Science Notes Part 41 to 45

41] Coal and Petroleum

Manpower Fuel

Car uses petrol and the bus uses diesel for cooking LPG (Liquefied Petroleum Gas)

Fuels

"Substances that burn in air to give heat energy are called fuels"

Fossil Fuels

Fossil fuels are formed from the buried remains of decayed plants and animals over millions of years, under the influence of heat and pressure in the absence of air. Coal, petroleum and natural gas are called fossil fuels.

COAL

Occurence of coal

Coal mining was started in India in 1774. India now ranks third among the coal producing countries in the world. USA and China have ⅔ of the world's coal reserve.

Three hundred million years ago, some plants grew into giant ferns and mosses. These plants got buried into the bottom of the soil and were converted as fossil due to high temperature and pressure. The decaying plants were pressed and coal was formed. As coal contains mainly carbon, the slow process of conversion of dead vegetation into coal is called **carbonisation**.

- *Coal would have a higher sulphur content if it was formed in swamps covered by sea water.*
- *Combustion is caused by the chemical reaction of hydrocarbon with oxygen. When ignited, the fuel molecules are broken down and release heat energy.*

COMPOSITION OF COAL:

Coal is a natural black mineral, which is a mixture of free carbon and compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur.

Types Of Coal

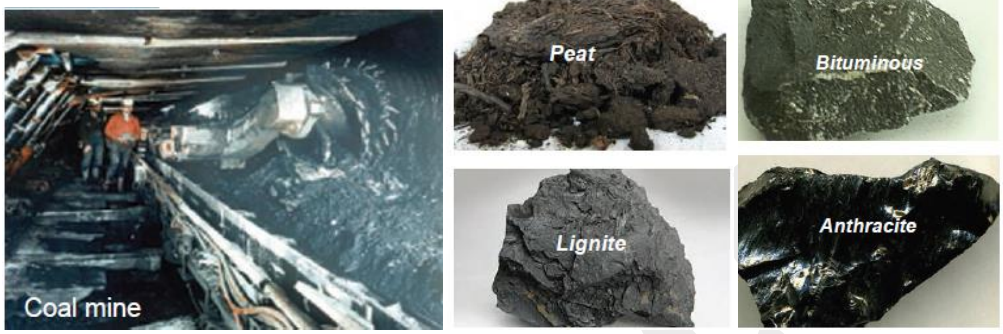
On the basis of carbon content, coal is classified into the following types:

1.PEAT : Peat is the first stage of coal. It is the most inferior variety of coal which contains 10-15% of carbon. When it is burnt, it produces a lot of smoke.

2.LIGNITE: Lignite is brown in colour. It contains 25-35% of carbon. Like peat it also produces a lot of smoke on being ignited. It can be used for power generation.

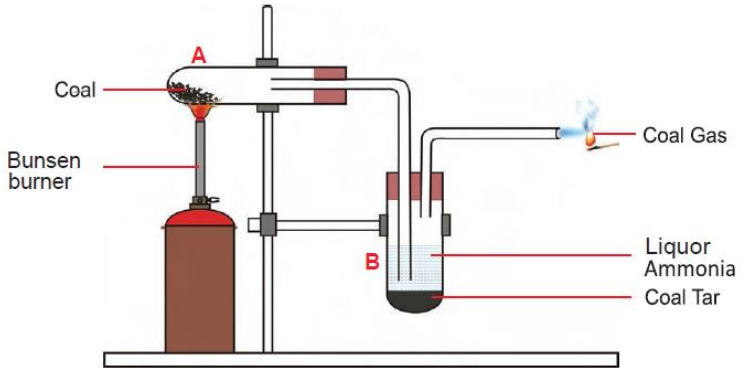
3.BITUMINOUS COAL: It is also called soft coal. It contains 45-86% of carbon. It is used as a common household fuel and industrial fuel.

4.ANTHRACITE COAL: It is also called hard coal. It is one of the most superior variety. It contains 87-97% carbon. It produces high heat energy.



Destructive distillation of coal

Heating coal in the absence of air is called destructive distillation of coal.



Products of coal and their uses

Products of coal	Uses
Coal Gas	As a fuel in cooking food
Liquor Ammonia	To make fertilizers
Coal Tar	To make plastics, paints, dyes, naphthalene balls and explosives
Coke	As a fuel and as a reducing agent in steel manufacturing

Consumption of Coal : The coal that we consume in one day is what the earth took 1000 years to form. The amount of coal we consume is greater than the amount that we produce.

On destructive distillation, 1000 kg of coal gives

- *700 kg of coke*
- *100 litres of ammonia*
- *50 litres of coal tar*
- *400 m3 of coal gas*
- *The world's first petroleum well was drilled in Pennsylvania, USA(1859.)*
- *Eight years later in 1867,oil was struck at Makum in Assam*

Petroleum

Millions of years ago, dead plants and animals were buried at the bottom of the sea. They got covered with layers of sand and clay. Due to high pressure and temperature, they transformed into petroleum.

Occurrence of Petroleum

The chief petroleum producing countries are U.S.A Kuwait, Iraq, Iran, Russia and Mexico. In India, petroleum is found in Assam, Gujarat, Maharashtra(Mumbai), Andhra Pradesh (Godavari and Krishna basin) and Tamil Nadu (Cauveri Basins). Petroleum is obtained by drilling through the earth. The crude oil is pumped out from the well as a black liquid.

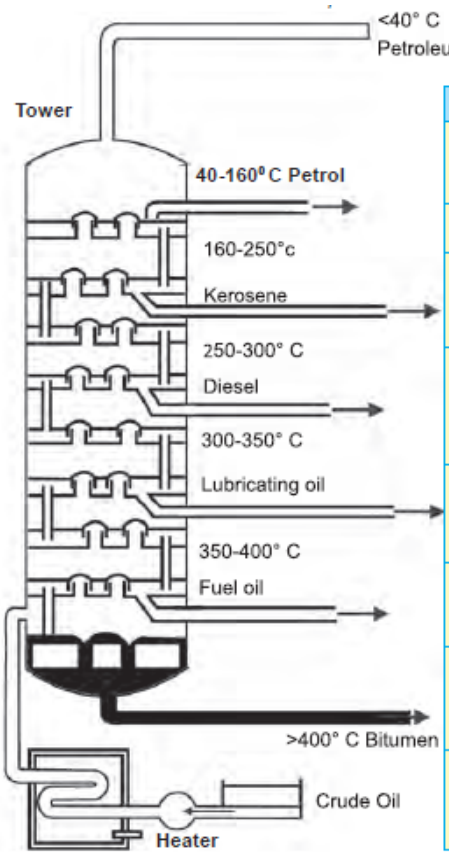
Refining of crude petroleum

Petroleum is a mixture of various constituents such as petroleum gas, petrol, diesel, kerosene, lubricating oil, paraffin wax, etc. The process of separation of the various constituents or fractions of petroleum by fractional distillation in fractionating columns is known as refining of petroleum. The

Petroleum and Natural Gas Formation

process of heating a mixture of liquids having different boiling points and then separating them by cooling is called fractional distillation.

Crude petroleum is first heated to about 400° C in a furnace. As the vapours of crude oil move up the tower, the various fractions condense according to their boiling point ranges. The various fractions of petroleum obtained are tabulated below;

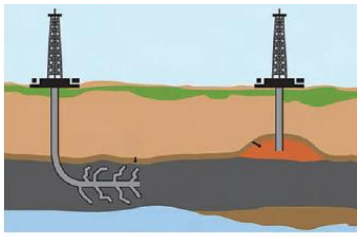


Fraction	Uses
Petroleum Gas	Fuel for home (LPG)
Petrol	Motor fuel
Kerosene	Fuel for stove and jet aircrafts
Diesel	Fuel for heavy motor vehicles
Lubricating oil	Lubrication
Fuel Oil	Fuel for Power Stations and Ship
Paraffin wax	Candles, Vaseline
Bitumen	Paints, Road surfacing

Many useful substances are obtained from petroleum and natural gas. These are termed 'Petrochemicals. These are used in the manufacture of detergents, fibres, and other man-made plastics like polythene. Hydrogen gas obtained from natural gas, is used in the production of fertilizers. Due to its great commercial importance, pertoleum is also called 'black gold'.

If we use petroleum rapidly as we do now, in the year 2,050 there may be no petroleum at all.

Natural Gas



Manali

Formation of Natural gas

Natural gas is formed whenever vegetation decomposes in marshy areas and waste sewages. It also occurs in coal mines and petroleum wells. It mainly contains 90% methane.


Neyveli

Occurence

Naturalgas in Tripura, Rajasthan, Maharashtra, Andhra Pradesh (Krishna, Godavari Basins) and Tamilnadu (Cauveri Delta.)

The way of using natural gas

1. CNG (Compressed Natural Gas)
2. LNG (Liquified Natural Gas)

CNG is stored at high pressure whereas LNG is in ultra cold liquid form. CNG can be produced at lower cost.

Advantages and uses of CNG

1. It is a less pollutant fuel.
2. It is directly used as fuel for burning at home and factories.
3. It is the basic material for the manufacture of a number of chemicals and fertilizers.

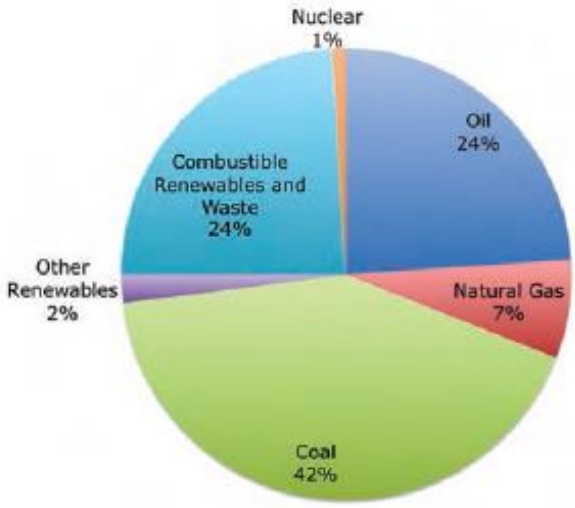
Natural Resources and Limitation

The natural resources in the world have been used by man in a rapid way and so very soon all our exhaustible sources like coal, petroleum and natural gas would be reduced to zero level. So we need to find new alternative sources of energy.

Natural Resources	Lasting period
Coal	148 years
Petroleum	40 years
Natural Gas	61 years

Iternative sources of energy

1. Biodiesel : Biodiesel is a fuel obtained from vegetable oils such as Soyabean oil, Jatropha oil, Cornoil, Sunflower Oil, Cotton seed oil, Rice bran oil and Rubber seed oil.



Energy sources in usage

2. Wind Mills : All of you might have seen wind mills. They have long blades connected to a dynamo. When wind blows, they rotate and current is produced in the dynamo. Wind mills are mostly located at Kayathar, Aralvaimozhi, Palladam and Kudimangalam in TamilNadu.

3. Solar Energy : Sun is the foremost energy source that makes life possible on our earth. Solar energy has been used by man from ancient times.

Solar energy is harnessed using

(i) solar cookers (ii) solar water heaters (iii) solar cells.

4. Gobar Gas: Gobar gas is obtained by the fermentation of cow dung in the absence of air (anaerobic conditions). It mainly contains methane and a little ethane. It is widely used in rural areas for cooking and operating engines.

Science today

Hydrogen - The future fuel

Hydrogen could be the best alternative fuel. It is a clean fuel as it gives out only water while burning. Moreover, it has the highest energy content. It does not pollute air.

Cold Fusion Process

Nuclear fusion is a process in which two or more lighter nuclei of atoms are combined to produce nuclear energy. This process requires very high temperature. If the nuclear fusion process is carried out at room temperature, it is called as cold fusion process.

Methane from sewage

Sewage sludge can be decomposed by microorganisms to produce methane gas along with impurities like carbon dioxide and hydrogen sulphide. After removing these impurities, methane gas can be used as an efficient fuel.

In India, the Petroleum Conservation Research Association(PCRA) advises people with methods of saving petrol/diesel while driving.

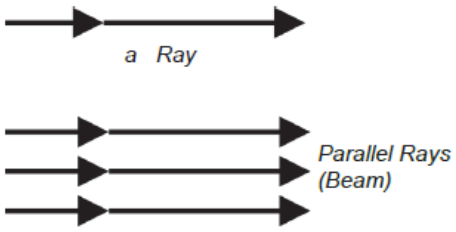
"Today's wastage - tomorrow's shortage"

"A mile we walk we save a litre of petrol and a day of life"

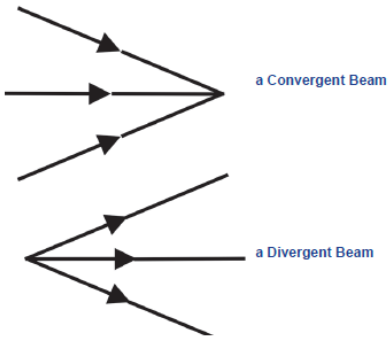
42] Light and Sound

Reflection of Light

The bouncing of light from the surface of a body is known as **reflection.** Everything that is around us is seen with our eyes because of the phenomenon of reflection of light.

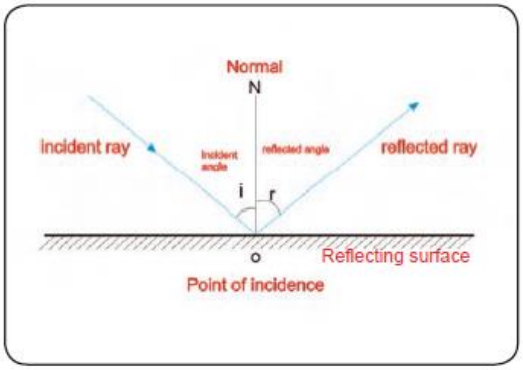


Light travels along a straight line. The path taken by the light is known as a ray and is represented by a straight line with an arrow mark. The arrow mark denotes the direction of the light.



Two or more rays form a beam. When the rays are parallel. It is known as parallel beam.

If the rays meet at a point (converge), they form a convergent beam. If the rays move away from a point it is called as divergent beam.



A light ray which strikes the surface is called an **incident ray.**

The light ray that comes out from the reflecting surface after reflection is called **a reflected ray.**

The perpendicular line drawn to the surface at the point of incidence is called a **normal.**

The angle between the incident ray and the normal at the point of incidence is called the **angle of incidence (i).**

The angle between the reflected ray and the normal drawn from the point of incidence is called the **angle of reflection (r).**

Inference

1. The incident ray, the normal and the reflected ray lie in the same paper plane.
2. The angle of incidence = the angle of reflection.

Laws of Reflection

1. The incident ray, the reflected ray and the normal to the surface at the point of incidence lie in the same plane.
2. The angle of incidence is equal to the angle of reflection.

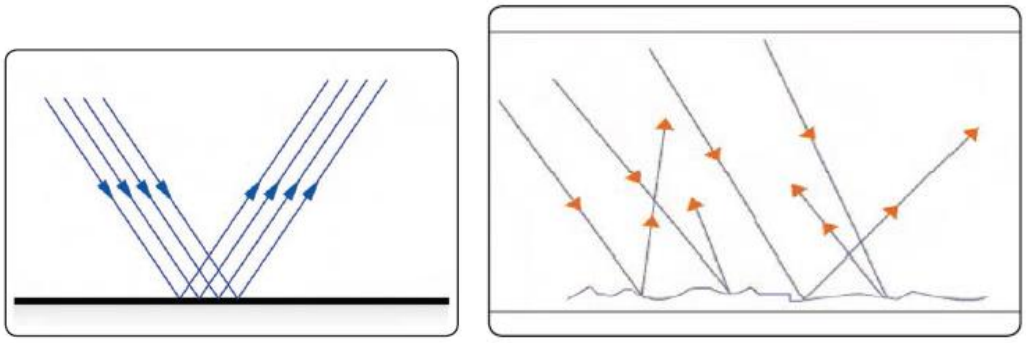
$$\angle i = \angle r$$

From this activity, We see that we can see our face clearly in the polished surfaces and not very clearly in the rough surfaces.

Regular and Irregular Reflections

Reflection from a polished surface is called **Regular reflection**.

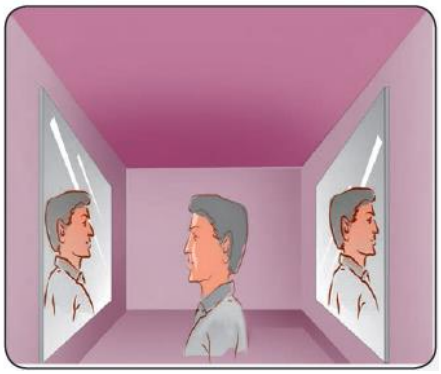
Reflection from a rough (unpolished) surface is called **irregular or diffused reflection.**



Multiple reflection

When we enter into a jewellery shop, a barber's shop, a hotel or a bakery, can we see a number of images in the mirror?

How does this happen? It is just a trick using the mirror.



The mirrors are arranged at a particular angle so as to get the maximum number of images. Have you ever tried to look at the back of your head in a mirror? Two plane mirrors are needed to see the back of our head as shown in the figure. This is due to multiple reflection.

Multiple Images

We are aware that a plane mirror forms only a single image of an object. But two or more mirrors are arranged to form number of images of an object. These are called Multiple Images.

A relation between the number of images and the angle between the mirrors.

Number of images = $\frac{360^0}{angle} - 1$

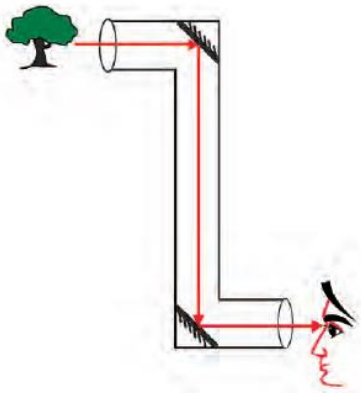
When the mirrors are placed parallel to each other, the maximum number of images will be formed.

Multiple reflection principle is applied in the kaleidoscope and periscope.

Mirror Periscope

The working of a periscope is based on the principle of successive reflections from two plane mirrors. It consists of two plane mirrors facing each other fixed at 45^0 to the frame work of a tube.

Fix the two mirrors at an angle of 45^0 as shown in the figure. View an object through one end.



Refraction

The path of light seems to have changed before reaching our eyes. We call this phenomenon deviation.

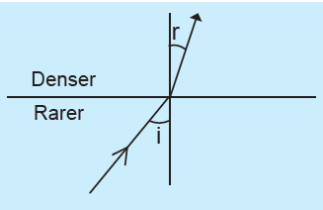
From the above activity we see that the pencil appeared bent when there was water and appeared straight when there was only air. Thus we see that the path of light behaves differently when it passes from one medium into another.

This bending of ray of light when it passes from one medium to another is called refraction.

The direction of deviation depends on the densities of the two media. The medium of greater density is known as denser medium. Ex : Glass

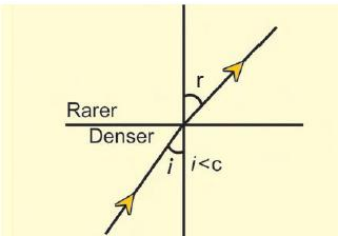
The medium of lower Density is known as rarer medium. Ex: Air

1. When light travels from a rarer medium and enters a denser medium, it will be deviated towards the normal.



Ex : From Air to Glass

2. The light will be deviated away from the normal when it passes from a denser into a rarer medium.



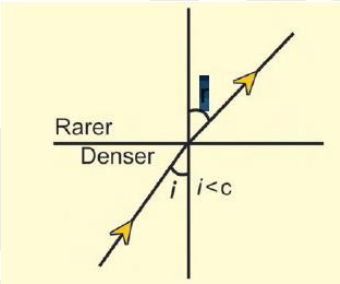
Ex : From Glass to Air

Every day effects of Refraction

1. A fruit appears to be bigger in a glass of water due to refraction.
2. Printed letters appear to be raised when a glass slab is placed over them.
3. A swimming pool appears more shallow than its actual depth.

Total Internal Reflection

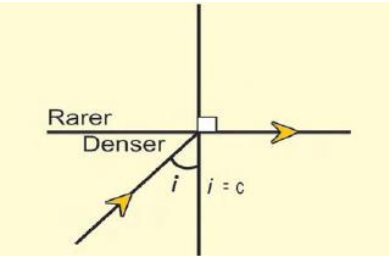
Consider a ray of light passing from a denser medium to a rarer medium.



When a ray of light passes from a denser medium to a rarer medium, the refracted ray is bent away from the normal.

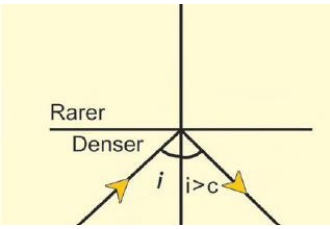
As the angle of incidence increases, the angle of refraction also increases.

At a certain angle of incidence, the angle of refraction becomes 90°. The angle of incidence for which the angle of refraction becomes 90° is called the critical angle C.



If you further increase the angle of incidence, at one point the ray will be completely reflected back into the same medium.

If the angle of incidence is more than the critical angle, the ray bends inside the denser medium itself. This phenomenon is total internal reflection.



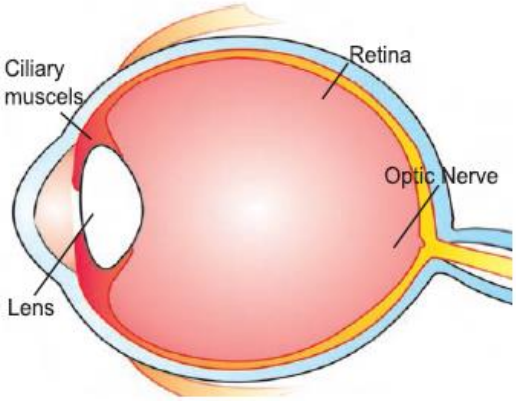
Necessary conditions for total internal reflection

1. The light must proceed from a denser medium to a rarer medium.
2. The angle of incidence in the denser medium must be greater than the critical angle.

Human Eye

The human eye has a convex lens. The convex lens of an eye forms an image of the object on a screen called the retina. The retina is covered by a large number of nerve fibres(optic fibres) which sensitive to light. They carry the image by means of optic nerves to the brain.

The human eye focusses the image for different objects at different distances by changing the focal length of the lens. This is done by the ciliary muscles, which stretch and relax to change the focal length of the lens. This action of the eye is called the power of accommodation of the eye. The most comfortable distance the normal eye can read is about 25 cm. This distance is called the least distance of the eye. The minimum distance at which the eye can see objects distinctly varies with age.



Sound

We hear many types of sounds around us everyday. Each sound is characteristic of the object producing it.

Sound needs a medium for propagation

- Sound can travel through solids.
- Sound can travel through liquids.

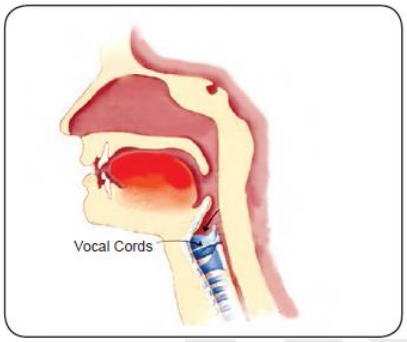
Sound needs a medium for propagation. Sound can travel through solid, liquid and gases. It can not travel through vacuum.

Sound plays an important role in our lives. It helps us to communicate with one another. It is difficult to communicate without talking. Every one and everything around us produce sounds.

Sound produced by humans

speak loudly or sing a song or buzz like a bee. What helps to do this activity?

In human beings, the sound is produced by the "voice box" or the larynx. The voice box has two "vocal cords". They are stretched across the voice box in such a way that there is a narrow slit between them for the passage of air. When we speak, the lungs force air through the slit and the vocal cords vibrate, producing sound.

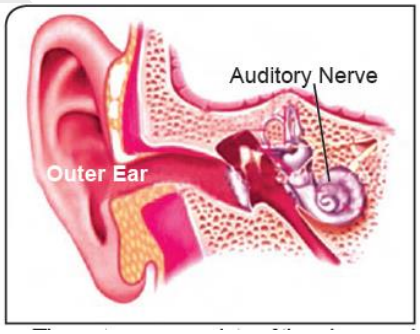


The vocal cords in men are about 20 mm long. In women, these are about 15 mm. Children have very short vocal cords.

Human ear and hearing

How do we hear sounds?

We know that vibrating objects produce sound which is carried in all directions through a medium. Our ears help us to hear sounds. The human ear has three important parts. Only one of its parts can be seen and felt by you, which is the outer ear.



The outer ear consists of the pinna and the ear tube. The shape of the outer part of the ear is like a funnel. When sound enters the ear, it travels down a canal at the end of which a thin membrane is called **"ear drum"** stretched tightly. It performs a very important function.

The middle ear has three tiny interlocked bones. The inner ear has a coiled organ of semi circular canals and the auditory nerve.

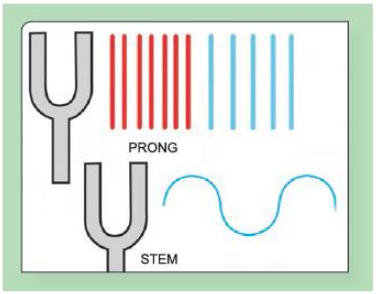
A vibrating body causes air molecules to vibrate. These vibrations reach our ear and are collected by the pinna and then funnelled into the ear tube. The vibrations strike the eardrum and start vibrating. The ear drum sends the vibrations to the inner ear. From there the signal goes to the brain. That is how we hear sounds.

We must never put a sharp or hard object into our ear. It can damage the eardrum. A damaged eardrum can impair hearing.

Amplitude, Time period and frequency of a vibration

You have learnt that to and fro motion of an object is called frequency. A tuning fork is made of steel. The two upper ends of the tuning fork are called the 'prongs', while the lower end is called the 'stem'.

Strike the prongs against a hard rubber pad and observe the vibrations. A vibrating tuning fork produces sound.



Frequency (n): The number of oscillations per second is called the frequency. Frequency is expressed by hertz – Hz

Time period (T): The time taken by the vibrating body to complete one vibration or oscillation is called the time period. The unit of period is second(s).

Amplitude (a): The maximum displacement of a vibrating body from its mean position is called amplitude. The unit of amplitude is metre (m)

The relation between frequency (n) and time period (T)

The period of oscillation is the reciprocal of the frequency.

Time period (T) = $\frac{1}{frequency\ (n)}$

We can recognize many familiar sounds without seeing the object producing these sounds. How is it possible? These sounds must be different to enable you to recognize them.

- Amplitude and Frequency are two important properties of sound.
- The loudness of the sound depends on its amplitude.

Audible and Inaudible Sounds

The human ear can hear the range of audible frequencies between 20 Hz and 20000 Hz. They are called audible sounds.

Sounds of frequencies lesser than 20 Hz and greater than 20000 Hz can not be heard by the human ear. They are called inaudible sounds.

Noise

Any unpleasant sound is called noise. In the classroom, if all the students speak together, what would the sound produced be termed? It is noise.

On the other hand, we enjoy sound from musical instruments. Musical sound is pleasing to the ear.

Noise pollution

Unwanted sound from any source that causes discomfort of any kind is called noise pollution.

Harmful effects of noise pollution

- Exposure to sudden high noise level can damage to the eardrum.
- High levels of noise can also lead to nervous tension and increase in blood pressure.
- Noise also disturbs sleep, increases stress and causes headache.

Sound waves of frequencies above 20,000 Hz are called ultrasonic waves. Bats use ultrasonic waves for their flight. Some animals can hear sounds of frequencies higher than 20000Hz. Dogs have this ability.

Steps to control noise pollution

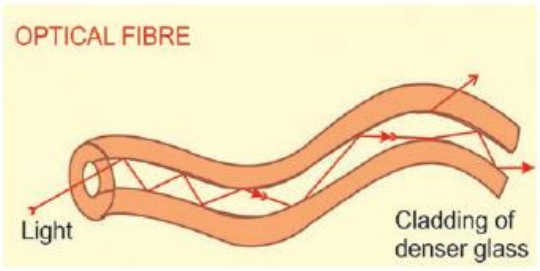
1. The use of loudspeaker in functions should be stopped.
2. Cars and other vehicles should not produce loud sounds.
3. T.V and Musical systems should be listened at low volumes.

Science Today

An optical fibre is a device based on the principle of total internal reflection.

Optical fibres are thin, flexible and transparent strands of glass which can carry light along them very easily. A bundle of such thin fibres forms a light pipe.

When light is incident at one end of the fibre at a small angle the light that passes inside undergoes repeated total internal reflections along the fibre and finally comes out.



Even if the fibre is bent or twisted, light can easily travel through the fibre. The method of using optical fibres to carry images and messages is called fibre optics.

Uses of optical fibres

1. Optical fibres are used to transmit communication signals.
2. In medicine, optical fibres are used in endoscope and laparoscopes.

43] Animal Kingdom

There are millions and millions of different organisms living along with us and around us. What if we could remember all of them by their names? Biologists have helped us achieve this by sorting all living things into meaningful groups.

Sorting living organisms into various groups based on similarities and dissimilarities is called classification. If you knew Greek language, you would refer to this subject as Taxonomy because 'taxis' in Greek means arrangement and 'nomia' means method. Thus **Taxonomy** is the branch of biology dealing with identification, description, nomenclature and classification.

A Swedish Botanist, Carl Linnaeus (1707-1778) developed a hierarchy of groups for taxonomy. A hierarchy helps to arrange organisms in a sequence according to different levels of similarity. Linnaeus wrote a huge book, Systema Naturae, in which he arranged all the living organisms that he could find around him into different groups. This Linnaean system of classification is what we use today to name, classify and compare all living things.

The largest group of organisms is the kingdom. Many sub-groups are formed at various levels and they are arranged in different levels called taxa. The levels of taxa are Kingdom, Phylum, Class, Order, Family, Genus and Species, in descending order. Every animal on the planet right down to the smallest ones are classified according to these taxa.

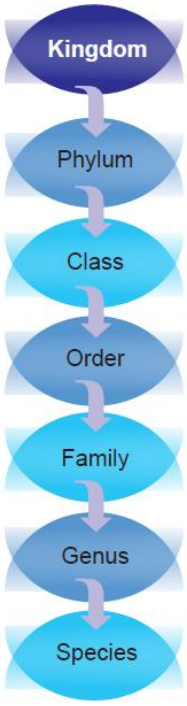
Organisms are separated into smaller and smaller groups on the basis of their common characteristics. Each group comes from the group before it. The smallest and the most specific group of classification is the species.

Some of the common characteristics or criteria that have been used for the purpose of classification are discussed below:

- Aristotle, the father of Zoology, was the first to classify animals based on their similarities and differences.
(384-322 BC)

- Carl Linnaeus, the Swedish Botanist is regarded as the father of modern taxonomy (1707-1778).

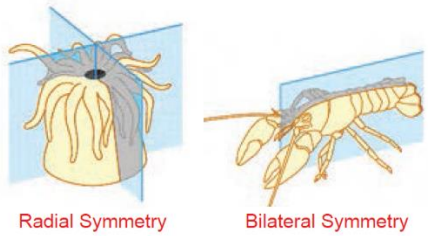
Levels of classification



Criteria for classification

1. Grade of organisation – Animals are grouped as Unicellular or Multicellular based on their number of cells.

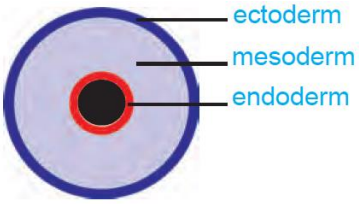
2. Symmetry - When we look at the shape and structure of an organism and see that body parts are arranged around a central axis in such a way that a flat plane passing through this central axis can divide it into two identical halves, then we can consider it to be radially symmetrical. e.g. Hydra.



Creatures like earthworm, lobster have a bilaterally symmetrical body. An imaginary line drawn through the central axis can divide its body into identical left and right halves in only one longitudinal plane.

Amoeba has an irregular shape and exhibits asymmetry because any flat plane drawn through the centre of its body does not divide it into equal halves.

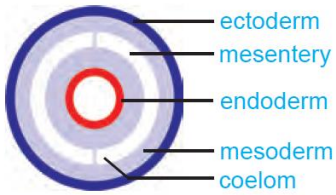
3. Germ layers – Germ layers are formed during the development of an embryo. These layers give rise to different organs, as the embryo becomes an adult. If an organism has two germ layers, the ectoderm and the endoderm, it is said to be diploblastic. If they have three germ layers, the ectoderm, the mesoderm and the endoderm, they are triploblastic animals.



The cross section of an embryo

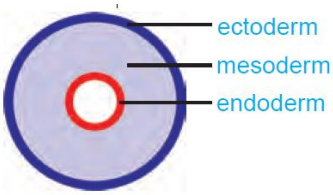
4. Coelom - Coelom refers to a fluid-filled cavity inside the body. It separates the digestive tract and other organs from the body wall. A true body cavity or coelom is one that is located within the mesoderm.

Based on the nature of the coelom, animals are divided into 3 groups. Organisms like the earthworm are called coelomates or eucoelomates because they have true coeloms.



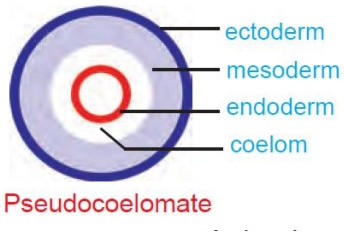
Eucoelomate

Tapeworm is an example of an acoelomate because it does not have a body cavity.



Acoelomate

Animals like the roundworm have a body cavity but it is located between the endoderm and the mesoderm. This is considered to be a false coelom and these organisms are called pseudocoelomates.



5. Body temperature - Animals can be classified into two groups based on the ability to regulate their body temperature. Some animals like the fish and the frog, have body temperatures that vary with the temperature of their surroundings. They are called poikilotherms. Creatures like bird and man are called homeotherms because their body temperature remains a constant and is maintained slightly higher than that of the environment.

Based on criteria such as those listed so far, ecologist R.H.Whitaker created a Five Kingdom Classification, where he grouped all living organisms under five kingdoms:

Animals that are multicellular and do not have cell wall or chlorophyll are grouped under Kingdom Animalia which includes the following phyla:

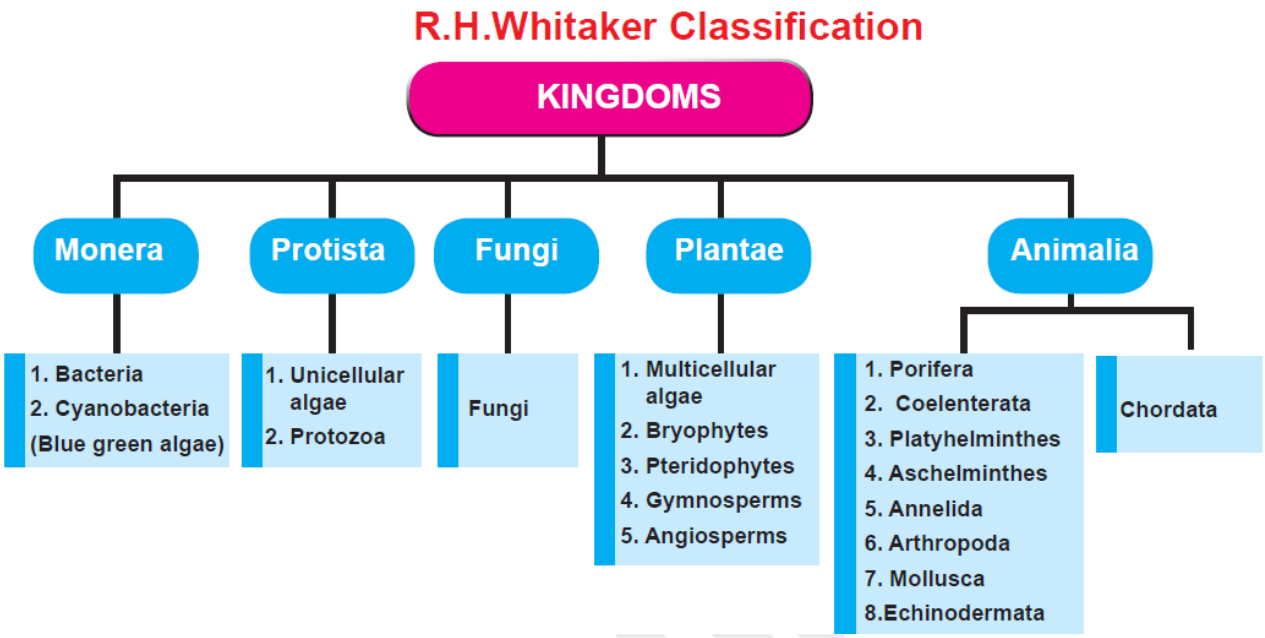
1. Phylum Porifera (e.g. Sponges)
2. Phylum Coelenterata (e.g. Hydra)
3. Phylum Platyhelminthes (e.g. Tapeworm)
4. Phylum Aschelminthes (e.g. Ascaris)
5. Phylum Annelida (e.g. Earthworm)
6. Phylum Arthropoda (e.g. Cockroach)
7. Phylum Mollusca (e.g. Snail)
8. Phylum Echinodermata (e.g. Starfish)
9. Phylum Chordata

Phyla 1 – 8 are generally referred to as invertebrates because these animals do not have an internal backbone or vertebral column. Phylum Chordata includes animals that have a notochord during some stage of their development. A notochord is a flexible rod-shaped structure made of cartilage found in the body of a developing embryo. It forms the mid-line and main support for an organism. Vertebrates are chordates where the notochord has become a part of the animal's backbone, forming a bony vertebral column .

INVERTEBRATES

1. Phylum Porifera: These are the simplest and the most colourful of all multicellular animals. They are also known as pore-bearers. They do not have a mouth, instead their body has tiny pores through which water is drawn into the body. Their cells are not arranged into tissues but they capture bacteria and particles floating in water and consume them as food. Poriferans are marine and sessile, attached to rocks

or shells at the bottom of the sea. The body is strengthened with the help of spicules that are made up of hard minerals like calcium or silica.



e.g. Sycon

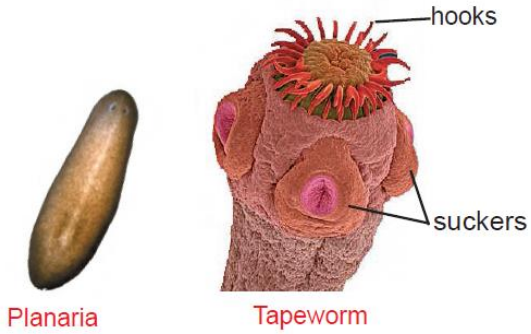
2. Phylum Coelenterata

Coelenterates are colourful aquatic animals. Members of this group can be found attached and sessile, called polyps; or free-floating as a medusa. Coelenterates are diploblastic and shows radial symmetry. There is a distinct sac-like space inside the body called the coelenteron or gastro-vascular cavity which takes care of digestion. They do not have organs. Coelenterates have long finger-like structures around the mouth, called tentacles, that are used to catch prey and to protect themselves. The tentacles have special cells called nematocysts. These stinging cells have poisonous barbs inside and they are used to stun their prey.

e.g. corals, sea anemone, hydra, jelly fish.

3. Phylum Platyhelminthes

These are flat, leaflike or ribbon-like organisms. They are more complex than Poriferans and Coelenterates. Their body is bilaterally symmetrical. The body wall is made up of three basic layers and hence the animals are triploblastic and acoelomate. Planaria is a free-living platyhelminth. Most flatworms, like the tapeworm, are parasites. These parasites have organs of attachments such as hooks or suckers that help them stay attached to the host.



4. Phylum Aschelminthes

Organisms belonging to this phylum are also referred to as 'roundworms'. Their body is cylindrical and unsegmented and protected by a resistant cuticle. Their bodies are bilaterally symmetrical and triploblastic. They are pseudocoelomates with a fluidfilled space between the mesoderm and internal organs. Most roundworms are free-living and some are parasitic, and known to cause diseases. For example, filarial worm causes the dreaded disease elephantiasis and pinworms are found as parasites in human intestines.

5. Phylum Annelida

All annelids are worms .They have elongated, cylindrical and segmented bodies. Each segment carries identical sets of organs. This feature is called metamerism. These worms move with the help of small bristles called setae. Annelids are also bilaterally symmetrical and triploblastic. Their body contains a true coelom. Earthworm, leech and lug worm are examples of annelids.

EARTHWORMS are referred to as "Farmer's Friend"? Why?
The earthworm plays a vital role in improving the fertility of the soil. It ploughs the land and assists in the recycling of organic matter for the efficient growth of the plants. The soil system is loosened, stirred up and aerated by the vertical migration of earthworms.

6. Phylum Arthropoda

Arthropods are the largest group in the animal kingdom. It includes crustaceans (e.g.crabs and prawns), insects (e.g.butterflies and cockroaches), arachnids (spiders and scorpions) and myriapods (centipedes and millipedes). The word 'arthropod' means 'jointed foot' and all arthropods have limbs that are made up of jointed segments. The jointed limbs are used for locomotion, feeding and sensing. Their body is also segmented and grouped together to form head, thorax and abdomen.

It is covered by a hard, firm external skeleton made up of a strong substance called chitin. All segments have flexible joints which enable movement. The arthropods exhibit bilateral symmetry. They have open type of circulation where blood vessels are absent and body-fluid circulates openly in the body cavity, bathing all the organs.

7. Phylum Mollusca

Molluscs and arthropods form a large part of the invertebrates that we come across in our lives.

When you look at the bodies of mollusks like snail, slug, clam, mussel, oyster, squid, and octopus you can see a large variety in shape. But they all share a common body plan: soft, unsegmented bodies without appendages, covered by a thin fleshy structure called mantle. The mantle protects the body by secreting a hard shell made of calcium carbonate. Most mollusks move around with the help of a muscular foot. Some molluscs, like the slugs, do not have shells.

8. Phylum Echinodermata

Sea stars, brittle stars, sea urchins, sea-cucumbers and sea lilies are some examples of echinoderms. 'Echinos – derma' means 'spiny skinned'. These are marine animals. Their young ones show bilateral symmetry while the adult body show radial symmetry. They are triploblastic and coelomate. The body
is covered by a thin outer skeleton, but they are not segmented. Echinoderms are unique because they have a system of water-filled canals inside the body.

These canals project out in the form of hundreds of tubefeet on the underside of their body. A starfish moves with the help of tubefeet. Tubefeet have suction cups at their ends and is powered by muscles and hydraulic force from the water-vascular system. The water-vascular system also helps in the exchange of gases, internal transport of nourishment and excretion.

The Australian sea wasp or box jellyfish (Chironex fleckeri) is the most venomous coelenterate in the world. It has enough poison to kill about sixty people.

VERTEBRATES

The vertebrates are the most advanced group of organisms on the earth. These animals are larger in size than the invertebrates. They are coelomate, triploblastic and bilaterally symmetrical. They have a strong and flexible vertebral column made of a chain of cylindrical bones. Vertebrates also show characteristics that include body segmentation, closed blood circulation and presence of a well developed internal skeleton. They also have a well developed brain.

Vertebrates can be grouped into five classes:

1.Class Pisces

Fishes are poikilothermic and exclusively aquatic vertebrates. Their body has a streamlined shape and is covered by overlapping scales. Fins are used for locomotion. Fishes breathe with the help of gills that are protected by a lid-like bony plate called the operculum. Some of them, like sharks and rays, have internal skeletons that are made of cartilage. The heart of the fish is the simplest among vertebrates. They are made up of two chambers: an auricle and a ventricle.

2.Class Amphibia

Amphibians are cold blooded vertebrates, but they do not have scales on their body. They are haracterized by the ability to spend a part of their life in water and a part on land. They are the smallest group among vertebrates. Their skin do not have hair or scales. In its lifetime, an amphibian uses both gills and lungs for respiration. Their moist skin also helps in the exchange of gases for respiration.
Frogs, salamanders and toads are examples of amphibians. An amphibian's heart has three chambers: two auricles and a single ventricle.

Unforgiving fish: The stonefish is the most poisonous fish in the world. The poison is carried in its skin and in sacs attached to razor sharp spines along its back. When attacked or even accidentally stepped on, the stone fish pushes its spines into the predator and releases the poison into the wounds which usually results in paralysis or death. Salamander

The drug derived from the extract of Poison arrow frog (Epipedobates tricolor) works as a powerful painkiller. It has the same benefits of morphine but without any side effects.

Amphibians are good indicators of environmental changes. They breathe partially through their skin which makes them sensitive to radiation, pollution and habitat destruction. Scientists believe that amphibians can show the first signs of environmental emergencies. In the last 20 years, the number of amphibian species has declined, with some species becoming extinct due to acid rain, ozone depletion and chemical pollution.

Sl.No	TOAD FROG	TOAD FROG
1	Short hind legs	Long hind legs
2	Rough, warty skin	Moist, smooth skin
3	Spends a little time in water	Spends more time in water
4	Walks and makes short hops	Jumps
5	Toothless	Teeth in upper jaw
6	Webless hind feet	Webbed hind feet

3. Class Reptilia

Snakes, turtles, crocodiles and lizards are examples of reptiles. These are poikilothermic. When the temperature outside is warm, the animals warm up and become active. When the temperature outside is cold, they become less active. Their skin is dry and scaly, making it waterproof. The heart of a reptile has three chambers. They use their lungs to breathe.

4. Class Aves

Birds are homeothermic vertebrates and have streamlined bodies covered with feathers. They have four limbs. The front limbs are modified to form wings for flight. They use lungs to breathe and their bones are much lighter than that of other vertebrates. Their hearts are fourchambered.
The pigeon, the crow and the sparrow are examples of birds that we commonly see flying around us. The ostrich, penguin, emu and cassowary are examples of birds that do not fly.

Dinosaurs were reptiles, but they all died about 65 million years ago. Lizards and crocodiles that live on the earth today are relatives of the dinosaurs.

5. Class Mammalia

Mammals are also homeothermic vertebrates. Their body is covered with hair unlike feathers that we see in birds. Their skin has sweat glands and oil glands. The teeth of mammals are varied and this kind of teeth pattern is called heterodont dentition. Mammals have a four-chambered heart. The heart and lungs are separated from the rest of the organs in the abdomen with the help of a muscular sheet called diaphragm.

Mammals are characterized by the presence of mammary glands that produce milk to feed their young ones. Rat, cat, whale, dolphin, elephant, monkey and man are examples of mammals. The bat is an example of a flying mammal.

Vedanthangal Bird Sanctuary
It is one of the spectacular breeding grounds in India. It is located in Kancheepuram District of Tamilnadu (about 75 km from Chennai). The bird life (domestic and migratory) include Cormarants, Darters, Herons, Egrets, Open billed stork, Spoon bills, White ibis, Little grebe, Blackwinged suits, Grey pelican etc. The ideal season to visit the sanctuary is from November to February

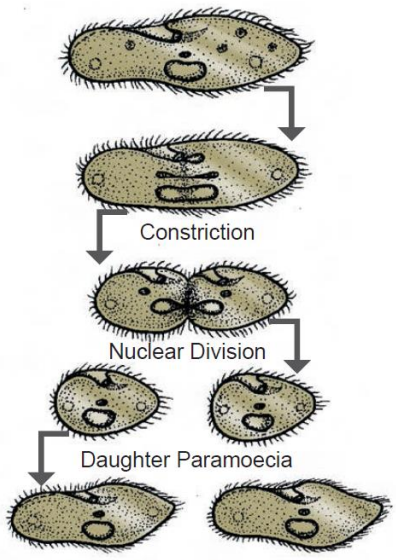
1.3. MODES OF REPRODUCTION IN ANIMALS

Reproduction is the capacity of an organism to produce young ones of their own kind. Living things reproduce to ensure the continuation of their species. All animals have the ability to reproduce. The process of reproduction can be asexual or sexual.

Sl.No	Asexual Reproduction	Sexual Reproduction
1	It involves a single parent.	It involves two parents (male and female) each capable of producing gametes.
2	It does not involve the fusion of gametes.	It involves the fusion of male and female gametes [sperm and ovum] resulting in the formation of zygote.

Asexual reproduction

During asexual reproduction, new individuals are formed from a single parent. A single celled organism may simply divide and give rise to independent daughter cells.



Binary fission in Paramoecium

Some of the ways in which organisms reproduce asexually are: multiple fission, binary fission, budding, gemmule formation and sporulation.

Paramoecium is an example of a unicellular organism that reproduces by binary fission. In this process, a constriction appears at the centre which divides the nucleus and cytoplasm into two parts. Thus a single Paramoecium gives rise to two daughter Paramoecia.

The Hydra reproduces asexually by budding. The body wall of the Hydra produces a bud-like outgrowth .This bud develops by repeated cell division, gradually grows in size and develops a mouth and tentacles at the free end. Soon a constriction appears at the point of contact; the daughter Hydra gets separated from the parent and leads an independent life.

Unfavourable conditions in the environment can also force some organisms to reproduce asexually.

For example, sponges reproduce sexually during normal conditions. Being hermaphrodites, they can give rise to both male and female gametes for fertilization. When conditions are unfavourable, they either give rise to buds or produce packets of cells called gemmules. Each gemmule has extra protection in the form of an outer thick layer carrying numerous air spaces and two inner chitinous layers. These gemmules are released from the body. When conditions become favourable, the cell mass comes out of the gemmule
through an opening called micropyle and develops into young sponges.

During unfavourable conditions, the protozoan Amoeba and the malarial parasite Plasmodium resort to an asexual method called cyst formation and sporulation. The protoplasm condenses and gets surrounded by a thick protective covering forming a cyst. When conditions become favourable again, the

cyst dissolves. The protoplasm regains its original nature and undergoes multiple fission giving rise to numerous independent daughter cells. This process is called sporulation.

Advantages of Asexual reproduction

1. It requires only one parent.
2. It is not complicated and does not involve gametes and fertilization.

Disadvantages of Asexual reproduction

1. Offspring do not show much variation from parents. This reduces the possibility of having a variety that could lead to formation of new species after hundreds of years.

2. Undesirable characters are transferred from the parent to the offspring without any change.

Sexual Reproduction

Sexual reproduction involves the production of sex cells or gametes. The male organism gives rise to male gametes or sperms and the female organism gives rise to the female gametes or the ova. In sexual reproduction, the male and female gametes fuse together to form a single cell called the zygote. The zygote grows to be a new adult.

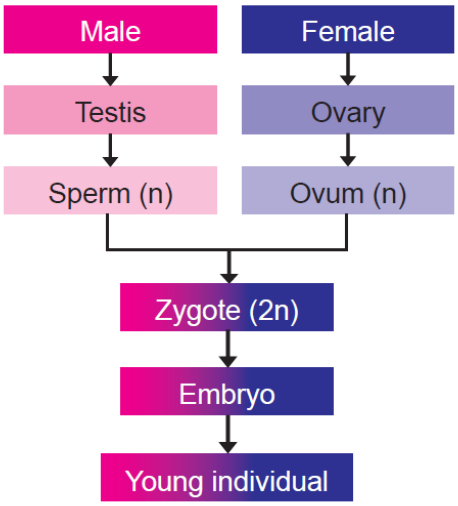
Gametes are produced in organs that are generally referred to as the gonads. The male gonads are the testes and the female gonads are the ovaries. If an organism carries any one type of gonad, it is said to be a unisexual organism. In this case, the sexes are said to be separate as male and female. Bisexual organism, also referred to as hermaphrodites, are those that possess both testis and ovary in the same body. Hydra and tapeworm are examples of bisexual organisms.

Unicellular organisms like Paramoecium are also known to reproduce sexually. Two Paramecia come together, establish a bridge-like connection and exchange genetic material. Each of them separate and divide independently to give rise to daughter cells. This method of sexual reproduction is called conjugation.

Fertilization is the process of fusion of male and female gametes. It can be described as internal or external fertilization based on where it occurs. In most fishes and amphibians, the female lays unfertilized eggs in the water and the male releases sperms over them. This type of fertilization that takes place outside the animal's body is said to be external fertilization. In reptiles, birds and mammals internal fertilization takes place, where the male releases sperms inside the body of the female organism.

Viviparous animals

In viviparous animals, example mammals, a zygote develops into an



Schematic representation of sexual reproduction

embryo that grows inside the mother, and receives nourishment directly from the mother. After a period of time, the mother gives birth to the young one that resembles the adult.

Oviparous animals

Insects, birds and most reptiles are oviparous. The zygote develops into a fertilized egg and is laid outside the body of the parent. These eggs are laden with yolk to nourish the embryo. Embryonic development takes place outside the body of the mother. These eggs have a hard calcareous shell that protects them from dehydration and are called cledoic eggs.

Young ones to adults

A zygote develops into an embryo and grows to become an adult. In insects, for example butterflies, young ones are in the form of larvae or caterpillars. They do not resemble their parents. These young ones undergo a complete transformation in their form and habit to become an adult. This process is called metamorphosis.

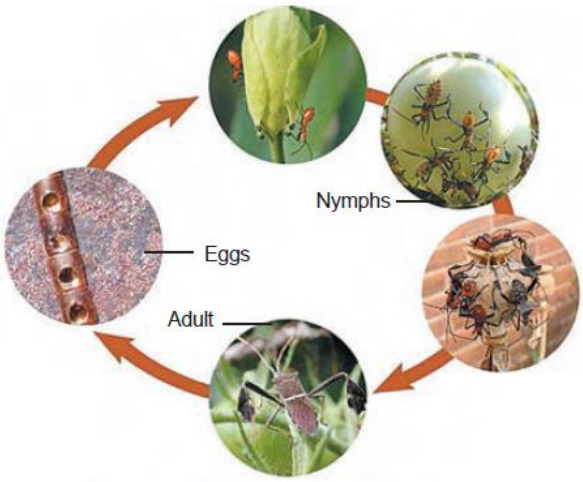
Incomplete metamorphosis

Among animals where the young ones resemble the adult, growth in size takes place.

Ovoviviparous animals

In these animals, the embryos develop inside the eggs that are retained within the mother's body until they are ready to hatch. The young ones are nourished by the egg yolk and there is no placental connection. e.g. Vipers

In arthropods, the shell covering the body is shed periodically, to attain adult stage. In grasshoppers, the young ones called nymphs hatch out of eggs. Nymphs resemble their parents but are very tiny. These nymphs grow in size and shed their outer covering. This periodic shedding of the outer covering is called molting. Molting takes place several times before the nymphs become adults. This kind of lifecycle where the pupa stage is absent is called incomplete metamorphosis.



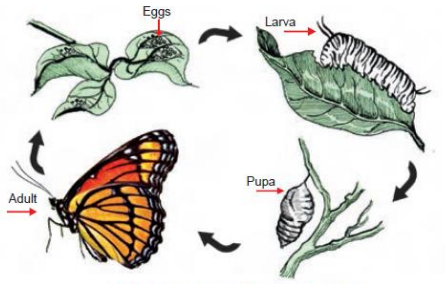
Incomplete metamorphosis

Egg ⟶ Nymph ⟶ Adult

Complete metamorphosis

The lifecycle of the butterfly and the silk moth are examples of complete metamorphosis. Their young ones are worm-like and strikingly different from the adults. This caterpillar feeds voraciously on leaves for a few days, increases in size and then enters a resting stage called pupa. It remains in a cocoon for a period of time, after which the adult or imago emerges out of the cocoon.

Lifecycle of the Butterfly



Complete metamorphosis

Egg ⟶ Larva ⟶ Pupa ⟶ Adult

44] Cells

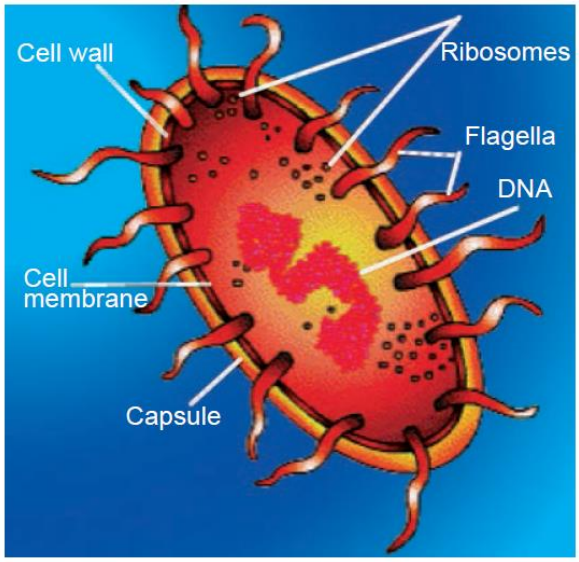
CELLS AND TISSUES

Cells are the smallest functional units in a living organism. Many billions of years ago, life on the earth began in the form of a one celled organism. These little organisms live even today and are probably the

simplest of all living things found on this planet; And now more than 1000 different types of one celled organisms have been discovered. This group of one-celled organisms is referred to as the 'prokaryotes'.

Prokaryota, in Greek means 'before nucleus'. Prokaryotes are organisms that do not have a well developed nucleus or any other structure in their cell that are bound by a membrane. Bacteria and bluegreen algae are examples of prokaryotes. Their genetic material is in the form of a single thread-like structure that lies within the cell membrane.

For millions of years, prokaryotes were the only living thing on this planet till they evolved into more complicated "eukaryotic cells".



A Prokaryotic cell (Bacteria)

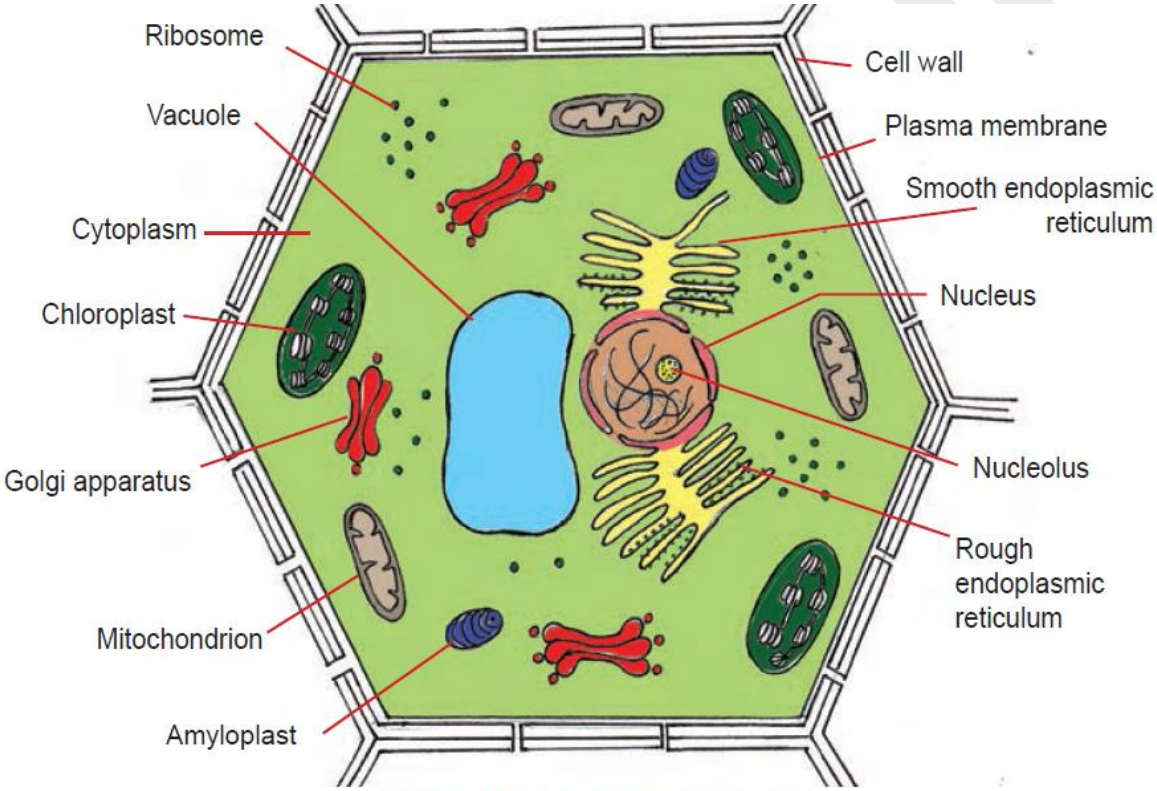
A eukaryotic cell has a well organized nucleus. It also has structures like endoplasmic reticulum, golgi body, mitochondria, plastids and vacuoles. Each of these structures is covered by a membrane. These specialized structures found in a cell are called organelles. Genetic material or chromosome is also found enclosed in a membrane-bound structure called nucleus. Protozoans, unicellular algae and fungi have eukaryotic cells. All plants and animals have eukaryotic cells.

Sl. No.	Prokaryotic Cell	Eukaryotic Cell
1	It is generally smaller (1-10 microns) in size.	It is comparatively larger (5-100 microns) in size.
2	It lacks a well organized nucleus as its nuclear material is not surrounded by a nuclear membrane.	It contains a well organized nucleus as its nuclear material is surrounded by a nuclear membrane.
3	It has a single chromosome.	It has more than one chromosome.
4	Nucleolus is absent.	Nucleolus is present.
5	It lacks membrane bound cell organelles.	It possesses membrane bound cell organelles.

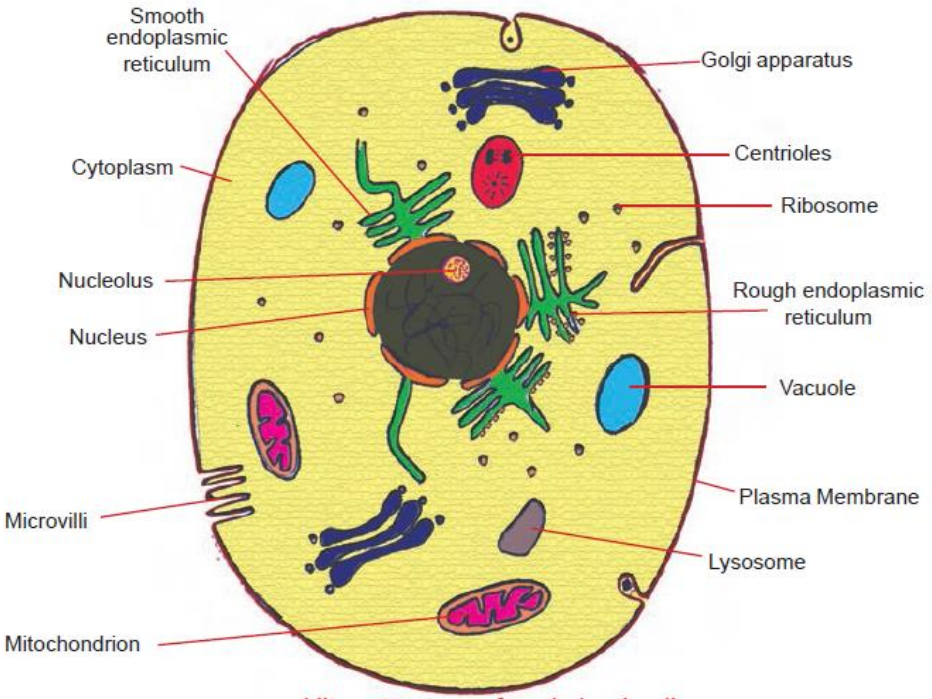
6	Cell division occurs by fission or budding. Mitotic and meiotic divisions are absent.	Cell division takes place by mitosis and meiosis.
7	Ribosomes are small.	Ribosomes are large.

You must have learnt about plant and animal cells. If we take a single cell of a plant and compare it with a single animal cell this is how it would look. You will find many things in common, in both plant and animal cells.

Study the diagrams and see if you can spot any difference between the plant cell and the animal cell:



Ultra structure of a Plant cell



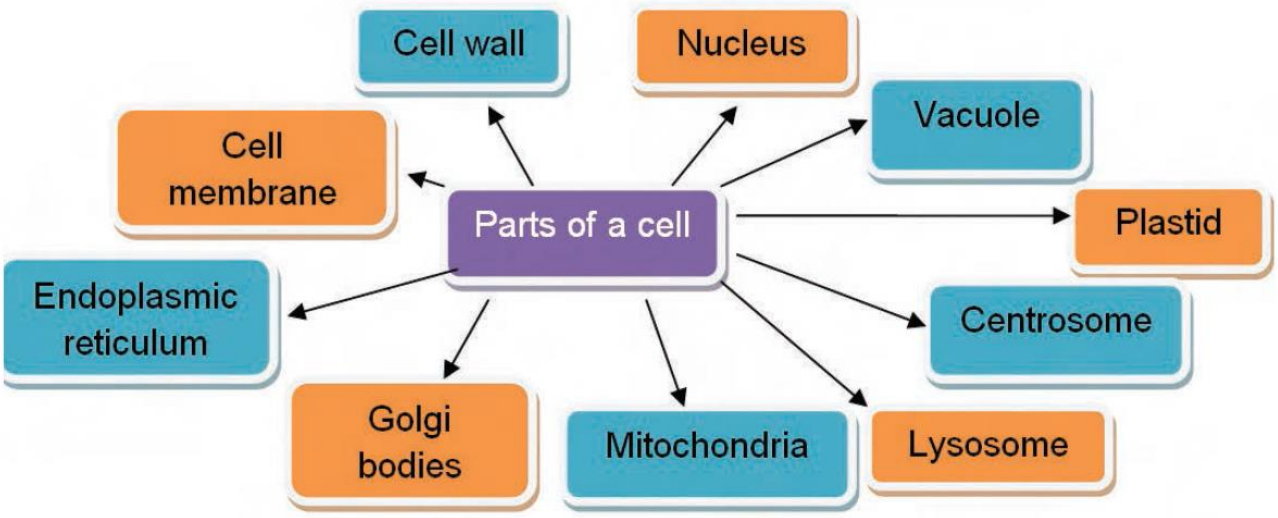
Ultra structure of an Animal cell

Differences between Plant cell and Animal cell

Sl.No	**Plant cell**	**Animal cell**
1	Plant cell has an outer rigid cell wall which is made up of cellulose.	Animal cell lacks a cell wall.
2	Plant cell is larger than animal cell.	Animal cell is comparatively smaller in size.
3	Plant cell has large vacuoles which occupy more space in the cell.	Animal cell usually lacks vacuoles. Even if they are present, they are minute in size.
4	Centrosome is present only in the cells of some lower plants.	All animal cells contain centrosomes.
5	Lysosomes are found only in the eukaryotic plant cells.	Lysosomes are found in all animal cells.
6	Plant cell contains plastids.	Plastids are absent.
7	Mostly, starch is the storage material.	Glycogen is the storage material.

- The study of cell is not possible without a microscope. Robert Hooke in 1665 coined the term cell and discovered the cellular structure of cork.
- Anton Van Leeuwenhoek (1674), studied the structure of bacteria, protozoa, etc. under the simple microscope which he himself designed.
- Robert Brown, a Scottish Botanist, discovered that all cells contain nucleus.
- Purkinje coined the term 'protoplasm' for the living substance present inside the cell.

Would you agree, if we say that a cell is like a little bag filled with jelly-like semi-fluid substance with colourful tiny structures suspended in it?
The entire content of a cell is referred to as protoplasm. The structures embedded in it are organelles. Every aspect of protoplasm takes care of the life of the organism. Therefore, the protoplasm is described as the 'physical basis of life'.



Parts of a cell

Cell Membrane (Plasma membrane or Plasmalemma)

The content of a cell is enclosed by a membrane called plasma membrane. It is found around all living cells. It is so important that it is also considered as an organelle that controls how substances move in and out of a cell. It acts as a barrier and helps the substances inside a cell to remain concentrated. It is made of a bilayer or a double layer of phospholipids in which proteins and carbohydrate molecules are arranged. All cell organelles are also bound by a similar membrane.

Functions of plasma membrane:

- It provides an outer boundary to the cell and protects it from injury.
- It controls the substances that are allowed to enter and exit the cell. This regulation is called selective permeability. This is why a cell membrane is also described as a selectively permeable membrane.
- It allows the flow of materials and information between different organelles of the same cell, as well as between the adjacent cells.

Cell Wall

In addition to plasma membrane, a plant cell has a cell wall around it. Take a look at the picture of the plant cell and spot the cell wall. Where is it located?

Cell wall is found around the plasma membrane. It is made of cellulose and lignin. Lignin is water-resistant. The cell wall provides rigidity, protection and support to a plant cell and prevents it from collapsing. The cell wall is slightly elastic and its combined strength helps both small plants and tall trees maintain their shape, even when they sway in strong winds.

The cell wall in young cells is called primary cell wall. It is much thinner and more elastic than those found in older cells and allows the young cell to grow. When a cell stops growing, the primary cell wall becomes thicker and develops a new layer between it and the plasma membrane. This is called secondary cell wall and it has more lignin than the primary cell wall. The cell wall also plays an important role in the transfer of materials between cells.

CYTOPLASM

Cytoplasm is the jelly-like, translucent, and homogeneous substance that fills up a cell. It is made up mostly of water and a few dissolved ions. It has a network of filaments that suspends the organelles and also maintains the shape of the cell. The cytoplasm also moves around slowly carrying the organelles around in a process called cytoplasmic streaming. It helps to keep the cell organelles dynamic and in motion.

The portion of cytoplasm immediately below the cell membrane is gel-like and is called ectoplasm. The cytoplasm between the ectoplasm and the nuclear membrane is liquefied and is called endoplasm.

The cytoplasm together with the nucleus is referred to as the protoplasm.

Endoplasmic reticulum

Endoplasmic reticulum (ER) is an interconnecting system of channels and tubules that look like sacs and folds. It is spread throughout the cytoplasm and is continuous with the plasma membrane and nuclear membrane. There are two types of ER : rough and smooth

The smooth ER are found in cells which synthesize steroids, hormones and lipids. The walls are smooth and form tubules.

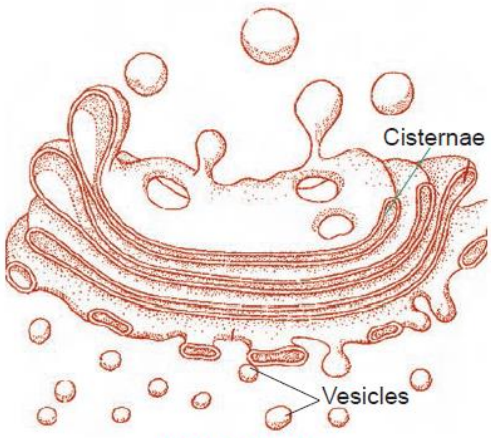
Rough ER are found in cells which synthesize proteins. This type of endoplasmic reticulum has bumpy-looking walls because ribosomes are stuck all over it. Rough ER plays an important role in protein synthesis.

Functions

1. Endoplasmic Reticulum (ER) provides large surface area for the metabolic activities of the cell.
2. Rough endoplasmic reticulum plays an important role in protein synthesis.
3. Smooth endoplasmic reticulum is involved in the synthesis of steroids, hormones and lipids.

Golgi Complex or Golgi Apparatus

Golgi complex refers to a collection of Golgi bodies that look like flattened, saclike compartments arranged in stacks. This apparatus was first disovered by Camillo Golgi. They work closely with the ER and package substances in the form of vesicles or cisternae and transport nutrients to various parts of a cell.



Golgi Complex

Functions

1. Golgi apparatus is involved in the formation of lysosomes.
2. It is also responsible for the synthesis of cell wall and cell membrane.

Lysosomes

Lysosomes are often referred to as 'suicide bags' or 'digestive bags'. They are membrane-bound vesicles produced by ER and Golgi complex, and often contain powerful digestive enzymes that are used to destroy worn-out organelles or digest foreign materials.

Functions

1. Lysosomes are involved in the intracellular digestion of food particles ingested by the cell through endocytosis.
2. The lysosomes of WBCs (White Blood Cells) destroy pathogens and other foreign particles and thus take part in natural defence of the body.

Lysosomes are involved in the destruction of aged and worn out cellular organelles. Therefore, they are also called demolition squads or scavengers or cellular housekeepers.

Vacuoles

Large fluid-filled sacs called vacuoles are found more in plant cells than in animal cells. Mature plant cells are found to have one large vacuole that almost fills up the entire cell. They may play the part of a contractile vacuole where excess water and waste is excreted from a cell. They also function as food vacuoles where they engulf material. For example, in Amoeba, the food vacuole engulfs food items and

digests it using digestive juices.

Functions

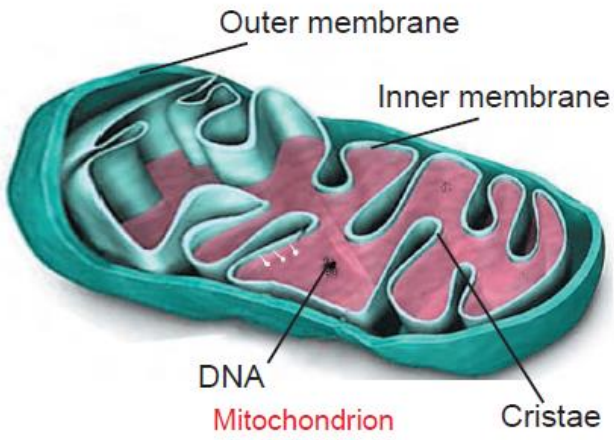
i) Vacuoles store and concentrate mineral salts as well as nutrients.
ii) They maintain proper osmotic pressure in the cell to maintain its turgidity.

Mitochondria

All living cells receive their supply of energy with the help of the mitochondria. They are very often referred to as 'powerhouses of the cell'. They are cylindrical in shape and bound by an inner and outer membrane. The inner membrane is drawn into folds called cristae that divide the chamber into incomplete compartments. These folds increase the surface area that can generate the energy-rich substance called Adenosine Tri Phosphate (ATP). The cristae have pin headed bodies called F1 particles or oxysomes, which play an important role in cell respiration. The area inside the inner membrane is called matrix.
The matrix contains enzymes that produce molecules used in the ATP.

Functions

1. Mitochondria synthesize energy rich compounds such as ATP.
2. The mitochondrial matrix also contains the mitochondrion's DNA and ribosomes.
3. This makes it a unique organelle.



Plastids

Plastids, cell wall and large vacuoles are specific characteristics of plant cells.

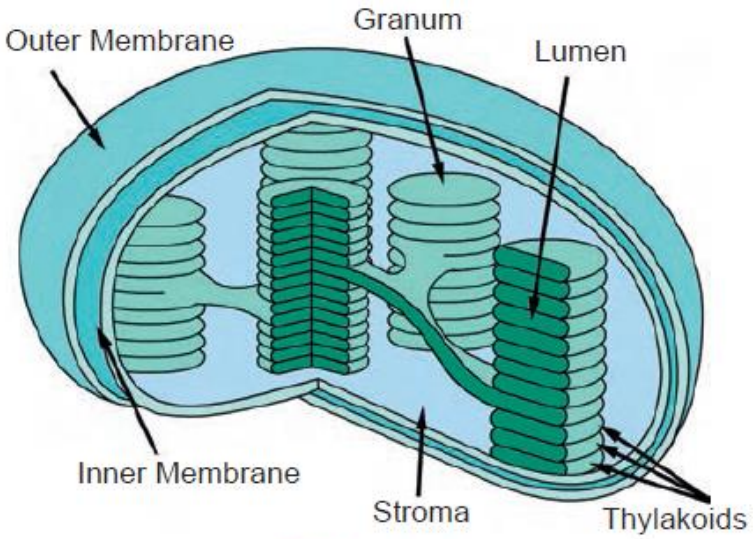
Plastids occur as disc-shaped or ovoid organelles. They may be found as colourless plastids called leucoplasts or coloured ones called chromoplasts. Leucoplasts are colourless and help to store starch, oil and protein molecules. Chloroplasts are green and contain chlorophyll pigments that are responsible for photosynthesis.

Structure of chloroplast

Each chloroplast consists of a double membraned envelope and a matrix. The inner membrane is arranged along the length of the plastids as lamellae. At certain regions, the lamellae are thickened and appear like a pile of coins. These are called the grana. Each granum consists of disc-shaped membranous sacs called thylakoids.

The photosynthetic pigment chlorophyll is located in the thylakoid membranes.

The non-thylakoid portion of the matrix is called stroma. It contains a number of enzymes involved in photosynthesis.



Chloroplast

Centrosome

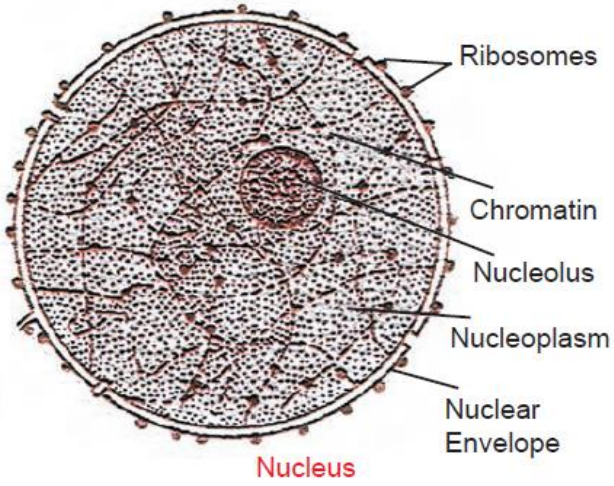
Centrosome is present in animal cells and in certain lower plants. It is absent in prokaryotic cells and higher plant cells. It is located in the cytoplasm, just outside the nucleus and contains a pair of small, hollow granules called centrioles.

Functions

Centrioles play an important role in the formation of spindle fibres during cell division.

Nucleus

A nucleus is commonly seen as a spherical structure surrounded by a double membrane called the nuclear envelope.



The nuclear envelope has a large number of holes or 'pores' that allow the cell to move molecules across the nuclear envelope and in and out of the nucleus. The nucleus performs two important functions. It controls the activity of the cell by determining what proteins are produced and when they are produced by the cell; and it also stores the genetic information of the cell, which is then passed on to daughter cells during cell division.

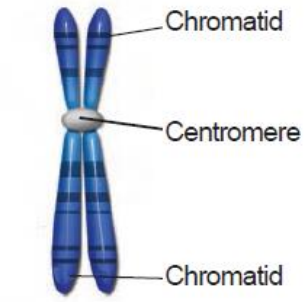
The nucleoplasm has two types of nuclear structures:
i) the nucleolus ii) the chromatin.

The nucleolus is a spherical body rich in protein and RNA. It is the site of ribosome formation. There may be one or more nucleoli in the nucleoplasm.

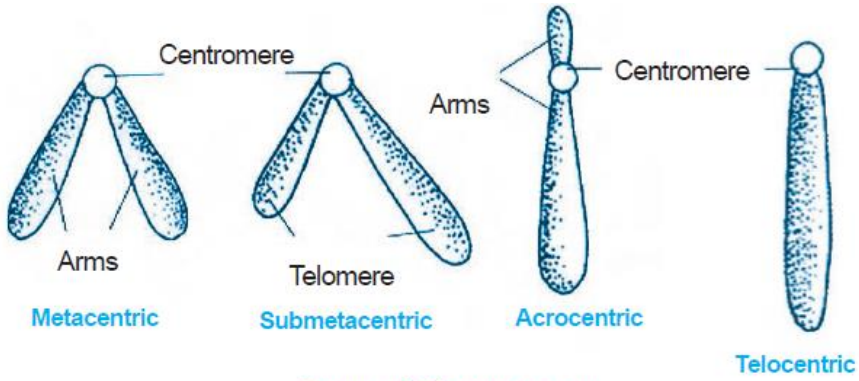
The genetic information is in the form of a chromatin network of fine threads composed of genetic material DNA (Deoxy ribonucleic acid) and proteins. During cell division, chromatin is condensed into thick cord like structures called Chromosomes. The chromosomes contain genes and each gene is responsible for one hereditary character of the organism. Genes contain information for inheritance of features from parents to next generation in the form of DNA molecule.

CHROMOSOMES

Chromosomes are the tightly coiled strands of genetic material that are visible as chromatin fibres only during cell division.



Structure of Chromosome



Types of Chromosomes

A chromosome can separate itself into two halves called chromatids. When separate, both sister hromatids remain attached to each other at the centromere, also known as the kinetochore.

Based on the location of the centromere, the chromosome can be grouped into four types:

1. Metacentric Chromosome: The centromere lies in the middle of the chromosome and the two arms are almost equal in length. It is a V-shaped chromosome.

2. Submetacentric Chromosome: The centromere lies slightly away from the middle of the chromosome and hence, its one arm is slightly shorter than the other. It is a 'J' shaped chromosome.

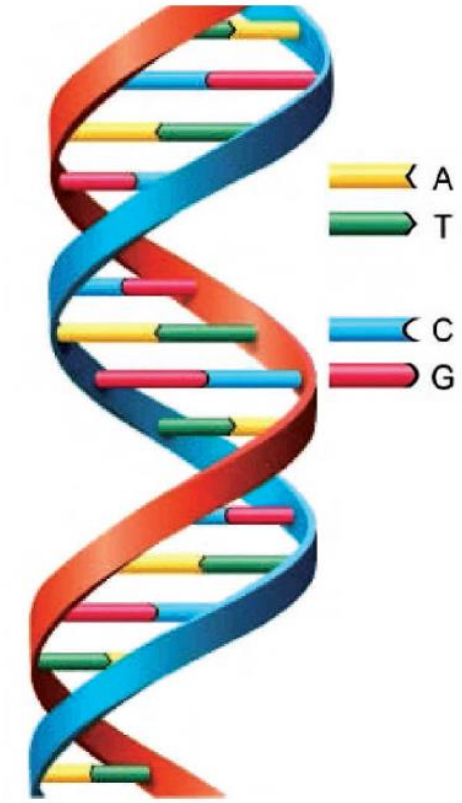
3. Acrocentric chromosome: The centromere lies near the end and hence, one arm is very short and the other arm is very long. It is a rod-shaped chromosome.

4. Telocentric Chromosome: The centromere lies at one end of the chromosome and hence, there is only one arm on one side. It is also a rodshaped chromosome.

DNA

Chromosomes are made of a long series of structures called genes.Genes are made of a chemical called Deoxyribo Nucleic Acid or DNA.

Each DNA strand is made up of millions of nucleotides. Each nucleotide is made up of a pentose sugar, a phosphate group and a nitrogenous base.



DNA Structure

The nitrogenous bases are of two kinds- Purines and Pyrimidines. Adenine and Guanine are the purines and Thymine and Cytosine are the pyrimidines.

The structure of DNA was proposed by Watson and Crick. DNA is a double stranded structure in which the two strands are coiled around each other forming a double helix.

The backbone of the helix is formed of sugar and phosphate molecules. The nitrogenous bases are attached to sugar molecules.

The two poly-nucleotide strands are held together by hydrogen bonds between specific pairs of purines and pyrimidines.

The phosphate and sugar molecules are same throughout the DNA strand but the nitrogenous bases change between any two of the purines and pyrimidines.

CELL DIVISION AND TYPES

One of the most important characteristics of a living being is its ability to reproduce. The process of reproduction involves an increase in the number of cells by cell division. New cells can arise from pre-existing cells only through the process of cell division. Cell multiplication is needed for growth, development and repair of the body.

Cells divide by three different methods. They are Amitosis, Mitosis and Meiosis. In each case, division of nucleus occurs before the division of cytoplasm.

Amitosis (Direct division)

Amitosis is a simple method of cell division. It is also called direct cell division. The nucleus elongates and develops a constriction around its middle. The constriction gradually deepens and finally divides the nucleus into two daughter nuclei. This is followed by the constriction of the cytoplasm to form two daughter cells. This type of cell division is common in prokaryotes.
(e.g. Bacteria, Amoeba)

Mitosis (or) Indirect cell division:

Mitosis takes place in somatic cells (body cells other than sperm and ovum). It is a continuous process and takes place in four phases. They are Prophase, Metaphase, Anaphase and Telophase.

Interphase

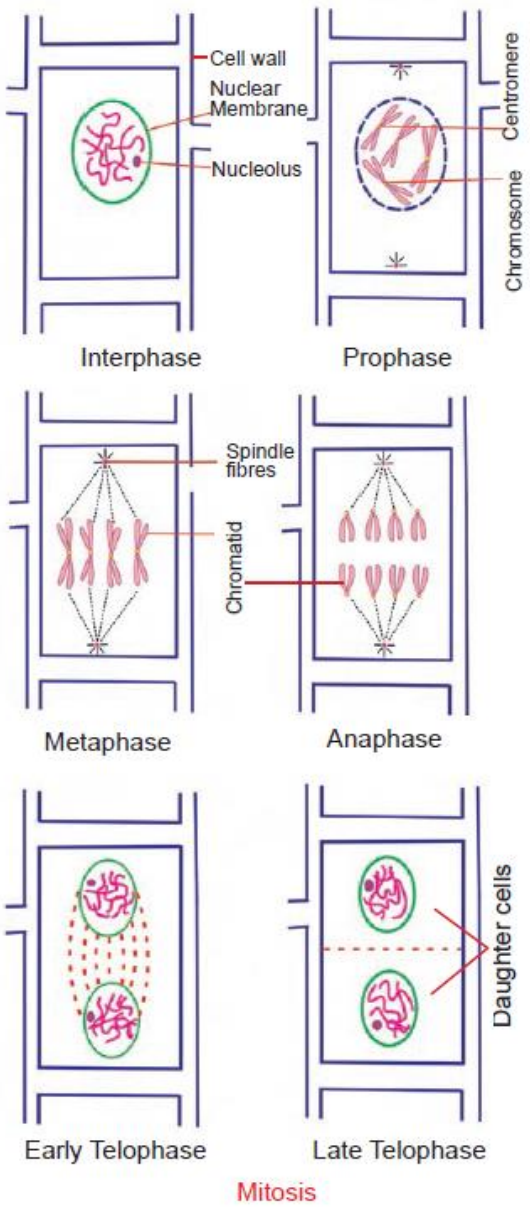
Before a cell undergoes mitotic division, it prepares itself for the division. This phase is called interphase. The chromatin material duplicates due to duplication of nucleic acids.

Prophase

- Chromatid fibres begin to coil and appear as long thread-like structures called chromosomes.
- Each chromosome consists of two chromatids that lie side by side and are joined along a point called centromere.
- Spindle fibres are developed from the poles towards the centre. Nuclear membrane and nucleolus start disappearing.

Metaphase

- The nuclear membrane totally disappears.
- Chromosomes become shorter and thicker.
- The chromatids move to the centre of the cell with their centromeres.
- Centromeres are attached to the spindle fibres.



Mitosis

Anaphase

- The centromere of each chromosome divides into two.
- When each chromatid gets a centromere, it becomes a chromosome.
- One of these chromosomes moves to one pole and the other towards the opposite pole by the contraction of spindle fibres.

Telophase

- The daughter chromosomes reach the poles.
- The nucleolus and nuclear membrane reappear and thus two daughter nuclei are formed at the two poles of the cell.
- The spindle fibres disappear.
- This division of nucleus is called Karyokinesis.

Cytokinesis

- The division of cytoplasm is called cytokinesis.
- In plant cells, the cytoplasmic division occurs by the formation of a cell plate at the centre of the cell between the two daughter nuclei. Thus at the end of mitosis, two identical daughter cells are formed.

Meiosis

Meiosis is a type of cell division which takes place in the reproductive cells of organisms. This results in the formation of gametes.

DIFFUSION OR EXCHANGE OF SUBSTANCES BETWEEN CELLS AND THEIR ENVIRONMENT

Materials are constantly exchanged between the cytoplasm and external environment across the plasma membrane by different processes. This transport across the membranes may be passive or active.

Passive transport happens when a substance moves across a membrane from a region of higher concentration to lower concentration. It does not require any metabolic energy.

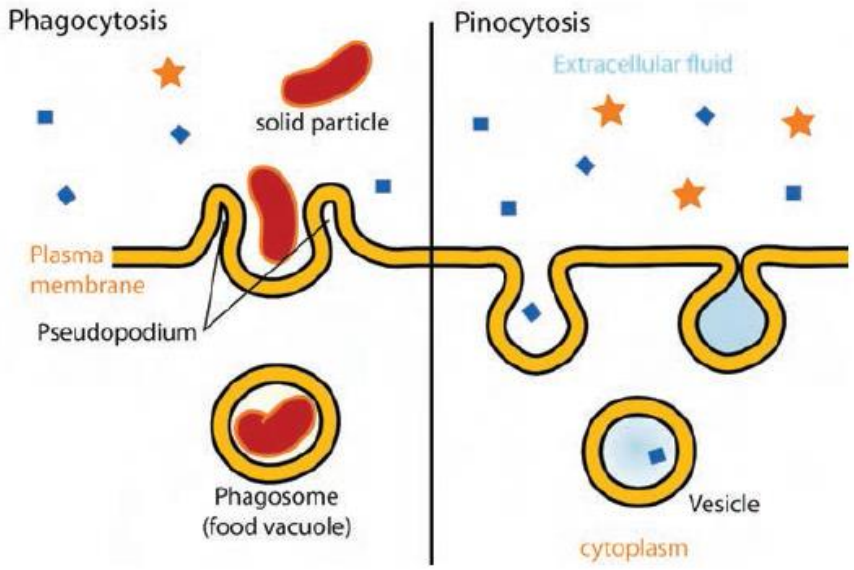
Osmosis, simple diffusion and facilitated diffusion are examples of passive movement of molecules.

The process by which the water molecules pass through a membrane from a region of higher water concentration to the region of lower water concentration is known as osmosis. The process in which the water molecules enter into the cell is known as endosmosis. The process in which the water molecules move out of the cell is known as exosmosis. In plant cells, due to excessive exosmosis, the cytoplasm along with the plasma membrane shrinks away from the cell wall. This process is known as plasmolysis.

During simple diffusion, molecules of gases such as oxygen and carbon dioxide enter the cell through the plasma membrane without the help of any other intermediary element.

When a substance takes the help of an intermediary element or a protein molecule to pass through a membrane, it is said to be a facilitated diffusion.

Substances are also transported across membranes from a region of lower concentration to higher concentration. This requires the use of energy molecules, like Adenosine Tri Phosphate or ATP. This type of movement across membranes is called active transport.



Materials can also enter or exit a cell without passing through the cell membrane. In endocytosis, the cell membrane takes a substance into the cell by folding inwards and forming a vesicle that encloses the substance. Lysosomes take substances or aging organelles in, by the process of endocytosis.

If a substance within a cell is enclosed in a vesicle and carried to the plasma membrane to be released outside the cell, it is said to be exocytosis. Enzymes and hormones are secreted by cells through the process of exocytosis.

During phagocytosis substances are taken up in solid form. Cells which involve in this process are called phagocytes and said to be phagocytic. (e.g. white blood cells). Cells take in liquids continuously through microscopic capillary structures on their cell membranes. This method of transport of substances is called pinocytosis.

45] Is Matter Around Us Pure?

Matter

The entire world that we see, touch and feel around us is made up of matter. The fragrant fresh air that we breathe, the beautiful flowers and trees around us, the tasty fruits that we eat, the pets that we love, the roof and walls of our houses, the ground that we walk on and why, even our own bodies are all made up of matter. Matter occupies space. In other words matter has volume. Some are large and some are small.

The quantity of matter contained in any object is referred to as mass. Hence, each and every matter is characterized by mass and volume.

All matter exists in any one of the three states - solid, liquid or gas. These are often referred to as the three physical states of matter.

Classification of Matter:

1. According to physical state as solid, liquid and gas.

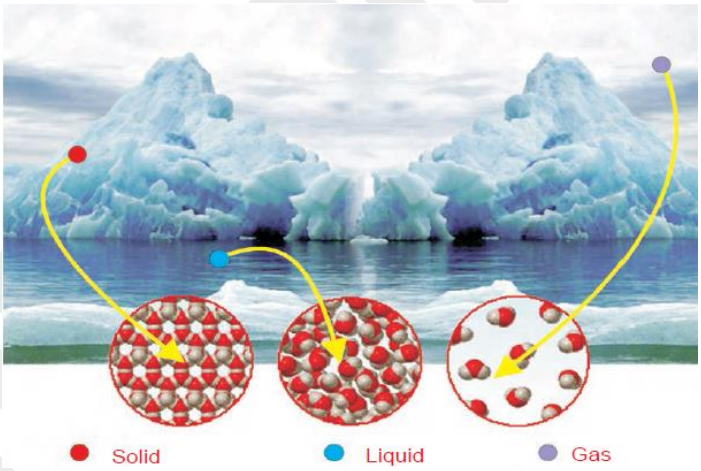
2. According to its composition as element, compound and mixture.

Physical States of Matter

Solid: Solids have a definite shape and a definite volume. They take a lot of energy to change the shape. They are rigid and not compressed appreciably even at high pressures. They usually have high densities and expand only very slightly, when heated. In a solid, the molecules are held tightly together in definite arrangements.

Liquid: Liquids have no definite shape and they take the shape of the container. They have a definite volume. They are not appreciably compressed by moderate pressures. They expand more than solids on heating and change into the gaseous state. They have lower densities than solids.

Gas: Gases have no definite shape. They take the shape of the containing vessel. Gases have no definite volume. They have the property to occupy the entire space available to them. They are easily compressed by even small pressures and also expand more than liquids on heating.
They have low densities.



Purity of Matter

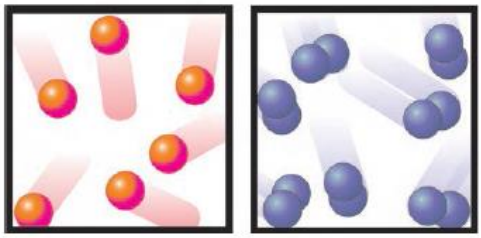
Substances rarely exist in a pure form in nature. They are often mixed with many other substances or materials. Their physical properties and chemical properties are either altered or not clearly visible because of the presence of other substances. **A pure substance is a distinct type of matter that has the same properties (physical and chemical) throughout the sample.**

Elements, Compounds and Mixtures

According to its composition, matter can be classified as an element, a compound and a mixture.

Elements

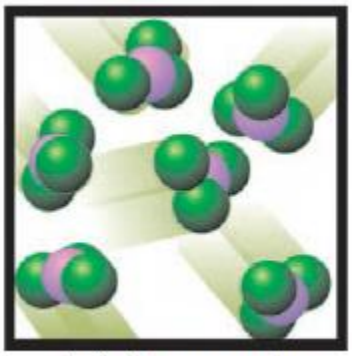
An element is the simplest substance that cannot be broken down chemically. When it is pure, the smallest unit of an element that displays all the properties of that element is an atom. Atoms of the same element may be visualized as similar looking tiny little objects, (figure (a) below) each particle having the same physical and chemical properties as well. Many elements especially gases do not exist as single atoms. They exist in clusters (usually identical clusters of two or three atoms) as shown in figure (b) below. Examples of such elements are hydrogen and oxygen.



(a) Atoms (b) Molecules

Compounds

Compounds are substances resulting from the chemical combination of two or more elements in fixed proportions. The elements in compounds are chemically bonded to each other. The physical and chemical properties of such compounds do not resemble the properties of any of the constituent elements. For example, when hydrogen gas and oxygen gas are stored together in a container in the ratio 2:1 by volume, under certain conditions they would explosively combine to form water which is a liquid and has physical and chemical properties that are totally different from those of either hydrogen or oxygen. Water is a chemical compound. A molecule can be broken down chemically into atoms of the constituent elements. (figure (c)).



(c) Compounds

MIXTURES

When two or more substances are mixed together and the substances retain their individual original identities, the combination is called a mixture. For example, if you mix sand and water, sand retains its own properties and water retains its own properties. In a mixture, two or more substances are brought together but no chemical reaction takes place.

The purity of a substance is often determined by measuring its physical properties. For example, a colourless, odourless, tasteless liquid which at atmospheric pressure, boils at 100° C, freezes at 0° C and has a density of 1.0 g cm^{-3} is water. A pure substance can exist as an element or a compound.

For example, if hydrogen and oxygen, in any ratio are mixed together in a container gently at low temperature in the absence of a spark, no chemical reaction would take place and the mixture would display the physical and chemical properties of hydrogen and oxygen.

CHARACTERISTICS OF MIXTURES

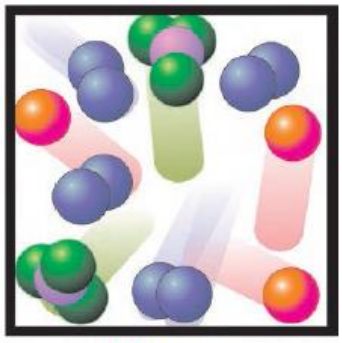
Mixtures may consist of substances in the same or different physical states. For example, bronze is an alloy consisting of the two solid metals, copper and tin; both are in the solid state. Most common solutions are mixtures of a solid in a liquid. For example, salt dissolved in water.

Mixtures are not pure substances, since they are neither a single type of distinct matter nor do they display a single set of physical and chemical properties throughout the whole sample.

As shown in figure (d) below, we can imagine mixtures to be different types of atoms or molecules held together but essentially retaining their individual physical and chemical properties.

In mixtures, elements are physically mixed in any ratio and no new compound is formed.

The substances that form a mixture are called **constituents** or **components.**



(d) Mixture

Types of mixtures	Examples
Solid in solid	Coins, alloys
Solid in liquid	Seawater
Solid in Gas	Smoke (carbon particles in air)
Liquid in solid	Amalgam (metal + mercury)
Liquid in liquid	Alcohol and water
Liquid in gas	Cloud, fog
Gas in solid	Gas absorbed by charcoal

Gas in liquid	Soda drinks
Gas in gas	Air

The lead in your pencil is actually a form of carbon called graphite mixed with clay.

The Law of Constant Composition

A pure compound always contains the same elements combined together in the same definite proportions by weight, irrespective of its method of preparation.

Is water a mixture or a compound?

Water is a compound because of the following reasons.

- It is homogeneous.
- It has definite physical constants such as boiling point, freezing point, density, etc.
- The properties of water are entirely different from those of its constituents, i.e, hydrogen and oxygen.
- Water has a definite composition by mass. The ratio of H:O by mass is 1:8.

Is air a mixture or a compound?

Air is a mixture because of the following reasons.

- Air does not have a fixed composition. The composition of air varies from place to place.
- Artificial air can be made by mixing the various components of air in the same proportions in which they occur at a place, and when this is done, no energy changes are noticed.
- The components of air can be separated by a physical method such as fractional distillation of liquid air.
- Liquid air does not have a definite boiling point. It boils over a range of temperature between -196ºC and -183ºC.
- If air is a compound, the composition of air expelled from humans should not be different from the composition of air around us. But it is known that during respiration, the exhaled air has lower percentage of oxygen than the ordinary air.

Composition of inhaled air and exhaled air during respiration.

Inhaled Air	**Exhaled Air**
Contains 78% nitrogen.	Contains 78% nitrogen.
Contains 20% oxygen.	Contains 16% oxygen.
Contains 0.03% Carbon dioxide.	Contains 4% Carbon dioxide.
Contains very little moisture.	Contains appreciable amount of moisture.

Composition of air

Gas	In mass %
Nitrogen	75.50%
Oxygen	23.20%
Argon	1.0%
Carbon dioxide	0.046%
Neon	Negligible
Helium	Negligible

Differences between mixture and compound

Mixture	Compound
Elements are physically mixed in any ratio and no new compound is formed.	Elements are chemically combined in a fixed ratio to form a new compound.
They have no sharp or definite melting point, boiling point, density etc.	They have definite melting point, boiling point, density etc.
A mixture exhibits the properties of its constituent or component elements.	Property of a compound is different from its constituent or component elements.
They are either homogeneous or heterogeneous in nature.	They are always homogeneous in nature.
Constituents of a mixture can be separated by physical methods like filtration, magnetic separation etc.	Constituents of a compound cannot be separated by physical methods.

TYPES OF MIXTURES

There are two types of mixtures. They are:

1. Homogeneous mixture
2. Heterogeneous mixture

Homogeneous mixtures and their types

Homogeneous mixtures consist of a uniform distribution of the substances throughout the mixture. Samples taken from any part of the mixture would have the same ratio of the ingredient substances and the same physical and chemical properties, although the properties of different samples may be different. Air is a homogeneous mixture of nitrogen, oxygen, argon and other traces of gases.

There are three types of homogeneous mixtures.

Solid homogeneous mixture - e.g. Alloys

Liquid homogeneous mixture - e.g. Alcohol in water

Gaseous homogeneous mixture - e.g. Air

Homogeneous Mixtures

Salt in water A cup of tea

Heterogeneous mixtures and their types

Heterogeneous mixtures do not have a uniform composition. For example, if you take dilute buttermilk in a vessel and leave it undisturbed for some time, the particles will settle at the bottom and the water will remain on the top. The composition is not uniform. The ingredients of a heterogeneous mixture need not necessarily be in the same

state - gas, liquid or solid.

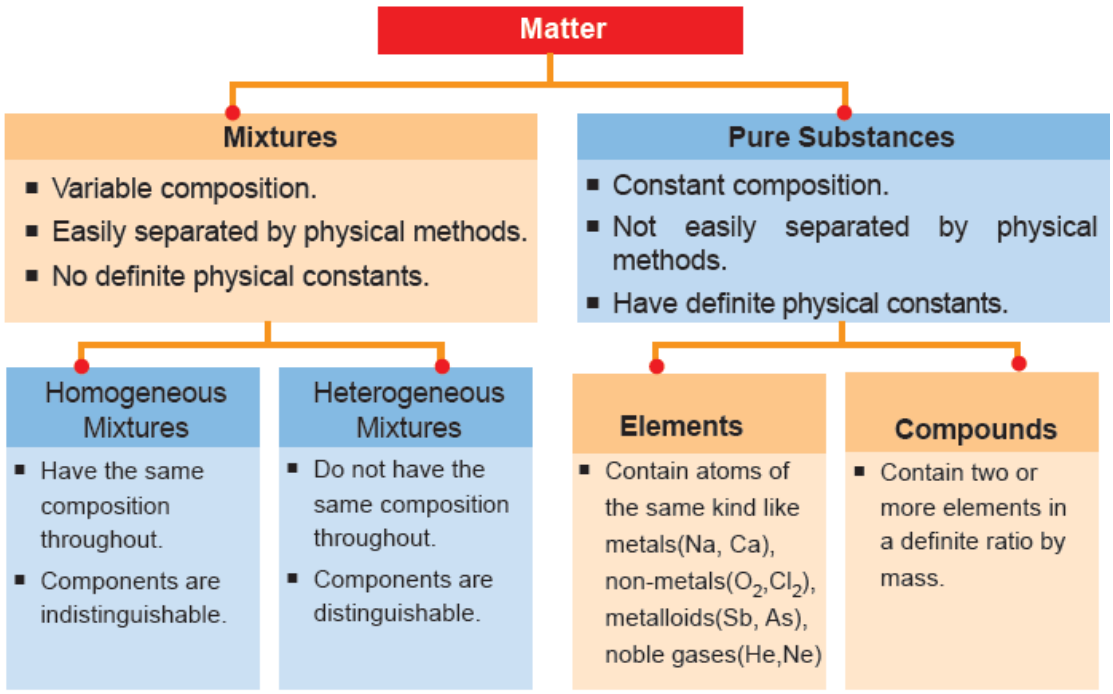
Solid - solid heterogeneous mixture - mixture of sugar and salt

Solid - liquid heterogeneous mixture - chalk powder in water.

Gas - gas heterogeneous mixture - smoke in air.

Liquid - liquid heterogeneous mixture - kerosene in water.

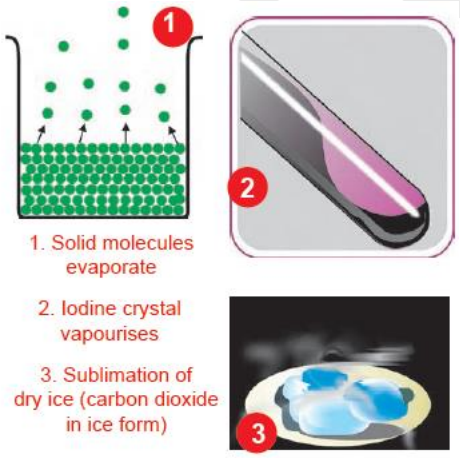
CLASSIFICATION OF MATTER



SEPARATION OF DIFFERENT COMPONENTS OF A MIXTURE

Mixtures can be separated by simple physical procedures. To be able to separate the ingredients of a mixture, we would need to know the physical properties of the individual ingredients. Using the properties that are distinct and different, we can separate them. For example, if both the ingredients of a mixture are soluble in water then we cannot separate the ingredients. However, if we know that the melting point of two ingredients are different, then we can use that knowledge to separate the ingredients. A good knowledge of physical properties is therefore very important. Separation of heterogeneous mixture.

1. **Decantation:** Used to separate a liquid from a solid (present as large particles) that does not dissolve in it.
2. **Filtration:** Used to separate a liquid from a solid (present as very small particles) which does not dissolve in the liquid.
3. **Sublimation:** Used to separate a volatile solid substance from a mixture containing a non-volatile solid substance.
4. **Separating funnel:** Used to separate two completely immiscible liquids.



Separation of mixtures by sublimation

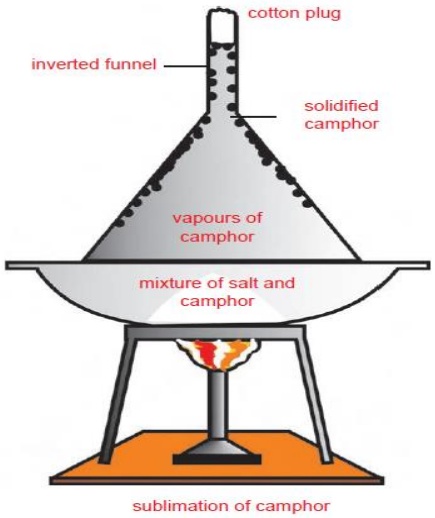
Sublimation is defined as a process, in which a substance in solid state is directly converted into vapour state.

At high temperature, the molecules of volatile solid move far away from each other changing the solid substance into vapour.

Consider a mixture containing **common salt and camphor**. Both common salt and camphor are solid substances. Common salt is a non-volatile substance. It does not undergo sublimation. Camphor undergoes sublimation. Hence camphor can be separated from common salt by sublimation.

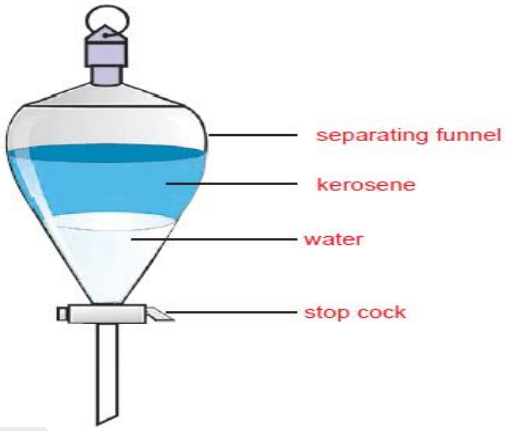
More to know

Solids that undergo sublimation are camphor, naphthalene, benzoic acid, iodine and ammonium chloride.



Separation of a mixture containing immiscible liquids

Immiscible liquids are usually separated by using a "separating funnel".



Consider a mixture containing kerosene and water. Both the liquids are immiscible with each other. By using a separating funnel, one liquid can be separated from the other. Less denser liquid remains in the upper layer while high denser liquid remains in the lower layer.

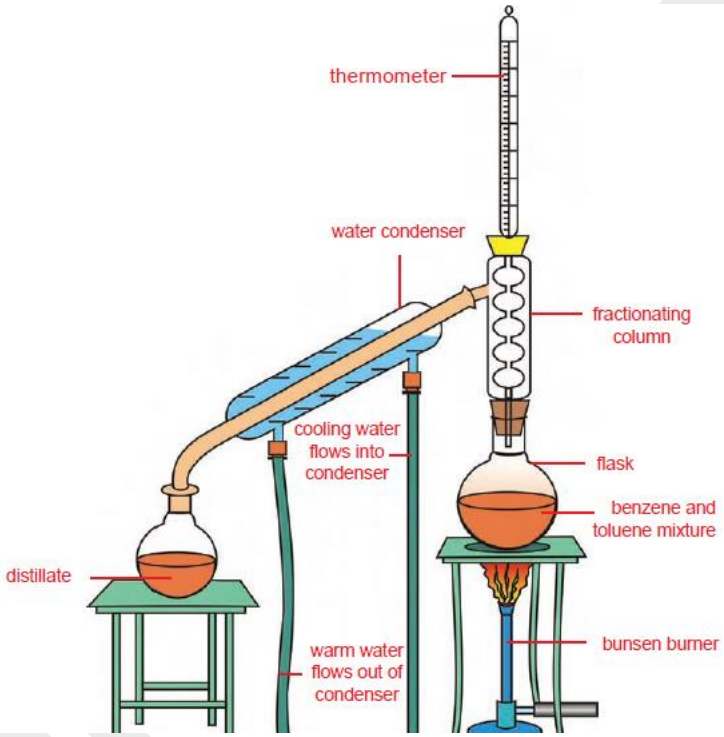
SEPARATION OF HOMOGENEOUS MIXTURE

1. Distillation: Used to separate a non-volatile solid and a volatile liquid mixed together in a solution.
2. Fractional distillation: Used for separating a mixture containing two or more liquids with an appreciable difference in their boiling points.
3. Chromatography: Separation of two or more dissolved solids can be carried out by chromatography. It can be used to separate samples as small as a pictogram (10-12 g) and as large as several ions. It involves the distribution of solutes between a moving phase and a non-moving or stationary phase.

Separation of a mixture containing miscible liquids

Fractional distillation is a suitable method for separation of a mixture containing miscible liquids. It works on the principle that the two liquids should vary in their boiling points by 25 K.

- Consider a mixture containing two liquids namely benzene and toluene.
- Both the liquids are miscible with one another.
- They can be separated by fractional distillation.
- Boiling point of benzene is 353 K.
- Boiling point of toluene is 384 K.
- The difference in their boiling points is 31 K.



FILTRATION PROCESSES ADOPTED IN VARIOUS FIELDS:

1. ***Carbon filter:*** *Powdered charcoal can be formed in such a way as to be full of tiny holes, which serves as a filter. As air is drawn through the holes, the charcoal traps gases and chemicals . Such carbon filters are put in the gas masks used by soldiers and firefighters.*
2. ***Air-Conditioning filter:*** *It circulates the air with fans and removes dust from air.*
3. ***Automobile filter:*** *Filters in the fuel line clean the fuel but they can block the flow of fuel, when they get clogged with dirt.*
4. ***Water filter:*** *Particles of matter suspended in water are removed by the use of chemicals like chlorine, potash alum and powdered carbon and filtered through beds of sand or porous separation.*

Identification of element, compound and mixture.