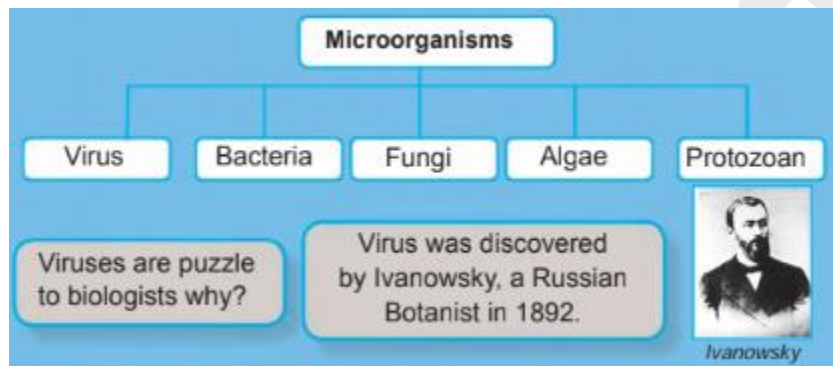


Science Notes Part 31 To 35

31] Microorganisms

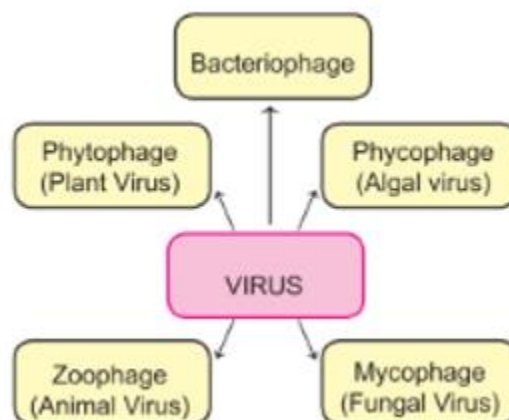
VIRUS

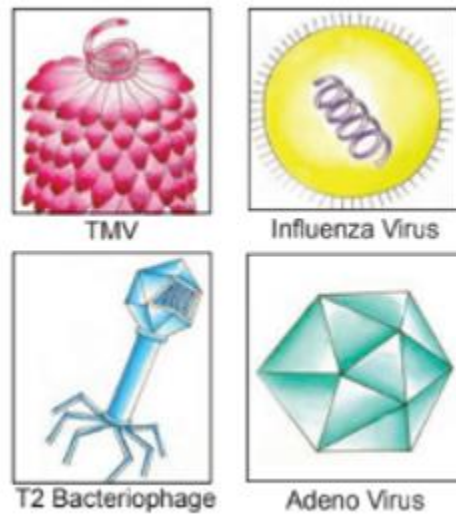
Virus is a Latin word which means poison. Viruses are the smallest and simplest of all living organisms. The study of viruses is called Virology. Viruses show both living and non-living characteristics. They are considered as being on the border line between living and non-living organisms.



The living cell inside which the virus grows and multiplies is known as host cell. Outside the host cell, viruses do not show any of the characteristics of living organisms.

Based on their host, viruses are classified into five types.



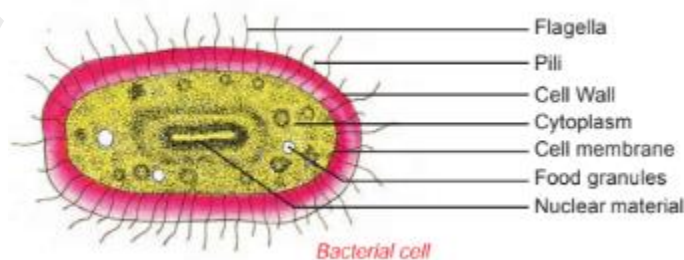


BACTERIA

The curd contains Lacto bacillus bacteria which helps to change the milk into curd. Let us now study about bacteria. Bacteria are unicellular and microscopic, belonging to the world of microbes. The study of bacteria is called Bacteriology. Bacteria were first observed under a microscope by the Dutch Scientist Anton Von Leeuwenhoek in 1675. Later, Louis Pasteur, Robert Koch and Lord Lister carried out detailed studies on bacteria.

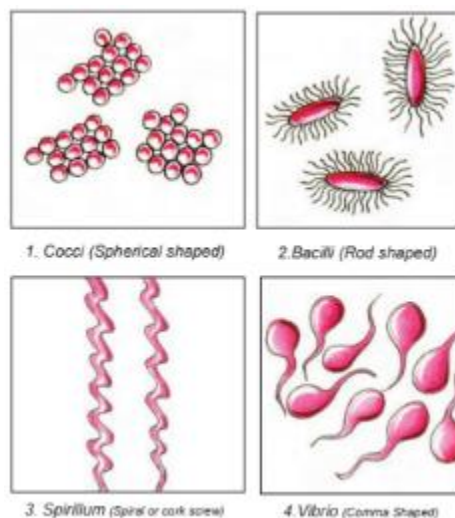
The structure of bacteria can be studied with the help of an electron microscope. The bacterial cell is a prokaryotic cell. It has a rigid cell wall protecting the cell and giving a definite shape to it. The living material inner the cell wall is called protoplasm. It is differentiated into cell membrane, nuclear material and cytoplasm.

Membrane bound organelles like golgi bodies, mitochondria, endoplasmic reticulum, lysosomes are absent. It contains bacteriochlorophyll pigments. The nuclear material of a bacterial cell is made of a circular, DNA molecule. It is not bound by nuclear membrane.



There are thread like appendages which are called flagella, the organs of motility. Pili are minute, straight, hair like appendages and are considered to be organs of attachment.

Bacteria are measured in microns. 1 micron = 1/1000 millimetre.

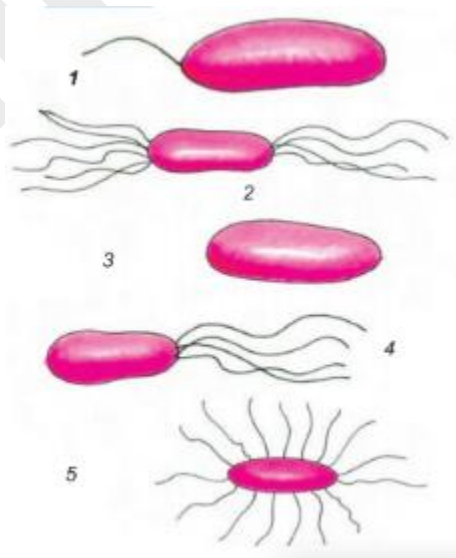


Four types of bacteria are recognised based on shape. They are

1. Cocci (Spherical shaped)
2. Bacilli (Rod shaped)
3. Spirillum (Spiral or cork screw)
4. Vibrio (Comma Shaped)

On the basis of the number and arrangement of the flagella, bacteria are classified as

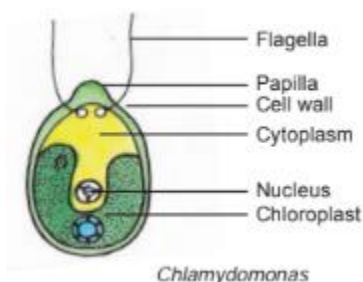
1. Monotrichous (Single flagellum at one end)



2. Amphitrichous (Tuft of flagella arising at both ends).

3. Atrichous (Without any flagella).
4. Lophotrichous (Tuft of flagella at one end).
5. Peritrichous (Flagella all around).

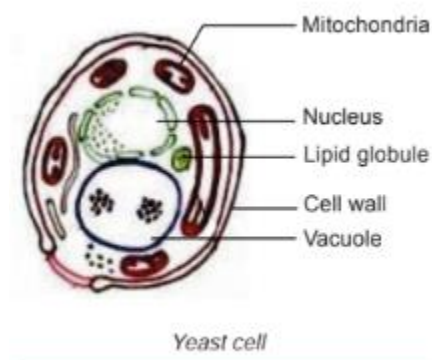
ALGAE

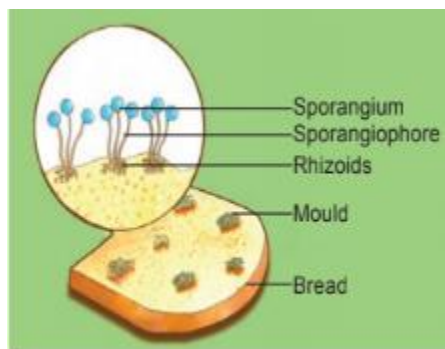


Chlamydomonas is a unicellular green algae. It is spherical or oval in shape. The protoplasm is surrounded by a cellulose cell wall. The cell wall may have a pectic sheath around it. There is a single large cup-shaped chloroplast. Inside the chloroplast a pyrenoid which contains starch may be present. There are two flagellae at the narrow end of the cell which helps in locomotion. There may be a vacuole at the base of the flagella. An eye spot is located at the anterior end. Based on the presence of other pigments, algae are classified into four classes. The study of algae is called Phycology which you have studied in the previous chapter.

FUNGI

The conversion of sugar solution into alcohol and liberation of carbon dioxide is known as fermentation. Here the sugar solution is fermented and gives a smell. Wine, alcohols are prepared from the molasses by the fermentation activity of the yeast. etc.

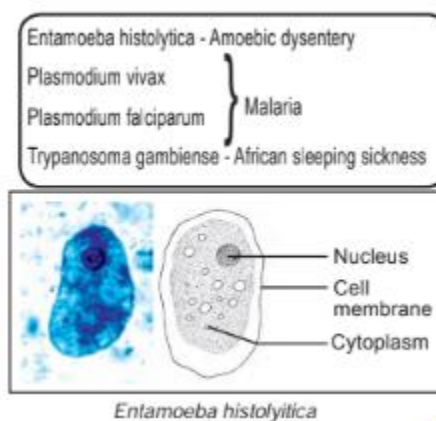




Bread mould

Yeast is a unicellular, saprophytic fungus. The cell is oval shaped. The nucleus is seen at one end of the vacuole. The cytoplasm shows the presence of organelles like endoplasmic reticulum, ribosome, mitochondria, etc., Fungi do not possess chlorophyll. Hence they are incapable of photosynthesis. The study of fungi is called Mycology. They lead a parasitic or saprophytic mode of life.

A black powdery spot with a network of thread like filaments, called hyphae is called mycelium (bread mould) which changes the colour of the bread.



PROTOZOA

Protozoans are unicellular organisms. Metabolic activities are done by organelles. Protozoans show mainly two modes of life, free living and parasitic. Free living organisms inhabit fresh and salt water. Parasitic forms live as ectoparasites or endoparasites. They cause diseases.



Alexander Fleming of Britain
in 1928 discovered the 'Wonder'
Drug 'Penicillin'.

Uses of Microorganisms IN MEDICINE, agriculture, industry and daily living. Microorganisms are used in the manufacture of antibiotics, linen, bread, wine, beer and the other industries. Microorganisms are used to enrich the soil fertility.

Name of the Species		Antibiotic
Bacteria	<i>Streptomyces griseus</i>	Streptomycin
	<i>Bacillus subtilis</i>	Bacitracin



Penicillium notatum

Fungi	<i>Penicillium notatum</i>	Penicillin
	<i>Penicillium chrysogenum</i>	



Penicillin

What is antibiotic?

Antimicrobial agents which are useful medicines or drugs and are extracted from the microorganisms. are called antibiotics. Bacteria, Fungi are used to make antibiotics, vaccines, etc.

AGRICULTURE

Agriculture :- The science that deals with the growth of plants and animals for human use is called agriculture.

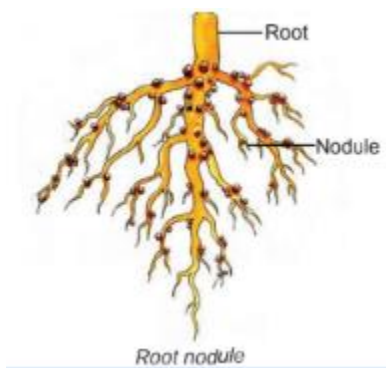
It may be defined as the science or practice of farming. Agriculture depends on soil fertility. Micro-organisms like bacteria, fungi, few algae enrich the soil fertility. Nitrogen is essential for all life.

Bacteria convert complex proteins in the dead bodies of plants and animals into ammonia, nitrites and nitrates. Bacteria play a major role in the cycling of elements like carbon, oxygen, nitrogen and sulphur as biological scavengers. They oxidize the organic compounds and set free the locked up carbon as carbon dioxide due to which we smell the foul odour.

The following bacteria are involved in enriching soil fertility:

Ammonifying bacteria:- e.g., *Bacillus ramosus*

Nitrifying bacteria:- e.g., *Nitrobacter*, *Nitrosomonas*.



Nitrogen-fixing bacteria:- e.g., *Azotobacter*, *Clostridium*, *Rhizobium* (Root nodules bacteria). Various blue green algae like *Oscillatoria*, *Anabaena* and *Nostoc* increase the soil fertility by fixing atmospheric nitrogen.

Role of microorganisms in industry and daily living.

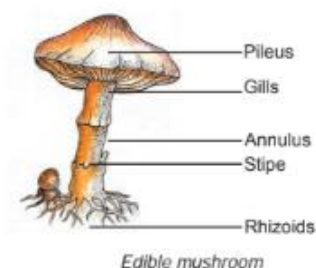
1. Curing of tea/Coffee: The leaves of tea, tobacco, the beans of coffee and cocoa are fermented by the activity of *Bacillus megaterium* to impart the characteristic flavour. This is called curing.

In the world today many industries totally depend upon the microbial activities of microorganisms such as Lactic acid bacteria.

2. Production of Vinegar: *Lactobacillus lactis* (lactic acid bacteria) converts milk protein into curd. Vinegar is manufactured from sugar solution employing *Acetobacter aceti* by the fermentation process.

3. Production of Alcohol: Butyl alcohol, methyl alcohols are prepared from molasses by the fermentation activity of *Clostridium acetobutylicum*. Alginic acid is obtained from brown algae.

4. Production of Oxalic acid: Oxalic acid is the fermentation product of fungi *Aspergillus niger*. Yeast is the best source of vitamin B complex and vitamin Riboflavin. Mushroom is also an edible (e.g.) *Agaricus*, *Morchella* are edible and are cultivated.



Chlorella and Spirulina are used as protein sources. Hence they are known as single cell protein.

Harmful microorganisms

Microorganisms cause damage to the plants and food materials. They contaminate food, which leads to food poisoning. Influence of microorganism on plants and animals reduce the market value of their product. The various harmful activities of bacteria, fungi and virus are given in the table.

- Fruits, Vegetables, fish, meat, milk, etc., are perishable foods.
- Wheat, rice, maize, pulses, sugar are non-perishable foods. Some times food is unfit for our consumption. Why?

The diseases caused by Microorganisms in Plants

S. No	Micro-organisms	Name of the Species	Diseases
1	BACTERIA	<i>Xanthomonas citri</i> <i>Pseudomonas solanacearum</i> <i>Xanthomonas oryzae</i>	Citrus Canker Wilt of Potato Bacterial blight in Rice
2	FUNGI	<i>Cercospora personata</i> <i>Cercospora arachidicola</i> <i>Pyricularia oryzae</i>	Tikka disease of groundnut Blast disease of rice
3	VIRUS	Bunchy Top Virus Tobacco Mosaic Virus Cucumber Mosaic Virus	Bunchy top of Banana Tobacco Mosaic disease Cucumber Mosaic disease.

PLANT DISEASES



Citrus Canker



Blast disease of rice



Cucumber Mosaic disease

Microbes affect human lives and pose a challenge to human health." Health is wealth" is just a saying. But today we hear of Rat fever, Malaria, Swine Flu, Birds Flu, etc., How do we get infected?

Viruses, bacteria, fungi, protozoa and certain worms are the main organisms causing diseases.

To cause disease, they must first gain entry into the body. Such entry must be either through the skin or through the nose into the respiratory system or through the mouth to the alimentary canal.

The method of carrying these disease organisms to the body is varied. The carriers of disease organisms are called vectors. They are said to transmit diseases.

Some organisms pass directly through the surface of the skin. Such is the case with the spores of the fungus which causes ring worm. Bacteria frequently enter the skin through a wound, causing inflammation of the wound.

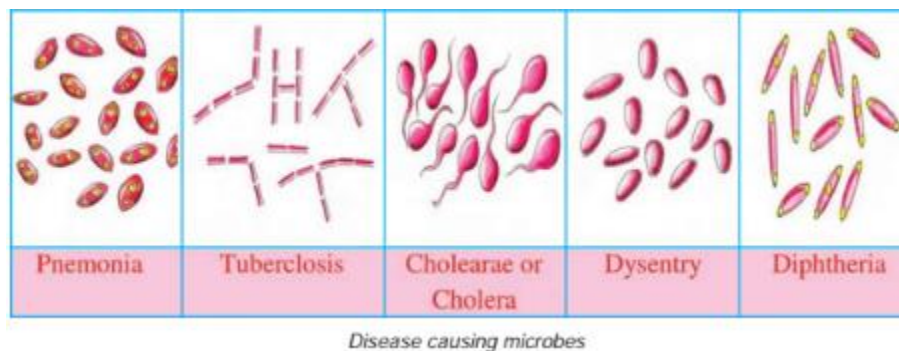
Many microorganisms enter through the nose or mouth and penetrate the delicate membranes of the respiratory system. Virus causing colds and influenza enter this way.

Parasitic bacteria, protozoans, viruses, etc., cause various communicable diseases in man.

Communicable diseases are pathogenic diseases which spread from, person to person, either directly or indirectly. The following table shows some of the common communicable diseases in man.

The diseases caused by Microorganisms in Human beings and animals

PATHOGEN	DISEASES	MODE OF TRANSMISSION
<i>VIRUS</i>	Common cold, Polio, Hepatitis, Influenza, Jaundice.	Air water, direct contact
	AIDS	Sexual Contact
<i>BACTERIA</i>	Cholera, typhoid	Contaminated water.
	Tetanus	Cuts and wounds
	Leptospirosis	Contact of animal's urine. (Rat and Squirrel)
	Leprosy	Contact (vector)
<i>FUNGI</i>	Athlete's feet	Spores in water and in ground.
<i>PROTOZOAN</i>	Malaria	Vector example mosquito



Harmful microorganisms in food and drink can be taken in through the alimentary canal unless high standards of hygiene are followed. The food may be contaminated in a variety of ways. Bacteria may enter the food causing it to go bad, if food is not properly stored. The bacteria causing cholera and typhoid and the protozoan causing amoebic dysentery are easily picked up from the infected food and water.

Disease causing microbes

Due to chemical reaction, butter milk gets spoilt if kept in a brass vessel. The starchy foods get spoilt due to change of starch into sugars by the enzymes present in the food articles.

MICROBES IN FOOD PRESERVATION

Food preservation is the process of treating and handling food to stop or greatly slow down spoilage (loss of quality, edibility or nutritive value) caused or accelerated by micro organisms. Canning, Pasteurization, refrigeration, dehydration, the use of preservatives, heating, boiling and drying are the effective methods of controlling microorganisms.

Bottling and Canning

The right types of containers have to be chosen. They are then sterilized. Preservatives such as vinegar, sodium benzoate, oil, citric acid are added to the food stuff, which is then packed and sealed properly.



What is Pasteurisation?

Pasteurisation is used to preserve milk. Milk is heated to 72°C for 30 minutes and then suddenly cooled to 12°C. Microbes are killed without causing damage to the taste, quality of milk for a longer time and packed in polythene pouches.

Dehydration: Fish, meat and vegetables with salt can be dried in the sun to reduce the moisture content and the growth of microorganisms. These are dehydrated under controlled conditions.

Relationship between man and microbes**Balances, imbalances and uses**

All existing things in the world and the universe around it made up of five basic elements, the earth, water, fire, air and space.

Human life and the knowledge of science as growing concern, have come into being almost simultaneously. In the past, man found that living in large groups was to his advantage. In his way, he had much better protection from his enemies. Man involved himself in many group activities, as a result ended up with many problems. The greatest problems of today are disease, population growth and pollution. Today in our present time, it is too late for any preventive measures because the diseases are already with us, and therefore, good medical services, conservation methods, and socio biological approaches are required.

Social Biology

Social biology is the study of how man lives with other men, with animals and plants and how he affects each of these.

Man of course has developed his knowledge and understanding about microbes to a greater extent and made use for its benefits in agriculture, soil fertility, medicine, industry and in genetic engineering.

Microbes are used as biological control. How?

Certain *Bacillus* species such as *B.thuringiensis* infect and kill the caterpillars of some butterflies and related insects. Since the bacteria do not infect other animals or plants they provide an ideal means of controlling many serious crop pests. This control measures is called as Biological control.

The role of microbes in genetic engineering**Gene transfer by virus and bacteria**

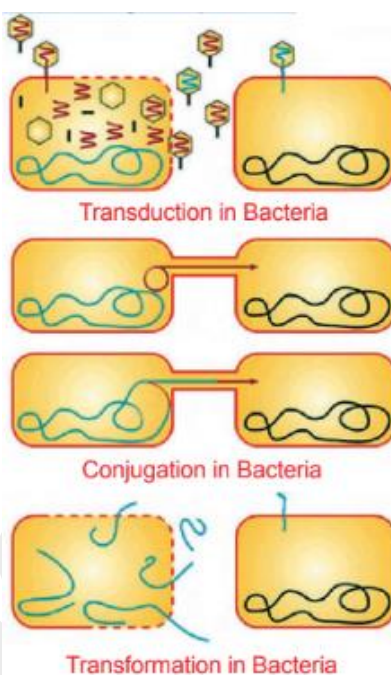
Viruses are useful in genetic engineering. Their ability to move genetic information from one cell to another makes them useful for cloning DNA and could provide a way to deliver gene therapy

(transformation). Viruses are very much used as biological research tools due to their simplicity of structure and rapid multiplication.

In order to attain the desirable

character such as insulin gene, nif gene the bacterial host such as E.coli, Bacillus subtilis and streptomyces are introduced.

By conjugation method, the fertility factor, undergoes replication.



Bacteria and nature:

Saprophytic bacteria and fungi cause decay and decomposition of dead bodies of plants and animals. They release gases and salts to the atmosphere and soil. Hence, the microorganisms like bacteria and fungi are known as Nature's scavengers.

Many bacteria like Rhizobium, Acetobacter and Clostridium can fix atmospheric nitrogen. This phenomenon is called biological nitrogen fixation.

The cyclic movements of chemicals of Biosphere between the organisms and the environment are referred as Bio - geo cycle.

Algal bloom: Under certain conditions, algae produce "blooms" i.e. dense masses of materials that cover the water surface, thereby decrease the oxygen content of water. This is followed by the death of aquatic organisms. Algal bloom leads to loss of species diversity which is known as Eutrophication.

Death of the coral reef in the ocean produces new pathogenic bacteria. Any septic operation theatre (Surgical arena) produces number of disease causing pathogens (disease causing microbes). Surgical wastes, medical wastes are dumped in catchment areas such as lakes, ponds and river banks causing communicable diseases.

Pathology is a science which deals with diseases of plants, animals and human beings caused by viruses, bacteria and fungi.

Man and microbes are in the biosphere. Man's interference with nature has caused imbalance in the biosphere. Man has to bring certain healthy changes in the field of agriculture and in industry in order to make a better habitat for his happy living with micro organisms. Let us start to create an eco-friendly nature for our better future.

32] Elements and Compounds around us

Types of pure substance

Read the above conversation. How often do we use words such as 'pure milk' and 'pure water'? Have you ever wondered what 'pure' really means?

For an ordinary person, "a pure substance" means that it is free from adulteration. In that sense, the air we breathe and the milk we drink are not pure. However, there are a few cases where the matter that we encounter in ordinary experience is pure' that is, they consists of only a single substance. Distilled water, sugar, baking soda etc. are pure substances like the copper used in electric wiring.

How to recognise a pure substance?

One can recognise a pure substance by its properties such as density, melting point, refractive index, electrical conductivity and viscosity. Then, how can we define a pure substance?

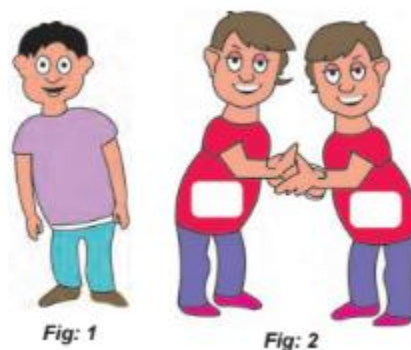
A pure substance has fixed composition and fixed properties which cannot be easily separated by physical methods.

For example, pure water boils at 100°C at one atmospheric pressure and ice freezes at 0°C . These are the properties of all samples of pure water, regardless of their origin. Pure water contains only two hydrogen atoms and an oxygen atom which cannot be separated by physical methods.

In science, a pure substance is either an element (e.g., iron) or a compound (e.g., Sodium chloride).

What is an element?

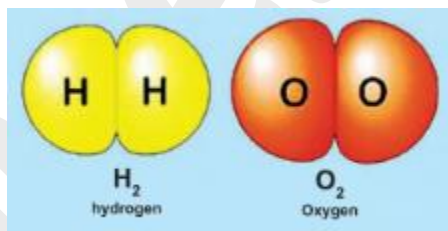
The unscrambled words such as iron, copper, gold, oxygen and carbon that we come across in our daily life are said to be elements. Look at the pictures. What do you notice? Did you notice this. In fig.1,



a boy is alone and in fig 2 two boys seem to be similar in all aspects (like twins)? Hence for analogy, we can say that both are elements. Let us see the different views of an element put forth by scientists

- An element is a pure substance that cannot be split into anything simple by physical or chemical methods. (BOYLE)
- An element is the basic form of matter that cannot be broken into a simpler substance. (LAVOISIER)
- An element is made of same kind of atoms. (Modern atomic theory)

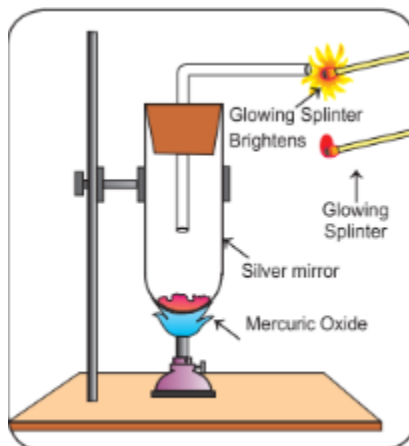
Elements and Compounds around us



Examples of elements are hydrogen, nitrogen, oxygen, carbon, aluminium, gold, silver etc. A lump of sulphur contains sulphur atoms only. Nitrogen contains atoms of nitrogen only. Copper wires contain only copper atoms.

Thus, all elements are made up of one kind of atom only. However, atoms of different elements are not identical. For example, if we compare atoms of copper and silver, we find that they differ from each other in size and internal structure.

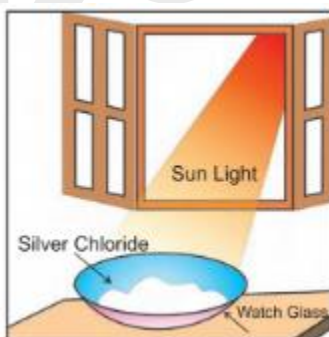
A complex substance like mercuric oxide is broken down into simpler substances, mercury and



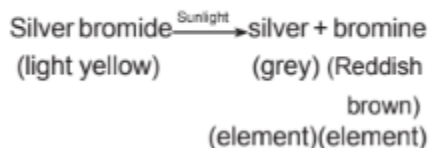
oxygen. It is not possible to split these substances any further by any other chemical method. Thus, mercury and oxygen are elements.

Mercuric oxide $\rightarrow$ Mercury (element) + Oxygen (element)

The crystal will slowly acquire grey colour. On analysis, it is found that sunlight has decomposed silver chloride into silver and chlorine (element)



you can repeat the same activity with silver bromide.



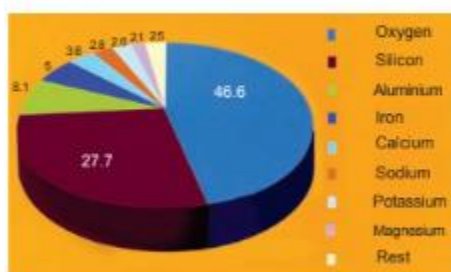
how many elements exist in nature?

There are 118 elements known at present, out of which 92 elements occur in nature and the remaining 26 have been prepared in laboratory by artificial methods. However, only 112 elements have been authenticated by IUPAC (International Union of Pure and Applied Chemistry), and are allotted symbols.

Let us see the relative abundance of various elements in earth's crust, either in free state or in the combined state.

In earth's crust, oxygen is the most abundant element followed by silicon. Together, these make up three quarters of the earth's crust.

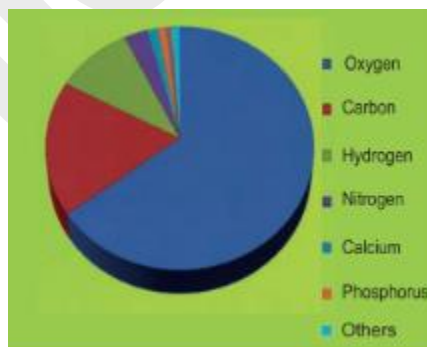
Elements and Compounds around us



Pie Diagram - Elements present in the earth's crust

Have you ever thought about the elements found in our body?

About 99% of the mass of human body is made up of six elements (oxygen, carbon, hydrogen, nitrogen, calcium and phosphorus) and the rest 1% by other elements.



Elements and Compounds around us

All the living things, both plants and animals, are made from a few elements only. They are, Oxygen (65%), Carbon (18%), Hydrogen (10%), Nitrogen (3%), Calcium (2%) along with some other elements.

Hydrogen and helium are the main elements in the universe and stars.

Classification of elements based on their physical state

Let us classify the known elements on the basis of their state of subdivision as solids, liquids and gases.

Liquids: Mercury, bromine, (at room temperature) cesium and gallium can exist in liquids around 30° C.

Gases: Hydrogen, nitrogen, oxygen, chlorine, fluorine, helium, neon, argon, krypton, radon and xenon.

Solids: Remaining elements are solids. e.g. Carbon, silicon, copper, gold etc.

Classification of elements based on properties

Now we classify the known elements on the basis of their properties as metals, non-metals and metalloids.

Metals: Of the 92 natural elements 70 elements are metals. Metals are hard lustrous (shining in appearance), malleable(can be beaten into very thin sheet) ductile(drawn into wire), good conductors of heat and electricity, and sonorous (producing sound)

e.g. Copper, gold, silver, iron etc.,

Non-metals: Only about 16-17 elements are soft, non lustrous, non-malleable, non-ductile, bad conductors of heat and electricity, and non-sonorous.

e.g. Hydrogen, oxygen, sulphur, carbon etc.,

Metalloids: Very few semi-metals are known as metalloids which shows properties of metals as well as non metals.

e.g. Boron, silicon, germanium etc.

Why symbols?

Every chemical change can be conveniently represented in the form of chemical equation. This is because describing a chemical change with the names of substances becomes difficult. So, we need symbol for an element.

What is symbol?

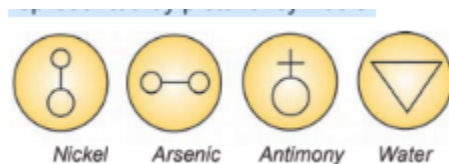
In chemistry, symbols are used to represent names of elements. A symbol is a shortened form of the name of an element. Let us learn the brief history of symbols of elements.

Greek symbols

Some earliest symbols in form of geometrical shapes were those used by the ancient Greeks to represent the four elements earth, air, fire and water.

Alchemist symbols

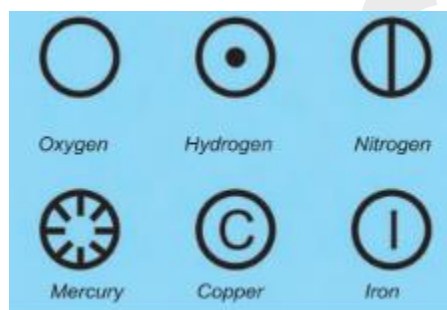
In the days of alchemists, the different materials that they used were represented by pictorial symbols.



The work of trying to change less valuable metal into gold was called alchemy, and the men who did this work were alchemists.

Dalton's symbol

In 1808, John Dalton, English scientist tried to name the various elements based on these pictorial symbols.



The uses of the above symbols are difficult to draw and inconvenient to use. Hence, Dalton's symbols are not used; it is only of historical importance.

Berzelius symbols

In 1813, Jon Jakob Berzelius, Swedish chemist devised a system using letters of alphabet. He argued that letters should be used because they could be written more easily than other signs. The modified version of Berzelius system follows under the heading

‘System for Determining Symbols of the Elements’

1. The symbols of the most common elements, mainly non-metals, use the first letter of their English name

Element	Symbol
Boron	B
Carbon	C
Fluorine	F
Hydrogen	H
Iodine	I
Nitrogen	N
Oxygen	O
Phosphorus	P
Sulphur	S
Vanadium	V
Uranium	U

2. If the name of the element has the same initial letter as another element, then symbol uses the first and second letters of their English name.

Element	Symbol
Aluminium	Al
Barium	Ba
Beryllium	Be
Bismuth	Bi
Bromine	Br
Cobalt	Co
Gallium	Ga
Helium	He
Lithium	Li
Neon	Ne
Silicon	Si

3. If the first two letters of the names of elements are the same, then the symbol consists of first letter and second or third letter of English name that they do not have in common.

Element	Symbol
Argon	Ar
Arsenic	As
Chlorine	Cl
Chromium	Cr
Calcium	Ca
Cadmium	Cd
Magnesium	Mg
Manganese	Mn

4. Some symbols are based on the old names or Latin name of the element. There are eleven elements.

Name of element	Latin name	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe
Copper	Cuprum	Cu
Silver	Argentum	Ag
Gold	Aurum	Au
Mercury	Hydrargyrum	Hg
Lead	Plumbum	Pb
Tin	Stannum	Sn
Antimony	Stibium	Sb
Tungsten	Wolfram	W

Name	Symbol	Name derived from
Americium	Am	America (Country)
Europium	Eu	Europe (Country)
Nobelium	No	Alfred Nobel (scientist)
Iodine	I	Violet (colour, greek)
Mercury	Hg	God mercury (mythologic character)
Plutonium	Pu	Pluto (planet)
Neptunium	Np	Neptune (planet)
Uranium	U	Uranus (planet)

How to write a symbol?

While writing a symbol for an element, one has to follow the method given below.

1. If the element has a single English letter as a symbol, it should be written in capital letter.
2. For elements having two letter symbols, the first letter should be in capital followed by small letter.

Significance of the symbol of an element

Symbol of an element signifies

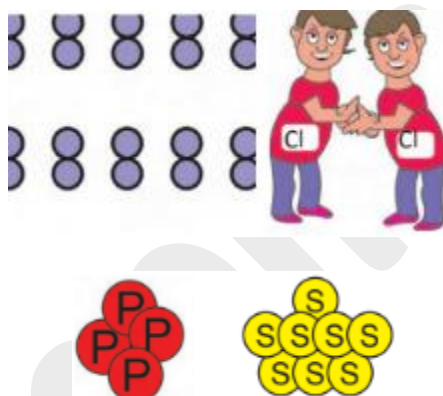
- Name of the element
- One atom of the element For example,

- The symbol N stands for the element of nitrogen
- One atom of nitrogen

MOLECULE OF AN ELEMENT

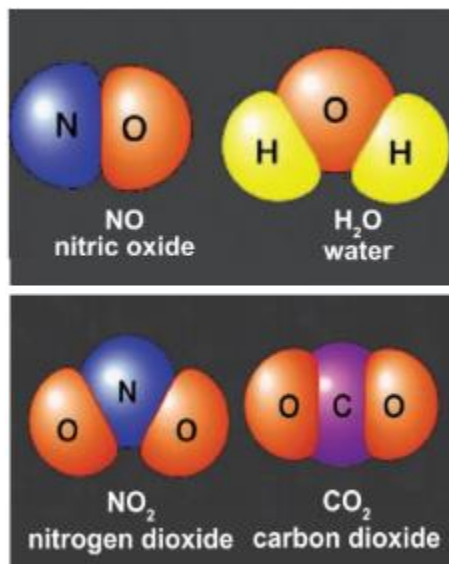
The molecule of an element contains two or more similar atoms. For example, a molecule of chlorine contains two atoms of chlorine; it is therefore written as Cl₂ (Chlorine). Similarly, a molecule of nitrogen contains two atoms of nitrogen; it is therefore written as N₂ (Nitrogen).

Molecules like chlorine and nitrogen which consist of two atoms of the same kind, are called diatomic molecules. A molecule of ozone consists of three atoms of oxygen and is represented as O₃. Similarly, some molecules, like phosphorus (P₄) and sulphur (S₈), consists of more than two similar atoms.



What is a compound?

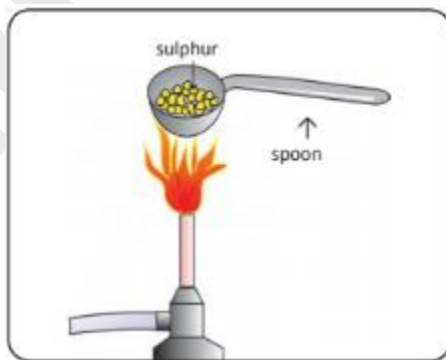
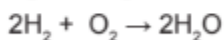
Do you know that common salt, water, sugar, sand etc., which we use daily are said to be compounds? Similarly, our body is composed of hundreds of compounds. We have learnt that there is limited number of elements (<120), but number of compounds is unlimited.



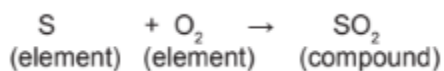
When two or more elements combine in a fixed ratio by mass, they form compound.

For example, water is a compound made of two hydrogen atoms and one oxygen atom in the ratio 2 : 1 by volume or 1 : 8 by mass. A compound is a pure substance composed of two or more elements combined together chemically in a fixed ratio by mass.

Element + Element → Compound

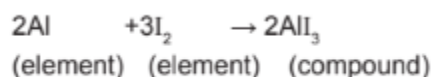


Sulphur combines with oxygen to form a colourless gas sulphur dioxide.





The greyish black compound formed is aluminium iodide.



The grey brittle compound is iron sulphide



Characteristics of a compound

1. Iron sulphide contains iron and sulphur in the ratio 7 : 4. by mass. Hence, we can say that a chemical compound is formed by the chemical reaction between two or more elements in a fixed proportion by mass.
2. Iron in iron sulphide cannot be pulled away by using a magnet. Similarly sulphur present in iron sulphide cannot be separated by dissolving it in carbon disulphide because sulphur present in it does not dissolve in carbon disulphide. Hence we can conclude that the components of the compound cannot be separated by simple physical methods.

3. When a mixture of iron powder and sulphur is heated it glows red hot, and the glow stays for a while even when bunsen flame is removed. This shows that heat is given out. This reveals that formation of a compound is associated with evolution or absorption of heat.
4. Pure iron sulphide melts at a definite temperature. Hence a compound has a fixed melting and boiling point.
5. Iron sulphide is not attracted by magnet. When dilute sulphuric acid is added to iron sulphide, a colourless gas with rotten egg smell is produced due to hydrogen sulphide but not hydrogen. Thus iron present in the compound does not show its property. When carbon disulphide is added to Iron sulphide, it does not dissolve in it. This shows that sulphur is also not able to show its characteristic property. Hence we can say the properties of a compound are different from those of its component elements.
6. When a sample of iron sulphide is viewed by magnifying lens, it is found to be homogenous throughout its mass. No individual particle of iron and sulphur can be seen in iron sulphide. Hence compound is homogenous.

Classification of compound Let us learn to classify the compounds based on the origin or chemical components as

1. Inorganic compounds Compounds obtained from non living sources such as rock, minerals, etc., are called inorganic compounds. eg. Chalk, marble, baking powder, etc.
2. Organic compounds Compounds obtained from living sources such as plants, animals etc., are called organic compound. eg. Protein, waxes, oil, carbohydrates, etc.

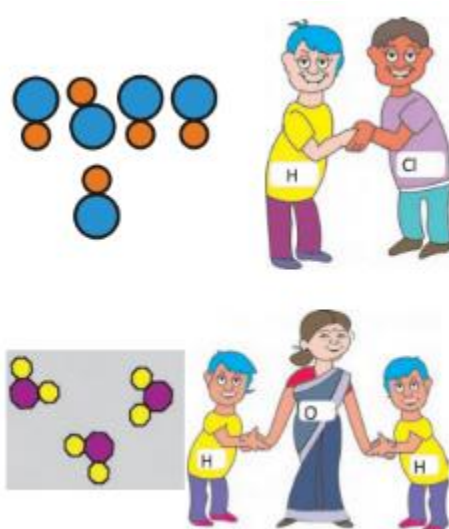
Uses of Compounds

Let us tabulate the some compounds and their components that we use in our daily life.

COMMON NAME	CHEMICAL NAME	COMPONENTS	USES
Water	Hydrogen Oxide	Hydrogen and oxygen	For drinking and as solvent
Table salt	Sodium chloride	Sodium and chlorine	Essential component of our daily diet, preservative for meat and fish.
Sugar	Sucrose	Carbon, hydrogen and oxygen	Preparation of sweets, toffees and fruit juices.
Baking soda	Sodium bicarbonate	Sodium, hydrogen, carbon and oxygen	Fire extinguisher, preparation of baking powder and preparation of cakes and bread.
Washing soda	Sodium carbonate	Sodium, carbon and oxygen	As cleaning agent in soap and softening of hard water.
Bleaching powder	Calcium oxy chloride	Calcium, oxygen and chlorine	As bleaching agent, disinfectant and sterilisation of drinking water.
Quick lime	Calcium oxide	Calcium and oxygen	Manufacture of cement and glass.
Slaked lime	Calcium hydroxide	Calcium, oxygen and hydrogen	White washing of walls.
Lime stone	Calcium carbonate	Calcium, carbon and oxygen	Preparation of chalk pieces.

Molecule of compound

The molecule of a compound contains two or more different types of atoms. For example, the molecule of hydrogen chloride contains one atom of hydrogen and one atom of chlorine. Similarly, one molecule of water contains two hydrogen atoms and one atom of oxygen.



What is a formula?

Just as an atom is represented by its symbol, a molecule of element or a compound is represented by means of a formula. The formula represents the number of atoms of each element in the molecule. For example H₂ represents one molecule of hydrogen formed when two atoms of hydrogen combine. The formula of water is H₂O. This indicates that two atoms

hydrogen chemically combined with one atom of oxygen to form water. The subscript " 2 " below H indicates the number of atoms of hydrogen present in one molecule of water. Notice that when only one atom is present the subscript "1" is not written.

What is valency?

Two atoms of hydrogen combine with one atom of oxygen to form a molecule of water. While one atom of hydrogen combines with one atom of chlorine to form a molecule of hydrogen chloride. You could say that oxygen atom has a greater capacity to combine with hydrogen than the chlorine atom. This is somewhat like some people being friendly with many people, while others are satisfied with just one friend.

The compounds are formed by combination of atoms of different elements. During the formation of molecules of the compounds, atoms combined in a fixed proportion. This is due to the fact that different atoms have different combining capacities.

Valency can be defined as the combining capacity of an element.

Valency with respect to hydrogen: The valency of hydrogen atom is taken as one and it is selected as the standard. Valency of other elements is expressed in terms of hydrogen. Valency of an element can also be defined as the number of hydrogen atoms which combine with one atom of the element.

Since most of the elements do not combine with hydrogen, the valency or the combining capacity of the element is also defined in terms of chlorine or oxygen.

Valency With Respect to Chlorine: Since valency of chlorine is one, the number of chlorine atom with which one atom of an element can combine is called its **valency**.

Valency with respect to Oxygen: We know that the valency of oxygen is 2. Double the number of oxygen atoms with which one atom of an element can combine is also called **valency**.

For example,

Valency of Fe in FeCl_2 is 2, Valency of Fe in FeCl_3 is 3

Some elements, especially rare gases like helium and neon, do not combine with other elements. They have zero valency.

33] Measurements

Measurement is nothing but comparing an unknown quantity with a standard quantity. The standard quantity is called unit. For example, if you say a distance as 300km, here 300 is its magnitude and km is its unit. We can't measure anything without a unit.

We have been following many system of units to measure physical quantities. For example kilometre, mile, foot, centimetre etc., are all units of length. Similarly kilogram, gram, pound etc., are units of mass.

Le Systeme International d' Unites (SI system of units)

To bring uniformity, the general conference on Weights and Measures in 1971, decided to have a uniform system of measurement called SI system of units. In SI system, the units for all physical quantities are fixed and derived. This is logically far superior to all the other systems. It has certain features, they are based on the properties of atom. So, they do not vary with time. SI system is more convenient to practice.

There are seven fundamental quantities and many derived quantities in this system of units.

Temperature

We know that temperature is a measure of degree of hotness or coldness of a body. Different scales like celsius, fahrenheit, etc. are used to measure temperature.

Types of scales	Lower fixed point (Melting point of pure ice)	Upper fixed point (Boiling point of water)
Celsius	0°C	100°C
Fahrenheit	32°F	212°F

There is also another type of scale called the Kelvin Scale with which we can measure the temperature. Kelvin is the primary unit of temperature in SI system.

The freezing point of water is 0°C in Celsius scale but at 0°C, water molecules do not come to rest. Only at -273°C, all the molecular movement comes to rest. Hence -273°C has been fixed as the lower fixed point in Kelvin Scale and is called as **absolute zero**.

Hence,

$$-273^{\circ}\text{C} = 0 \text{ K}$$

$$0^{\circ}\text{C} = 273 \text{ K}$$

The usage of negative values in Celsius scale can be avoided by using Kelvin scale.

Conversion of scales of Temperature

Fahrenheit to Celsius

The number of divisions between upper and lower fixed points in Celsius scale is 100 and in Fahrenheit scale is 180.

$$\frac{C}{100} = \frac{F - 32}{180}$$

$$C = (F - 32) \times \frac{100}{180}$$

$$C = (F - 32) \times \frac{5}{9}$$

Using this we can convert a Fahrenheit temperature to a Celsius temperature. Similarly to convert Celsius to Fahrenheit

$$(F - 32) = \frac{C}{100} \times 180$$

$$(F - 32) = \frac{9C}{5}$$

$$F = \frac{9C}{5} + 32$$

Converting Kelvin into Celsius scale

$$-273^{\circ}\text{C} = 0 \text{ K}$$

$$0^{\circ}\text{C} = 273 \text{ K}$$

$$100^{\circ}\text{C} = 373 \text{ K}$$

Worked out problems

1. Convert 37°C to Fahrenheit scale

$$F = \frac{9C}{5} + 32$$

$$F = \frac{9 \times 37}{5} + 32$$

$$F = 98.6^\circ\text{F}$$

2. Convert 100°F to Celsius scale

$$C = (F - 32) \times \frac{5}{9}$$

$$C = (100 - 32) \times \frac{5}{9}$$

$$C = 37.7$$

$$100^\circ\text{F} = 37.7^\circ\text{C}$$

3. Convert 40°C to Kelvin scale

$$-273^\circ\text{C} = 0\text{ K}$$

$$0^\circ\text{C} = 273\text{ K}$$

$$40^\circ\text{C} = 273 + 40$$

$$40^\circ\text{C} = 313\text{ }^\circ\text{K}$$

Electric current

SI unit for electric current is **ampere**.

Amount of Substance

SI unit for amount of substance is **mole**.

Quantity	SI Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric Current	ampere	A
Amount of substance	mole	mol
Luminous Intensity	candela	cd

Luminous intensity

Candela is the SI unit for **luminous intensity**.

A candle emits light with a luminous intensity roughly equal to one candela.

Conventions to be followed in writing the units in SI system

- The symbols for units should be written with a small letter For example: m for metre, kg for kilogram
- Units which are named after scientists should always be written with small letter. For example: newton, joule
- The symbols of the units named after scientist should be written by capital

Letter For example: N for newton, W for watt

- Symbols should not be written in plurals but in words, plurals are used. For example: 30 kg or 30 kilograms
 - There should be no full stop at the end of a symbol for units For example: Symbol for unit of length is m(it is not m)
1. The intensity of sound is measured in a unit called decibel (dB).
 2. Intensity of earthquakes are measured in Richter scale.

Units of Length

10 millimetres (mm) = 1 centimetre (cm)

10 centimetres = 1 decimetre (dm) = 100 millimetres

10 decimetres = 1 meter (m) = 1000 millimetres

10 metres = 1 decametre (dam)

10 decametres = 1 hectometre (hm) = 100 metres

10 hectometres = 1 kilometre (km) = 1000 metres

Units of Area

100 square millimetres (mm²) = 1 square centimetre (cm²)

100 square centimetres = 1 square decimetre (dm²)

100 square decimetres = 1 square metre (m²)

100 square metres = 1 square decametre (dam²) = 1 are

100 square decametres = 1 square hectometre (hm²) = 1 hectare (ha)

100 square hectometres = 1 square kilometre (km²)

Units of Liquid Volume

10 millilitres (ml) = 1 centilitre (cl)

10 centilitres = 1 decilitre (dl) = 100 millilitres

10 decilitres = 1 litre = 1000 millilitres

10 litres = 1 decalitre (dal)

10 decalitres = 1 hectolitre (hl) = 100 litres

10 hectolitres = 1 kilolitre (kl) = 1000 litres

Units of Liquid Volume

10 millilitres (ml) = 1 centilitre (cl)

10 centilitres = 1 decilitre (dl) = 100 millilitres

10 decilitres = 1 litre = 1000 millilitres

10 litres = 1 decalitre (dal)

10 decalitres = 1 hectolitre (hl) = 100 litres

10 hectolitres = 1 kilolitre (kl) = 1000 litres

Units of Mass

10 milligrams (mg) = 1 centigram (cg)

10 centigrams = 1 decigram (dg) = 100 milligrams

10 decigrams = 1 gram (g) = 1000 milligrams

10 grams = 1 decagram (dag)

10 decagrams = 1 hectogram (hg) = 100 grams

10 hectograms = 1 kilogram (kg) = 1000 grams

1000 kilograms = 1 megagram (Mg) or 1 metric ton(t)

Some Common measurements used in our daily life.

1 Feet = 30.48 cm

1 Sq.feet = 30.48 cm x 30.48 cm = 929.0304 sq.cm

1 Ground = 2400 sq.feet

1 Kuzhi = 145.2 sq.feet

1 Cent = 435. 60 sq.feet

1 Acre = 43560 sq.feet = 300 Kuzhi = 100 Cent

34] Force And Pressure

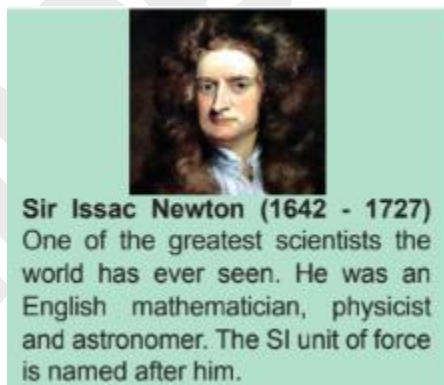
Actions like opening the door, lifting a bag, kicking a ball, pulling a drawer, pushing a box are - All these actions result in the change of position of an object.

Each of these activities involve a push or a pull? From this we infer that to move any object, effort is needed (push or pull). This effort is called a **force**.

Force is a push or a pull acting on an object which changes or tends to change the state of the object.

UNIT OF FORCE

In the International system of units (SI System), the unit of force is newton (N).

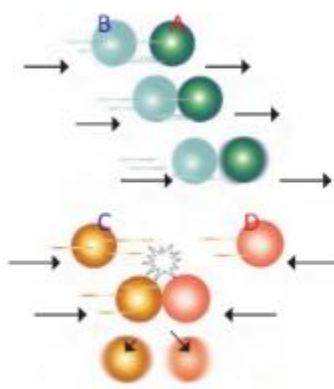


STATE OF MOTION

Set a marble A in motion. Hit it from behind with another marble B. What do you notice?

The marble A moves faster. It is because the marble B exerted a force on A.

Take two more marbles C and D. Let them move in the opposite direction and collide with each other. After the collision, the marbles C and D change their directions of motion as shown in the figure. This is due to the exertion of force between them.



Hence a force changes either the speed of an object or its direction of motion.

A change in either the speed of an object or its direction of motion or both is described as a change in its state of motion. Thus, a force may bring a change in the state of motion of an object.

A force does not always result in a change in the state of the object. For example, the wall of a room may not move at all even if we apply the maximum force that we can exert. This does not mean that we are not applying force, but the force that we are applying is not sufficient to move the wall.

Action of force and its effects

Column 1	Column 2
Moving an object which is at rest	
Changing the speed of an already moving object.	
Changing the direction of motion of an object	
Changing the shape of an object	

- can change the state of an object (rest to motion/ motion to rest)
- may change the speed of an object if it is already moving.
- may change the direction of motion of an object.
- may bring about a change in the shape of an object.
- may cause some or all of these effects.

It is important to note that none of these actions is possible without the action of a force.

Contact Forces

Generally, to apply force on an object, we need to come in contact with that object. A force that can cause or change the motion of an object by touching it is called Contact Force. In the above activities, the force is caused by the action of muscles. Hence this force is known as muscular force. Do you agree that muscular force is a contact force? Are there other types of contact forces?

A ball rolling on the play ground gradually slows down and comes to rest. If the ground is made smooth, the distance covered by the ball would be more than that what was covered earlier. Why?

The ball slows down due to the force acting between the ball and the ground. It is the force of friction which causes the ball to rest. The frictional force is always in a direction opposite to the direction of motion of the object.

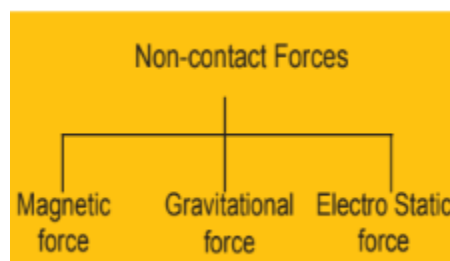
The force of friction arises due to contact between the ball and ground. It acts between any two bodies when both are in contact with each other and either any one or both are moving. Is friction also a contact force? Yes.

Non-contact Forces

A non-contact force is any force applied to an object by another body without any contact.

Magnetic Forces

Is it necessary to bring the two magnets in contact to observe the force between them? No. A magnet can exert a force on another magnet without touching it. Magnetic force is a non contact force.



Gravitational Force

Have you wondered why the cricket ball hit high by a batsman falls back to the ground? Or why a mango or an apple falls to the ground? Why are objects fall towards the earth? It is because the earth pulls them down. This force is called the force of gravity. This is an attractive force. This is an example for non-contact force.



Electrostatic Force

The force exerted by a charged body on another charged or uncharged body is known as electrostatic force. This force acts when the bodies are not in contact. The electrostatic force is another example of non contact force.

Pressure

We understand that the effectiveness of the force applied depends on the area on which it is acting.

Now we will define a new physical quantity, pressure.

Pressure is defined as the force acting on a unit area

Force

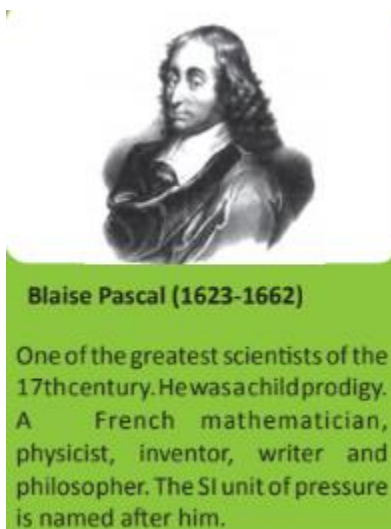
$$\text{Pressure} = \frac{\text{Force}}{\text{Area on which it acts}}$$

The SI unit of pressure is N/m^2 . It is also called pascal (Pa) .

Can you say which brick will give more pressure why?

The image shows three identical red bricks. Brick A is standing vertically on its smallest rectangular face. Brick B is lying on its side on its medium rectangular face. Brick C is lying flat on its largest rectangular face. The labels A, B, and C are placed below each respective brick.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area on which it acts}}$$



Substituting the values

$$\text{Pressure} = 100\text{N} / 2\text{m}^2$$

$$= 50 \text{ N/m}^2$$

$$\text{Pressure} = 50 \text{ N/m}^2$$

Pressure exerted by Liquids and Gases

You know that liquids and gases are called fluids. Solids always exert pressure downwards. But the fluids exert pressure in all directions.

Fluids exert pressure on all bodies immersed in them and also on the walls of the container that holds them.

Pressure exerted by Liquids

Is the pressure exerted by a glass of water the same on the earth and the moon?

No, on the earth we have more gravitational force and hence the pressure exerted by the glass of water will be more.

On the moon, the gravitational force is less compared to our earth. Hence the pressure exerted by a glass of water is less on the moon. So, pressure of a liquid depends on gravitational force.

The pressure of a liquid can also be calculated by using a formula

$$p = h d g$$

p = pressure of a liquid

h = height of the liquid column

d = density of the liquid

g = acceleration due to gravity

Pascal's Law

The pressure applied to an enclosed liquid gets transmitted equally to every part of the liquid. This property was first demonstrated by Pascal and is called Pascal's law.

Hydraulic devices, like earth excavators (JCB) and car brakes work on the above principle.

Take a stout flask with holes of equal size at different places as shown in the figure. Fit a piston which can be moved up and down along the neck of the flask. When a force is applied on the piston, the piston moves down and the water flows out equally in all directions through holes. This shows pressure exerted on water is transmitted equally throughout the water. So that water comes out of all holes with equal force.



Pressure exerted by air

We must have walked on the road while there is a strong wind. How did we feel? Did we feel any force while walking against the wind?

What happens to the bicycle tube when it has a puncture?

From the above observations you can say that air also exerts pressure on the walls of their container.

Atmospheric pressure The earth is surrounded by air all around. This thick envelope of air is called the atmosphere. The atmospheric air extends up to many kilometers above the surface of the earth. The pressure exerted by this air column is known as the atmospheric pressure.

We know pressure is force per unit area, and if we imagine a unit area and a very long cylinder standing on it filled with air, up to the height of atmosphere, then the weight of the air in this cylinder is atmospheric pressure.

The atmospheric pressure at sea level is approximately $1,00,000 \text{ N/m}^2$ (or 10^5 N/m^2). As we go higher and higher above the earth surface, the atmospheric pressure decreases.

Measurement of atmospheric pressure The atmospheric pressure is not the same at all places. It decreases as we go above the earth's surface. The instrument used to measure the atmospheric pressure is called Barometer.

In 1643, an Italian scientist named Torricelli invented the first barometer. It was a mercury barometer. Aneroid barometer and Fortin's barometer are other instruments used to measure the atmospheric pressure.

Friction

We must have seen children skating. These children wear shoes with wheels. Is it possible to skate on bare feet?

The force which opposes the action of sliding your foot on the floor is called '**friction**'.

We saw earlier that the frictional force is a contact force.

Friction is the force created whenever two surfaces move or try to move over each other.

Friction is caused by the irregularities on the two surfaces in contact. Even those surfaces which appear very smooth have a large number of irregularities on them. Irregularities on the two surfaces lock into one another. When we attempt to move any surface, we have to apply a force to overcome the interlocking. On rough surfaces there are larger number of irregularities. So the force of friction is greater if a rough surface is involved.

Factors affecting friction

The force of friction depends on two main factors

1. Mass of the body
2. Nature of the surfaces in contact

As the mass of the body increases, the force of friction also increases. A football when kicked goes farther than a cricket ball since the mass of the cricket ball is more than that of the football.

Friction is less when the surface is smooth. This you can understand by rolling a stone on a tar road (rough surface) and a house floor (smooth surface).

Friction

Friction plays, an important role in our daily life. Friction opposes motion and it has both advantages and disadvantages.

Advantages of Friction

1. We are able to walk or run properly on the floor because of friction. If there is less or no friction we will slip and fall down.
2. It would not be possible to light a match stick without friction between its head and the side of the matchbox.
3. Cars and buses are able to run on the roads because of the friction between the wheels and the road.
4. We cannot write on paper without friction between the tip of a pen or a pencil and the paper.

Disadvantages of Friction

1. Friction produces heat. This heat causes wear and tear of the machinery parts.
2. Vehicle tyres and soles of footwear wear out because of friction.

Increasing and reducing friction

We have seen in the earlier section that friction is desirable in some situations. Can we increase this friction?

You may have seen that the sole of shoes and footwear are grooved. Why is it so? Have you ever thought of it?

It is done to provide them better grip on the floor, so that you can move safely. This means you have increased the friction.

The treaded tyres of cars, trucks and bulldozers provide better grip with the ground.

Sand and gravel are strewn on the slippery ground during rainy season to increase the friction. Just as we can increase the friction, we can also reduce the friction.

Friction can be reduced

1. By using suitable lubricants, friction can be reduced. eg. Oil (for light machinery), grease (for heavy machinery),
2. If the surfaces are polished, they become smooth and in turn, reduce friction between them.
3. By the use of wheels

4. By the use of ball bearings. Ball bearings have small balls of steel between metal surfaces. They are placed between hubs and the axles of ceiling fans, bicycles, motor cycles etc. to reduce friction.

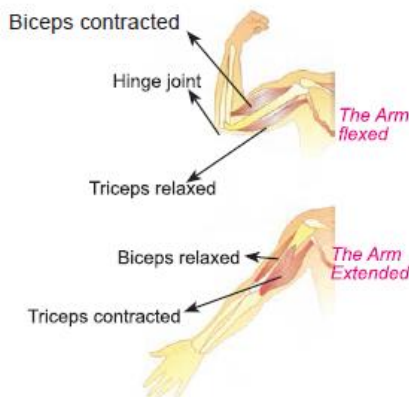
35] Body Structure

Human Body and its Movements

Human body performs all activities with the help of the movements of bones and muscles.

Human body is made up of a very important framework of bones which is known as the skeletal system and it is associated with muscles.

Most of the muscles help in the movement of various parts of the body and some help the body stay upright. Muscles cannot push, they can only pull. Many of them work in pairs. They are attached to bones by tendons. Tendons are thick strands or sheets of connective tissues. A muscle tightens and becomes shortened while pulling the bone attached to it. When it relaxes the other muscle tightens and the bone moves back.

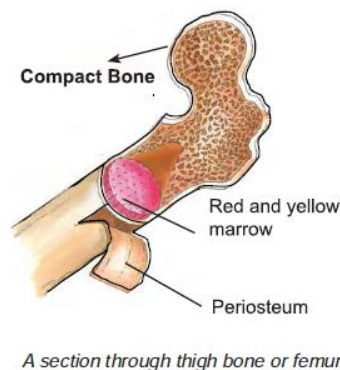


In the figure, the movement of the elbow joint shows how the two muscles- biceps and triceps work antagonistically (in opposite directions) to bend (flex) and stretch (extend) the arm at the hinge joint of the elbow. The muscle that lies above the upper arm is the biceps.

Muscle on the back of the upper arm is triceps. The bicep muscles can be seen and felt bulged when you flex your arm at the elbow and get relaxed, when you extend your arms. Likewise, when you straighten(extend) the arms, the tricep muscles at the back of the upper arm get contracted and when you flex the arms they get relaxed.

Bone is a hard, greyish-white substance of which substance of which, two-thirds is composed of inorganic matter or minerals like Calcium, Phosphate and Carbonate. They make the bone more brittle. The remaining one-third is organic matter.

Bones are not solid. They have a strong outer layer of light weight compact bone which is spongy inside. In the centre, a soft marrow is present which produces new Red Blood Cells (RBC) and White Blood Cells (WBC) for the blood. Bones protect and maintain the body's delicate vital organs like brain, lungs, heart, etc. Almost all the bones of the body may be classified into four main types, on the basis of their shape. Bones have a strong membranous covering over its surface like the skin and this outer layer is called periosteum.



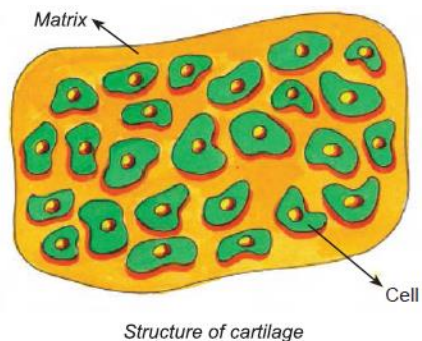
S.No	Shape	Example
1	Long Bones	Bones of things, legs, toes, arm, forearm and fingers
2	Short Bones	Wrist and ankle
3	Flat Bones	Cranial bones, scapula clavicle and sternum
4	Irregular Bones	Vertebrae coccyz and certain skull facial bones

Joints and types of joints

Bones fit together at the joints and are held firmly by ligaments. The ligament is a fibrous form of connective tissue.

What is a Joint?

A joint is a point of contact between the bones and the cartilage and between the bones and teeth. The structure of the joint reflects its function.



Types of Joints

Some joints permit no movement, others permit slight movements and still others afford considerable movements.

S.No	Name of the joint	Nature	Example	<i>A typical synovial joint at the hip</i>
1	Fibrous Joints	Bones are held together by fibrous connective tissue with no synovial cavity. These joints include immovable sutures	Skull bone, between calf bone and tibia.	
2	Cartilagenous joints	Bones are held together by cartilage with no synovial cavity	Earbones, tip of nose sternum	
3	Synovial Joints	All synovial joints are freely movable in selected directions and contain synovial cavity, articular cartilage and a synovial membrane.	Hip joint, shoulder joint, elbow, atlas and axis, tarsal bones	

Some Synovial Joints

Ball and Socket Joint

Example: Hip joint and Shoulder Joints.

It consists of a ball like surface of one bone fitted into a cup-like cavity of another bone.



Hinge Joint

Example: Elbow and ankle. It is one in which the convex surface of one bone fits into the concave surface of another bone.



Gliding Joint

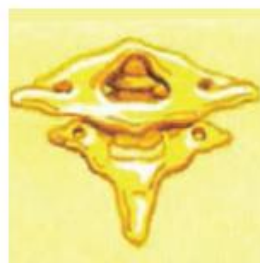
Example: Tarsal bones, the sternum and the clavicle. The articulating surface of bone in these joints is usually flat. Movement is not around an axis.



Pivot Joint

Example: Atlas and Axis

This joint allows us to turn our head from side to side. It is one in which a rounded, pointed or conical surface of one bone articulates within a ring formed partly by a ligament.

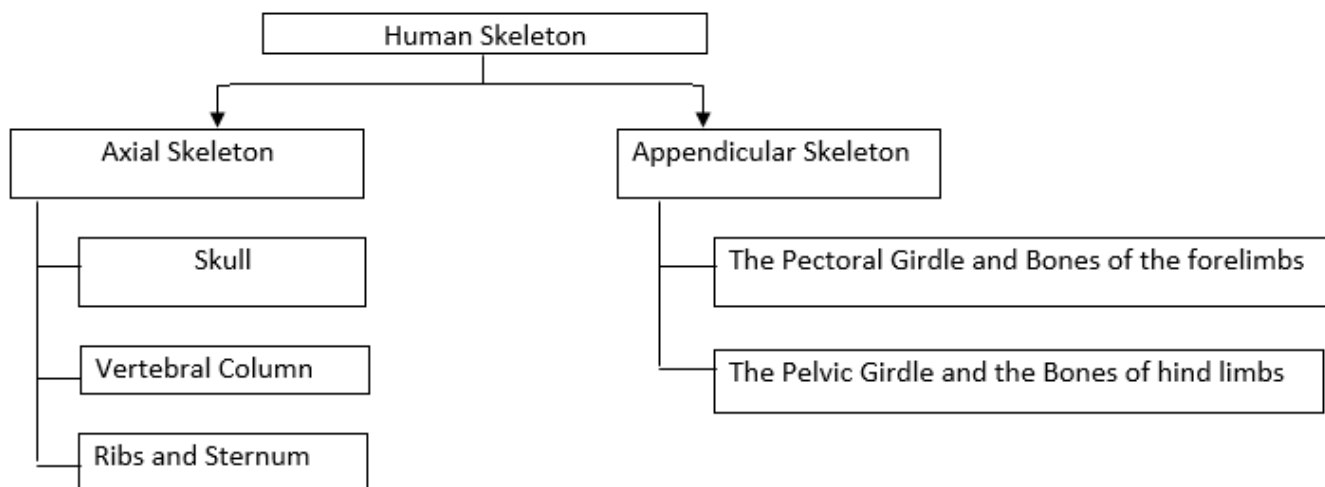
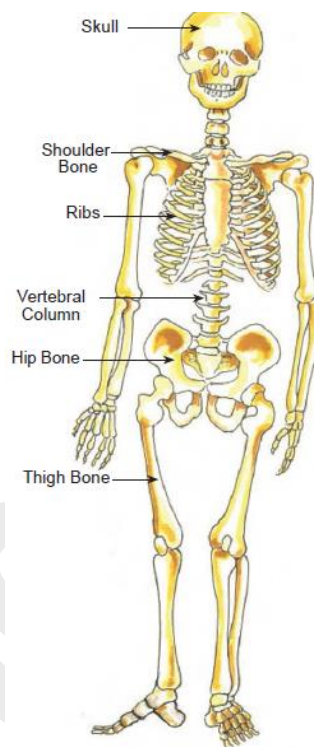


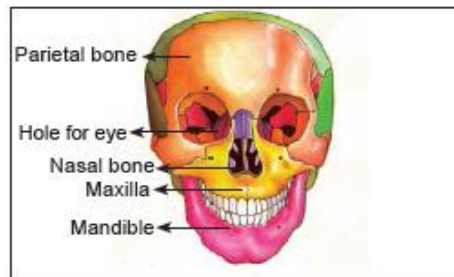
Skeleton

We studied that the Skeletal System is instrumental in performing movements such as walking, running, etc. we shall observe the divisions of the Skeletal System, in this unit.

Can we count all the bones in the human skeleton?

Yes, we can. The adult human skeleton consists of 206 bones. They are classified into axial skeleton and appendicular skeleton.





Axial Skeleton

The vertebral column has a characteristic curve. It has five distinct regions. They are listed below:

The cervical Region (neck region) consisting of seven vertebrae.

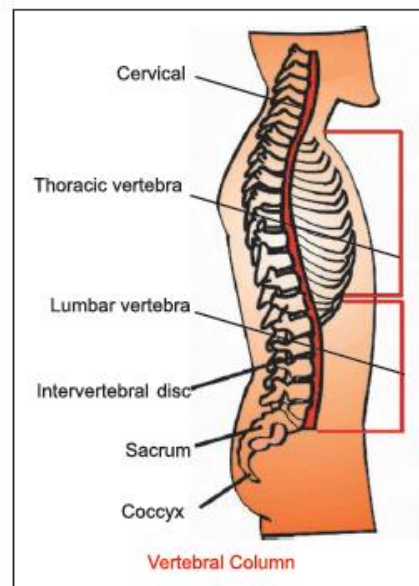
The thoracic Region (chest region) consisting of twelve vertebrae.

The lumbar Region (Abdominal region) consisting of five vertebrae.

The Sacral Region (Hip region) consisting of five vertebrae. The Coccygeal Region (vestigial region) consisting of four vertebrae. They are rudimentary.

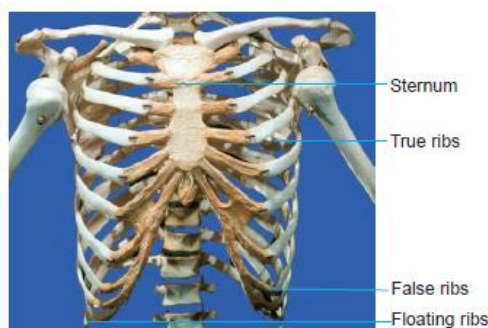


Atlas and Axis



Ribs and Sternum (Rib cage)

It protects the vital organs like lungs, heart, etc. There are twelve pairs of ribs.



Ribs and Sternum

The ribs at the sides, the sternum in the front and the backbone together form the “chest box”.

The first seven pairs of ribs are directly attached to the sternum and are called ‘true ribs’.

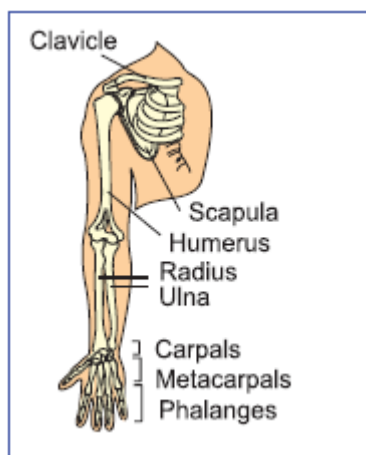
The next three pairs of ribs which are not directly attached to the sternum are called ‘false ribs’.

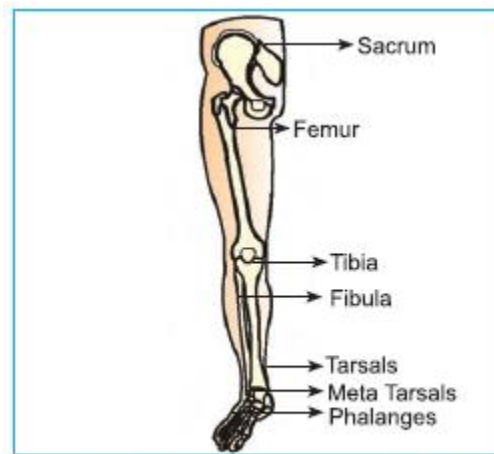
The last two pairs of ribs (11th and 12th) are short and are not attached to the sternum. They are called ‘floating ribs’.

Appendicular Skeleton

The appendicular skeleton includes the pectoral and pelvic girdles and the bones of the limbs (arms and leg bones).

Regions of the Skeleton	No. of Bones
Axial	80
Appendicular	126
Total	206



Right pectoral girdle and upper arm

Right pelvic girdle and lower limb bones

More to Know**The largest and the smallest bones in our body.**

- The largest bone in the human body is the thigh bone or femur. It is about 45cm long in an average man.
- The smallest bone is the stapes. It is found inside the human ear.

Functions of the Skeletal System

Support: Provides framework and supports the soft tissues of the body.

Protection: Protects many vital internal organs like brain, heart and lungs.

Movement facilitation : Bones serve as levers and enable us make movements.

Storage of minerals: stores minerals like calcium, phosphate and carbonate.

Production of blood cells: The marrow produces the RBC, WBC and blood platelets.

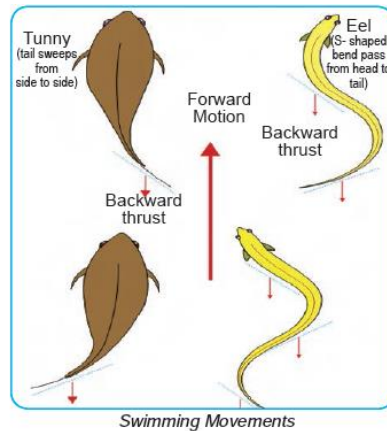
Movement of Animals

Animals move from place to another in response to different stimuli-in search of food and shelter, in order to mate and to escape from predators. These movements are enabled by muscular actions in response to stimuli. Various kinds of organs like cilia, flagella, appendages, fins, limbs, setae, muscular feet and wings are present in animals to help them perform these movements.

Fishes

Fishes live only in water. Their stream lined bodies are best suited for locomotion in water. Fins are their locomotory organs. The fins are also adapted to move efficiently through the water. Most fishes swim by waving their tails from side to side (e.g. Tunny fish). Some fishes, such as plaice and flounders are flat. When these fishes swim, they move up and down.

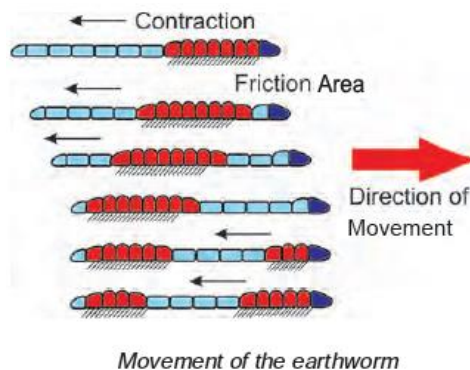
The eel is a fish with a long body. It swims by moving its whole body from side to side. Bony fish possess swim-bladders, which are filled with gas or air. They are hydrostatic in function. By



moving certain fins, fishes can change directions, they can go up and down, from left to right or from to left.

Earthworms

Earthworms move with the help of body muscles (both circular and longitudinal muscles) and setae. The setae can be projected or withdrawn with the help of protractor and retractor muscles in setae sacs. These setae provide a grip for the animal to move on the surface of the soil. The earthworm moves at the rate of 25cm per minute. The nervous system coordinates the activities of the circular and the longitudinal muscles. So, the contraction of any layer of muscle brings about relaxation of the



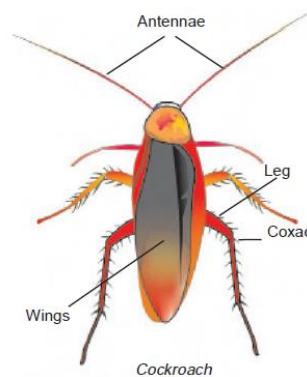
other muscle layers. The coelomic fluid serves as a hydraulic skeleton because a decrease in its pressure results in the relaxation of muscles.

The earthworms can move on smooth and hard surfaces like glass by using mucus as adhesive because the setae cannot anchor to the substratum.

Cockroach

The cockroach is a swift runner as well as a flier.

It has six legs which are helpful in walking or running. When the cockroach is at rest, the coxae of the legs lie back against the body and the first pair of legs are directed forward. The hind legs are stretched out to the posterior and the middle legs take whatever position is convenient. During locomotion, the first pair of legs is directed forward which determines the movement of the insect.



during walking or running. The Thorax bears two pairs of wings. The forewings are elytra and they form a protective covering. The hindwing is membranous and is used for flight.

Snake



Movement of the snake

Many snakes use a S-shaped movement, known as undulatory locomotion, when they travel on land and in water. Starting at the neck, a snake contracts its muscles thrusting its body from side to side, creating a series of curves. In water, this motion easily propels a snake forward because each contraction pushes against the water. On land, snake usually finds resistance points on the surface such as rocks, branches or dents and uses its scales to push on the points all at once, thrusting the snake forward.

More to know

Support and Movement of some Invertebrates

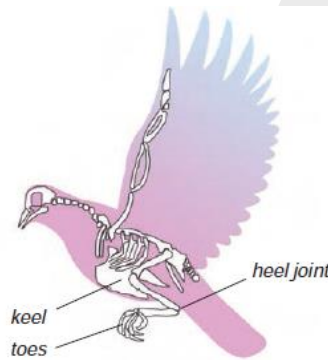
Roundworms are fluid-filled with muscles directed longitudinally, permitting lashing movements only.

Certain molluscs make use of the hydrostatic property to perform digging movements with the muscular foot.

In molluscs, external shells are formed from the material continuously secreted by the mantle and they take several forms.

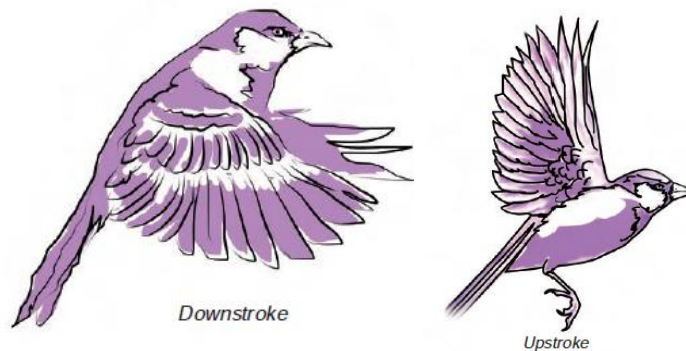
Birds

Birds are best suited for the aerial mode of life. The body is streamlined and thus offers the least amount of resistance for movement in the air. Their wings are modified forelimbs. The light



weight of the body facilitates easy flight. This is brought about by the hollow(pneumatic) bones and the air sacs in the cavities of bones. The powerful flight muscles are anchored to a bony flap on its chest. The flap is called keel. The powerful pectoral muscles serve in pulling the wings downwards and upwards.

The following pictures show how most of the birds fly.

**Downstroke**

On the downstroke of the wing, the feathers overlap so that no air can get through and the bird can push itself along through the air.

Upstroke

On the upstroke, the feathers twist open. So air passes through, allowing the bird to lift its wings easily.

Landing

The bird lands by spreading out its wings and tail as a brake.

