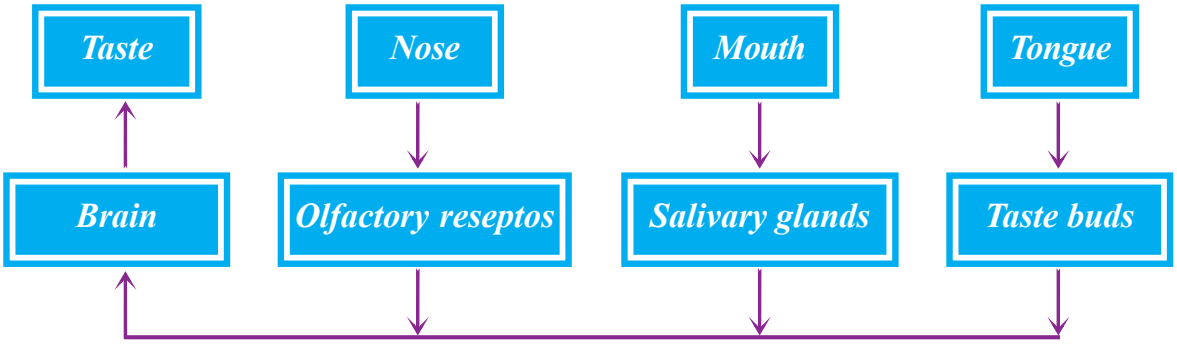


fig-2: Tongue and palate

Taste is something connected to the tongue and the palate

Based on the above activity we know that taste can be identified easily when the tongue is pressed against the palate. As we know the tongue is sensory in function and contains taste buds. These taste buds are tiny papillae with an opening on top. Within them there are several taste sensitive cells. Any food substance when placed on the tongue gets dissolved in the



saliva secreted by salivary glands in the mouth. When the tongue is pressed against the palate the food substance is pressed against the opening of the taste bud letting it to reach the taste cells and triggering taste signals. Finally the taste is recognized in the brain.

- What pathways connected to sensation of taste does the diagram show?

Mouth the munching machine

Would you be able to comfortably munch your food if you had lost some of your teeth?

Activity-5

To show break down of food by using the model of chalkpiece kept in vinegar.

Break a piece of chalk into two halves. Crush one half to tiny pieces leaving the other as it is. Take two small mineral water bottles ($^1/_2$ ltr bottle) cut them into two equal halves and discard the upper portion. Now we have two beakers from the lower cut portion.

Fill them half with vinegar and add the crushed chalk to one beaker and the half full chalk to the other. Obseve them after half an hour or so.

- Which one dissolved faster the crushed chalk or the whole one ?

The above experiment tells us the need of mechanical crushing of food. Hence the food in the mouth has to be broken down into tiny pieces to increase the surface area for action of substances that aid in digestion.

- How does this process of mechanical crushing goes on in the mouth?
- Which parts in the mouth are involved in this?
- What are the systems involved in this process?

You know that teeth helps in chewing food material. Let us know about different types of teeth in our mouth and how they helps in digestive process.

Activity-6

Observe the model or chart of jaw, how teeth are arranged? Are all the teeth similar in shape and size? Is there any relation between shape and function of the teeth? Dental formula explains the arrangement of teeth. Now fill up the following table with proper information based on the figure given here.

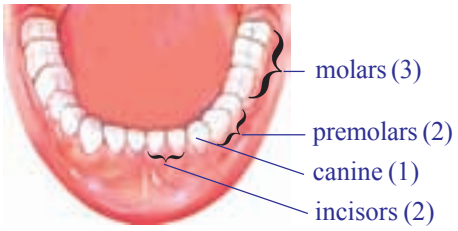


fig-3: Dentition

Table-

Name of Teath	Number	Shape	Function

The circular muscles of the mouth enable the food to be pushed into the oral cavity and to be moved around. As the food cannot be swallowed directly the teeth grind, chew and shred. This process is called mastication. For this purpose the surface muscles of the jaw help in biting and chewing actions, while the deep muscles of the jaw move the jaw up, down, forward and backward during food mastication. You may have observed your lower jaw moving up and down as you chew food. The teeth help in cutting and grinding while tongue movements evenly spread out the food and help in mixing it with saliva. The muscles of the mouth enable the food to be pushed in the oral cavity and to be moved around. The fifth cranial nerve has been found to control the movement of muscles in the jaw.

- Does the level of saliva secretion change due to presence of food in the mouth?
- Can the process of chewing go on in the absence of saliva?
- Does the saliva have other roles to play as well?

Let us find out the role of saliva.

Activity-7

Action of saliva on flour (ata)

Take a test tube half filled with water and add a pinch of flour to it. Shake the test tube well till the flour gets mixed. Take a few drops of this in a watch glass and test for the presence of starch by putting a drop of diluted tincture iodine in it. A blue black color confirms the presence of starch. Now devide the mixture into two equal halves by transferring it to another test tube. Note that both the test tubes have the same amount of solution. Add a teaspoon of saliva to one of the test tube and mark it. Do not add anything in the other test tube. After some time (45mts) add a drop of dil. Tincture Iodine solution to test tubes containing the solution.

- Do you observe any change in the solutions? Why does the change occur?
- Do you think the same process goes on in the mouth when the food is taken?

Under the action of autonomous nervous system saliva secreted by three pairs of the salivary glands moisten the food to make chewing and swallowing easier. As a result of chewing, food forms into a slurry mass called 'bolus' that is transported into the oesophagus by the action of swallowing with the help of the tongue. The enzyme salivary amylase in the saliva breaks down the large starch molecule into smaller subunits usually into sugars. The mechanism for swallowing is also under nervous coordination and its control center is somewhere in the brain stem (medulla oblongata and others). During mastigation food size become convinient to swallow.

- What is the use of such an increase in surface area of food?
- What about the nature of medium of for salivary amylase to act on food component?
- Do you think the pH of our mouth changes?

Activity-8

Testing pH of mouth at intervals of one hour.

Ask your chemistry teacher to give you a strip of pH paper with a colour chart.

You can do this in your school by taking a small piece of the pH paper and touching it to your tongue. Match the colour with the colour chart and note the pH. See to it that you are able to take some readings after having your food at lunch break. Compare your readings with that of your friend. Take at least 4 readings and draw a graph of pH against time.

- What is the usual range of pH of your mouth? Acidic or basic?
- Did you observe any change in pH? What caused the change?
- In what kind of pH do you think salivary amylase acts well?
- Does even the type of food have any role to play on the pH of our mouth?

Test with different types of food as you eat them and check just after you have swallowed them.

Do not hurry to complete the table. Take your own time.

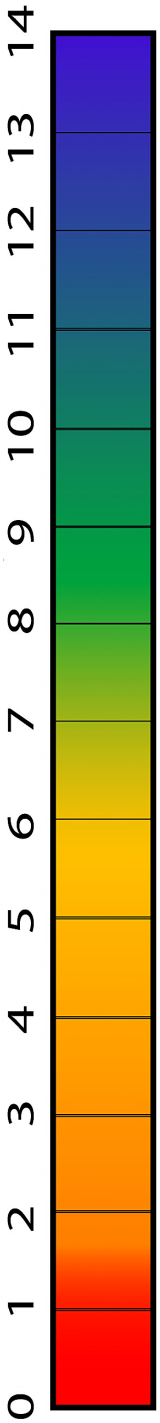


fig-4: pH scale

(pH beyond 7 is alkaline, pH- below 7 is acidic, pH 7 is neutral).

Based on the above tests we know that the saliva secreted causes the medium to change to alkaline as it aids in action of enzyme, salivary amylase.

Why do we salivate during a nap of daytime?

Do you know ?

You have heard about Nocturnal animals, which are active during nights, but we are active during daytime and take rest at night. All the systems of our body are active in function during the time of our activity. Hence, man is a diurnal animal. Our digestive system is also active and ready to receive the food for digestion. If we sleep during daytime saliva oozes out of our mouth and wets the pillows. This will not happen during nighttime.

- What are the different systems that contribute to the proper functioning of digestion in the mouth?
- After the digestive process in the mouth where does the food moves to?

Travel of food through oesophagus .

The oesophagus receives the food pushed by the swallowing action of the mouth.

- What are the systems that come into play for swallowing food?

Easophagous is a tube like structure. Its upper end connects to pharynx and lower end connects to the stomach. When we swallow slippary food is falls down in easophagous. Let us observe movement of food material in easophagous.

Activity-9

Making a model of oesophagus to observe how bolus moves forward.

fig-5: Potato in cycle tube

Take a piece of waste cycle tube and insert one or two potatoes into it. Lubricate the inner side of the tube with oil. In the same way smear oil over the potatoes. Insert oil coated potatoes in the tube. Now try to push the potatoes by squeezing the tube.

- How do you squeeze the tube to make the potatoes pass through?
- Do you think that the muscles in the wall of the oesophagus have to do something like this?

Peristalic movement in oesophagus

Look at the diagrams which shows the wave like movement of wall of oesophagus and observe the position of the food bolus.

- How did the position of the bolus change?

What is the similarity of movement of food illustrated in the diagram and the activity performed by you?

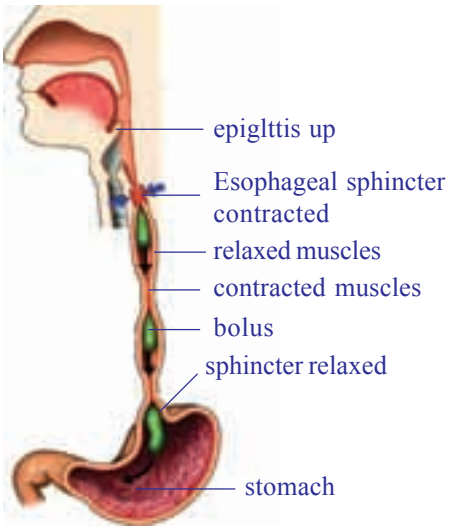


fig-6: Peristalic movement of bolus

The wall of the oesophagus is made up of two kinds of smooth muscles. The inner layer consisting of circular muscles and the outer layer with longitudinal muscles. Contraction of the circular muscles results in narrowing of the oesophagus just behind the bolus. So the food is squeesed downwards. Contraction of the longitudinal muscles infront of the bolus widen the tube, this results in shortening of that particular part of the oesophagus. Contraction and relaxation of these muscles bring in a wave like motion that propels the food bolus into the stomach by the action called *"**peristalsis**"* (you have studied about this in the chapter on nutrition). This is involuntary and under the control of autonomous nervous system.

- What make the movement of the food bolus in the oesophagus easy?

The walls of the food pipe secrete a slippery substance called mucus. Mucus lubricates and protects the oesophageal walls from damage. This helps the food bolus to slide down easily just as the oiled potatoes that move in the tube. Besides this, the saliva in the bolus also aids in easy movement of food, which moves into the stomach.

Think why people are advised not to swallow food without chewing properly or do not eat in hurry.

Stomach the mixer and digester

- Why do you think the stomach is structured like a bag rather than a tube like oesophagus?

The food taken has to remain in the stomach for a long time. So it has to be processed for proper digestion and absorption. If it was like a tube it would just pass down without undergoing much changes.

- What sets such processes into action?

When the food is in the oral cavity, the nerves in the cheek and tongue are stimulated. These carry messages in the form of nerve impulses-to the

brain. These messages are transmitted from the brain, to the wall of the stomach, and stimulate the gastric glands to produce gastric juice.

The walls of stomach secrete strong hydrochloric acid (HCl) and other juices as the food is about to reach it or even when we feel hungry. This is stimulated by the nervous system. The contraction of the stomach muscles squeeze and mix the food with the acids and juices of the stomach. These digestive juices turns the food into a smooth porridge like consistency called ***chyme***. Some large protein molecules are also broken down here.

- What stimulates stomach muscle into action?
- What causes the stomach to churn and mix the food?

As the process of digestion in the stomach nears completion, the contractions of the stomach decrease. This prompts the muscles, called as pyloric sphincter at the opening of the stomach into the first part of the small intestine or duodenum, to contract. This opens the pathway into duodenum releasing the partially digested food (chyme) in small quantities into the duodenum.

- Why partially digested food travels in small quantities from stomach to duodenum?

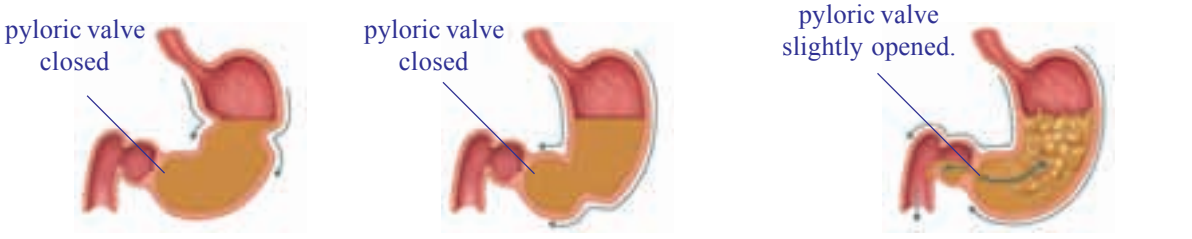


fig-7: Peristalic movement in stomach

Peristalsis involves the contraction of the muscle behind the food and the relaxation of the muscle in front of the food giving rise to a thrust that pushes the food forward through the digestive canal. A wave of contraction followed by relaxation in muscles helps in forward movement of food.

- What is involved in bringing about peristalsis?
- What is the direction of peristalsis (which end of the gut does it begin)?
- What happens to its direction when we vomit?

Even semi digested food in form of chyme may squirt back as we vomit.

Try to mark the direction of peristaltic wave of such reflexes in the above diagram.

Have you observed a ruminating cow/ buffalo under a tree or somewhere else? Carefully observe its neck and throat. Do you see something moving from its throat to mouth? After that, the cow /buffaloe starts chewing. Can you tell what is the happening in it ?It is the bolus moving from a part near the stomach of the animal to its mouth. It is reverse peristalsis. Though it is a common process in ruminants such as the cow, buffalo etc. that have an extra pouch in the stomach to store quickly swollen food., in human beings it is mainly a protective mechanism of expelling unwanted substances from the food canal.

We observe that digestion of food starts from mouth. While travelling the food through the alimentary canal settles some time for digestion at every stage. So this do not move uniformly through the digestive system. Let us observe the time period.

Table-

Percentage	Emptying of stomach	Emptying of small intestine
50%	2.5 to 3 hours	2 .5 hours
Total 100%	4 to 5 hours	30 to 40 hours (Transit through colon)

(These are only averages. The movement of materials varies among individuals and time after different meals.)

Our stomach is not like a bag with specific volume. It is like a pouch which is elastic in nature. the size of the stomach increase based on the food that we intake. Digestive juices are produced depending on the quantity of food material. If the stomach produce same amount of digestive juices irrespective of the food quantity the walls of stomach may destroy. The size and shape of stomach become crumbled in persons having habit of vigorous fasting.

If we eat undigested or unwanted food, the digestive mechanism recognize and refuse to digest it. Under control of autonomic nerves system stomach walls irritates and squirts out an undigested food along with chime. We call it as vomiting. Sometimes sudden belching with fluid from the stomach moves up the food pipe and enters the mouth too. It is followed by burning sensation in the throat and chest. This is due to the upward flow

of acids is a good example for reflexes of the food canal. All such muscular contractions are involuntary and under the control of the X cranial nerve of autonomous nervous system.

We know the stomach secretes strong acids during digestion. The HCl secreted by the walls of the stomach is strong enough to digest the hard bones as well..Then how is the stomach protected from the secretions of its own acids. To understand this we will perform the following experiment.

Take a green leaves collected from your school garden. Grease one leaf with petroleum jelly leaving the other free. Add 1 or 2 drops of some weak acid on both the leaves .Observe them after half an hour or so and write your observation in your note book.

- What kind of change did you observe in the leaves?
- Which leaf showed change and which did not? Give reasons.

Though the gastric glands of the stomach secrete acids .Some of the glands in the walls of the stomach produce mucus as well. Resultant a thin lining of mucus covers the walls of the stomach internally. This counters the action of acid. The function petrolium jelly can be compared to that of mucus lining the stomach walls. Hence the stomach is protected from damage being caused by the secretion of its own acids.

Travel of food from the stomach to the intestine

Food is a soup like mixture when it leaves the stomach and enters the small intestine. When the food enters the intestine the acidic nature of the chyme initiates the production of hormones Secretin and Cholecystochynin which stimulate pancreas, liver and walls of small intestine to secrete pancreatic juice, bile juice and succus entericus.

The absorption of nutrients by villi in the small intestine is a very selective process. The walls of the intestine allows only tiny nutrient particles to pass through and leaving the larger ones trapped inside. Let us recall transportation of materials across plasma membrane that you have studied in class 9^{th}.

- Why small intestine is long and coiled?

Activity-10

Paper tube and folded papers

Provide the students with a piece of paper. Let them calculate the area of one side of the paper and make a roll of it. Try to fill the tube by inserting

few folded papers as much as possible in it. Pull out the papers from the tube, unfold them and find out the whole area of the papers.

- Compare the area of the folded papers with that of the roll. Do you find any increase in the area ?If so try to find out the reasons?

The inner surface of the small intestine contains thousands of finger like projections called Villi .In what way are these projections related to the paper folds?

The villi present inside increases the surface area so that the food retained in the folds can remain longer thereby enhancing obsorption.

- What systems do you think are working together here?
- Do you think those systems work together in the whole length of the digestive canal? Why / Why not?

The digestive tract is unique among internal organs because it is exposed to a large variety of physicochemical stimuli from the external world in the form of ingested food. As a consequence, the intestine has developed a rich store of coordinated movements of its muscular apparatus along with neural apparatus to ensure the appropriate mixing and propulsion of contents during digestion, absorption, and excretion.

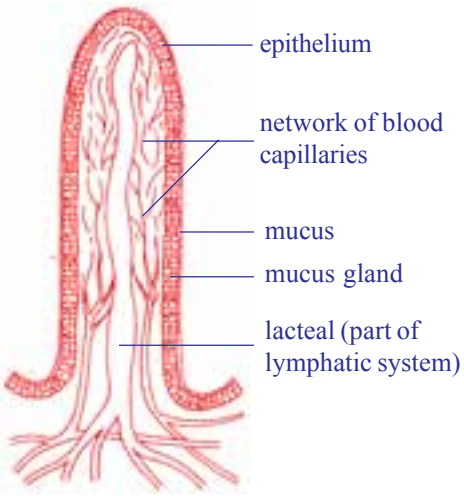


fig-8: Schematic diagram of a villus

The neural apparatus of our digestive tract comprises of such a vast and complicated network of neurons that it has been nicknamed by scientists as the second brain!

Research in this area is currently investigating how the second brain mediates the body's immune response; after all, at least 70 percent of our immune system is aimed at the gut to expel and kill foreign invaders.

Scientists are also working to find out how trillions of bacteria in the gut ***'communicate'*** with the cells of gut nervous system.

A deeper understanding of this mass of neural tissue, filled with important neurotransmitters, is revealing that it does much more than merely handle digestion or inflict the occasional nervous pang of hunger. The little brain in our inner yards, in connection with the big one in our skull, partly determines our mental state and plays key roles in certain diseases throughout the body.

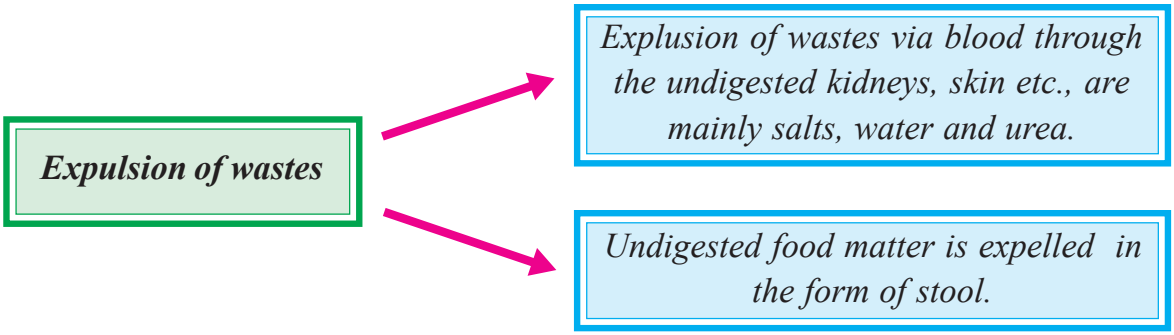
Often you may have experienced that if you have tension for some reason you start having lose motions.

- What does this show us?

Although its influence is far-reaching, the second brain is not the seat of any conscious thoughts or decision-making. Technically known as the enteric nervous system, the second brain consists of sheaths of neurons embedded in the walls of the long tube of our gut, or alimentary canal, which measures about nine meters end to end from the esophagus to the anus. The second brain contains some 100 million neurons, more than in either the spinal cord or the peripheral nervous system. This multitude of neurons in the enteric nervous system enables us to "feel" the inner world of our gut and its contents. Stimulating and coordinating the breaking down of food, absorbing nutrients, and expelling of waste requires chemical processing, mechanical mixing and rhythmic muscle contractions that move everything down the line.

Thus equipped with its own reflexes and senses, the second brain can control several gut functions often independently of the brain. Several scientists also believe that the system is a way too complicated to have evolved only to make sure things move through and out of our gut smoothly.

- What moves out of the gut?



- Two major pathways of waste expulsion are shown above. Which of the two do you think happens exclusively through the gut?

Obviously it's path way of the left side. Thelarger food particles reach the large intestine to be sent out. But how?

Imagine you made a roll by wrapping a hand full of left over tea leaves in a tissue paper. Later you pressed the roll gently and opened it. What did you observe? You find the tissue paper had absorbed the water from the tea leaves.

Similarly when the unwanted waste material (stools / faeces) reach

the large intestine. The peristaltic waves move the stool from the left side of the colon into the rectum .The left side of the colon acts like a storage tank of faeces. Water gets reabsorbed and the remaining wastes usually the hard mass gets stored in the last part (Rectum) of the large intestine. This smelly yellowish faecal mass usually called as toilet is later expelled out of the body through the anus.

- What controls the exit of stools from the body?
- Do you think the control is voluntary? Why / why not?

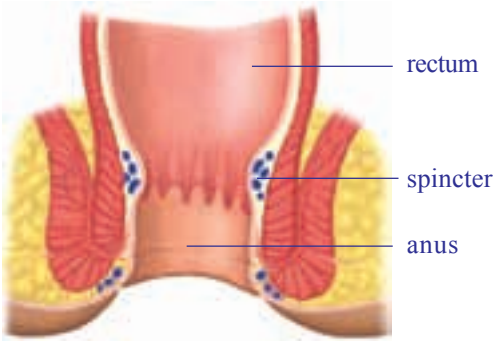


fig-9: Anal spincter

There are two muscular layers forming the anal sphincters. One that is under involuntary control the internal anal sphincter and the other is voluntary the external anal sphincter which you have control over it.

In a sick person the glands of alimentary canal stop functioning, in other words the flow of digestive juices come to a standstill. This is due to the blood flow being directed to other actively working parts like those that lungs, kidneys, brain etc., the person does not notice this. He Takes food and it gets digested. How does this process go on?

This was a mystery recently solved by the Physicians. The digestive juices secreted by a faulty gland are stored in the lining of the intestines that help in digestion during such conditions. Sometimes the nervous signals to the Gastro Intestainal tract are stopped temporarily, still peristalsis and other functions of digestive process goes on. This is because, the signals necessary for contraction are generated in the smooth muscle cells, to overcome adverse conditions.

We have so far seen how several systems work together to bring about the process of digestion. Where does this process draw energy to run smoothly?

Moreover what is the fate of the digested substances that move into blood from the intestine?

If energy has to be obtained from food it has to be oxidised. For this purpose respiration has to go on. Then how is energy released from food in this process?

During inhalation oxygen moves across the walls of the alveoli and enters the blood. From here it enters the red blood cells and gets distributed throughout the cells of our body. At the same time carbon

dioxide from the blood moves into the alveoli of the lungs and breathed out during exhalation. Nutrients in the cells get oxidized and energy is released.

- Where this released energy stored in the cells?

During respiration we breathe continually by inhaling and exhaling air. This is an involuntary process controlled by the medulla oblongata of the autonomous nerves system (ANS). During respiration the movement of inter costal muscles/diaphragm moves the ribs cage inflating and deflating the lungs. Air containing more of oxygen enters the blood stream through lungs. If the oxygen has to reach the tissues it has to be circulated through blood. How does this process go on?

Hence the process of digestion which is a complex process that involves many organs and organ systems. Though digestion occurs in the food canal, co-ordination of respiration and blood circulation is necessary otherwise oxidation of food and transport of substances which is vital for energy releasing process will not take place. This may lead to shut down of systems that are interdependent on each other.

Key words

Ghrelin, Leptin, Gustatory, Chemoreceptors, Papillae, Food bolus, Peristalsis, Chyme, Pyloric Sphincter, Villi, Medulla oblongata , Brain stem.

What we have learnt

- The food taken by us it has to be broken down into constituent substances for proper digestion, assimilation and energy releasing processes.
- The human digestive digestive system involves both the muscular and nervous systems.
- A special nervous system that exists in the gut consist of nearly 100 billion nerves that coordinates the muscular activity ,blood flow,digestion and absorption of nutrients and other activities of the food canal (gastro intestinal tract).
- The hormone Ghrelin secreted in the stomach is responsible for hunger generating sensations. Another hormone leptin that gets secreted suppresses hunger.
- Taste can be identified easily only when the tongue is pressed against the palate.

- Taste and smell are closely related. The chemoreceptors receptors present in the nose and and the tongue trigger signals in the form of nerve impulses to the brain where the smell and taste is detected.
- The saliva secreted maintains an alkaline medium that's aids in digestion of starch. Our mouth secretes acid as well ,this gives protection to our mouth from harmful bacteria etc., Under the action of autonomous nervous system Saliva released by the salivary glands moistens the food to make chewing and swallowing easier.
- The muscular and sensory organ in the oral cavity is the tongue which is not only gustatory in function but also performs different functions including, shifting and mixing the food in the oral cavity and swallowing.
- The mechanism for swallowing is coordinated by the swallowing centre in the brain stem.
- Contraction and relaxation of the muscles in the gut brings in a wave like motion that propels the food forward, is called peristalsis . This is a muscular wave that travels the entire length of the food canal. This is involuntary and under the control of autonomous nervous system as well as gut nervous system.
- The muscular contractions of the stomach churns the food into a semiliquid substance known as chyme. Entry of chyme into the duodenum is regulated by a muscle called as the pyloric sphincter.
- The strong acid (HCl) renders the pH in stomach acidic causing the protein digesting enzymes to swing into function.
- Juices secreted in the stomach breaks down the food into a smooth mixture called chyme.
- The mucus lining of the stomach protects it from damage by its own acids.
- The coordination among the processes of digestion, respiration and circulation is necessary for utilization and oxidation of food and transport of the nutrients. Muscular and nervous control helps to carry out the processes in a regulated manner.

Improve your learning

1. What do you meanby hungerpangs? (AS1)
2. What are the body systems involved in digestion of food which we eat? (AS1)
3. Rafi said smell also increase our appetite can you support this statement. how? (AS1)
4. Give reasons
   a) If we press tongue against the palate we can recognise taste easily.
   b) If cann't identify taste when food is hot.

c) In mouth food forms into a slurry mass.

d) Small intestain is similar to a coiled pipe.

5. Draw the block diagram of showing sensation of taste from food material to brain. (AS5)
6. How can you mouth is munching machine? (AS1)
7. What is mastication? Explain the role of different teeth in this process. (AS1)
8. What experiment you perform to understand action of saliva on flour? Explain it's procedure and operatus that you followed. (AS3)
9. What happen if salivary ducts are closed? (AS2)
10. During the journey of food from mouth to stomach through oesophagus. How muscular system coordinate in this process? (AS1)
11. Write difference between the following

    a) bolus - chyme b) small intestain - large intestain

    c) mastication - rumination d)
12. Draw a neatly labled diagram showing a peristallic movement in oesophagus. Explain the importance of mucus on the walls of food pipe. (AS5)
13. Write a note on peristalasis and sphincter function in stomach. (AS1)
14. Observe the given part of the digestive system. What is it? What is it's role during digestion? (AS1)

15. Draw a schematic diagram of villus in small intestain. Explain how digestive system coordinate with circulatory system. (AS5)
16. If size an shape of small intestain like oesophagus what will happen? (AS2)
17. Prepare a quessioneer to understand nervous coordination in digestion process. (AS2)
18. Collect information related to feeling and hunger from your school library andprepare a note on it. (AS4)
19. Prepare a cartoon on Pavlov's experiment with a suitable caption. (AS6)
20. There is a great variety in diversified life processes, express your feelings in the form a poem. (AS7)
21. Suggest any two important habitual actions to your friend while eating food, keeping in view of this chapter. (AS7)
22. Fill in the blanks with suitable words.
    1. 3:2:1:2 is the ratio of our dentition. Here 1 represents _____
    2. Large protein molecule are broken down in _____ of digestive track.
    3. _____ is the strong acid which secreats during digestion.
    4. Olfactory reseptors present in _____ triggering signals to brain.

5. pH of saliva is _____ in nature.

Choose correct answers.

1. Which of the following situation you can taste quickly.
   a. Put sugar cristals on tongue.
   b. Put sugar solution on tongue.
   c. Press the tongue slowly against the palate.
   d. Swallow directly without graind and shred.
2. Peristalasis is because of
   a. Contraction of longitudinal muscles.
   b Contra ction of circular muscles.
   c. Under control of autonamous nervous system.
   d. Digestive secretions.
3. Sphincter that helps in opening of stomach into deodinum
   a. Cardiac
   b. Pyloric
   c. Anal
   d. Gastric
4. Glucose and amino acids are absorbed through the following part of villas.
   a. epithelial cells
   b. blood capillary
   c. lymphatic vessel
   d. all
5. Brain portion that controls hunger signals
   a. medulla
   b. diencephalon
   c. cerebrum
   d. mid brain
6. Human organism is an internal combustion mechine because of
   a. assimillation of energy from food
   b. liberate CO_2 during respiration
   c. Expel waste food at the end state digestion
   d. Secrete powerful digestive juices

1) Rajesh feels hungry upon seeing food.Sheela s ays no more food as she is not hungry.What makes Rajesh hungry and what suppresses Sheelas hunger?

2) Suggest a simple experiment to prove the role of palate in recognizing taste.

3) How is taste and smell related?

4) With the help of a diagram show the movement of food from mouth to the stomach.What muscles and nerves are involved in the movement of food and what is this action called as?

5) List out the sphincter muscles of the food canal you have observed and give a brief description ?

6) How do you appreciate stomach as a churning machine .How does this coordination go on?

7) Is there any reason for the intestine to be coiled with many folds.In what way its helpful during the process of digestion?

8) The mere smell or sight of food stimulates hunger .Describe the process through a neat diagram?

9) Refer to the diagram on breathing mechanism and explain how air is forced in and out of the lungs?

10) The mechanism of respiration in men and woman is same.True or false support your answer with suitable explanation.

11) skim through these parts Stomach Small intestine Large intestine and name the process in the Boxes.

12) What is the function of peristalsis in these parts ?

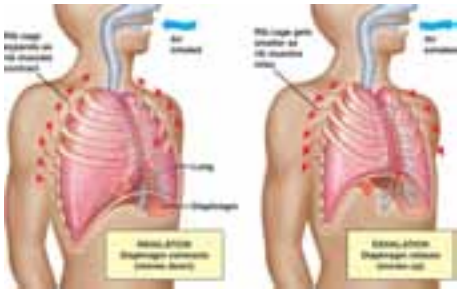
a) Oesophagus b) stomach c) small intestine d) large intestine

13) How can you justify the entric nervous system as the second brain of the gut ?

Fill in the blanks with suitable words given below.

a) . Fluctuation s of hormone——1——— levels results in sensation of hunger and motivation of consuming food. When you feel your stomach is full and there is no need of food any more. Another hormone ——*2*——— that gets secreted suppresses hunger. When we take food into the mouth it has to be chewed

thoroughly.For this purpose the————3————muscles help in chewing actions, while the ————4————muscles of the jaw moves the jaw up,down ,forward and backward during food mastication. The ——5—— nerve controls the muscles of the jaw. . Under the action of——6——nervous system Saliva is released by the salivary glands moistens the food to make chewing and swallowing easier. The salivary ——7—— in the saliva breaks down the starch into sugars.. As a result of chewing the food is transported into the oesophagus by the action of swallowing which is coordinated by the swallowing centre in the ——8—— and the——9————.The tongue which is gustatory recognizes the taste and—10—— nerve plays an important role in sensation of taste.



Choose the right ones.

1) leptin, grehlin gastrin secretin.

2)ghrelin leptin secretin gastrin.

3)deep muscles ,surface muscles ,circular muscles, striated muscles.

4)surface muscles, deep muscles, neck muscles, long muscle.

5) fifth cranial nerve ,second cranial nerve,fifth facial nerve, spinal nerve.

6)central nervous system, peripheral nervous system autonomous nervous system.

7)lipase, sucrase, galactase,amylase.

8) medulla oblongata, cerebrum , 8th spinal nerve,cranial nerve.7th cranial nerve.

9) Pons varoli, brain stem ,medulla oblongata, mid brain.

10) 6th cranial nerve, 5th cranial nrve, 10th cranial nerve, optic nerve.

Contraction and relaxation of the——11—— in the oesophagus propels the food bolus into the stomach. This action is also called as—12—— which is—13———— and under the control of autonomous nervous system. The muscular movements of the stomach—15—the food and breaksdown it into a semiliquid substance known as—16——. The—17— muscle at the end of the stomach regulates the entry of food into the duodenum. The——18——wave pushes the food into the small intestine and the folds in the intestine increase the area of—19—-, and the –20—- in the intestine absorb the nutrients.When the food enters the large intestine Water gets reabsorbed and the remaining wastes gets stored in the—21—- last part of the large intestine.The exit of stools is controlled by two muscles the internal sphincter and the external sphincter of the—22——..

Choose the right answer.

11) wall muscle, hard muscle, smooth muscle, long muscle.

12) peristalsis, plasmolysis, osmolysis,

14) voluntary, involuntary, reflex, selective,

15) presses ,churns,pushes.

Historical evidence of human digestion that led to discovery of other truths

The man with a window in his stomach.

One fine morning at Fort Mackinac on the upper Michigan peninsula a 19 year Voyageur Alex St.Martin had a gun wound in his stomach that was fired accidiently. The wound perforated the abdominal wall and stomach with profused bleeding. Dr.Beaumont the army surgeon was called on to attend the wounded man. Dr. Beaumont cleaned the wound and pushed the protruding portions of lungs and stomach back into the cavity and dressed the wound.

Dr. Beaumont was surprised to see St. Martin alive the next day as he never expected so. With his medical expertise Dr. Beaumont treated the wound and did his best to extend his life. When the wound got healed completely, the stomach had fused with the body wall leaving a hole. Part of the wound formed a small flap that resembled a natural valve. This allo-wed Dr.Beaumont to draw out fluids from Martin's stomach for testing.

Dr.Beaumont turned St.Martin to the left side depressing the flap he inserted a 5-6 inch tube into the stomach gathered gastric juice had its components identified. He introduced food through the hole of the stomach with a string attached to it so that he could retrieve the partially digested food for further examination. He conducted many experiments on food digestion to know the function of stomach which had not been done before. He discovered many things that were new to science.

For centuries stomach was thought that cooks food by producing heat. Also theStomach was viewed as a mill,a fermenting vat or a stew pan. Through his experiments Dr.Beaumonts experiments revolutioned the concepts of digestion. June -on16,1822 became the beginning for the the most pioneering experiments in medicine. He recounted many of his observations and experiments in his journal which says "I concider myself but a humble experimentor " in which the information provided still obeyed scientific method basing all the inferences on direct experimentation.

Some of the discoveries of Dr.Beaumont were.

.1) He measured the temperature of the stomach during digestion .To his surprise he found there was no change or alteration in temperature. He found the temperature being maintained constant (100F/38C).

2) He found out that pure gastric juice contains large amounts of HCl ,contrary to the previous opinions that gastric was nothing but contains simply water. As suggested by some authors as the most general solvent in nature and of the alimentary canal. Even the hardest bone cannot with stand its action .Even outside the stomach its capable of effecting digestion. Based on the evidences he concluded that HCl as chemical agent that aids in chemical reaction.

3) He found Gastric juice is not stored in the stomach. But ,is secreted when the food is taken. When the food enters the stomach it exites the vessels to discharge its contents immediately for digestion.

4) He understood that digestion begins immediately when the food enters the stomach. He tested the contents

Of the stomach exactly 20 mts after taking food (dinner containing ordinary food of boiled and salted beef, potatoes ,bread, beef and turnips) by collecting the fluids from the flap and found digestion had commenced

and was progressing well at that time.

5) He also discovered that food in the stomach satisfies hunger even though its not eaten. (food reaching the stomach without passing the mouth and oesophagus) To confirm his assumptions he made St. martin fast from breakfast time till 4'0 Clock and then introduced food into the stomach through the flap. The sensation of hunger subsided.

Though it was fortuitous experiments in medicine connected to digestion raised many questions.

*What is the cause of hunger ? *How does the brain know the happenings of the stomach? *What causes the gastric juices to secrete ? How and what makes the food to be mixed with the digestive juices? *Does the process of digestion occur independently or involves other systems like nervous and muscular as well ?

Chapter

8

Heridity - From parent to progeny

You know that there is a vast diversity of organisms in nature. Other than the ones that we see around us there is a world of millions of organisms we can see only under the microscope. We had learnt about some of them in the chapters on Microbial world in class 8.

Apart from the tremendous diversity in organisms, we see similarities as well among them which forms the basis of classification and evolution. Differences among closely related organisms which we have studied as variations, usually lead to often observable changes in life forms.

Evolution is the process of acquiring change. Most life forms that we see today had variations that accumulated over the years to allow the organisms possessing them to survive.

Some organisms or species adapt better and survive in a community of organisms, why do you think this may happen?

In this chapter we shall try to explore such questions.

fig-1: Variations of flowers

Variations

If we observe parents and their children i.e. parents and offspring (their children) there will be some similar features in the offspring of the parents. At the same time we find differences between parents and offspring in their features. These differences are an example of variations. Variations are quite apparent among closely related groups of organisms.

We take roses as an another example. We observe number of varieties in them.

- What difference do you see in the plants in the pictures given above?

But, you can still find some characters similar to all plants. Thus rose plants have similar physical features, at the same time they have differences in characters like flower colour, number of petals, leaf size, stem, spains, etc. These differences in features are variations.

Activity-1

Observe any five of your friends of your class and find out differences in features and note them.

Table-1

Name of your friend	Colour of skin	Ear lobes Free/attached	Height	Fore head	Chin	Eyes	Any other feature

Take the help of images give here.

Fig-2: Variations in organs

We find more variations in sexually produced offspring like human beings and higher plants.

- What is the importance of variations? How are variations useful for an organism?

Variations are present in nature among all communities of organisms. These would perhaps help a certain group in a community when conditions would otherwise be unfavourable for other groups.

Variations and their role in nature have been studied by naturalists over centuries. During the early 19th century, a lot of work was done by several scientists. Some of these studies shall help us to understand how variations occur and are transferred from one generation to the next. We shall study a detailed account of experimental evidences provided by Mendel in the early 19th century.

fig-3: Gregor Johans Mendel

In about 1857 Gregor Johans Mendel started working on the problem of how variations were passedon from one generation to the other. Mendel did not do his experimental work in a University or in a Laboratory. He was a monk and simply did his experiments in the garden of the monastery. He worked for over seven years after which he presented conclusions from his experimental data in a form of a detailed paper.

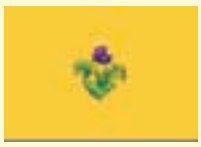
Mendel made many careful observations of pea plants and asked himself questions about what he observed and then planned and designed experiments to find the answers. He had worked on nearly 10,000 pea plants of 34 different varieties.

Observing pea plants carefully, Mendel noted that they differed from one another in many ways. For example some were tall, some were short. Some had round and yellow seeds and some had wrinkled and green seeds. A list of characters that Mendel had chosen consisted of 7 such distinguishing forms.

The characters which were selected for experiment relate: (as shown in table-2)

1. To the difference in the form of the ripe seeds. These are either round or roundish, the depressions, if any, occur on the surface, being always only shallow; or they are irregularly angular and deeply wrinkled.
2. To the difference in the color of the seed albumen (endosperm). The albumen of the ripe seeds is either pale yellow, bright yellow and orange colored, or it possesses a more or less intense green tint. This difference of color is easily seen in the seeds as their coats are transparent.
3. To the difference in the color of the seed-coat. This is either white, with which character white flowers are constantly correlated; or it is gray, gray-brown, leather-brown, with or without violet spotting, in which case the color of the standards is violet, that of the wings purple, and the stem in the axils of the leaves is of a reddish tint. The gray seed-coats become dark brown in boiling water.
4. To the difference in the form of the ripe pods. These are either simply

Table-2: The results of Mendel's F_1 corsses for seven characters in pea plants

Character	Dominant Traint	Recessive Trait	F2 Generation Dominant: Recessive	Ratio
Flower colour	Purple 	White 	705:224	3.15:1
Flower position	Axial 	Terminal 	651:207	3.14:1
Seed colour	Yellow 	Green 	6022:2001	3.01:1
Seed shape	Round 	Wrinkled 	5474:1850	2.96:1
Pod shape	Inflated 	Constricted 	882:299	2.95:1
Pod colour	Grenn 	Yellow 	428:152	2.82:1
Stem length	Tall 	Dwarf 	787:277	2.84:1

inflated, not contracted in places; or they are deeply constricted between the seeds and more or less wrinkled.

5. To the difference in the color of the unripe pods. They are either light to dark green, or vividly yellow, in which coloring the stalks, leaf-veins, and calyx .
6. To the difference in the position of the flowers. They are either axial, that is, distributed along the main stem; or they are terminal, that is, bunched at the top of the stem and arranged almost in a false umbel; in this case the upper part of the stem is more or less widened in section.
7. To the difference in the length of the stem. The length of the stem is very various in some forms; (it is, however, a constant character for each, in so far that healthy plants, grown in the same soil, are only subject to unimportant variations in this character.) In experiments with this character, in order to be able to discriminate with certainty, the long axis of 6 to 7 feet. was always crossed with the short one of $^{3}/_{4}$ feet to $1^{1}/_{2}$ feet.

Mendel hypothesized that characters were carried as traits and an organism always carried a pair of factors for a character. He also hypothesized that distinguishing traits of the same character were present in the population of an organism. He assumed that the traits shown by the pea plants must be in the seeds that produced them. The seeds must have obtained these traits from the parent plants.

How do parent plants passon their traits to the seeds? Will seeds from tall plants always produce new tall plants?

Mendel carried out several experiments to find out answers to this type of questions.

Examples of experiments performed by Mendel

For all experiments that Mendel performed he made a note. The following section shows the number of experiments performed, fertilizations carried out and the number of plants involved.

1. 1st experiment 60 fertilizations on 15 plants.
2. 2nd experiment 58 fertilizations on 10 plants.
3. 3rd experiment 35 fertilizations on 10 plants.
4. 4th experiment 40 fertilizations on 10 plants.
5. 5th experiment 23 fertilizations on 5 plants.
6. 6th experiment 34 fertilizations on 10 plants.
7. 7th experiment 37 fertilizations on 10 plants.

We shall study a generalized version of the actual experiments performed by Mendel.

Mendel selected such plants that expressed the selected character over several generations. Such plants according to him were pure breed for the character. For example for the colour of seed the distinguishing characters were yellow and green. In the section that follows we shall represent yellow with 'Y' and green with 'y'.

Mendel started with two pure breeds of peas with different properties. We here take as an example a characteristic colour of the pea seeds-yellow and green.

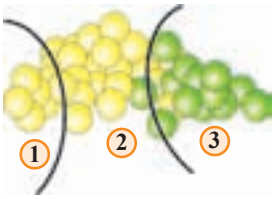
Cross pollinating a pure breed of yellow and green gave

F1 generation (Mendel called it first filial or offspring of first generation parents)

All pea seeds that were Yellow. These pea plants on self pollination gave.

F2 generation [About 75% yellow (seeds) peas and about 25% green (seeds) peas.]

F3 generation (Mendel self pollinated these pea plants too, and found out that



1. A set of peas (about 25%) gave only yellow (seed giving) pea plants.
2. Rest of the yellow (seed)pea plants gave About 75% yellow & About 25% green (seed giving) pea plants.
3. The set of green peas gave only green (seed giving) pea plants.

Mendal made some assumptions by which he could explain his observations.

Assumption 1: Every pea plant has two 'factors' which are responsible for producing a particular property or trait.

Mendal had carefully chosen the plants which do not produce a mixed result. (pure) In our example of yellow and green peas. A pure breed (parental stage) will have both the 'factors' of the same type.

A pure breed (parental) yellow seed giving pea will have both the 'factors' of the same type. Let us call them 'Y'.

A pure breed (parental) Green seed giving pea will have both the 'factors' of the same type. Let us call them 'y'.

Assumption 2 : During reproduction one 'factor' from each parent is taken to form a new pair in the offspring.

Assumption 3 : One of these will always dominate the other if mixed together.

Parental generation - Cross pollination

We will assume that Y (the one causing yellow colour) is a dominating 'factor'. That means if Y and y come together Y will dominate. The pea seed will be yellow in colour.

From assumption 2 the breed after cross pollination will have one of the factor from pure breed yellow (Y) and one from the pure breed green (y). That is, all the peas will have the factor pair 'Yy' and by assumption 3 all the peas will be Yellow as Y factor will dominate.

♀ \ ♂	Y	y
Y	Yy	Yy
Y	Yy	Yy

Yy ..... (yellow)

Yy ..... (Yellow)

Yy ..... (yellow)

Yy ..... (Yellow)

All the pea plants are yellow (F1-Generation)

Self pollination in F1-Generation

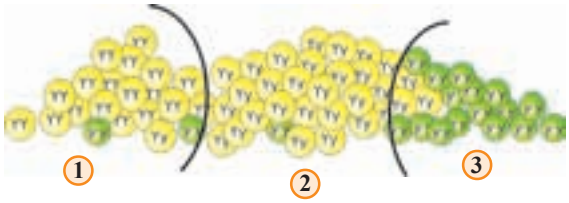
On self pollinating these peas (ones with Yy factor). The new breed can have any combination of Y and y.

♀ \ ♂	Y	y
Y	YY	Yy
y	yY	yy

It can be YY, Yy, yY or yy. All of them are equal.

So in this heap we will get approximately equal number of YY, Yy, yY and yy peas. But any pea that has a Y factor will be yellow. Any pea that has both yy will be green. Since all combinations are equally likely:

1. YY will be approximately 25% and is yellow.
2. yY will be approximately 25% and is yellow, Yy will be approximately 25 % and is yellow
3. yy will be approximately 25% and is green.



Some seeds appear yellow in colour in F1 generation. When we so these seeds some of the plants produce green peas. We can't determine internal character based on external character.

Pheno type:

Thus in F1 generation all seeds are yellow in colour. When we sow them we will get 75 percent plants produce yellow seeds. 25 percent plants produce green seeds. The character which can be seen is known as **'Phenotype'** and this ratio is called as 'phenotype ratio' is **3:1.**

Genotype:

In F1 generation 75 percent yellow seed giving pea plants only 25 percent pea plants yellow seed giving are pure (YY),which one also known as **'homogygous'** remaining 50 percent yellow seed giving pea plants are (**Yy,Yy**) **heterogygous** . The remaining 25 percent green seed giving pea plants are pure (yy). This one is known as **genotype.** This ratio is known as genotype ratio is **1:2:1**

On self pollinating these peas (F2 generation) we get,

♀ \ ♂	Y	Y
Y	YY	YY
Y	YY	YY

1

♀ \ ♂	Y	y
Y	YY	Yy
y	yY	yy

2

♀ \ ♂	y	y
y	yy	yy
y	yy	yy

3

1. The YY peas will on self pollination give only yellow (YY) peas. This corroborates with the experimental result that this set gave 100% yellow peas.
2. The Yy or yY peas on self pollination give about 75% yellow peas and about 25% green peas. This situation is same as step 2 ratio 3:1.
3. The green peas that contain yy factors will give only green peas.

In nature there are many factors responsible for different properties. Can we test our hypothesis with more than one factor?

How does all this get applied to Mendel's experiment? We assume two characteristics,

1. Colour of peas - yellow or green (symbolically indicated as Y & y).
2. Peas being smooth or shrivelled (symbolically indicated as R & r).

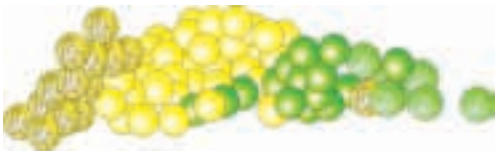
We will assume yellow and smooth are dominant trends. Let us assume initially we have two sets of 'pure' peas, that are Yellow and has smooth skin and another plant that grows green peas with wrinkeled cover.

On cross pollination

All pea seeds that were yellow and smooth skin. Each pea will now have factors YyRr

Since Yellow colour (Y factor) and smooth skin (R factor) are dominant triates. All the pea seeds will be smooth and yellow (F1 generation).

Mendel self pollinated these peas too and found that



He got some seeds smooth yellow (YyRr or YYRR), some seeds smooth and green (yyRR or yyRr), some seeds were wrinkled and yellow (Yyrr or Yyrr), and some seed were wrinkled and green (yyrr).

- What should be the percentage of each type?
- Can you find out using the list of probabilities given on previous page?

Note that the probability of each combination is same. To understand the above questions the following table will be help you.

- Do your results match with Mendel's observations?

Mendel's laws of independent assortment

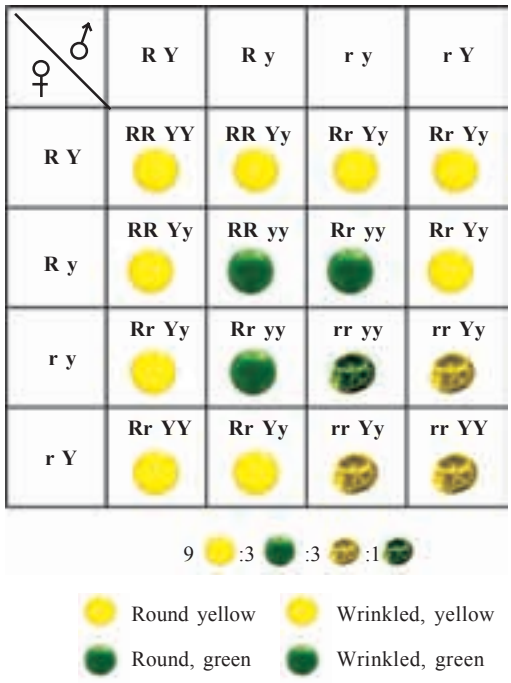
In the above dihybrid cross parents produced offspring contains the factors (genes) of Characters (Traits) of Yellow (YY), Round (RR), and wrinkled (rr), green (yy) appeared independently mixing with each other in F2 generation. Which were produced by self pollination in F1 generation.

1. RRYY, 2. RRYy, 3. RrYY, 4. RrYy, 5. RRYy, 6. RrYY, 7. RrYy, 8. RrYy, 9. RrYy are having Round and Yellow

1. RRyy, 2. Rryy, 3. Rryy are having Round and Green

1. Rryy, 2. rrYy, 3. rrYy are having Wrinkled and Yellow

1. rryy are having Wrinkled and Green



From the above results it can be concluded that the factors for each character or Trait remains separate and maintain its identity in the gametes. The factor are independent to each other passes to its offspring (through gemmates).

In the inheritance of more than one pair of characters (Traits) the factors for each pair of characters assorts independently of the other pairs. This is known as **"Law of independent assortment".**

Mendel believed that every character or trait is controlled or responsible by a pair of factors. The factors which are responsible for character or trait of an organism, now named as 'genes'**.** The pair of genes which are responsible for character is called them as **'**allele'**.** Alleles are two types one is homozygous type (YY or TT) and second one is heterozygous type (Yy or Tt**).**

- Can we prepare an activity for above Mendel's experiment?

Activity-1

Let us do the following activity to understand the Mendalian principles of Heredity

Materials required :

1. 3 c.m 's length and 1 c.m breadth chart pieces - 16
2. 2 c.m length and 1c.m breadth chart pieces - 16
3. Red buttons - 16

♀ \ ♂	E	F	G	H
A	1	2	3	4
B	5	6	7	8
C	9	10	11	12
D	13	14	15	16

4. White buttons - 16
5. Chart, scale, sketch pen, pencil

Method: Prepare a chart with 5×5 boxes along with number and Symbol as shown in the figure

Game 1: Pure Bread

Take 4 long strips. Each one represents as male or female gametes. Take 4 long strips and put them in each box marked A, B, E, F.

Then drag strips from E and A to box 1 and E and B to box 5. In the same way drag strips from boxes F and A to box 2 and F and B to box 6. Now you have 2 long strips in the boxes 1, 2, and 5,6.

Discuss: What do you understand about pure breads?

Can you play the same game with short strips and with any other characters? Think and play and discuss with your friends and note the points.

Game 2: Monohybrid cross

Take 4 long strips and 4 short strips. Put a pair of long strips in each box marked 'A' and 'B', put apair of short strips in each box marked E and F.

Drag one strip from boxes marked E and A to box 1.

Drag one strip from boxes marked E and B to box 5.

Drag one strip from boxes marked F and A to box 2.

Drag one strip from boxes marked F and B to box 6.

Discuss: What do you understand about F1 generation?

Game -3: Dihybrid cross (law of independent assortment)

Take 16 long strips , 16 short strips, 16 Red buttons and 16 White buttons.

Put 4 long strips in each box marked A, B, E, F. (4 + 4 + 4 + 4=16)

Put 4 short strips in each box marked C, D, G, H. (4 + 4 + 4 + 4=16)

Put 4 Red buttons in each box marked A, C, E, G. (4 + 4 + 4 + 4=16)

Put 4 White buttons in each box marked B, D, F, H. (4 + 4 + 4 + 4=16)

Then,

Drag one strip and one button from each boxes marked E and A to box '1'. (2 stips and 2buttons total 4 in one box)

Drag one strip and one button from each boxes marked E and B to box '5'.

Drag one strip and one button from each boxes marked E and C to box '9'.

Drag one strip and one button from each boxes marked E and D to box'13'.

In the same way fill the boxes in all the rows with strips and buttons carefully.

Discuss: What do you understand about law of independent assortment? Think and discuss with your friends. (Take help of your teacher). Assume Long and Red are dominant, Short and White are resistive. What type of characters will be seen in the following boxes.

I) In Box

1. Long and Red , 2. _____,
3. _____, 5. _____,
6. _____, 7. _____,
9. _____, 10. _____,
11. _____.

II) In boxes

4. _____, 8. _____,
12. _____.

III) In boxes

13. _____, 14. _____, 15. _____.

IV) In box

16. _____.

♀ \ ♂	E	F	G	H
A	1	2	3	4
B	5	6	7	8
C	9	10	11	12
D	13	14	15	16

Law of Dominance

As we may note only one trait is expressed in the offsprings of first generation crosses.

Crossing yellow and green seeds produced all yellow seeds. Why is this so? Mendel propounded that, among a pair of alleles for a character, only one expresses itself in the first generation as one of the allele is dominant over the other.

Law of Segregation

The Law of Segregation states that every individual possesses a pair of alleles (assuming only a pair are present) for any particular trait and that each parent passes a randomly selected copy (allele) of only one of these to its offspring.

Parent to progeny

He resembles his grand father, she seems to be a xerox copy of her aunt, generally we heard such comments. The characters are the inherited traits transmits from parent to progeny. Let us do the following activity to understand inherited traits in human beings.

Activity-2

Take a mirror and observe your facial features nose, chin, fore head, ear lobes, hairs etc. Whom do you resembles? Your father? Your mother? Or your grandparents. List them out in the table:

Table-3

Traits	Resembles mother	Resembles father	Resembles grand parents
Nose			
Eyes			
Chin			
Fore head			
Ear lobes			
Skin colour			
Other trait			

In which characters did you resemble of your mother? Is there any character that you inherited from your grandparents?

From above experiences we know that some of our characters resembles our mother or our father or may be our grandparents. Those characters which pass from parents to children or from one generation to next generations are called as "Inherited Traits" or 'inherited characters'. We had also found that traits like the colour of seed, seedcoat, length of stem etc. were heritable traits according to Mendel.

The process of acquiring characters or traits from parents is called **'**Heredity**'**. .

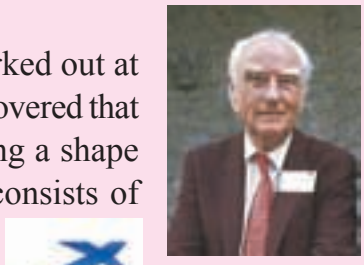
The process in which Traits are passed from one generation to another generation is called 'Inheritance'.

How do traits get expressed?

Mendel hypothesised that each character or trait is expressed due to a pair of factors or 'alleles' (contrasting expressions of the same trait), as he named them. Now we know that these are known as 'genes'. Gene is a segment of a nucleic acid called 'DNA' which is present in the nucleus of every cell. That controls the expression of trait or character.

Do you know?

In 1953 the detailed structure of DNA was finally worked out at Cambridge by Francis Crick and Janmes Watson. They discovered that DNA molecule looks rather like a spiral stair case, having a shape known as a double helix. The framework of stair care consists of alternate sugar and phosphate groups and the steps which join the framework together are pairs of chemical compounds called bases. They are adenine, guanine, thymine, cytosine. Watson and crick awarded Nobel prize jointly with Franklin and Maurice Wilkins.



Watson

fig- :DNA

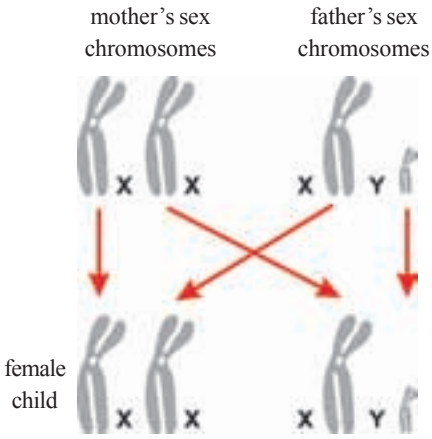
Crick

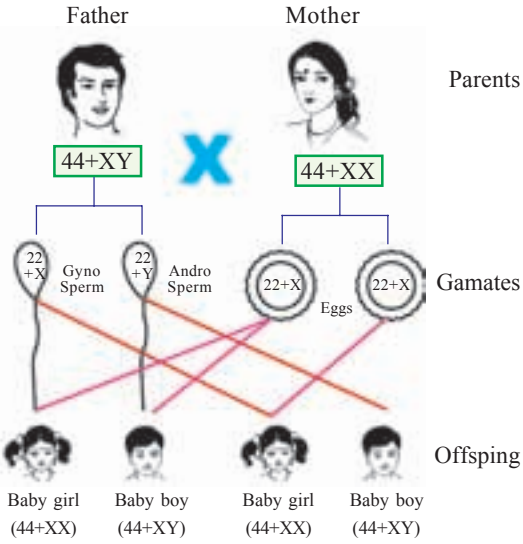
Colour of the hair, the skin etc. are examples of trait. Slight inheritable changes in the chemical structure of DNA may lead to change in the characteristic or trait of offspring of an organism, this leads to Variations.

Sex determination in human beings

We inherited our traits from our parents. Let us see how sex is determined in human beings. Each human cell contains 23 pairs (46) of chromosomes. Out of 23 pairs 22 pairs chromosomes are called autosomes. Remaining one pair is called allosomes (sex chromosomes). There are two types of sex chromosomes one is 'X' and the other is 'Y'. These two chromosomes determine the sex of an individual. Female have two 'X' chromosomes in their cells (XX). Males have one 'X' and one 'Y' chromosomes in their cells (XY). All the gametes (ovum) produced by women will be with only X chromosomes. The gametes (sperm) produced by man will be of two types one with X chromosomes and other Y chromosomes. If the sperm carry in X chromosomes fertilize with the ovum (X chromosome). The resultant baby will have XX condition. So the baby will be a girl. If the sperm carry in Y chromosomes fertilize with the ovum (X chromosome). The resultant baby will have XY condition. So the baby will be a boy.

Now let us discuss who decide the sex of the baby – mother or father.





Do you know?

Discovery of the sex chromosomes

Walter setton and Thomas Hunt Morgan studied on a small fruit fly (darosophila Melanogaster) at Columbia University. The discovery of sex linked triates in drosophila indicated that genes are on chromosomes. They worked out the details of inheritance in drosophila.

Evolution

Variations develop during reproduction in organisms. Sexual reproduction and errors in DNA copying leads to variations in offspring in a population. Let us try to know the consequences of these variations in the population in its environment.

Variation in a population

Diagram showing variation in beetle population and it its impact.

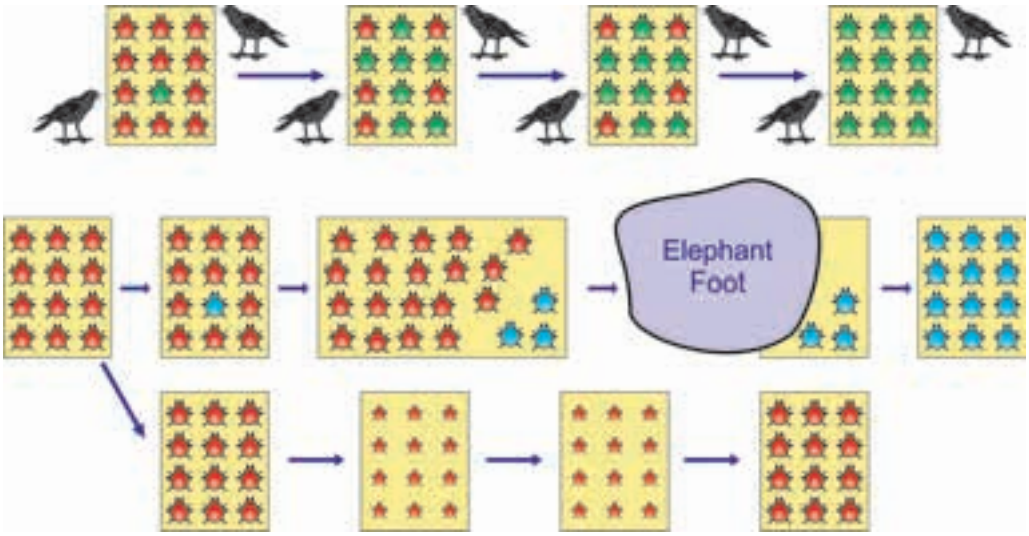


fig- Variation in population

Activity-3

Observe the above figure / diagram and changes in consequence figures.

Let us consider a group of twelve beetles as shown in Fig. They live in bushes on green leaves. Their population will grow by sexual reproduction. So they generate variations in their population. Let us assume crows eat these red beetles. If the crows eat more red beetles their population slowly reduced.

Let us think different situations,

Situation-1:

In situation one colour variation arises during reproduction. So that there is a one beetle that is green in colour instead of red.

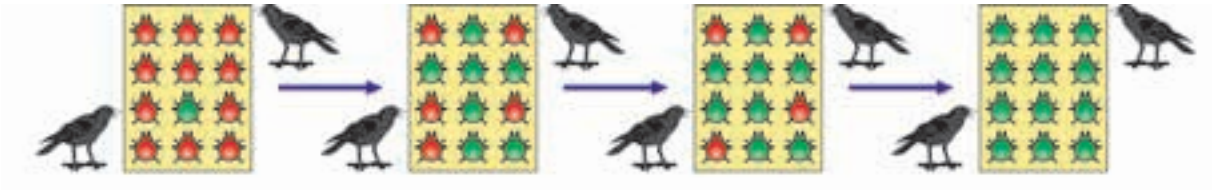


fig- Red and green beetle

More over this green colour beetle passes it's colour to it's off spring (Progeny). So that all its progeny are green. Crows cannot see the green coloured beetles on green leaves of the bushes and therefore crows cannot eat them. But crows can see the red beetles and eat them. As a result there are more and more green beetles than red ones which decreasing in their number.

The variation of colour of beetle 'green' gave a survival advantage to 'green beetles' than red beetles. In other words it was naturally selected. We can see that the 'natural selection' was exerted by the crows. The more crows there are, the more red beetles would be eaten and the more number of green beetles in the population would be. Thus the natural selection is directing evolution in the beetle population. It results in adaptation in the beetle population to fit their environment better.

Let us think another situation.

Situation-2:

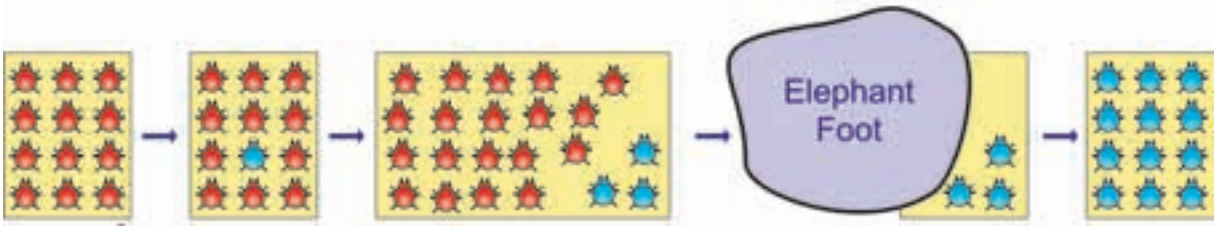


fig- Blue and red beetle

In this situation again a colour variation occurs in its progeny during reproduction, but now it results 'Blue' colour beetles instead of 'red' colour beetles. This blue colour beetles can pass its colour to its progeny. So that all its progeny beetles are blue.

Crows can see blue coloured beetles on the green leaves of the bushes, as well as red ones. And therefore crows can eat them both red and blue colour beetles. In this case no survival advantage for blue colour beetles as we have in case of green colour beetles.

What happens initially in the population, there are few blue beetles, but most are red. Imagine at this point an elephant comes by and stamps on the bushes where the beetles live. This kills most of the beetles. By chance the few beetles survived are mostly blue. Again the beetle population slowly increases. But in the beetle population most of them are in blue colour. Thus sometimes accidents changes frequency of genes in small populations this one is known as "Genetic drift', which provides diversity in the population.

Let us think about another situation:

Situation-3:

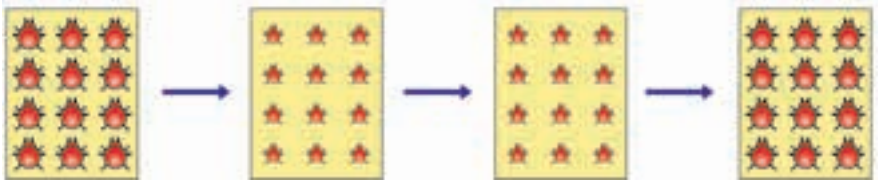


fig-

In this case beetles population increasing, but suddenly bushes got a plant disease in which leaf material were destroyed or in which leaves are affected by this beetles got less food material. So beetles are poorly nourished. So the weight of beetles decreased but no changes taking place in their genetic material (DNA). After a few years the plant disease eliminated. Bushes are healthy with plenty of leaves. Think what would be weight of beetles?

Acquired and Inherited Characters and Evolution

We discussed the idea that the germ cells of sexually reproducing population are made in specialised reproductive tissue. If the weight of the beetles is reduced because of starvation, that will not change the DNA of the germ cells. Therefore, low weight is not a trait that can be inherited by progeny of a starving beetle. Therefore even if some generations of beetles are low in weight because of starvation, that is not an example of evolution, since the change is not inherited over generations. Change in non-reproductive tissues cannot be passed on to the DNA of the germ cells. Therefore the experiences of an individual during its lifetime cannot be passed on to its progeny, and cannot direct evolution.

Jean Baptist Lamarck (1774–1829)

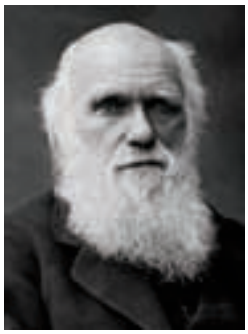
In the olden days people believed that all the organisms on the earth have not undergo any change. Jean Baptist Lamarck was the first person to

propose the theory of evaluation. He thought that at some point of time in the history the size of giraffe was equal to that of deer. Due to shortage of food material on the ground and lower branches of trees giraffes started stretching their necks. Because of continuous usage of neck, after several generations giraffes obtained longer necks. Such characters that are developed during the life time of an organism are called "acquired characters". Lamarck proposed that these acquired characters are passed to its offspring i.e. to next generation, which one is known as 'Inheritance of acquired characters'. For example elongation of neck and forelimbs in giraffe.

Jean Baptist Lamarck

But Augustus Weismann, tested this theory by an experiment on rats. He removed tails of parental rats. He observed its offspring's which have normal tails. He has done it again for twenty two generations but offspring are with normal tails. He proved that the bodily changes which may occurs due to environment which won't be passed to its offspring.

CHARLES ROBERT DARWIN (1809 – 1882)



Charles Darwin

Charles Darwin who proposed 'Natural selection' the famous theory of evolution.

Charles Darwin voyaged for five years, just when he was 22 years old. In the world survey ship H.M.S. Beagle. He visited number of places including Galapagos Islands. He keenly observed the flora and fauna of these places. He gathered lot of information and evidence.

Large ground finch (seeds) | Cactus ground finch | Vegetarian finch (buds) | Wood pecker finch (insects)

fig- Some Darwin finches

Darwin observed a small group of related birds which are exhibiting diversity in structure was noticed in the Galapagos islands. These birds are Finch birds.

He was influenced by the book written by Sir Charles Lyell, named by 'Principles of geology'. And he was also influenced by famous 'Malthus

theory'. This was written in 'An essay on the principles of population'. Malthus observed that population grows geometrical progression (1, 2, 4, 8, ...) where as food sources increases in arithmetic progression (1, 2, 3, 4, 5, ...).

Darwin proposed the theory of "Natural selection", means nature only selects or decides which organism should survive or perish in nature. That means survival of fittest. The organisms with useful traits will survive. The organisms having harmful traits going to be perished or eliminated from its environment.

For example we have seen in the case of red beetles which were seen and eaten by crows. So the population of red beetles gradually eliminated or perished from its environment. But the same time the beetles which are green in colour which are present on green leaves were not seen by crows, so the green beetles survived in its environment and its population have grown. This is nothing but "natural selection".

Think and discuss

In a forest there are two types of deers, in which one type of deer can run very fast. But second type of deer can less fast. Lions, Tigers haunt deers for their food. Imagine which type of deers going to survive in the forest, which type of deers population is going to be eliminated? And why?

Variations which are useful are retained, while those which are harmful are lost. In a population when there is a struggle, the 'fittest' will be survive.

Nature favours only useful variations. Each species tend to produce large number of off spring. They compete with each other for food, space, mating and other species. In this struggle for existence, only the fittest can survive.

This is called survival of fittest. Over long period of time this leads to formation of new species.

Darwin theory of evolution in a nutshell

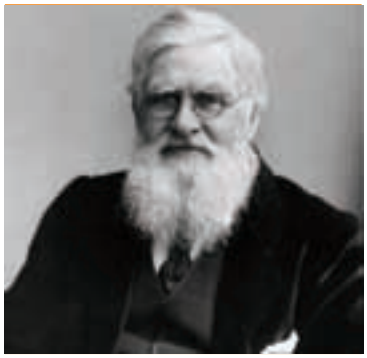
1. Any group of population of an organism contains variations: not all members of group are identical.
2. Variations are passed from parent to offspring through heredity.
3. The natural over abundance of offspring lead to a constant strugel for survival in any population.

4. Individual organisms with variations that help them to survive and reproduce tend to live longer and to have more offspring than organisms with less useful features.
5. The offspring of survivors inherit the useful variations, and the same process happens with every new generation until the variation become common feature.
6. As the environment changes, the organism within the environment adopt and change to the new living conditions.
7. Over long period of time, each species of organism can accumulate so many changes that it become a new species, similar to but distinctly different from the original species.
8. All species on earth arise in this way.

Do you know?

Identical thoughts of Charles Darwin and Alfred Russel Wallace.

When Charles Darwin was formulating the theory of evolution in his mind, he received a letter with an article sent to him by Alfred Russel Wallace about his studies in the Indonesian island, Natural selection was the subject matter of the article. Darwin was surprised about same theory in his mind. Later in the same year Charles Darwin and Alfred Wallace jointly published an article in the 'Journal of Linnaean Society' about natural selection. It was only after this Darwin published his famous book, "The origin of Species" by means of natural selection.

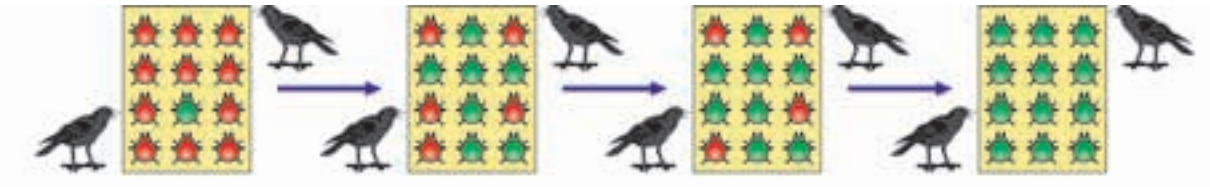


Alfred Russel Wallace

Speciation

How new species are evolved?

We have seen variations in a population of species, in which the organism contain the Traits helps to adapt to its environment. These organisms going to be survive more efficiently. But in the same population



the organisms which contain the trait which may not help to adopt in its environment may going to perish or eliminated slowly, like red and green beetles in a population which we have studied earlier in this chapter. These small changes within the species for example colour of beetles red and green is known as micro evolution. Now we are going to discuss how new species is going to be formed. This is known as speciation, which one also known as Macro evolution.

We have seen red and green beetles can mate each other, can have off spring. But let us imagine these red and green beetles is separated by some cause (for example while eating beetles crows dropped some beetles accidently in the long distance faraway places) for long years. There may be lot of variation taken place in these years in the red and green beetle population. Now even though they may meet accidently, they cannot mate and produce new off spring. They can only mate in its population red or green and can reproduce its off spring. Thus new species has been formed.

Evidences of evolution

Homologous and analogous organs

How evolution of organisms have taken place? Whatever scientists say they require evidences or proofs. In the same way evolution of organisms requires evidences. Let us examine some of them.

When we try to follow evolutionary relationships, how do we identify traits as common? These traits in different organisms would be similar because they are inherited from a common ancestor. You may wonder to know that the internal structure of forelimb of a whale (swimmer) come bat (flyer), horse (runner), mole (digger) and man (grasping). If we carefully observe the anatomy all the animals have a common pattern in the arrangement of bones. Even though there external form and functions are different. It indicates that all the vertebrates have evolved from a common ancestor these organs are called homologous organs. This type of evolution is called divergent evolution.

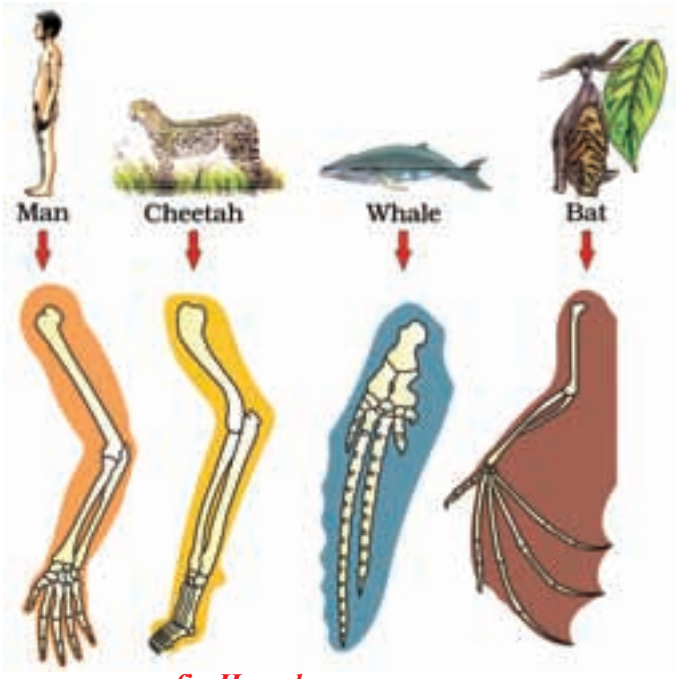


fig-Homologus organs

However, all similarities simply in organ shape are not necessarily because of common ancestry. What would we think about the wings of birds and bats, for example (fig-). Birds and bats have wings, but squirrels and lizards do not. So are birds and bats more closely related to each other than to squirrels or lizards?

Before we jump in to this conclusion, let us look at the wings of birds and bats more closely. When we do that, we find that the wings of bats are skin folds stretched mainly between elongated fingers. But the wings of birds are a feathery covering all along the arm. The designs of the two wings, their structure and components are different. They look similar because they have common use for flying, but their origins are not common. This makes the 'analogous' characteristics (Traits). As above 'the organs which are structurally different but functionally similarity is known as 'Analogous' organs'. This type of evolution is called convergent evolution.

Evidences from embryology

Activity-5

Let us observe different stages of development of vertebrate embryos. Try to find out similarities and differences and discuss with your friends.

Embryology is the study of the development of an organism from egg to adult stage. Tadpole of frog which resemble more the fish than the frog. What indicates this? Does it indicate that frogs have evolved from fish ancestors?

fig-embryological evidences

There are remarkable similarities in the embryos of different animals from fish to man. The resemblance is so close that at an early stage even an expert embryologist would find difficult to distinguish one embryo from the other. What it indicates? Does it indicates that life history of every individual, it exhibits the structural features of it ancestors? This strengthens the view of the existence of a common ancestor from which these have evolved.

Fossils

We know some of species which are present million years ago, but we may not find them now. They might be extinct. Some of them we can find

in the form of fossils . For example we know Dinosaurs the biggest animal which was present long time ago but now it is extinct. We can't see them but scientists got evidence of presence of Dinosaurs like animals at long time ago in the form of fossils.

What are fossils?

fig- Fossil

Fossil are evidence of ancient life forms or ancient habitats which have been preserved by natural processes. Fossil evidence is typically preserved with in sediments deposited beneath water, also occur on land. They can be actual remains of once living thing such as bones or seeds or even traces of past event such as dinosoucers foot print or ripple marks on a pre historic shore. Usually when organisms die, their bodies will decompose and be lost. But sometimes the body or at least some parts may be in an environment that does not let it decompose completely. For example if a dead insect get s caught in mud, it will not decompose quickly and the mud will eventually harden and retain the impression of the body parts of insect. All such preserved traces of living organisms are called fossils.

fig- Dinosarus

Geologists can tell the age of fossil. The study of fossil is called 'Palaeontology'. Palaeontologists determine the age of fossil by using carbon dating method. The breakdown of radioactive isotopes of certain elements such as Carbon, Uranium and potassium takes place at a known rate. So the age of rock or mineral containing isotopes can be calculated.

A rare and magnificent fossil of the dinosaurs, kotasaurus belonging to the lower Jurassic age going back to about 160 million years were collected from Yamanapalli in Adilabad district in Andhra Pradesh. This 14 meters length and 5 meters height fossil is preserved in BM Birla Science Centre Hyderabad.

Do you know?

Connecting link Archeoptics How it ressembles? As like a bird ? or like a Reptile? Or both? Some fossils may link two different group of organisms. The fossile of archaeopteryx clearly indicates us that birds had originated from the reptiles.

fig- Archeoptics

Do you know?

Vestigial organs

By the time of evolution some organs remain in organisms. You have studied about appendix in the digestive system. In human beings it has no role to play in the process of digestion. But in herbivores like rabbit appendix play important role. Such type of organs which are not useful in animal are called vestigial organs. There are nearly 180 vestigial organs in human beings. For example pinna, hair on skin, mammalian glands in male, etc. That's why human being said to be a moving museum of vestigial organs.

Human evolution

Human evolution is the evolutionary process leading up to the appearance of modern human being. We ' the present human beings are also have evolutionary history like plant and other animals. Early man like forms appeared about 7 lakhs 50 thousand years ago. The first sure fossil of our own species of man Homo sapiens, indicate that true man appeared on the earth 2 lakh50 thousand years ago.

fig- Human evolution

Evolution of man through ages:

Homo habilus "lived between 1.6 to 2 million years ago"

Homoerectus " lived about 1-1.80 million years ago

Homo sapiens neanderthalensis " lived about 12.5 lakhs years ago"

Homo sapiens (present man) appeared about 40 thousand years ago

There is a great diversity of human forms and features across the planet. So much so that, for a long time, people used to talk about human 'races'. Skin colour used to be the commonest way of identifying these so called races. Some were called black, some white or brown. A major question debated for long time was, have these apparent group evolved differently ? over recent years, the evidence has become very clear. The answer is that there is no biological basis to the notion of human races. All humans are a single species.

Not only that, regardless of where we have lived for the past few thousand years, we all come from Africa. The earliest members of the human species, Homo sapiens, can be traced there. Our genetic footprints can be traced back to our African roots. A couple of hundred thousand

years ago, some of our ancestors left Africa while others stayed on. While the residents spread across Africa. The migrants slowly spread across the planet –from Africa to west Asia, Then to Central Asia, Eurasia, South Asia, East Asia. They travelled down the island of Indonesia and the Philippines to Australia, and they crossed the Bering land bridge to the Americas. They did not go in a single line, so were not travelling for the sake of travelling, obviously. They went forwards and backwards, with groups sometimes separating from each other, even moving in and out of Africa. Like all other species on planet, they had come in to being as an accident of evolution, and were trying to live their lives the best they could.

Key words

Variations, off springs, traits, phenotype, genotype, heterozygus, homozygous, independent assortment, allele, heridity, autosomes, allosomes, natural selection, analogus organs, embryological evidences, Human evolution.

What we have learnt

- Variations are quite apparent among closely related groups of organisms.
- In about 1857 Gregor Johans Mendel started working on the problem of how variations were passed on from one generation to other.
- Mendal had choosen consisted of seven distinguishing forms: flower colour, position, seed colour, shape, pod colour, pod shape, stem length.
- In F1 generation all pea seeds were yellow.
- In F2 generation about 75% seeds were yellow and about 25% seeds were green. This is called phenotype. The ratio is 3:1.
- In F2 generation out of 75%, 25% were pure yellow seeds 50% were yellow seeds but green as a ressisive factor. Remaining 25% were pure green. This is called genotype. The ratio 1:2:1.
- Every pea plant has two 'factors' which are responsible for producing a particular property or trait called allele.
- The factors for each pair of characters assorts independently of the other pairs. This is known as "Law of independent assortment".
- Crossing yellow and green seeds produced all yellow seeds. Because yellow is dominant factor.
- Each parent passes a randomly selected copy (allele) of only one of these to its offspring.

- The process of acquiring characters or traits from parents is called 'Heredity'.
- Each human cell contains 23 pairs of chromosomes. Out of these 22 pairs called autosomes and one pair called allosomes.
- Lamarck proposed that the acquired characters are passed to its offspring to next generation.
- Each species tend to produce large number of off springs, but only the fittest can survive.
- Homologus, analogus organs and embryological evidences explains evolutionary relationships.
- Some traits in different organisms would be similar because they are inherited from a common ancestor.
- Fossil are evidence of ancient life forms or ancient habitats which have been preserved by natural processes.

Improve your learning

1. What are variations? How accumulation of variations helps organisms? (AS1)
2. One student (researcher) wants to cross pure tall plant (TT) with pure dwarf (tt) plant, what might be in F1 and F2 generations? Explain. (AS1)
3. One experimenter cut the tails of parent rats , what might be the its offspring's trait weather the daughter rats contains tails or not? Explain your argument. (AS1)
4. In a mango garden a former saw one mango tree with full of mango fruits but with full of pests/ disease, and saw another mango tree without pests but with less mango fruits. But the former wants the mango tree with full of mango fruits and pest free. Is it possible to create new mango tree which one the former wanted? Can you explain how it is possible? (AS1)
5. Explain monohybrid experiment with an example, which law of inheritance we can understand? Explain. (AS1)
6. What is the law of independent assortment? Explain with an example? (AS1)
7. How sex determination takes place in human? Explain with example. (AS1)
8. Explain the Darwin's theory of evolution 'Natural selection' with an example? (AS1)
9. What are variations? Explain with a suitable example. (AS1)
10. What variations generally you observe in the species of cow? (AS1)
11. What are the characters Mendal selected for his experiments on pea plant? (AS1)
12. In what way Mendal used the word 'Traits'- explain with an example. (AS1)
13. What differences Mendal identified between parent and F_2 generation. (AS1)
14. Male in responsible for sex determination of baby – do you agree then? Write your answer with a flow chart. (AS1)
15. Write a brief not on analogues organs. (AS1)
16. How scientists utilise information about fossils? (AS1)
17. Mendal select pea plant for his experiments. Gums the reasons in your point of view. (AS2)

18. If the theory of inheritance of acquired characters proposed by Lamark was correct how the world will be? (AS2)
19. Collect information for the inherited traits in your family members and write a note on it. (AS4)
20. With help of given information write your comment on evidences of evolution. (AS4)
    Mammals have four limbs as do birds, reptiles and amphibians. The basic structure of the limbs similar, though it has been modified to perform different functions.
21. Collect information about carbon ducting method – discuss with your physical science teacher. (AS4)
22. Draw a flowchart checker board showing board law of independent assortment and explain the ratio. (AS5)
23. Explain the process to understand monohybrid cross of Mendal experiment with checker board. (AS5)
24. Prepare a chart showing evolution of man through ages. (AS5)
25. Nature selects only desirable characters. Prepare a cartoon to this structure. (AS6)
26. What is your understanding about survival of fittest give some situations or examples that you observed in your surroundings? (AS7)
27. Write a monologue on evolution of man to perform stage show on theatre day in your school. (AS7)

Fill in the blanks

1. The process of accuring change is called _____.
2. In Mendal's experiment of stands for _____.
3. Four characters observed in the experiments on law of independent assessment are _____.
4. If we cross pollinate red flower plant with white flower we will get _____ percent of mixed colour plants.
5. TT or YY Tt or Yy are responsible for character called _____.
6. Female baby having 22 pair of autosomes at the age of 18 years she has _____ pair autosomes and _____ of sex chromosomes.
7. Population grows _____ progression where as food sources grow in _____ progression.
8. A goat which walks properly can't life for a long time. According to Darwin this represents _____.
9. Fore limb of whole is for swimming where as horse it is used for _____.
10. Study of fossils is called _____.

Choose the correct answer

11. Which of the following is not a variation in rose plant

    a) Coloured petals b) Spines c) Tendrils d) Leaf margin

12. According to Mendal alleles have the following character

    a) Pair of genes b) Responsible for character c) Gametes d) Ressisive factors

13. Natural selection means

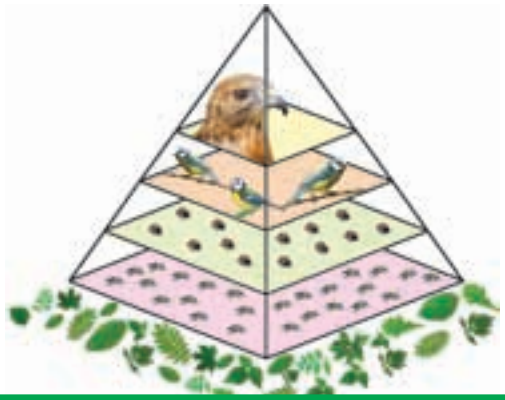
    a) Nature select desirable characters b) Nature rejects undesirable characters

    c) Nature recent with organism d) a, b

14. Palaeontologist dealing with

    a) Embryological evidences b) Fossil evidences

    c) Vestigious organ evidences d) Heredity variations



Chapter

9

Our evnironment

All life on our planet is confined to a thin envelope consisting of the atmosphere, oceans and earth's crust. This region the world of living things is termed the bio **sphere.**

In the previous classes we discussed about different eco systems in our surroundings. Understanding about major terrestrial ecosystems on the earth helps us to know more about our environment.

- Are all terrestrial ecosystems similar?

Let us observe the following diagram showing how mountain climatic regions can be compared with the horizontal climatic regions of the earth.

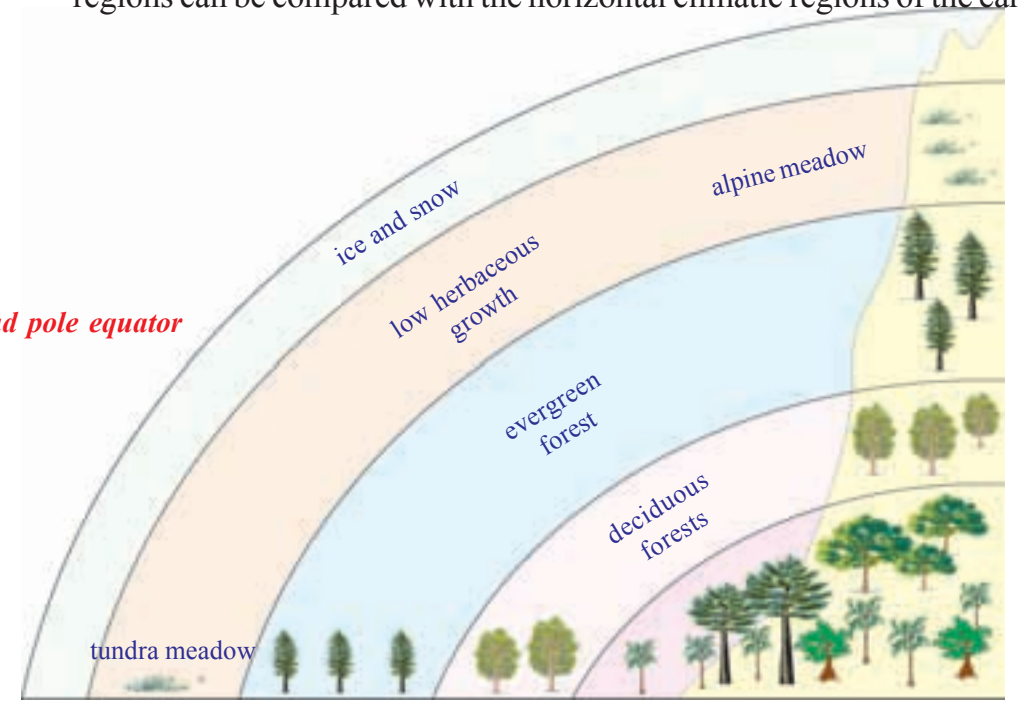


fig-1: Altitud pole equator

Within the biosphere there are a number of major ecosystems, the terrestrial ones being determined largely by the variations in climatic conditions between the Poles and Equator .In a similar way, if you climb a moun-tain such as Kilimanjaro in Equatorial Africa, you quickly go through a comparable system of ecosystems, starting with tropical rain forest at the base and ending with perpetual snow and ice at the summit.

The main climatic influences which determine these ecosystems are rainfall, temperature and the availability of light from the sun. For instance, forests are usually associated with high rainfall, but the type is influenced by temperature and light; the same applies to deserts which occur in regions where rainfall is extremely low.

Let us consider the characteristics of some of the major ecosystems.

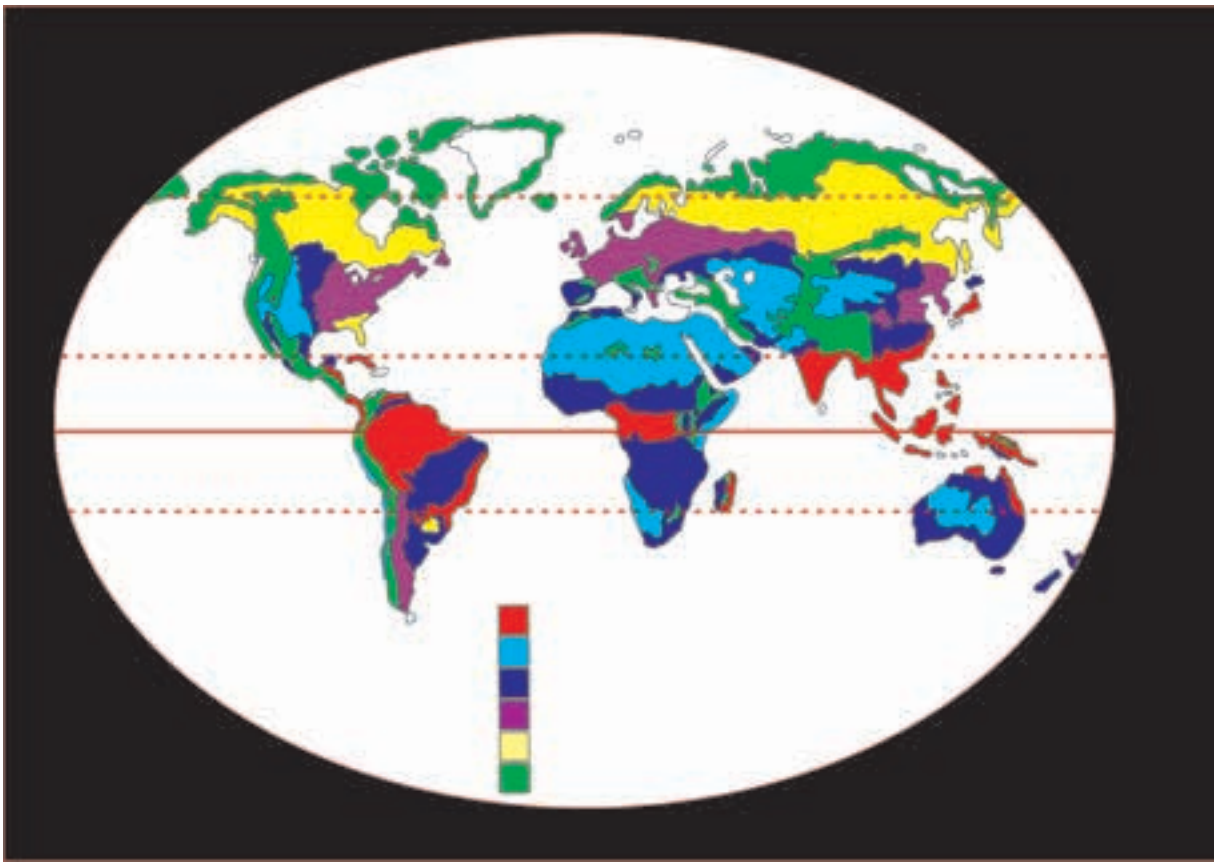


fig-2: World echosystems

1. Tundra

This region, which adjoins the permanent ice of the polar region, is devoid of all trees, but stunted shrubs such as birch and sallow occur in its more southern parts. The ground flora includes many lichens, mosses and sedges. The soil is frozen for most of the year, but the top layer melts

during the summer, allowing a short growing season of about two months. The fauna include polar bear, Arctic fox, reindeer, Arctic hare, lemming, snowy owl and ptarmigan.

2. Coniferous forest

This region occurs south of the tundra. Here the winters are not so long and the greater summer warmth allows trees to develop. In the north they occur only in sheltered places, but further south are extensive forests dominated by spruce, pine and other conifers. The fauna include lynx, wolverine, wolf, elk, red squirrel and grouse.

3. Deciduous forest

This region lies to the south of the coniferous belt. Most of Britain lies within this region. It has been greatly reduced in size and modified by man's activities, but what remains is dominated by such trees as oak, beech, birch, ash and alder with many shrubs and herbaceous plants. The fauna include fox, badger, red deer, roe deer, mole, mice and voles.

4. Savannah

This is a tropical region dominated by grasses with scat-tered trees and fire-resisting thorny shrubs. The fauna include a great diversity of grazers and browsers such as antelopes, buffalo, zebra, elephant and rhinoceros; the car-nivores include lion, cheetah, hyena, mongooses and many rodents such as mice and ground squirrels.

5. Tropical forest

This occurs in the equatorial region where rainfall is heavy. It consists of lush forest vegetation with tall trees and woody vines with stems that climb up and hang down from trees, called **lianas.** The fauna include chimpanzee, mon-keys, okapi, forest elephant, small antelopes, hornbills, woodpeckers and many other species of birds.

6. Deserts

Deserts are regions of very low and sporadic rainfall. With low humidity the sun's rays easily penetrate the atmo-sphere making ground temperatures very high, but nights are often cold by contrast as the earth loses heat rapidly. Many plants such as cacti and thorny shrubs are adapted to such conditions by having deep roots and water storage tissue. The fauna is remarkably varied. Many animals are nocturnal, avoiding the heat of the day by burrowing: they include desert foxes, snakes and lizards and the many herbivores which form their prey, such as many kinds of insects, jerboas and kangaroo rats.

Food relationships

In the early classes we discussed about biotic, abiotic, factors of different ecosystems. With the help of food chains and food web we had try to understand the food relationships among living things. Food chains are interconnected and when we try to see these connections among a number of food chain then it becomes a food web. As you know a food chain shows who eats what in a particular habitat. The arrows between each item in the chain always point from the food to the feeder.

If we want to show a food chain consisting of grass, rabbit, snake, and hawk then connect the given picture of organism by putting arrows and make a food chain.

- Name the producer and consumers in the above food chain.
- Try to guess what the arrows made by you are indicating?
- Identify at least four other food chains from your surrounding. Name the producers and different level of consumers in those food chains.

While identifying different food chains form your surrounding you will find that most food chains are quite short and they rarely consists of not more than four steps. You will also notice that as we move from producer to consumers (primary, secondary & tertiary) in a food chain the numbers of organisms at each level decreases.

- Why most of the food chains consist of four steps?
- Why the numbers of organisms get decrease as we move form producer to different level of consumers?

To get answers of the above question we have to recall some of the things which have been discussed in the earlier classes. In chapter 7 "Different Ecosystem" of class 8th it was mentioned that all organisms in an ecosystem derive energy from food to live and sunlight is the main source of the energy. Food chain shows that how energy passed from one organism to another. At each transfer a large proportion (80 to 90 percent) of energy is dissipated as heat produced during the process of respiration and other ways. Thus about three steps in a food chain very little energy is still available for use by living organisms.

But these links are never as simple or rigid as the word 'chain' suggests. For example, aphids are eaten by many insectivorous birds in addition to warblers, and also ladybirds and other insects; hawks, on the other hand, prey upon a considerable variety of birds and small mammal-So the term food web is often a better one to use when being precise, as it suggests a far greater number of possible links and reflects the fact that the whole

community is a complex inter-connected unit. Thus the original energy from the sun flows through the whole ecosystem from one tropic level to another.

fig-3: Food relationships

Let us observe the diagram(fig) that shows some of the feeding relationships amongst organisms living in deciduous woodland. You will see from the diagram that animals fit into special positions within the food web; each is described as its niche. For instance, there is a niche for insects such as aphids which suck up the juices of leaves. Another niche for insects such as caterpillars which have strong jaws for biting off pieces of leaf; and a niche for relatively large animals such as deer which browse on the vegetation. All these animals feed on leaves but they differ both in size and in the manner in which they feed. So the term 'niche' denotes not only the animal's position in the food web and what it eats, but also its mode of life. Just as a habitat is the place where an animal lives, so a niche describes its occupation the way it 'goes about its business and earns its livings.

Ecological pyramids

Apart from the food chain pyramids are another type of representations which show flow of energy from one organism to another. You may have heard about pyramids of Egypt. The ecologists also use this idea of pyramid to show relationship among organisms in an existing food chain. In short we can say that graphic representation of the feeding level (tropic level) structure of an ecosystem by taking the shape of a pyramid is called "Ecological pyramid". It was first introduced by a British ecologist Charles Elton in 1927. In the ecological pyramid the producers (first tropic level) are represented at the base; and other successive tropic levels (primary, secondary and tertiary consumers) are represented one above the other with top carnivores at the tip. There are three types of pyramids; pyramid of biomass, pyramid of number, pyramid of energy. In this chapter we will try to discuss about the pyramid of number and biomass.

fig-4: Pyramid of Egypt

Do you know?

A pyramid is a structure whose shape is roughly that of a pyramid in the geometric sense; that is, its outer surfaces are triangular and converge to a single point at the top. The base of a pyramid can be trilateral, quadrilateral or any polygon shape. The square pyramids, with square base and four triangular outer surfaces, is a common version.

Pyramid of number

The number of biologists are not only interested in studying the food relationships which exists between living things, but they also compare the numbers of organisms at each link in the chain. Here is an example of food web to make estimates of the comparative numbers of organisms present at each stage of chain. The comparison need only involve the use of such terms as most, many, several, few and scarce. Does there appear to be any relationship between the numbers? Is there any comparison that could be made about the sizes of the organisms involved at each stage.

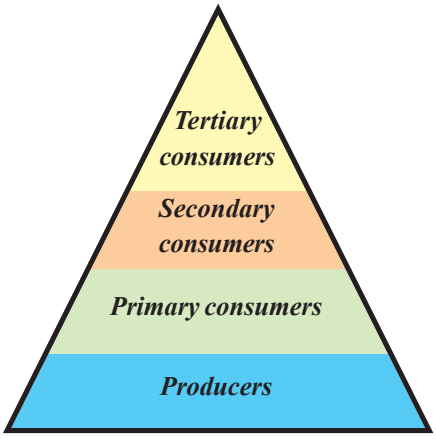


fig-5(a): Pyramid of numbers

The number of organisms in a food chain can be represented graphically in a pyramid. Each bar represents the number of individuals at each tropic level in the food chain. At each link in a food chain, from the first-order consumers to the large carnivores, there is normally an increase in size, but decrease in number. for example in a wood, the aphids are very small and occur in astronomical numbers, the ladybirds which feed on them are distinctly larger and not so numerous, the insectivorous birds which feed on the ladybirds are larger still and are only present in small numbers, and there may only be a single pair of hawks of much larger size than the insectivorous birds on which they

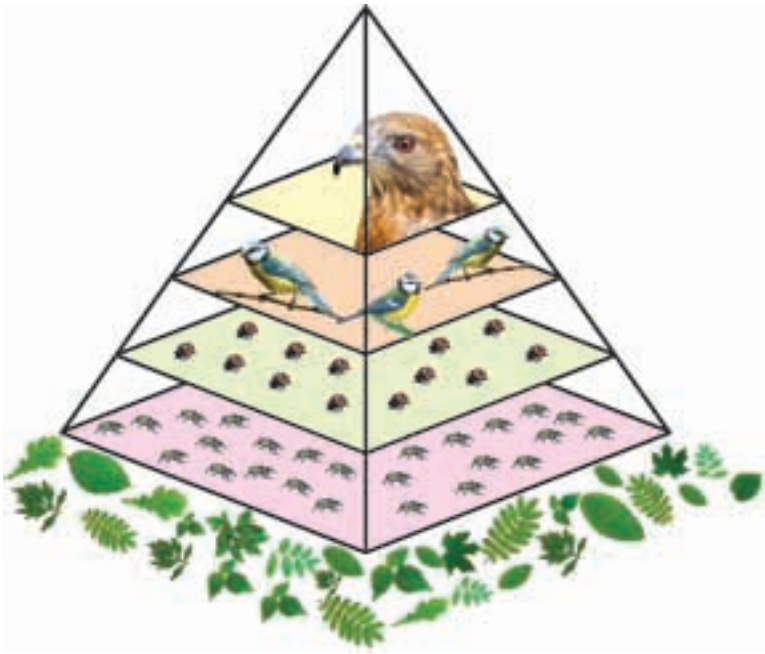


fig-5(b): Pyramid of numbers

prey. This relationship is best shown as a pyramid.

- Draw pyramid of number for the following food chains

  (i) Banyan → insects → Woodpecker

  (ii) Grass → rabbit → flea

- Are the pyramid of number having same structure in both of the above two cases as compare to the example given in the earlier paragraph?
- If there is difference then what was it?

Sometimes the pyramid of numbers does not look like a pyramid at all. This could happen if the producer is a large plant such as tree or if one of the organisms at any tropic level is very small. So keep one thing always in mind that whatever the situation, the producer still goes at the bottom of the pyramid.

Pyramid of Biomass

What is biomass?

Biomass is organic material of biological origin that has ultimately derived from the fixation of carbon dioxide and the trapping of solar energy during photosynthesis. This includes trees, shrubs, crops, grasses algae, aquatic plants, agricultural and forest residues and all forms of human, animal and plant waste. Any type of plant or animal material that can be converted into energy is called biomass. When this material used for energy production it becomes a bio fuel.

The pyramid of biomass represents the relationships that exist between the quantity of living matter (biomass) at different tropic levels. In terrestrial ecosystems, the biomass progressively decreases from producers to top carnivores.

- Think why the pyramids are always upright?

In an aquatic ecosystem, the biomass of phytoplankton is quite negligible as compared to that of the crustaceans and small herbivorous fish that feed on these producers. The biomass of large carnivorous fish living on small fishes is still greater. This makes the pyramid of biomass inverted. It is found that 10 - 20 % of the biomass is transferred from one tropic level to the next in a food chain.

A more accurate idea of food relationship may be obtained if the above number of pyramid is converted into a pyramid of **biomass.** This indicate the mass of plant matter which is used by the aphids to produce the mass of the of aphids population, the total mass of the ladybird population that

could be supported by the aphids and so on through the chain. In short we can say that biomass is food for the next tropic level in a food chain.

Do you know?

To reduce our dependence on fossil fuels (fuels formed by natural processes such as anaerobic decomposition of buried dead organisms, like coal, petrol etc.), and to help reduce air pollution, biomass can also be used as a source energy. Using biomass as fuel still puts carbon dioxide back into the atmosphere, but it is the same carbon dioxide taken from the air as the biomass was produced.

The biomass in each tropic level is always less than the tropic level below. This is because biomass is a measure of the amount of food available. When animals eat, only a small proportion of their food is converted into new tissue, which is the food for the next tropic level. Most of the biomass that animals eat is either not digested, or used to provide the energy needed for staying alive.

The biomass pyramid shows that animals are relatively inefficient in converting food into body tissues, the remainder of the food being undigested and passing out as waste, or broken down in respiration to supply energy for such activities as feeding. Many animals convert no more than 10% of their food into their body tissues, some herbivorous even less. Let us take an example of a food chain which has been worked out in some detail- one in which we are involved when we eat fish. In this chain the plant plankton in the surface of waters of sea are food producers. They trap energy from sunlight. The animal plankton feed on the microscopic plants and the fish in turn feed on the animal plankton; we are at the end of the chain when we eat the fish:

fig-6: Pyramid of biomass

The pyramid of biomass for this particular food chain will be as follows-

In this particular food chain roughly 90% of the food is lost at each step. So it allows that it would take 1000 kg of plant plankton to produce 100 kg of animal plankton to form 10 kg of fish to produce 1 kg of human tissues, with a corresponding loss of the original plant potential energy that came from the sun. Thus we can conclude that the nearer an animal species is to the original plant source in a food chain the greater the amount of energy is available to the population of that species. In other words, the fewer the steps in the food chain, the more energy will be for the species at the top.

Pyramid of Energy

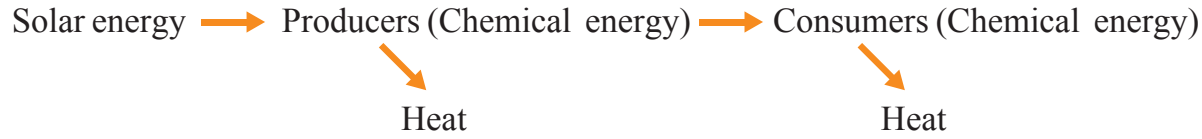
Food is the source of energy for organisms that are used in the growth and rebuilding of the parts of the body; that are constantly wearing out. The food by its nature is the chemical energy and by in its stored form, it is the potential energy. There are several mechanisms in organisms for continuous absorption of materials for the production of organic material, and for the release and conversion of organic material into inorganic form. Plants absorb the minerals from the soil. They are absorbed into the plant in water through roots. Photosynthesis s is an essential process for the life. The energy of sunlight, carbon dioxide, and the water, which of course needed by all living things, belong to non - living things. As a result of photosynthesis, these can be made available in a suitable form of energy - the food to the world of living things - the animals/consumers, only by the green plants - the producers. The food chains and food webs help in transfer of the food and energy from the producers to different consumers. Animals obtain the minerals from the plant or animal food or both. Thus the mineral matter is constantly being removed from the earth to become a part of the plant, which may become a part of animal body.

Curd that we eat is processed from milk, which comes from a cow, which in turn eats grass. The grass carries out photosynthesis and prepares food. In every case, the origin of food materials can be traced back to green plants.

Once the food is eaten, its energy follows a variety of pattern through the organisms. Not all the food can be fully digested and assimilate. Hair, feathers, insect exoskeletons, cartilage and bone in animal foods, cellulose and lignin in plant foods cannot be digested by most animals. These materials are either egested by defecation or regurgitated in pellets of

indigested remains.

Assimilated energy (that is not lost through respiration or excretion) is available for the synthesis of new biomass through growth and reproduction. Organisms lose some biomass by death, disease or annual leaf-drop, where they enter the detritus pathways of the food chain i.e., after the death and decomposition of organisms the materials flow back into the environment. The remaining biomass is eventually consumed by herbivores or predators and its energy there by enters the next higher tropic level in the ecosystem.



The materials keep on cycling i.e. entering the living beings and through death and decay returning to the soil and atmosphere Such a flow of materials between organisms and their environment is called Cycling of materials or mineral circulation or Biogeochemical cycles (You have learnt in class IX).

Energy enters the producers in the ecosystem from the sun in the form of solar energy or solar radiation. No other organisms except green plants and Photosynthetic bacteria due to the presence of chlorophyll are capable of absorbing solar energy and converting it into chemical energy.

From the producers, the chemical energy passes to the consumers from one tropic level to the next through the food. At each tropic level, organisms use the most of the food energy that they assimilate into their bodies to fulfill their metabolic requirements- performance of work, growth and reproduction. Because biological energy transformations are inefficient, a substantial proportion of metabolized food energy is lost, unused as heat.

Only a small fraction goes to the eater at next tropic level. Organisms are no different from man-made machines in this respect. Most of the energy in gasoline is lost as heat in a car's engine rather than being transformed into the energy of motion. In natural communities, energy used to perform work or dissipated as heat cannot be consumed by other organism and is forever lost to the ecosystem.

Ten percent law

The ratio between energy flows at different topic levels along the food chain expressed as percentage is called ecological efficiency. The amount

of energy transferred decreases with successive tropic levels. Slobodkin (1959) suggested that the transfer of energy from one tropic level to the next is of the order of 10% and this is called Gross ecological efficiency. Thus, if there are 1000 calories of net production at producer level, only 100 calories of secondary production would be expected at the herbivore level, only 10 calories at first carnivore level and 1 calorie at top carnivore level. This is known as Ten percent law, originally observed by Lindeman (1942).But in 1974, Steele proved it to be 20 to 30%. Therefore in an ecosystem, the energy exists in different forms - Solar energy, Chemical energy and the Heat. One form of energy is converted into another. The flow of energy from producers to consumers is Unidirectional

The effects of human being on ecosystems

In the earlier classes we have studied about different pollution as a result of human interventions in ecosystem. In this section we will try to understand that when we cut forest to grow food crops, how this activity brings harmful changes in ecosystem and affects organisms of each tropic level.

When a forest is cut down and a food crop is grown in its place, a natural established ecosystem with its vast number of species in a state of dynamic equilibrium is replaced by a monoculture i.e. an unnatural concentration of a single crop of various kinds grown in different fields-some to provide cereals or roots, others grass for domestic animals.

When we grow crops in large concentrations we also get food in abundant quantities. This situation is optimum for pest, parasites like fungi to grow on this food material. If the quantities of food are larger then multiplication of pests and parasites is rapid and the resulting damage very great. To avoid this happening we have tried to eliminate these competitors for his crops by using toxic chemicals (pesticides, herbicides, and fungicides). Many of them have been very effective, but their use has also created new problems.

The perfect pesticides is one which destroys a particular pest and is completely harmless to every other form of life; no such pesticides exists or likely to.

- Name any two pesticides you have heard about?
- How food grains and cereals are being stored in your house so that they can be protected from pests and fungus?

Pesticides are often indiscriminate in their action and vast numbers of other animals may be destroyed. Some of these may be predators which

naturally feed on these pests, others may be the food of other animals. Thus causing unpredictable changes in food chains and upsetting the balance within the ecosystem.

A further danger is that some have a cumulative effect. Pesticides vary in their length of "life" as toxic substances. Some of the pesticides as well as herbicides are degradable. They are broken down into harmless substances in a comparatively short time, usually a year. Others are non-degradable, and include those which contain mercury, arsenic or lead. These non-degradable pesticides are potentially dangerous as they accumulate in the bodies of animals and pass right through food web. Being further concentrated at each step until animals at the top of pyramid may receive enough to do considerable harm. The process of entering of pollutants in a food chain is known as **Bioaccumulation**, whereas the tendency of pollutants to concentrate as they move from one tropic level to the next is known as **Biomagnifications**.

In many areas man has changed the natural ecosystems very greatly by damming rivers, draining marshes, re-claiming land from the sea, cutting down forests, plough-ing up land and growing crops, and by building towns, cities, canals and motorways. These changes have greatly altered the communities of plants and animals living there.

Take the development of a large town, for example. There will be three kinds of change:

a) Some plants and animal species will die out.
b) Some will adapt to the new conditions sufficiently to survive in re-duced numbers,
c) Some will benefit by the new conditions and will in-crease in num-bers.

Do you know?

Minimata disease was first discovered in Minimata city in Kumamoto prefecture, JApan, in 1965. It was caused by nthe release of methymercury in the industrial wastewater from the Chisso coeporation's chemical factory, which continued from 1932 to 1968. This highly toxic chemical bioaccumulated in shellfish and fish in Minimata Bay and the Shiranui Sea, which, when eaten by the local populace, resulted in mercury poisoning. While cat, dog, pig and humans deaths continued for 36 years.

Many of these changes will vary according to where the town is but, as you would expect there will be some organisms in the last category which benefit from being in close association with man and his buildings, such

as sparrows, starlings, pigeons, rats, mice and many plants we describe as weeds. Can you add to this list and think out which plants and animals in your area would come into the first two categories?

Steps towards prevention

If we think about the ways through which we can prevent ourselves and other living being from the harmful effects of the use of toxic material as pesticides, then the instinct reaction may be to Ban the pesticides. It is easy to say "Ban all pesticides" but the pests still have to be kept in check. After using pesticides then also we are having a significant amount of loss of food material because of pests. Now you can imagine if pesticides were totally banned what would happen to the diseases they are controlling and the crops we so vitally need for our growing population.

The long term answer to this problem is to find other effective methods of controlling pests which have far less harmful effects and are based on sound biological principles.

Activity

Prepare a suggestive action plan for controlling harmful effects of human activities. For this you are suggested to refer 9th class biology and other books available in your school library. Before that read the following article and discuss in your class about how human activities are inhuman.

'What fools they were in those days'

It would be a mistake to assume that everything absorbed into the tissues of an animal through a food chain is going to be of value to it.

Since the end of the Second World War, there has been a great increase in the use of chemical materials to control pests that attack crop plants or live as parasites on the bodies of farm animals. Such chemicals are called pesticides and include a range of substances collectively known as chlorinated hydrocarbons - aldrin, dieldrin, heptachlor, and DDT. Their molecules consist partly of carbon chains. The tissues of living organisms are largely built up from carbon chains, and when the chlorinated hydrocar-bons are applied in the form of seed dressings, sprays, and washes they become absorbed into the bodies of the pests, and kill them.

As their use became more widespread, observers began to notice changes in other forms of life. Butterflies seemed to be scarcer. Bee-keepers began to complain that they were losing colonies through the foraging bees bringing poisonous substances into the hives and passing them on to the larvae. Large birds - above all such predators as hawks -

were harder to find. Small birds were noticed in a sickly condition, trembling and staggering, and there seemed to be more dead birds in the fields.

When the suggestion was made that pesticides were responsible, neither the chemical manufacturers nor the Government were ready to agree to a ban on the use of them. They wanted definite evidence that such substances were harmful to other animals besides the pests. Without this evidence, the suggestion remained a hypo-thesis. Then the Royal Society for the Protection of Birds took a hand. It arranged to test the hypothesis, by analysing the tissues of any dead birds which the finders suspected of having been poisoned.

In the ten months 484 bodies of 80 species of birds were received for examination. Not all of these were fresh enough to be analysed, but 333 results were made available. Pesti-cides were found in all but 29 of these dead birds, including all 19 nestlings which were sent in. Garden birds headed the list - black-bird, song thrush, house sparrow, wood pigeon, starling, greenfinch and blue tit. There were 57 birds of prey belonging to 11 different species. Water birds were affected - heron, great crested grebe, pochard, water rail, and moorhen. Poisons were not confined to the tissues of the birds themselves; they had even reached their eggs. They were found in 42 out of 46 fertile eggs belonging to 17 different species. Poisons were found in earthworms and slugs on land, and in fishes and leeches in water.

The toxic chemicals included the chlorinated hydrocarbons which have already been mentioned. Their presence indicates a serious and subtle threat, namely the gradual spread of such poisons throughout the countryside, and their passage from one species to another by way of food chains. There is even a danger of water supplies becoming affected.

Eagles in this region had been carefully observed for a quarter of a century, and it was found that an extraordinary drop had taken place in the number of pairs actually rearing young birds. This high rate of failure included disturbing features which had already been seen in some other declining species, notably in the peregrine falcon - the breakage of their own eggs by the birds themselves and the failure of some of them to lay eggs at all. Ten infertile eggs were taken from seven nests of the golden eagle and analysed. All were contaminated with such poisons as dieldrin and DDT, and all but one contained traces of heptachlor.

How had the eagles absorbed the poison? Much of the country where they live is wild upland, and there is very little cultivation, but sheep are

reared on a considerable scale. These animals are treated with solutions (sheep dips) to kill off various pests, DDT has been widely used in dips, followed by dieldrin some ten years later. Besides living prey, eagles feed on carrion in the form of dead sheep, and when they do, they eat some of the skin and fleece, the wool appearing in their cast-up pellets as proof of the diet. Poisons could, therefore, be taken in from these tissues. Poisons could also come from the fat and flesh, since experiments in the laboratory have shown that some of them can pass directly through the skin of mammals.

Heptachlor is rarely used in sheep dips, but it is common as a dressing for the seeds of cereal crops. The heptachlor found in eagles' eggs may have come through other birds as a result of a food chain. Common and herring gulls, and hooded crows, all visit sown fields, and are preyed upon by golden eagles.

In 1962, a book was published entitled Animal Dispersion In Relation to Social Behaviour, by V. C. Wynne-Edwards. The author made the ingenious suggestion that, when peregrines break then eggs, they are practising a kind of birth control, and do it when there is a shortage of food, so that each of the remaining nestlings receives a larger share, and has a better chance of surviving than if more young birds were reared, all of them undernourished. But this strange habit has only recently become widespread, *and* yet there is no sign of a fall in the supply of food.

During the past eight years, egg-breaking among peregrines has increased and, at the same time, the population has declined so much that, in some areas it has dwindled almost to vanishing point. Much the same applies to sparrow hawks and golden eagles. Clearly, then, the habit is a dis-advantage to the birds. Some of the pesticides are nerve poisons, and might bring about changes in behaviour. It seems likely that egg-breaking is one form of disturbed behaviour due to poisons entering the tissues of the birds.

Confronted with evidence of this kind, the Government has acted. It has taken the first step towards imposing a ban on the use of three of the more dangerous substances - aldrin, dieldrin, *and* heptachlor. This is no more than a step in the right direction, for it does not mean the end of every threat from agricultural chemicals. It takes time for withdrawal to become complete: meanwhile, poisonous residues continue to accumulate in the tissues of predators. Some of our larger, more attractive species may be in danger of extermination from poisons already present in the sur-roundings, which will take an unknown number of years to become

harmless. The less deadly chemicals still permitted (such as DDT)are a threat because of their persistence and their tendency to build up in those species which are at the end of the food chains. Indeed, there might even be an increase in the use of DDT until alternatives are produced by the pesticide industry.

We sometimes exclaim, 'What fools they were in those days!' when we see the ugliness of towns built during the Industrial Revolution, or read of the way valuable garden soil was defiled to permit to build factories. How much more serious is the present threat. If you say, 'I've never seen a house sparrow or a golden eagle, and I couldn't care less', it is well to remember that human beings, like birds of prey, are at the end of a food chain, and may also become affected by the gradual piling up in their bodies of poisons drawn from the countryside.

Within a few years, you will be responsible for your nation's laws. Any alteration in the law to meet the threat will only be made as a result of strong evidence. Even before you leave school, you can help to safeguard the heritage of your own countryside.

Read the poem "Or will the dreamer wake" in unit - VI from your enligh textbook.

Key words

Food chain, Food web, Pyramid, Biomass, Pesticides, Bioaccumulation, Biomagnifications

What we have learnt

- Food chain shows that how energy passed from one organism to another.
- The arrows between each item in the food chain always point from the food to feeder.
- Pyramid of numbers and pyramid of biomass are other ways to show food relationship and flow of energy among living things
- A pyramid is a structure whose shape is roughly that of a pyramid in geometric sense.
- Pyramid of number shows the population of organisms at each trophic level in a food chain.
- Pyramid of biomass represents the available food as a source of energy at each trophic level in the food chain.
- Biomass can also be used as fossil fuel.

- Toxic material used to prevent the pest, fungus and other disease away from the food crop and grains do harms in many ways to ecosystem.
- Bioaccumulation is the entering of pollutants in the food chain.
- The tendency of pollutants to concentrate as they move from one trophic level to the next is known as Biomagnifications.
- There are several alternatives of pesticides through which we can get more crops with less harm like rotation of crops, biological control, development of genetic resistant strains etc.

Improve your learning

1. What happens to the amount of energy transferred from one step to the next in a food chain?(AS1)
2. What do pyramids and food chain indicate in an ecosystem? (AS1)
3. Write a short note on pyramid of number for any food chain? What can we conclude from this pyramid of numbers? (AS1)

Tree → insect → woodpecker

4. What is biomass? Draw a pyramid of biomass for the given food chain- (AS1)

grass leaves → herbivores → predators → hawk

5. How use of toxic material is affecting the ecosystem? Write a short note on bioaccumulation and biomagnifications. (AS1)
6. Should we use pesticides as they prevent our crop and food from pests or we should think of alternatives? Write your view about this issue and give sound reason for your answer. (AS1)
7. What is tropic level? What does they represent in an ecological pyramid? (AS1)
8. If you want to more about flow of energy in an ecosystem, what questions you are going to ask?(AS2)
9. What will happen if we remove predators from food web? (AS2)
10. Observe a plant in your kitchen garden, and write a note on producer- consumer relationship.(AS3)
11. What type of information you require to explain pyramid of biomass? (AS4)
12. Draw a pyramid of number consider yourself as top level consumer.(AS5)
13. Prepare slogans to promote awareness in your classmates about eco friendly activities.(AS7)
14. Suggest any three programmes on prevention of soil pollution in view of avoiding pesticides.(AS7)

Choose the correct answer

1. What does a food chain always start with - ( )
   (a) The herbivore (b) The carnivore (c) The producer (d) none of them
2. Which of the following do plants not compete for? ( )
   (a) Water (b) Food (c) space (d) all above
3. Ban all pesticides, this means that ( )
   a) Control on usage of pesticides b) prevention of pesticides
   c) promote eco friendly agricultural practices d) stop bio chemical factories
4. According to Charles Elton ( )
   a) carnivores at the top of the pyramid b) energy trapping is high at the top of the pyramid
   c) No producers at the top of the pyramid d) A and C