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Assessment



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UNIT

14

ACIDS AND BASES



Learning Objectives

After the completion of this lesson, students will be able to:

- ◆ define acids and bases.
- ◆ understand the properties of acids and bases.
- ◆ distinguish between acids and bases.
- ◆ list out the uses of acids and bases.
- ◆ understand the neutralisation reaction between acids and bases.
- ◆ know about acid – base indicators.



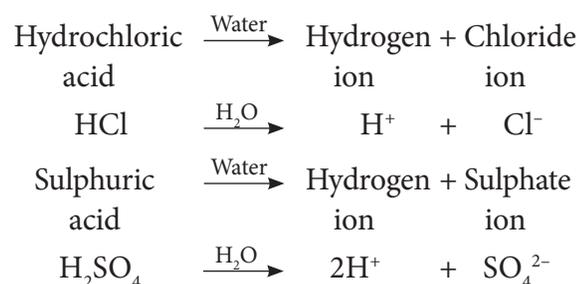
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Introduction

In our daily life we come across different food substances. Some substances like tamarind, grapes, curd and lemon are sour. They are said to be acidic. Some substances like sodium bicarbonate and soap are bitter in taste. They are said to be basic. This means that they contain either acid or base. But what are acids and bases? Acids and bases are one of the important classifications of chemical compounds, which play a significant role in every field of science. Acids and bases find applications in various products from the soap used for shower to the vinegar in the kitchen. Acids and bases are biologically, industrially and environmentally important compounds. For example, among the medicines we use, aspirin is acidic and antacids are basic. Similarly, many biological molecules are also either acids or bases. Dietary fats are acids and the chemical compounds in DNA are bases. In this lesson we will study about the properties and uses of acids and bases, neutralisation of acids and bases and acid-base indicators.

14.1 Acids

The term acid is derived from the Latin word 'acidus' which means sour. Thus, the chemical compounds which have sour taste are generally called as acids. All acids contain one or more replaceable hydrogen atoms in their molecules and when dissolved in water they release H^+ ions. For example, Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4) and Nitric acid (HNO_3) release hydrogen ions (H^+) when dissolved in water.



DO YOU KNOW?

Swedish chemist Svante Arrhenius proposed a theory on acids. According to him, an acid is a substance which furnishes H^+ ions or H_3O^+ ions in aqueous solution.



Thus, acids are defined as the chemical substances which release hydrogen ions when dissolved in water.

Acids can be classified into organic acids and inorganic acids depending on the sources. Some acids occur naturally in fruits and vegetables. These are called organic acids. Examples: Citric acid, tartaric acid etc.,

Table 14.1 Organic acids and their sources

Name of the Acid	Source
Citric acid	Lemon
Lactic acid	Sour milk
Oxalic acid	Tomato
Acetic acid	Vinegar
Malic acid	Apple
Tartaric acid	Tamarind

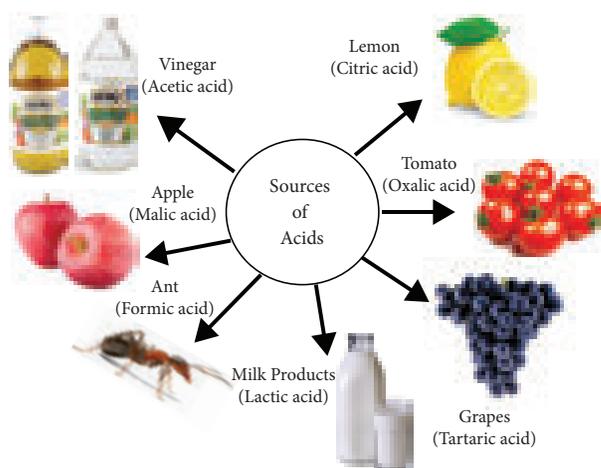


Figure 14.1 Acids and their sources

On the other hand, acids are produced artificially in industries. These acids are called mineral acids or inorganic acids. Examples: Hydrochloric acid (HCl), Sulphuric acid (H₂SO₄), Nitric acid (HNO₃) etc., There are many more classifications of acids. You will study about them in your higher classes.

14.1.1 Properties of Acids

a. Physical properties

- Acids are sour in taste.
- They are corrosive in nature. Strong acids can spoil substances like human skin, clothes and paper.

- Generally acids exist in liquid state but few acids exist in solid state as well. E.g. Benzoic acid
- Acids are colourless.
- Acids change the colour of the indicators. Blue litmus paper turns red and methyl orange turns pink when treated with acids.
- They are soluble in water.
- Solutions of acids conduct electricity due to ionisation in water.

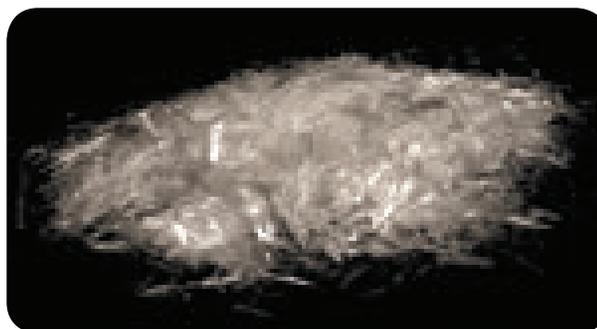


Figure 14.2 Benzoic acid crystals

DO YOU KNOW?

We feel hungry due to the corrosive action of hydrochloric acid on the inner lining of the stomach. When the level of hydrochloric acid goes higher, it causes ulcer.

b. Chemical properties

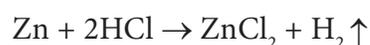
i. Reaction with metals

Metals like zinc, magnesium, aluminum, iron etc., react with acids like hydrochloric acid, sulphuric acid to form metal salts and release hydrogen gas.

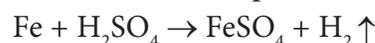
Metal + Dilute acids → Metal salt + Hydrogen

Examples

Zinc + Hydrochloric → Zinc chloride + Hydrogen acid



Iron + Sulphuric acid → Ferrous sulphate + Hydrogen sulphate



Activity 1

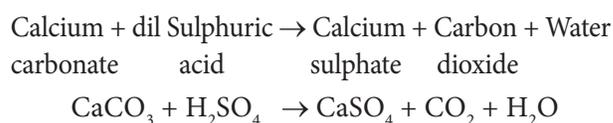
Take a clean test tube with holder and pour some dilute hydrochloric acid. Add few pieces of magnesium ribbon slowly. What do you observe? Now show a burning match stick near the mouth of the test tube. Do you hear any sound? The gas burns with a pop sound. From this it is observed that hydrogen gas is formed due to the reaction between acid and metal (Do it under the supervision of the teacher).



Copper or brass cooking vessels are coated with tin metal (eyam). If it is not coated the organic acids present in the food materials will react with copper and make the food poisonous. The tin isolates the vessel from the action of acids and prevents food poisoning.

ii. Reaction with metal carbonates and bicarbonates

When carbonates and bicarbonates come into contact with dilute acids carbon dioxide is given out along with water. For example, limestone (calcium carbonate) reacts with dilute sulphuric acid to form calcium sulphate, carbon dioxide and water.



Activity 2

Take some lemon juice in a tumbler and add baking soda slowly. What do you see? What do you infer from this?

iii. Reaction with metal oxide

Oxides of various metals react with dilute acids to form their metallic salts and water.



Example:



14.1.2 Uses of Acids

- Hydrochloric acid present in our stomach helps in the digestion of food materials.
- Vinegar (acetic acid) is used to preserve food materials.
- Benzoic acid is also used to preserve food materials like pickles.
- Sodium or potassium salts of higher fatty acids are used to make washing and bathing soaps.
- Sulphuric acid is called the king of chemicals. It is an effective dehydrating agent. It is used in various industries to make detergents, paints, fertilizers and many more chemicals.
- Hydrochloric acid, nitric acid and sulphuric acid are important laboratory reagents.
- Cells of all living organisms contain the fundamental nuclear material called nucleic acids. Animals have deoxy ribo nucleic acid (DNA) whereas plants contain ribo nucleic acid (RNA).

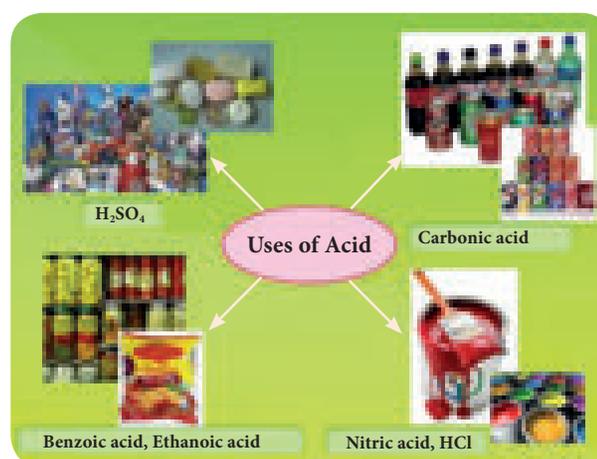


Figure 14.3 Uses of Acid



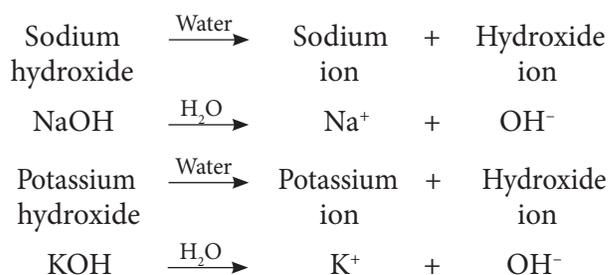
Pickles remain in good condition for long time because they contain vinegar (acetic acid) or benzoic acid.



14.2 Bases

We use soaps for bathing as well as washing. Soaps are slippery in nature. Do you know why? Soaps are slippery due to the presence of 'base'. Bases are chemical substances that are corrosive and bitter in taste. A lot of bleaches, soaps, detergents, toothpaste, etc., contain bases. In contrast to acids which release hydrogen ions in water, bases release hydroxide ions in water.

Thus, the chemical substances that release hydroxide ions when dissolved in water are called as bases. Examples: Sodium hydroxide (NaOH) and Potassium hydroxide (KOH).



Water soluble bases are called Alkalis. Bases like sodium hydroxide, potassium hydroxide, calcium hydroxide and ammonium hydroxide are highly soluble in water and hence they are called alkalis. Certain chemical substances which do not release hydroxide ions when dissolved in water also behave as bases. Examples: Sodium carbonate, Sodium bicarbonate, Calcium carbonate etc.

Table 14.2 Common bases in some products

Base	Formula	Products
Magnesium hydroxide	Mg(OH) ₂	Milk of magnesia
Sodium hydroxide	NaOH	Detergent
Ammonium hydroxide	NH ₄ OH	Solution for cleaning windows
Calcium hydroxide	Ca(OH) ₂	Lime water
Potassium hydroxide	KOH	Soap



Sodium carbonate (Na₂CO₃) is commercially called as washing soda. Similarly sodium bicarbonate (NaHCO₃) is commercially called as baking soda. Caustic soda is sodium hydroxide (NaOH) and caustic potash is potassium hydroxide (KOH).

Activity 3

Classify the following substances.

Sodium oxide, Potassium hydroxide, Calcium oxide, Copper oxide, Calcium hydroxide, Ammonium hydroxide, Ferric hydroxide, Zinc oxide

Base	Alkali	Oxide

14.2.1 Properties of Bases

a. Physical properties

- Bases generally exist in solid state but some bases exist in liquid state also. E.g. Ammonium hydroxide, calcium hydroxide
- Bases give soapy touch only in aqueous medium not in dry nature.
- Bases are bitter in taste.
- Bases are corrosive in nature. When come in contact with the skin frequently they form painful blisters.
- Bases are generally colourless.
- Bases also change the colour of the indicators. Red litmus paper turns blue when treated with bases. Similarly, they turn methyl orange to yellow and phenolphthalein to pink colour.
- Bases also conduct electricity in aqueous solution.

b. Chemical properties

i. Reaction with metals

Generally metals do not react with bases. Metals like aluminium and zinc react with bases like sodium hydroxide forming aluminates and release hydrogen.

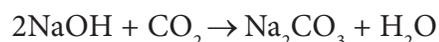
Aluminum + Sodium hydroxide + Water →
Sodium aluminate + Hydrogen



ii. Reaction with non-metal oxides

All bases react with non metallic oxides to form salt and water. For example, sodium hydroxide reacts with carbon dioxide to form sodium carbonate.

Sodium hydroxide + Carbon dioxide →
Sodium carbonate + Water



iii. Reaction with ammonium salts

Bases react with ammonium salts to form metal salts, ammonia gas and water.

Sodium hydroxide + Ammonium chloride →
Sodium chloride + Ammonia + Water



Though acids and bases have some unique properties there are certain similarities between them. Some of them are given below.

- They are corrosive in nature.
- They undergo ionization in aqueous solution.
- They conduct electricity in aqueous solution.
- They undergo neutralization reaction.

Some of the differences between acids and bases are given in Table 14.3.

Table 14.3 Difference between acids and bases

Acids	Bases
They produce H^+ ions in water.	They produce OH^- ions in water.
They are sour in taste.	They are bitter in taste.
Few acids are in solid state.	Most of the bases are in solid state.
Acids turn blue litmus paper red.	Bases turn red litmus paper blue.

14.2.2 Uses of Bases

- Potassium hydroxide is used to make bathing soaps.
- Sodium hydroxide is used to make washing soaps.
- Sodium hydroxide is also used in paper industries, textile industries and in the preparation of medicines.
- Calcium hydroxide is used for white washing.
- Aluminum hydroxide and magnesium hydroxides are used in antacids to cure acidity problems.
- Ammonium hydroxide is used to manufacture fertilizers, nylon, plastics and rubber.



Figure 14.4 Uses of bases in daily life

14.3 Neutralisation Reaction

When neutrality is achieved between two different chemical substances with different chemical properties through a reaction then it is called neutralization in chemistry. Thus neutralization is a chemical reaction in which

an acid and a base react with each other to form salt and water. Neutralization reaction between an acid and a base can be written as:



In this reaction, H^+ and Cl^- ions are produced by the hydrochloric acid and Na^+ and OH^- ions are produced by sodium hydroxide (base). When these ions combine together sodium chloride (NaCl) salt and water are produced.

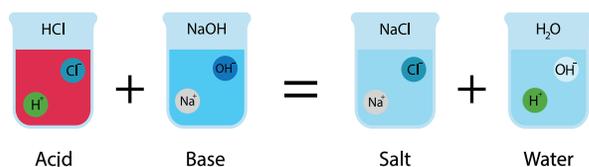


Figure 14.5 Acid – Base reaction

Similarly other acids also produce their salts when they react with bases. Some of the salts produced by neutralization reaction are given below in Table 14.4.

Table 14.4 Salts produced by neutralisation

Acid	Base	Salt
Hydrochloric acid HCl	Sodium hydroxide NaOH	Sodium chloride NaCl
Sulphuric acid H_2SO_4	Sodium hydroxide NaOH	Sodium sulphate Na_2SO_4
Nitric acid HNO_3	Sodium hydroxide NaOH	Sodium nitrate NaNO_3
Acetic acid CH_3COOH	Sodium hydroxide NaOH	Sodium acetate CH_3COONa

14.3.1 Neutralisation reactions in our daily life

Balancing acids and bases is important for our health and for our environment. We come across various neutralization reactions in our daily life. Let us study about the importance of some of those reactions.

Bee bite

Whenever bees or red ants bite us they inject an acid called formic acid into our body. This acid cause burning sensation and pain.

To suppress the pain a suitable base in the form of calcium hydroxide (lime paste available at home) is applied so as to neutralise the formic acid.



Figure 14.6 Bee bite

Wasp bite

When we are bitten by wasp, we feel the burning sensation and pain. It is due to an alkaline substance injected by the insect. To neutralise the alkalinity we use vinegar which is an acid.



Figure 14.7 Wasp bite

Tooth decay

Generally it is advised by the doctors that we should brush our teeth twice a day. This is because the bacteria present in our mouth decompose the food particles stuck in the gaps between our teeth thereby causing acid formation which leads to tooth decay. To prevent this we have to neutralize the acid. When we brush with tooth powder or tooth paste containing weak bases, the acid gets neutralized. So our teeth will be strong and healthy.

Acidity

As we know, hydrochloric acid present in our stomach helps the digestion of food material along with the enzymes secreted by liver, gallbladder and pancreas. Sometimes due

to excessive production of hydrochloric acid in our stomach we feel burning sensation in food pipe and in chest area. If this happens again and again ulcer will be formed in stomach and food pipe, which further aggravates the conditions. In order to neutralize, antacids which are nothing but weak bases like aluminum and magnesium hydroxides are used. As a result the acidity is removed.

Agriculture

Acidic soil is not suitable for plant growth. So farmers add lime fertilisers such as powdered lime (CaO), limestone (CaCO_3) or ashes of burnt wood to the soil to neutralise the acidity.



Figure 14.8 Acidic soil

Industries

Effluents from the industries contain acids such as sulphuric acid. It is treated by adding lime to neutralise it before it is discharged into rivers and streams. Similarly, in power stations fossil fuels such as coal are burnt to produce electricity. Burning fossil fuels will liberate sulphur dioxide gas as an acidic pollutant in the air. Hence, power stations treat this acidic



Figure 14.9 Industrial Effluents

gas using powdered lime (CaO) or limestone (CaCO_3) to neutralise it so that air pollutant can be prevented.

14.4 Indicators

An indicator or acid–base indicator is a chemical substance which indicates the acidic or basic nature of a solution by suitable colour change. These may be natural or synthetic.



14.4.1 Natural indicators

Natural indicators are chemical substances which are obtained from the natural resources. Litmus, turmeric juice, China rose petals, red cabbage, grape juice and beetroot juice are the indicators obtained from natural resources.

Turmeric indicator

By adding small amount of water to turmeric powder a paste is prepared. This is applied on a blotting paper or filter paper and dried. These strips are used as indicators to find the nature of the solution. In acidic solution turmeric indicator paper has no change in colour. That means it remains yellow. In basic solution the colour changes from yellow to red.



Figure 14.10 Turmeric indicator

Activity 4

Take a white cloth with turmeric powder stain. Wash the cloth with washing soap. Do you observe any change in the colour? Why?

Hibiscus flower indicator

Some hibiscus flowers soaked in warm water for about 5 to 10 minutes forms a solution. This solution can be used as indicator. In acidic solution, the colour will be changed to deep pink or deep red. In basic solution, the colour will be changed into green.

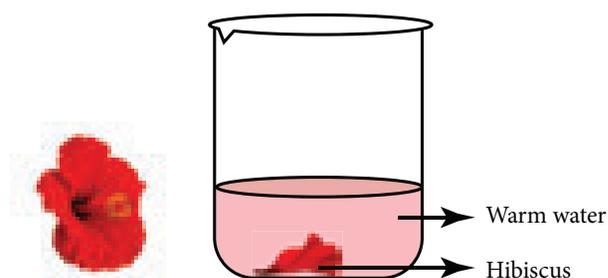


Figure 14.11 Hibiscus solutions as indicator

Beet root juice indicator

Extracts of beet root are also used as an indicator for identifying the acidic or basic nature of a solution.

Activity 5

Take a small beet root vegetable and cut it into pieces. Boil them in hot water and filter the extract. Take two test tubes. Take sodium hydroxide solution in one test tube and vinegar or lemon juice in another test tube. Add beet root extract slowly. Observe the colour change. What do you infer?

Litmus

Litmus is the most common indicators used in the laboratories. Litmus is a natural indicator which is extracted from lichens.

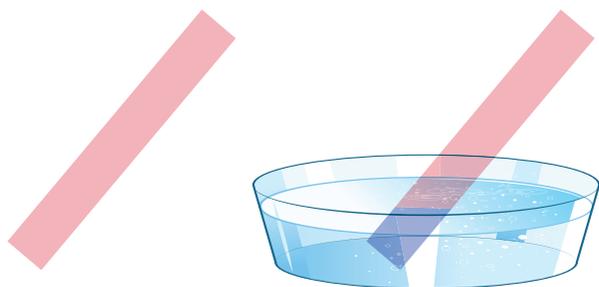


Figure 14.12 Litmus paper

It is available in the form of solution or in the form of strips prepared by absorbing litmus solution on filter paper. It is either red or blue in colour. Blue litmus paper turns red in acidic solution and red litmus paper turns blue in the basic solution.

Activity 6

Find out the nature of the solution.

Sample solution	Change of colour in litmus paper		Acid / Base
	Red litmus	Blue litmus	
Lemon juice			
Vinegar			
Calcium hydroxide solution			
Bathing Soap solution			
Orange juice			

14.4.2 Synthetic indicators

An indicator prepared from artificial substances is known as synthetic indicators. Phenolphthalein and methyl orange are the examples for synthetic indicators.

Phenolphthalein

Phenolphthalein is a colourless compound. Its alcoholic form is used as an indicator. It is colourless in acidic solution but turns pink in basic solution.

Methyl orange

Solid methyl orange is dissolved in hot water and its filtrate is used as an indicator. It turns red in acidic solution and yellow in basic solution.

The following table gives the colour changes of different indicators in acidic and basic medium.

Table 14.5 Colour change in Indicators

Indicator	Acidic solution	Basic solution
Blue litmus	Red	No change in colour
Red litmus	No change in colour	Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Red	Yellow

Points to Remember

- Acids produce H^+ ions when they are dissolved in water.
- Acids are generally corrosive in nature and sour in taste
- All dilute acids react with metallic oxides to form respective metallic salts and water.
- Natural acids (organic acids) and mineral acids are the two types of acids.
- Acetic acid and benzoic acid are used as food preservatives.
- Sulphuric acid is known as king of chemicals.
- Bases are the substances that give hydroxide ions (OH^-) on dissolving in water.
- Bases which are soluble in water are called alkalis. All alkalis are bases but all bases are not alkalis.
- Bases are generally corrosive in nature. They give soapy touch only in aqueous medium not in dry nature.
- Bases are used in paper industries, textile industries and in the preparation of medicines. They are used to manufacture fertilizers, nylon, plastics and rubber.
- When acids and bases are mixed together in aqueous solution, they react chemically to produce salt and water. This is known as neutralisation reaction.
- An indicator is a chemical substance (either natural or artificial) which indicates the end of a chemical reaction by a suitable colour change.
- Extracts of turmeric powder, hibiscus, beet root and vegetables are used as natural indicators. Phenolphthalein and methyl orange are artificial indicators.

A-Z GLOSSARY

Acid	A substance which contains one or more replaceable hydrogen atoms.
Alkali	Water soluble bases.
Base	A substance that releases hydroxide ions when dissolved in water.
Indicator	Chemical substance which indicates the acidic or basic nature of a solution by suitable colour change.
Inorganic acid	Acids produced artificially in industries.
Natural indicators	Substances obtained from plants and used as indicators.
Neutralisation reaction	Reaction between an acid and a base which produces water and salt.
Organic acid	Acids which occur naturally in fruits and vegetables.
Synthetic indicators	Artificially produced indicators .



TEXTBOOK EXERCISES



I. Choose the best answer.

- Acids are _____ in taste.
 - sour
 - sweet
 - bitter
 - salty
- Aqueous solutions of _____ conduct electricity.
 - acid
 - base
 - salt
 - All of these
- In acidic solutions blue litmus changes into _____ colour.
 - blue
 - green
 - red
 - white
- Base is a substance that gives _____ on dissolving in water.
 - OH^-
 - H^+
 - OH
 - H
- Sodium hydroxide is a _____.
 - acid
 - base
 - oxide
 - alkali
- Red ant sting contains _____.
 - acetic acid
 - sulphuric acid
 - oxalic acid
 - formic acid
- Magnesium hydroxides are used for treating _____.
 - acidity
 - head pain
 - teeth decay
 - None of these
- Acid mixed with base forms _____.
 - salt and water
 - salt
 - water
 - No reaction
- We brush our teeth with tooth paste because it is _____ in nature.
 - basic
 - acidic
 - Both a and b
 - None of these
- In basic solution turmeric indicator paper changes from yellow to _____.
 - blue
 - green
 - yellow
 - red

II. Fill in the blanks.

- Benzoic acids are used for _____.
- The word sour refers to _____ in Latin.
- Bases are _____ in taste.
- Chemical formula of calcium oxide is _____.
- Wasp sting contains _____.
- Turmeric is used as a _____.
- In acidic solution the colour of the hibiscus indicator paper will change to _____.

III. State true or false. If false, correct the statement.

- Most of the acids are not soluble in water.
- Acids are bitter in taste.
- Bases are soapy to touch when they are dry.
- Acids are corrosive in nature.
- All bases are alkalis.
- Hibiscus flower is an example for natural indicator.

IV. Answer briefly.

- Acid - Define.
- Write any four physical properties of acids.
- What are the similarities between acids and bases?
- State the difference between acids and bases.
- What is an indicator?

6. What is a neutralization reaction?
7. Write any four physical properties of base.

V. Answer in detail

1. What are the uses of acids?
2. What are the uses of bases?
3. Explain the neutralization reactions in our daily life.
4. How will you prepare natural indicator from turmeric powder.

VI. Higher Order Thinking Questions.

1. Vinu and Priyan take their lunch at school. Vinu eats lemon rice and Priyan eats curd rice. Both lemon rice and curd rice are sour in taste. What is the reason?
2. Heshna and Keerthi are friends. Keerthi's teeth are white without caries, but Heshna has teeth with caries. Why? How is it formed?



REFERENCE BOOKS

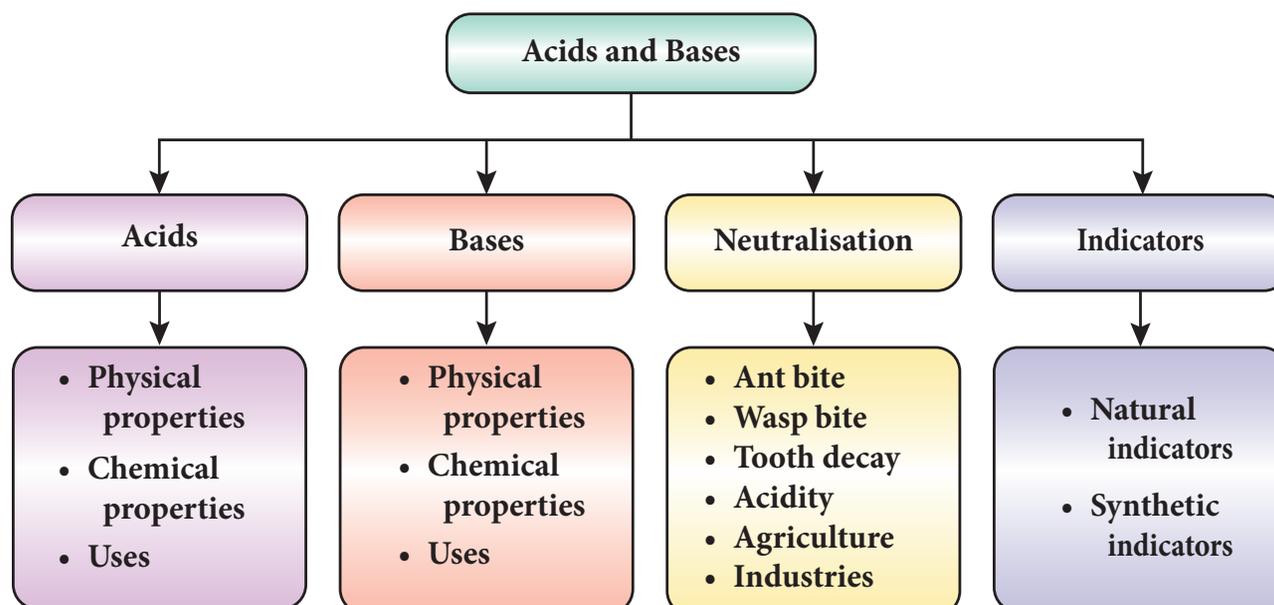
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INTERNET RESOURCES

1. <https://www.chem4kids.com>
2. <https://www.khanacademy.org/science/chemistry/acids-and-bases-topic>
3. <https://www.khanacademy.org/science/chemistry/neutralization>
4. <https://courses.chemistry/chapter/acids-and-bases>

Concept Map



UNIT

15

CHEMISTRY
IN EVERYDAY LIFE

Learning Objectives

After the completion of this lesson, students will be able to:

- ◆ know about different types of hydrocarbons.
- ◆ understand the formation of fossil fuels.
- ◆ list out the properties and uses of different fuel gases.
- ◆ understand the process involved in the refining of petroleum.
- ◆ know about the types and uses of coal.
- ◆ know about the characteristics of ideal fuel.
- ◆ list out the applications of solar energy.



E5A1A5

Introduction

When we hear the word chemistry we think of chemical reactions conducted in the laboratories. But chemistry is beyond that. We can find chemistry in everything in our surrounding. It is in the air we breathe, the food we eat and in everything we use in our daily life. Our body is made of elements like nitrogen, phosphorous, hydrogen, oxygen, calcium, potassium, sulphur, magnesium etc. All the chemical reactions taking place in our body are due to chemistry.

Our whole life is dependent on various chemical compounds. Among them, hydrocarbons are the most important one. They find application in our daily life. We can say that the whole civilization is driven by hydrocarbons because they make up the fossil fuels petroleum, coal and natural gas. In this lesson we are going to study about different types of hydrocarbons, fossil fuels like petroleum, coal and natural gas, characteristics of fuel and solar energy and its applications.

15.1 Hydrocarbons

Hydrocarbons are the organic compounds consisting of carbon and hydrogen atoms. They are combustible and produce large amount of heat energy along with carbon dioxide and water vapour, on burning. Hence, many hydrocarbons are used as fuels.

15.1.1 Sources of Hydrocarbons

Hydrocarbons occur naturally and they are found in fossil fuels like crude oil, natural gas and coal. About 300 million years ago plants and animals died and they were buried on the ocean floor. Overtime they were covered by silt and soil layers.

Then they were buried deep inside the earth and compressed through temperature and pressure and converted to fossil fuels like oil and natural gas. These fuels are found in porous rocks which lie below large bodies of water, especially oceans. By drilling these rocks hydrocarbons can be extracted. Hydrocarbons are present in different trees and plants also.



Figure 15.1 Formation of Hydrocarbons

15.1.2 Properties of Hydrocarbons

Among all the chemical compounds hydrocarbons have some unique properties. Some of them are given below.

- Most of the hydrocarbons are insoluble in water.
- Hydrocarbons are less dense than water. So they float on top of water.
- Most hydrocarbons react with oxygen to produce carbon dioxide and water.
- Hydrocarbons can be gases (E.g. methane and propane), liquids (E.g. hexane and benzene) or waxes (paraffin).
- Hydrocarbons are capable of making bonds with one another. This property is known as catenation (chain formation). Due to this property they form more number of complex molecules.

15.1.3 Types of Hydrocarbons

In hydrocarbons carbon and hydrogen atoms are linked together through different chemical bonds. Depending on the bond between these atoms there are number of hydrocarbons. The four general classes of hydrocarbons are: alkanes, alkenes, alkynes and arenes. Some of the common hydrocarbons are methane, ethane, propane, butane and pentane.

Methane is the simplest hydrocarbon in which four hydrogen atoms are linked with one carbon atom. It is a colourless, odourless and inflammable gas. It is an eco-friendly fuel because

it does not produce any harmful products. It is used as a fuel in electricity generation. Methane is also known as marsh gas as it is present in marshes. Dead and decaying plants and animals release methane gas. It is a renewable source of energy. Sewage sludge can also 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.



Figure 15.2 Structure of methane

Activity 1

Make a model using clay and match sticks for the following hydrocarbons.

Name	Formula	Structure
Methane	CH_4	
Ethane	C_2H_6	
Propane	C_3H_8	
Butane	C_4H_{10}	
Pentane	C_5H_{12}	

Propane is an odourless and highly inflammable gas. It is heavier than air. It is liquefied through pressurisation and commonly used as LPG (Liquefied Petroleum Gas) along with butane. Propane is used as fuel in heating, cooking and vehicles. Propane can also be used as refrigerants.



Figure 15.3 LPG Cylinders

DO YOU KNOW?

Propane is used in LPG cylinders. Since it is an odourless gas, any leakage cannot be detected. Hence, a chemical by name Mercaptan is mixed with LPG to help in detection of any leakage of LPG.

Butane is a gas at room temperature and atmospheric pressure. They are highly flammable, colorless gases that quickly vaporize at room temperature. Butane is used as a fuel gas and propellant in aerosol sprays such as deodorants. Pure forms of butane can be used as refrigerants. Butane is also used as lighter fuel for a common lighter or butane torch.

Pentanes are liquids with low boiling point. They are used as fuels and solvents in the laboratory. They are also used to produce polystyrene.

15.2 Natural Gas

Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane along with other higher alkanes and a small percentage of carbon dioxide, nitrogen and hydrogen sulphide (H_2S). If the

natural gas contains lower hydrocarbons like methane and ethane, it is called dry gas. If higher hydrocarbons like propane and butane are also present in the gas, it is called wet gas.

Natural gas is always found above the oil in the oil wells. This gas is trapped inside the small spaces in underground rocks called reservoirs. Conventional natural gas can be extracted through drilling wells. Natural gas can also be found in reservoirs with oil and is extracted along with oil. This is called associated gas.

Natural gas is a fossil fuel used as a source of energy for heating, cooking and electricity generation. Natural gas occurs in Tripura, Rajasthan, Maharashtra, Andhra Pradesh (Krishna, Godavari Basins) and Tamil Nadu (Cauveri Delta). It is also formed by the decomposition of organic matter in marshy areas and waste sewages. The natural gas formed by this way contains mainly methane.

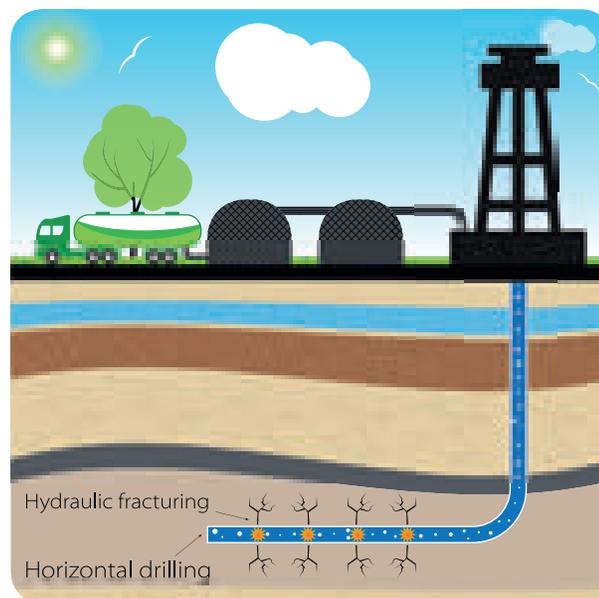


Figure 15.4 Extraction of natural gas

Activity 2

Take a glass bottle and put some leaves, twigs, waste paper and saw-dust in it. Pour some water in it and keep it for 20 days. Open the bottle and bring a glowing splinter near the mouth. You can see a gas burning near the mouth showing its combustible nature. It is due to the evolution of natural gas.

15.2.1 Uses of Natural Gas

- Natural gas is used as an industrial and domestic fuel.
- It is used in thermal power stations.
- It is used as fuel in vehicles as an alternative for petrol and diesel.
- When heated it decomposes and forms hydrogen and carbon. Hydrogen thus formed is used in the manufacture of fertilizers.
- It is used to manufacture chemicals, fabrics, glass, steel, plastics and paints.
- It is also used in electricity generation.



Figure 15.5 Uses of natural gas



Moderate temperature and humidity is needed to keep paintings and other ancient artifacts from being destroyed by environmental factors. Thus natural gas is used in museums to protect the monuments.

15.2.2 Advantages of Natural Gas

- It produces lot of heat as it can be easily burnt.
- It does not leave any residue.
- It burns without smoke and so causes no pollution.
- This can be easily supplied through pipes.
- It can be directly used as fuel in homes and industries.

15.2.3 Compressed Natural Gas

When the natural gas is compressed at high pressure, it is called Compressed Natural Gas (CNG). Nowadays it is used as fuel in automobiles. The primary hydrocarbon present in CNG is methane (88.5%). Natural gas is liquefied for shipping in large tankers. This is called Liquefied Natural Gas (LNG). CNG is stored at high pressure whereas LNG is stored in ultra cold liquid form. CNG has the following properties.

- It is the cheapest and cleanest fuel.
- Vehicles using this gas produce less carbon dioxide and hydrocarbon emission.
- It is less expensive than petrol and diesel.



More to Know

The average composition of CNG.

Constituents	Percentage
Methane	88.5
Ethane	5.5
Propane	3.7
Butane	1.8
Pentane	0.5

15.3 Other Gases

Apart from natural gas, there are some other gases which are used as fuel. Producer gas, coal gas, bio gas and water gas are some of them.

Producer Gas

Producer gas is a gaseous mixture of carbon monoxide and nitrogen. It is produced by passing air mixed with steam, over red hot coke at a temperature of 1100 °C. It is used as an industrial fuel for iron and steel manufacturing.



Producer gas is known by different names in different countries. It is referred as Wood gas in USA and as Suction gas in UK.

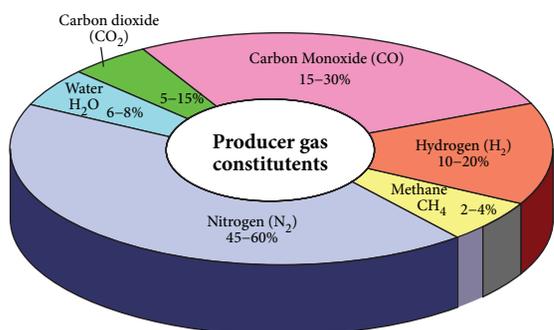


Figure 15.6 Composition of Producer Gas

Coal Gas

It is a mixture of gases like hydrogen, methane and carbon monoxide obtained by the destructive distillation of coal. Heating coal in the absence of air is called destructive distillation. It is used in heating open hearth furnace in the manufacture of steel. It is also used as a reducing agent in certain metallurgical operations.

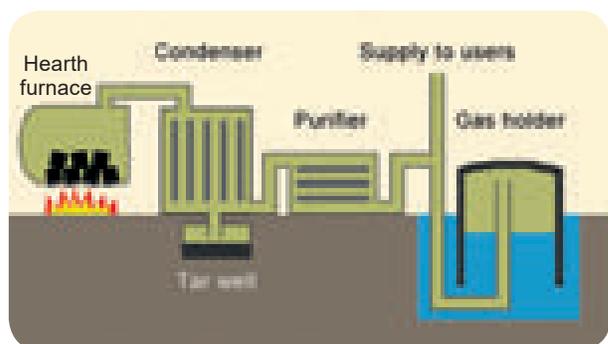
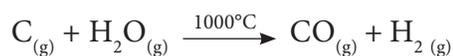


Figure 15.7 Production of coal gas

Water Gas

It is a gaseous mixture of carbon monoxide and hydrogen. It is made by passing steam over incandescent coke at a temperature of 1000°C.



It is also called as syngas or synthesis gas as it is used to synthesize methanol and simple hydrocarbons. It is used as an industrial fuel also.

Bio-Gas

Bio-gas is a mixture of methane and carbon dioxide. It is produced by the decomposition of plant and animal waste which form the organic

matter. The breaking down of organic matter in anaerobic condition (ie., in the absence of oxygen) leads to the formation of biogas. It is an example for renewable source of energy.

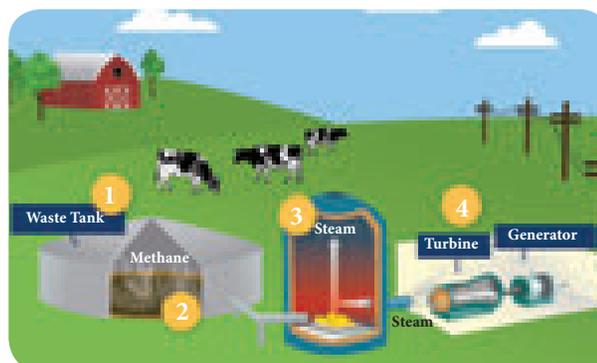


Figure 15.8 Bio-gas

Activity 3

Visit a bio-gas plant in your area with your teacher. Find out how it is prepared. Discuss about the uses and advantages of bio gas. In what way it will be helpful to the people in rural area?

15.4 Coal

Coal is one of the fossil fuels. It is a mixture of free carbon and compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur. Three hundred million years ago, some plants grew into giant ferns and mosses. These plants got buried into the bottom of the soil. They slowly started to decompose and formed a dense, sponge like material called peat. Over time peat was compressed due to high temperature and pressure and coal was formed. As coal contains mainly carbon, the slow process of conversion of dead vegetation into coal is called carbonization.

15.4.1 Extraction of Coal

Coal is extracted from the coal beds found below the surface of the earth. Coal found inside the earth is broken into pieces by explosives and brought above. Depending on the depth of the coal bed, coal is extracted in two ways.

Surface mining

If the coal beds lie within 22 feet of the earth's surface, the top soil is removed and coal is dug out. This is called surface mining.



Figure 15.9 Surface mining of coal

Underground mining

In some places, coal beds are found very deep inside the earth. In that case underground tunnels are made to get this coal. This is called underground mining or deep mining.



Figure 15.10 Underground mining of coal

Coal reserves can be found in about 70 countries worldwide. The largest coal reserves are available in United State, Russia, China, Australia and India. The US is the international leader in coal reserves, with nearly 30% of the world's supply. Coal mining was started in India

in 1774. India now ranks third among the coal producing countries in the world. USA and China have two third of the world's coal reserve.

15.4.2 Types of Coal

Coal is classified into four main categories based on the amounts of carbon it contains and the heat energy it can produce. They are lignite, sub bituminous, bituminous and anthracite. Among these four types anthracite is the most desirable one due to its high heat content.

Lignite

Lignite is a brown colored coal of lowest grade. It has the lowest carbon content. The carbon content of lignite is 25 – 35%. Lignite contains a high amount of water and makes up almost half of our total coal reserves. It is used for electricity generation. The other uses include generating synthetic natural gas and producing fertilizer products.

Sub-bituminous

When lignite becomes darker and harder over time sub-bituminous coal is formed. Sub bituminous coal is a black and dull coal. It has higher heating value than lignite and contains 35-44% carbon. It is used primarily as fuel for electricity power generation. This coal has lower sulphur content than other types and burns cleaner.

Bituminous

With more chemical and physical changes, sub-bituminous coal is developed into bituminous coal. Bituminous coal is dark and hard. It contains 45-86% carbon. It has high heating value. It is used to generate electricity. Other important use of this coal is

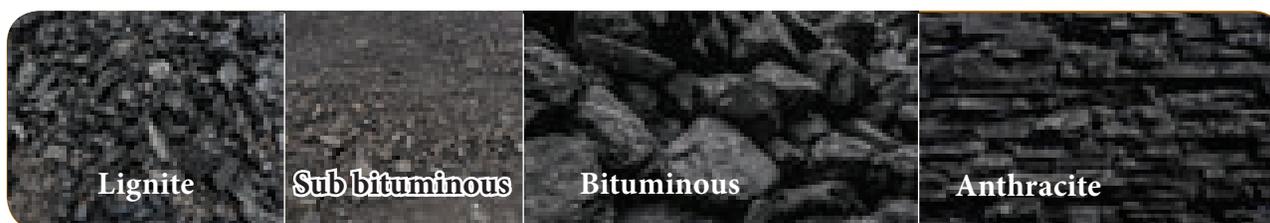


Figure 15.11 Types of Coal

to provide coke to iron and steel industries. By-products of this coal can be converted into different chemicals which are used to make paint, nylon, and many other items.

Anthracite

Anthracite is the highest grade coal. It has a very light weight and the highest heat content. Anthracite coal is very hard, deep black and shiny. It contains 86-97% carbon and has a heating value slightly higher than bituminous coal. It burns longer with more heat and less dust.

Activity 4

In an outline map of India mark the places where coal mines are found. Also identify the type of coal found in those areas.

15.4.3 Uses of Coal

- Coal is used to generate heat and electricity.
- It is used to make derivatives of silicon which are used to make lubricants, water repellents, resins, cosmetics, hair shampoos, and toothpaste.
- Activated charcoal is used to make face packs and cosmetics.
- Coal is used to make paper.
- Coal helps to create alumina refineries.
- Carbon fibre which is an extremely strong but light weight material is used in construction, mountain bikes, and tennis rackets.



Figure 15.12 Uses of Coal

- Activated carbon, used in filters for water and air purification and in kidney dialysis machines is obtained from coal.

15.4.4 Products obtained from coal

Coal when heated in the absence of air does not burn but produces many by-products. This process of heating coal in the absence of air is called destructive distillation of coal. The destructive distillation of coal can be carried out in the laboratories. The apparatus is as shown in Figure 15.13.

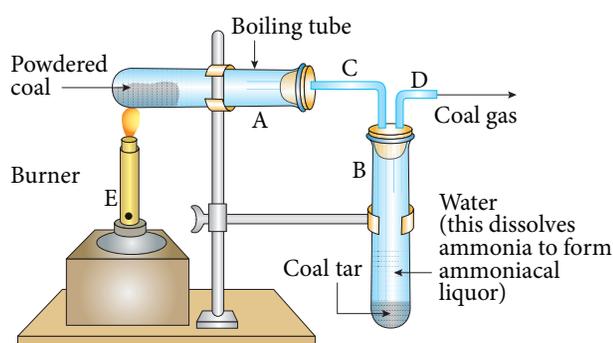


Figure 15.13 Destructive Distillation

Finely powdered coal is taken in a test tube and heated. At a particular temperature coal breaks down to produce coke, coal tar, ammonia and coal gas. Coal tar is deposited at the bottom of the second test tube and coal gas escapes out through the side tube. Ammonia produced is absorbed in the water, forming ammonium hydroxide. Finally a black residue called coke is left in the tube.

Thousands of different products have coal or coal by-products as their components. Some of them are soap, aspirins (tablet), solvents, dyes, plastics, and fibres, such as rayon and nylon. The main by products obtained during destructive distillation are coke, coal tar, ammonia and coal gas.

Coke

Coke contains 98% carbon. It is a porous, black and the purest form of coal. It is a good fuel and burns without smoke. It is largely used as a reducing agent in the

extraction of metals from their ores. It is also used in making fuel gases like producer gas and water gas.

Coal tar

Coal tar is a mixture of different carbon compounds. It is a thick, black liquid with unpleasant smell. The fractional distillation of coal tar gives many chemical substances like benzene, toluene, phenol and aniline. They are used in the preparation of dyes, explosives, paints, synthetic fibers, drugs, and pesticides. Another product obtained from coal tar is naphthalene balls which are used to repel moth and other insects.

Coal gas

Coal gas also known as town gas is mainly a mixture of gases like hydrogen, methane and carbon monoxide. The gases present in coal gas are combustible and hence, it is an excellent fuel. It has high calorific value.

Ammonia

The other by product obtained from coal is ammonia. It is used for making fertilizers such as ammonium sulphate, ammonium superphosphate etc.



It is also known as **Black Diamond** owing to its precious nature. On destructive distillation, 1000 kg of coal gives 700 kg of coke, 100 litres of ammonia, 50 litres of coal tar and 400 m³ of coal gas.

15.5 Petroleum

The term 'petroleum' is derived from the latin words 'petra' meaning rock and 'oleum' meaning oil. It is a fossil fuel formed from the remains of ancient marine organisms through decaying process. Petroleum is a complex mixture of hydrocarbons that occur



in Earth in liquid, gaseous, or solid form. The term petroleum commonly denotes the liquid form, crude oil. But technically petroleum also includes natural gas and bitumen, a solid form. The natural gas and the crude oil constitute the primary fossil fuels.



Figure 15.14 Petroleum Extraction



People in ancient cultures used crude oil for binding materials. It was also used as a sealant for waterproofing various surfaces.

15.5.1 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),

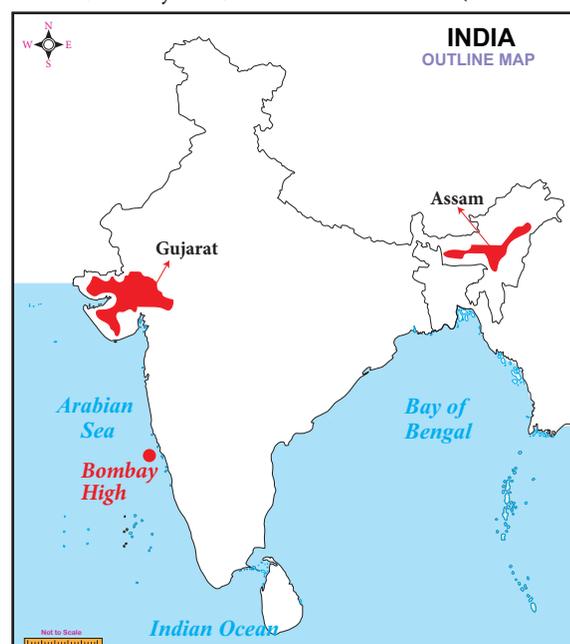


Figure 15.15 Places where petroleum is extracted

Andhra Pradesh (Godavari and Krishna basin) and Tamil Nadu (Cauveri Basins). By drilling through the earth the crude oil is pumped out from the well as a black liquid.

DO YOU KNOW?

The first oil well in the world was drilled in Pennsylvania, USA in 1859. The second oil well was drilled in Makum, Assam, India in 1867.

15.5.2 Refining of crude petroleum

The crude petroleum obtained from the well is a dark colored viscous liquid which contains many impurities such as water, solid particles and gases like methane and ethane. To make it useful for different purposes, it must be separated into various components. The process of separating petroleum into useful by-products and removal of undesirable impurities is called refining. The steps involved in this process are given below.



Figure 15.16 Crude Oil

Separation of water

The crude oil obtained from the oil wells will have salt water mixed with it. As the first step the water is removed from the crude oil.

Removal of sulphur compounds

The crude oil will have harmful sulphur compounds as impurities. In this step these impurities are removed.

Fractional distillation

Petroleum is a mixture of various constituents such as petroleum gas, petrol, diesel, kerosene, lubricating oil, paraffin wax, etc. The process of separation of various constituents or fractions of petroleum is done by fractional distillation in fractionating columns. The 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 given in Figure 15.17. Many useful substances are obtained from petroleum and natural gas. These are termed as '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, petroleum is also called 'black gold'.

15.5.3 Uses of Petroleum

Products obtained from crude oil have a number of uses.

- Liquefied Petroleum Gas or LPG is used in houses as well as in the industry.
- Diesel and petrol are used as fuels for vehicles. It is also used to run electric generators.
- Petrol is used as a solvent for dry cleaning.
- Kerosene is used as a fuel for stoves and also in jet planes.
- Lubricating oil reduces wear and tear and corrosion of machines.
- Paraffin wax is used to make candles, ointments, ink, crayons, etc.
- Bitumen or asphalt is mainly used to surface roads.

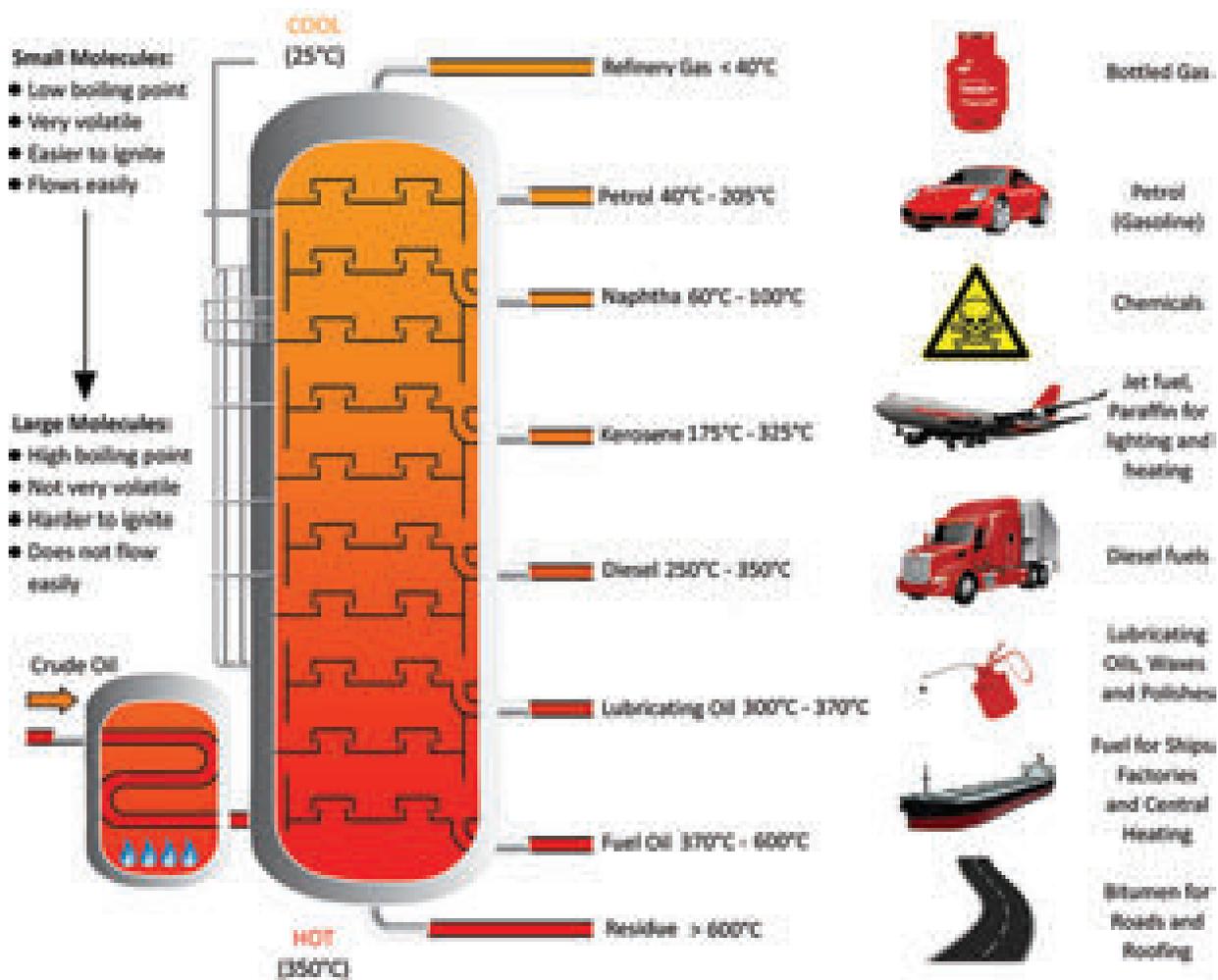


Figure 15.17 Product obtained from petroleum

Activity 5

Find out where petroleum is extracted on a large scale in India. Also list out the petroleum refineries in India.

15.6 Fuel

Any substance that can produce heat and energy on burning is called fuel. We use this heat for various purposes such as cooking, heating and many industrial and manufacturing purposes. Some of the fuels that we use in our daily life are wood, coal, petrol, diesel and natural gas.

15.6.1 Types of fuel

Fuels are classified into different types according to their physical state. They are classified into solid, liquid and gaseous fuels.

Solid fuels

Fuels like wood and coal are in solid state and they are called solid fuels. This type of fuel was the first one to be used by man. These fuels are easy to store and transport. The production cost is also very low.

Liquid fuels

Most of the liquid fuels are derived from the fossil remains of dead plants and animals. Petroleum oil, coal tar and alcohol are some of the liquid fuels. These fuels give more energy on burning and burn without ash.

Gaseous fuel

Coal gas, oil gas, producer gas and hydrogen are some of the gaseous fuels. These fuels can be easily transported through pipes and they do not produce pollution.

15.6.2 Characteristics of fuel

An ideal fuel should have the following characteristics.

- It should be readily available
- It should be easily transportable
- It should be less expensive
- It should have high calorific value
- It should produce large amount of heat
- It should not leave behind any undesirable substances

15.6.3 Efficiency of Fuel

Any fuel contains carbon as its main constituent. During the combustion of fuel carbon combines with oxygen and liberates large amount of heat. It is expected that a fuel liberates maximum amount of heat in the short time. The efficiency of a fuel can be understood from the following terms.

Specific Energy

Specific energy is the amount of energy produced by unit mass of a fuel. It is defined as the energy per unit mass. It is used to measure the stored energy in certain substances. Its unit is Jkg^{-1} .

Calorific Value

It is the quantity of heat produced by the complete combustion of fuel at constant pressure and normal conditions. It is measured in terms of KJkg^{-1} .

Table 15.1 Calorific value of some fuels

Fuel	Calorific Value (KJ/kg)
Cow dung cake	6000 – 8000
Wood	17000 – 22000
Coal	25000 – 33000
Petrol	45000
Kerosene	45000
Diesel	45000
Methane	50000
CNG	50000
LPG	55000
Biogas	35000 – 40000
Hydrogen	150000

Octane Number

Octane number denotes the amount of octane present in petrol. The fuel having high octane number is called as an ideal fuel.

Cetane Number

Cetane number measures the ignition delay of the fuel in diesel engine. When cetane number is higher the ignition delay is shorter. The fuel with high cetane number is called as the ideal fuel.

Table 15.3 Difference between Octane number and Cetane number

Octane Number	Cetane Number
Octane rating is used for petrol	Cetane rating is used for diesel
It measures the amount of octane present in petrol.	It measures the ignition delay of the fuel in diesel engine.
Octane number of petrol can be increased by adding benzene or toluene.	Cetane number of diesel can be increased by adding acetone.
The fuel with high octane number has low cetane number	The fuel with high cetane number has low octane number.

15.7 Alternative Fuel

The natural resources in the world have been used by man in a rapid way and they will be exhausted soon. The traditional fuel that we use today including petroleum are non renewable and they would be depleted soon. It is estimated that coal will last for 148 years, petroleum for 40 years and natural gas for 61 years. So we need to find alternative sources of energy. More over fossil fuels emit harmful gases like carbon dioxide, carbon monoxide and sulphur dioxide which pollute the atmosphere. Burning fossil fuels also cause temperature rise in the earth's atmosphere. Many believe that fuel which does not cause pollution is needed to enhance the quality of our environment. Some of the alternative fuels are given below.

Bio diesel

Bio diesel is a fuel obtained from vegetable oils such as soya bean oil, jatropha oil, corn oil, sunflower oil, cotton seed oil, rice-bran oil and rubber seed oil.



Hydrogen - The future fuel

Hydrogen could be the best alternative fuel in the future. 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.

Wind energy

Wind energy is obtained with the help of wind mills. When wind blows, they rotate the blades of the wind mills and electricity is produced by the dynamo. Wind mills are mostly located at Kayathar, Aralvaimozhi, Palladam and Kudimangalam in Tamil Nadu.



Figure 15.18 Wind Mill

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.

15.8 Solar Energy

Sun is the first and foremost energy source that makes life possible on the earth. Solar energy is the only viable fuel source of non depleting nature for sun provides a free and renewable source of energy. It is the renewable type of energy without endangering

the environment. It is the potential source to replace the fossil fuel in order to meet the needs of the world. With the advancements in science and technology, solar energy has become more affordable, and it can overcome energy crisis. Solar energy is a clean energy. With the minimum efforts maximum energy can be harnessed using various equipments.

15.8.1 Applications of Solar Energy

Solar energy has wider applications in various fields.

- It is used in solar water heater.
- It is used in drying of agricultural and animal products.
- It is used in electric power generation.
- It is used in solar green houses.
- It is used in solar pumping and solar distillation. It is used for solar cooking and solar furnaces also.



Figure 15.19 Solar panel

Points to Remember

- Methane is the simplest hydrocarbon in which four hydrogen atoms are linked with one carbon atom.
- Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane.
- CNG is the cheapest and cleanest fuel. Vehicles using this gas produce less carbon dioxide and hydrocarbon emission. It is less expensive than petrol and diesel.
- Producer gas is a gaseous mixture of carbon monoxide and nitrogen.

- Water gas is a gaseous mixture of carbon monoxide and hydrogen. It is also called as syngas or synthesis gas.
- The term 'petroleum' is derived from the latin words 'petra' meaning rock and 'oleum' meaning oil.
- Any substance that can produce heat and energy on burning is called fuel.
- Specific energy is defined as the energy per unit mass. It is used to measure the stored energy in certain substances. Its unit is Jkg^{-1} .
- Cetane number measures the ignition delay of the fuel in diesel engine.
- Solar energy is the energy derived from the sun in the form of solar radiation.

A-Z GLOSSARY

Bio Gas	Mixture of the gases methane and carbon dioxide.
Calorific Value	The quantity of heat produced by the complete combustion of fuel at constant pressure and normal conditions.
Catenation	The property of carbon atom to form bonds with itself resulting in a single large structure or chain.
CNG	Compressed natural gas obtained at high pressure.
Destructive distillation	The process of heating coal in the absence of air.
Fractional distillation	The process of heating a mixture of liquids having different boiling points and then separating them by cooling.
Hydrocarbons	Organic compounds consisting of hydrogen and carbon atoms.
LPG	Liquefied Petroleum Gas
Octane Number	The number which denotes the amount of octane present in petrol.
Water Gas	Gaseous mixture of carbon monoxide and hydrogen.



TEXTBOOK EXERCISES



I. Choose the best answer.

1. The chemical mixed with LPG that helps in the detection of its leakage is _____
 - a. methanol
 - b. ethanol
 - c. camphor
 - d. mercapton
2. Which is known as syn gas?
 - a. Marsh gas
 - b. Water gas
 - c. Producer gas
 - d. Coal gas
3. The unit of calorific value of fuel is _____
 - a. KJmol^{-1}
 - b. KJg^{-1}
 - c. KJkg^{-1}
 - d. Jkg^{-1}
4. _____ is the coal of superior quality.
 - a. Peat
 - b. Lignite
 - c. Bituminous
 - d. Anthracite

5. The main component of natural gas is _____
- a. methane b. ethane
c. propane d. butane

II. Fill in the blanks.

1. Producer gas is a mixture of _____ and _____
2. _____ is known as marsh gas.
3. The term petroleum means _____
4. Heating coal in the absence of air is called _____
5. An example for fossil fuel is _____

III. Match the following.

Octane rating	Diesel
Cetane rating	Methane
Simplest hydrocarbon	Petrol
Peat	Brown in colour
Lignite	First stage coal

IV. Answer briefly.

1. What do you mean by catenation?
2. Mention the advantages of natural gas.
3. Expand CNG. List out its uses.
4. Identify the gas known as syngas. Why is it called so?
5. Anthracite is known as the highest grade coal. Give reason.

6. Distinguish between octane number and cetane number.
7. Name the places in Tamilnadu harnessing wind energy from wind mills.
8. Solar energy is a non depleting energy. Justify.

V. Answer in detail.

1. Explain the different types of coal.
2. What is known as destructive distillation? Write about the products obtained from fractional distillation of petroleum.
3. Explain the different types of fuel gases.



REFERENCE BOOKS

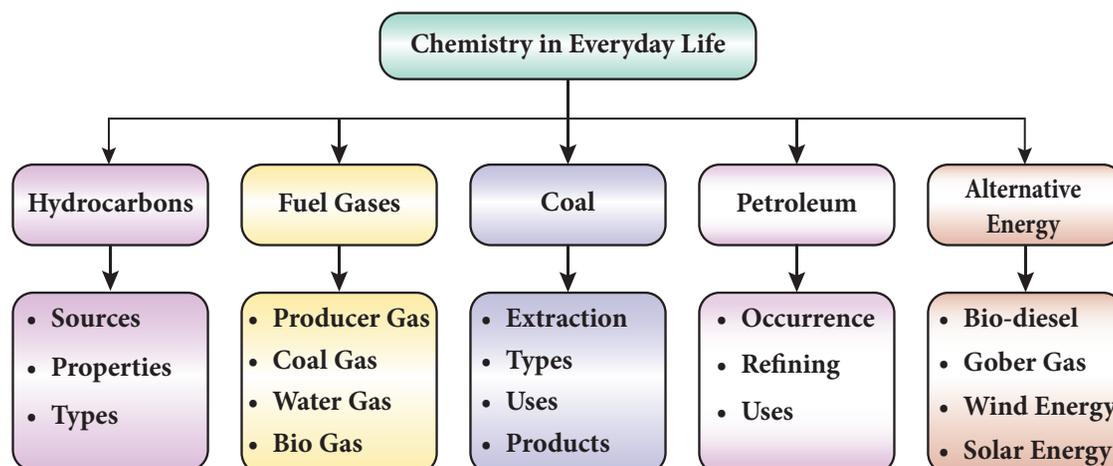
1. Chemistry in daily life by Kirpal Singh.
2. Chemistry in action: The molecules of everyday life by Nina Morgan.
3. Engineering Chemistry by Dr. A. Ravi krishnan.



INTERNET RESOURCES

1. www.learnchem.net
2. <https://edu.rsc.org/resources>

Concept Map





Learning Objectives

After the completion of this lesson, students will be able to:

- ◆ understand different types of microorganisms.
- ◆ differentiate various microorganisms based on their shape and occurrence.
- ◆ know the role of microbes in various fields such as medicine, agriculture, industry and daily life.
- ◆ know the effects of harmful microorganisms.
- ◆ understand the relationship between man and microbes.
- ◆ know the effects of prions and virions on human health.



T4XGTA

Introduction

Microorganisms are very small in size that they cannot be seen through naked eye. These organisms can be seen only with the help of a microscope. Therefore, they are also known as microbes. The science that deals with the study of microorganisms is known as **microbiology**. Microorganisms are found everywhere. They are found in air, water (ponds, lakes, rivers and oceans), soil and even inside our bodies. They remain inactive under unfavourable conditions and become active during favourable conditions. Microorganisms can be studied under five categories. They are: virus, bacteria, fungi, algae and protozoa. Let us study about them in detail.

16.1 Virus

A virus is a tiny particle made up of genetic material and protein. They are intermediate between living and non living things. Virus means 'poison' in Latin. Viruses are intracellular obligatory parasites. The study of virus is called **virology**. Viruses are 10,000 times smaller than bacteria. Viruses have different shapes. They can be rod shaped, spherical or of other shapes.

16.1.1 Structure of Virus

A virus contains a core DNA or RNA. Surrounding that core is a protein coat. In some viruses, the protein coat is covered by an envelope made of proteins, lipids, and carbohydrates. These envelopes have spikes that help the virus particles attach to the host cells. Viruses cause many diseases to plants, animals and human beings.

16.1.2 Characteristics of Virus

Viruses show both living and non living characters.

Living characters

- They respond to heat, chemicals and radiations.
- They reproduce inside the host cells and produce copies of themselves.

Non-living characters

- They are inactive when present freely in the environment.
- They can be crystallized and stored for a very long time, like other non-living things.



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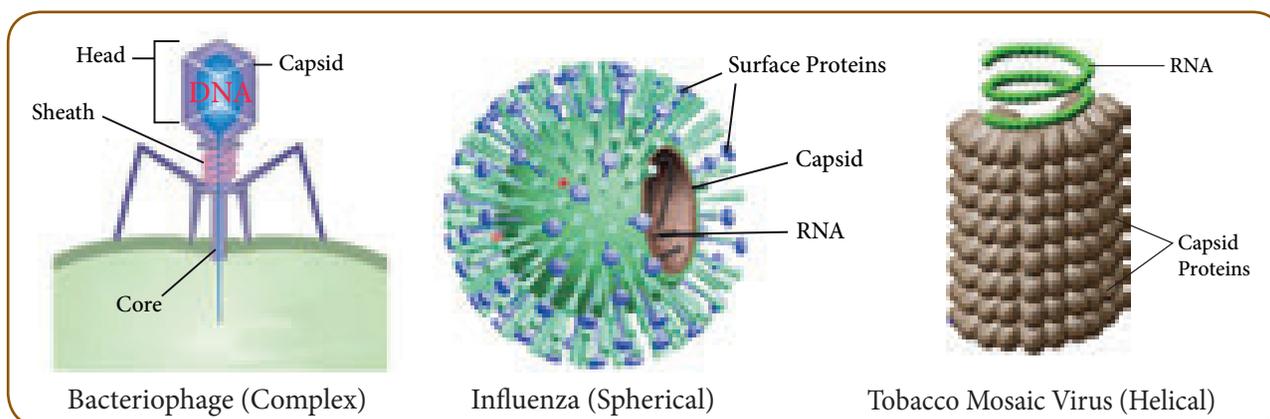


Figure 16.1 Shapes of Virus

16.2 Bacteria

Bacteria are single-celled prokaryotes (cells without nuclei). They are considered to be the first living organisms on earth. Bacteria are grouped under the kingdom Monera. The study of bacteria is called bacteriology. The size of bacteria ranges from $1\mu\text{m}$ to $5\mu\text{m}$ (micrometer). Bacteria are of two types based on respiration. They are:

- Aerobic bacteria (requires oxygen).
- Anaerobic bacteria (does not require oxygen).

16.2.1 Cell structure of Bacteria

A bacterium has an outer covering known as the cell wall. Nuclear material is represented by a nucleoid without nuclear membrane. An extra chromosomal DNA called plasmid is present in the cytoplasm. Protein synthesis is carried out by 70S ribosomes. Other cell organelles (mitochondria, golgi body, endoplasmic reticulum etc.,) are absent. Flagella aids in locomotion.

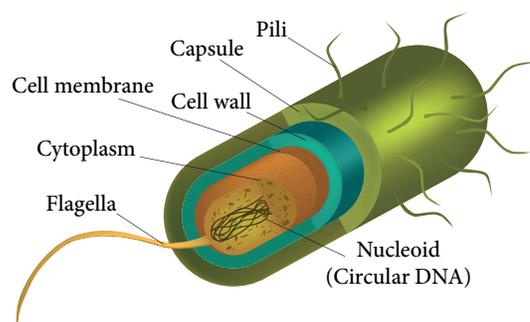


Figure 16.2 Cell structure of Bacteria

Bacteria are classified according to the shape of their cells. They are:

- Bacilli: Rod shaped bacteria.
Eg. *Bacillus anthracis*
- Spirilla: Spiral shaped bacteria.
Eg. *Helicobacter pylori*
- Cocci: Spherical or ball shaped bacteria. They can stick together in pairs (diplococcus) or form a chain (streptococcus) or occur in bunches (staphylococcus).
- Vibrio - Comma shaped bacteria.
Eg. *Vibrio cholera*.

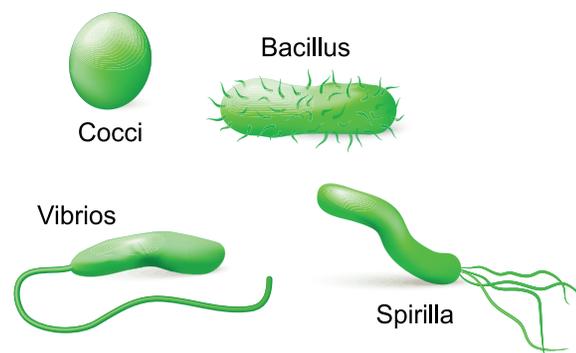


Figure 16.3 Shapes of Bacteria

Bacteria are also classified according to the number and arrangement of flagella. They are as follows.

- Monotrichous: Single flagella at one end.
Eg. *Vibrio cholera*
- Lophotrichous: Tuft of flagella at one end.
Eg. *Pseudomonas*.
- Amphitrichous: Tuft of flagella at both ends.
Eg. *Rhodospirillum rubrum*.

- Peritrichous: Flagella all around. Eg. *E.coli*.
- Atrichous: Without any flagella.
Eg. *Corynebacterium diphtherae*.

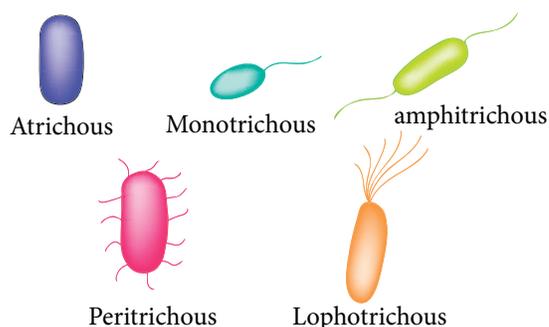


Figure 16.4 Flagellation types in Bacteria

Bacteria get their food in many ways. Photosynthetic bacteria make their own food (Eg. Cyanobacteria). Bacteria that live in harsh environment use chemicals (Ammonia, Hydrogen sulphide) to produce their food instead of utilizing energy from the sun. This process is called chemosynthesis. Some bacteria exhibit symbiotic relationship (Eg. *E.coli* lives in the intestine of man). Bacteria reproduces by fission (Binary and multiple fission).

Activity 1

Take one or two drops of butter milk on a slide and spread it. Heat the slide slightly on a lamp (3 – 4 seconds). Add a few drops of crystal violet and leave it for 30 to 60 seconds. Then wash the slide gently with water. Observe the slide under the compound microscope.

16.3 Fungi

Fungi are a group of eukaryotic organisms that lack chlorophyll. They grow in dark environments. They may be either unicellular (Eg. Yeast) or multicellular (Eg. Penicillium). They are found in all kinds of habitats. They are included under kingdom Fungi. The study of fungi is called **mycology**. Some fungi are macroscopic (Eg. Mushroom). There are around 70,000 species of fungi, living in the world.

Here, we will study about yeast which is a unicellular fungi. You will study about multicellular fungi elaborately in Chapter 17.

16.3.1 Cell structure of Yeast

Yeasts are found freely in the atmosphere. Yeast grows in all kinds of media containing sugar. The cell is ovoid in shape, containing cell wall and a nucleus. The cytoplasm is granular, and has vacuoles, organelles and glycogen an oil globules. Yeast aids in fermentation with the help of the enzyme zymase. It respire anaerobically and reproduces by budding.

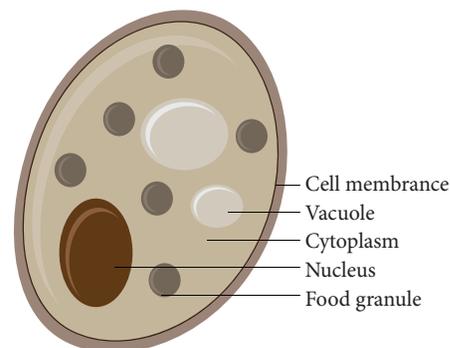


Figure 16.5 Structure of Yeast

16.4 Algae

Algae are very simple plant like eukaryotic organisms. They are found in moist habitats. They are rich in chlorophyll and can be seen as thin film on the surface of lakes and ponds. Therefore they are known as 'grass of water'. They are autotrophic and they produce their own food with the help of chloroplast. Chloroplast contain chlorophyll (green pigments) for photosynthesis. The study of algae is called **algology (phycology)**.

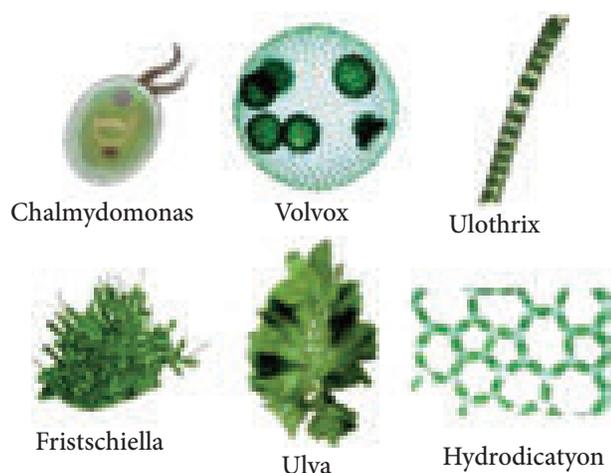


Figure 16.6 Different types of Algae

Their size varies from 1 micron to 50 meter. Algae may be unicellular and microscopic (Eg. *Chlamydomonas*) or multicellular and macroscopic (Eg. *Sargassum*). Unicellular algae exhibits variety of shapes (i.e., spherical, rod, spindle), where as multicellular algae are in the form of filaments and branches. In this section we will study about unicellular algae (*Chlamydomonas*) alone. Multicellular algae are explained in detail in the next chapter.

16.4.1 Cell structure of *Chlamydomonas*

Chlamydomonas is a simple, unicellular, motile fresh water algae. They are oval, spherical or pyriform in shape. The pyriform (pear shape) is a common one found in ponds, ditches and water tanks. They have a narrow anterior end and a broad posterior end.

The cell is surrounded by a thin and firm cell wall made of cellulose. The cytoplasm is seen in

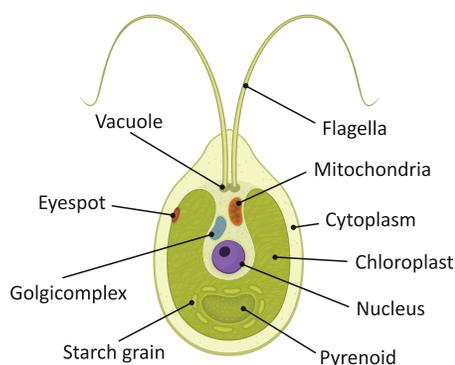


Figure 16.7 Structure of *Chlamydomonas*

between the cell membrane and the chloroplast. The cell contains large dark nucleus lying inside the cavity of the cup shaped chloroplast. The anterior part of the cell bears two flagella which helps in locomotion. Two contractile vacuoles are seen at the base of each flagellum. The anterior side of the chloroplast contains a tiny red coloured eyespot. *Chlamydomonas* exhibits sexual and asexual modes of reproduction.

16.5 Protozoa

A protozoan (In Greek, 'protos' means first and 'zoan' means animal) is a single-celled eukaryote. They are included under the kingdom **Protista**. The study of protozoa is called **Protozoology**. They are found in ponds, ocean, in moist soil, and in the cells and tissues of plants and animals causing diseases. They range from 2 to 200 microns. Protozoans have specialized organelles. These organelles are used for movement, feeding, and other functions. The types of protozoans are as follows:

Ciliates: Presence of cilia for locomotion.

Eg. *Paramecium*

Flagellates: Presence of flagella for locomotion.

Eg. *Euglena*

Pseudopods: Presence of pseudopodia for locomotion. Eg. *Amoeba*

Sporozoans: Parasites.

Eg. *Plasmodium*

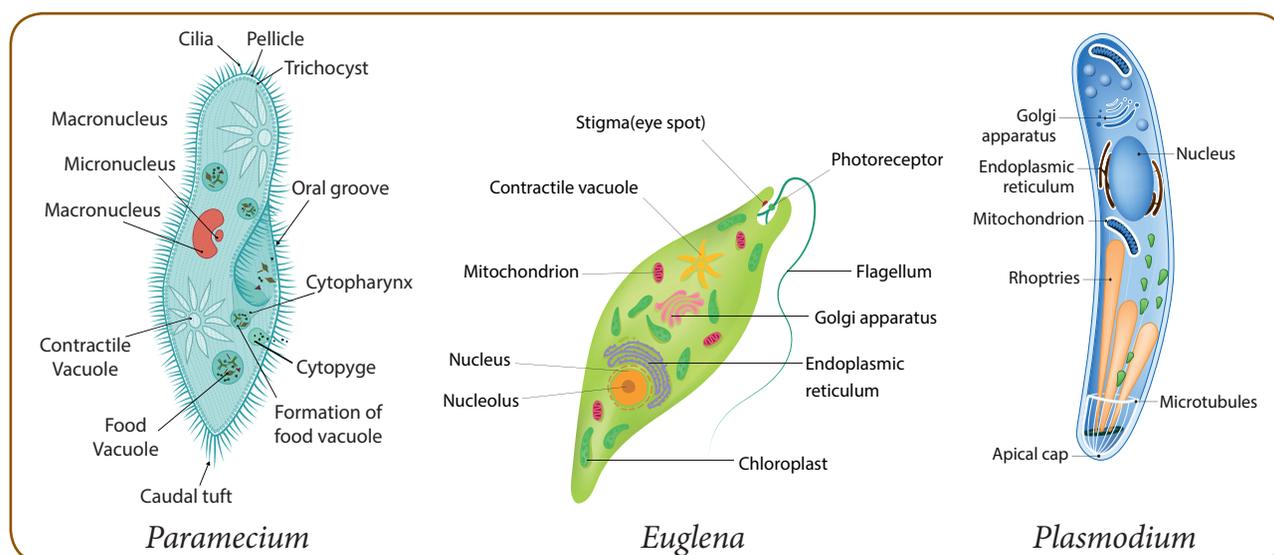


Figure 16.8 Common Protozoans

Activity 2

Take one or two drops of hay (In tamil, vaikol) decoction on a slide and observe it under the microscope.

16.5.1 Cell structure of Protozoa

Amoeba is a unicellular microscopic organism. It is found in ponds. *Amoeba* is irregular in shape. It has cell membrane, cytoplasm and nucleus. It is a protozoan that moves by means of pseudopodia (In Latin, 'false feet'). Pseudopodia are the extended part of cell membrane. It helps to catch its prey (Algae). The body flows around the food particle and engulfs it forming food vacuoles. Contractile vacuoles are seen in the cytoplasm that help in excretion. *Amoeba* reproduces by means of fission and sporulation.

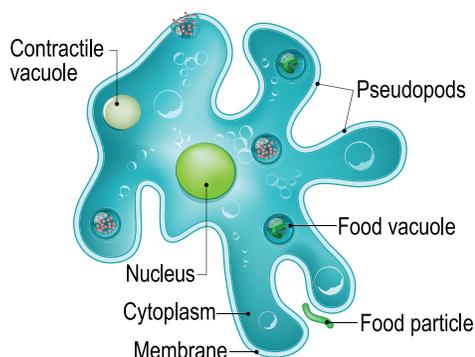


Figure 16.9 Amoeba

16.6 Prions

The word prion is derived from 'proteinaceous infectious particle'. Prions have neither DNA nor RNA to transmit infection. A prion is a mutated form of a usually harmless protein. Prions cause

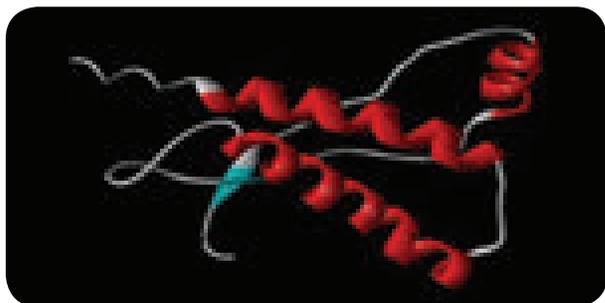


Figure 16.10 Structure of Prion

diseases by affecting brain or neural tissue. Eg. Creutzfeldt-Jacob disease. Another example is Kuru- associated with cannibalism.

16.7 Virions

Virion is an entire virus particle consisting of an outer protein shell called a capsid and an inner core of nucleic acid (RNA or DNA). If the virus is found outside the cell (extracellular) it is known as virion. Virion has the capacity to infect the living tissue.

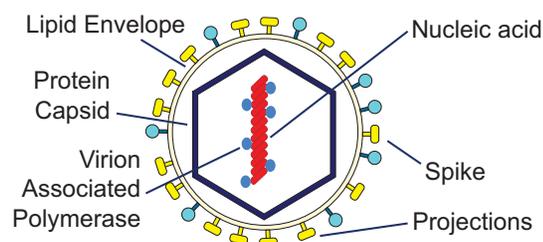


Figure 16.11 Structure of Virion

16.8 Uses of Microorganisms

Microorganisms are useful in different fields such as medicine, agriculture and industry. Some of them are given below.

16.8.1 Medicine

We obtain antibiotics and vaccines from microbes.

Antibiotics

The word 'anti' means 'against'. Antibiotic is a substance produced by living organisms which is toxic for other organisms.



Figure 16.12 Penicillium chrysogenum

Sir Alexander Fleming was the first person to discover the antibiotic penicillin in the year 1928. The antibiotic penicillin was obtained from the fungi *Penicillium chrysogenum*. It is used to treat diseases such as tetanus and diphtheria. The antibiotic, streptomycin is obtained from *Streptomyces* bacteria to cure various bacterial infections. Eg. Plague.

Vaccines

Vaccines are prepared from dead or weakened microbes. Edward Jenner was the first person to discover small pox vaccine. He coined the term vaccination. When the vaccine is injected to the body of a patient, the body produces antibodies to fight against the germs. These antibodies remain inside the body and protect from future invasion of the germs. Therefore, vaccination is otherwise called as immunization. Eg: MMR vaccine is given for preventing Measles, Mumps and Rubella. BCG (Bacille Calmette Guerin) vaccine is given for preventing Tuberculosis.

16.8.2 Agriculture

Natural fertilizer

Microorganisms are called as decomposers because they act upon degradable wastes. During the process, nitrates and other inorganic nutrients are released into the soil, making the soil fertile. This compost is called as natural fertilizer.



Figure 16.13 Types of Biofertilizers

Nitrogen fixation

Rhizobium bacteria living in the root nodules of leguminous plants enrich the soil by fixing the atmospheric nitrogen as nitrates which are essential for the growth of plants. Some free living bacteria in soil, like Cyanobacteria Nostoc can also fix nitrogen biologically.

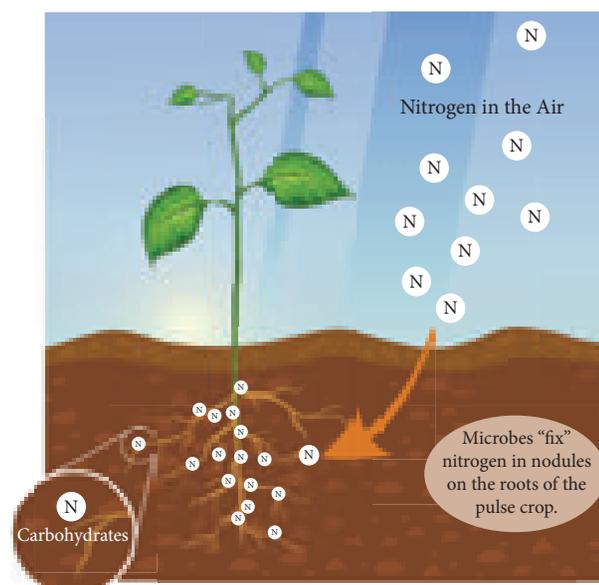


Figure 16.14 Nitrogen fixation in plants

Bio-control agents

Microbes are used to protect the crops from pests. Some of them are given below.

- *Bacillus thuringiensis* (Bt cotton) helps to control insects.
- *Trichoderma* (Fungi) helps to protect roots and controls plant pathogens.
- *Baculoviruses* (Virus) attack insects and other arthropods.

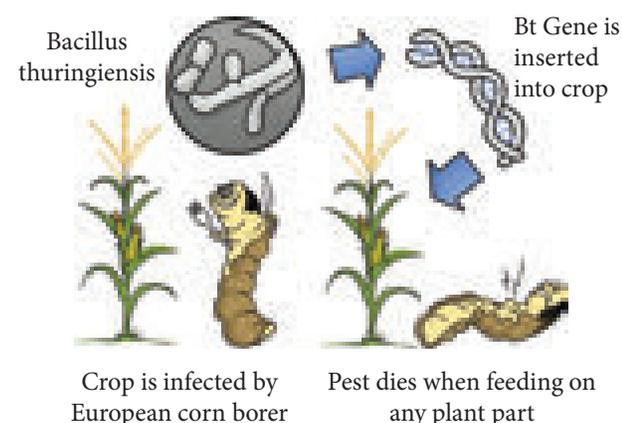


Figure 16.15 Biocontrol agents

16.8.3 Industry

Sewage treatment

Aerobic microbes are allowed to grow in the primary effluent during the secondary stage of waste water treatment. These microbes consume the major part of the organic matter in the effluent. Eg. *Nitrobacter* sps. In the anaerobic treatment of sewage *Methanobacterium* is used.

Production of biogas

Human and animal faecal matter and plant wastes are broken down by anaerobic bacteria to produce methane (biogas) along with carbon dioxide and hydrogen. These bacteria are called as methanogens.

Production of alcohol and wine

Alcoholic drinks are prepared by fermentation process using yeast. Sugars present in grapes are fermented by using yeast. Beer is produced by the fermentation of sugars in rice and barley.

Microbes in retting and tanning

Flax plants are tied in bundles and kept in water. Bacteria loosen the supporting fibres of the stem by acting on the stem tissues. This process is known as retting. Linen thread is made from these fibres. Eg. *Pseudomonas aeruginosa*.

In tanning industry bacteria act upon the skin of animals and makes it soft and therefore it becomes pliable.

16.8.4 In daily life

Making bread

Yeast is used in bakeries to make bread and cakes. They are added to the dough to produce carbon dioxide which makes the dough rise. Bread and cakes are soft due to

carbon dioxide gas. *Chlorella* (green algae) which is rich in proteins and vitamins is added to the dough to enrich the bread with nutrients.

Preparation of curd and cottage cheese

Lactose in the milk gets turned into Lactic acid by the action of *Lactobacillus* (bacteria). Therefore, milk becomes thick (curd). It gives the sour taste. When curd is processed cottage cheese (panneer) is obtained.



In Human Intestine

- *Lactobacillus acidophilus* that lives in the human intestine helps in digestion of food and fights against harmful disease causing organisms.
- *E.coli* bacteria living in human intestine help in synthesizing vitamin K and vitamin B complex.

16.8.5 Microbes in Food Process

Microorganisms commonly used for food processing are yeast, bacteria, and moulds. Fermentation process which is carried out by microorganisms results in the production of organic acids, alcohol and esters. They help to preserve food and generate distinctive new food products.

a. Food preservation

Two techniques are followed in food preservation. They are:

- Traditional techniques
- Modern techniques

1. Traditional techniques

Fermentation, pickling, boiling and sugaring are the traditional techniques followed in food preservation.

Fermentation

Fermentation is the microbial conversion of starch and sugars into alcohol. It makes foods more nutritious and palatable.

Pickling

Pickling is a method of preserving food in an edible antimicrobial liquid. It is of two types: chemical pickling and fermentation pickling.

In chemical pickling, food is placed in an edible liquid that kills bacteria and other microorganisms. Eg. Vinegar, alcohol, vegetable oil (pickling agents). In fermentation pickling, bacteria in the liquid produce organic acid as preservation agent that produces lactic acid due to the presence of *Lactobacillus*.

Boiling

Boiling liquid food items kill all the microbes. Eg. Milk and Water.

Sugaring

Sugar is used to preserve fruits in an antimicrobial syrup with fruits such as apples, pears, peaches, plums or in a crystallized form, so that the product is stored in dry condition.

2. Modern techniques

Pasteurization

It is a process for preservation of liquid food. This method was invented by Louis Pasteur in 1862. Milk is preserved by this method. It is heated up to 70°C to kill the bacteria and it is cooled to 10°C to prevent the growth of remaining bacteria. Then milk is stored in sterilized bottles in cold places.

b. Food production

Probiotics

Probiotics are live food supplements used in yoghurt and other fermented milk products. Eg. *Lactobacillus acidophilus* and *Bifidobacterium bifidum*. These bacteria improve the microbial spectrum in the gut and thus contribute to the following effects.

- Decrease the risk of colon cancer
- Decrease cholesterol absorption
- Prevent diarrheal diseases by increasing immunity.

16.9 Harmful Microorganisms

A few microorganisms are harmful to plants, animals and humans. They cause diseases and hence they are called as pathogens. Pathogens enter into the body through cuts and wounds in the skin, mouth or nose and cause diseases. Viruses causing 'flu' are spread through air. When the patient sneezes droplets containing viruses spread in air and it gets entered to another person when he breathes. Some of the diseases caused by the microorganisms in plants, animals and humans are given in the tables below.



Citrus canker

Potato blight disease

Figure 16.16 Disease in plants

Table 16.1 Diseases caused by microorganisms in plants

Plant diseases	Causative microorganisms	Mode of transmission	Symptoms	Preventive measures/ Treatment
Citrus canker	<i>Xanthomonas axonopodis</i> (Bacteria)	Air, water	Lesions on leaves, stems and fruit	Copper based bactericides can be used
Potato blight disease	<i>Phytophthora infestans</i> (Fungi)	Air	Brown lesions on the surface of tubers	Fungicides are used

Table 16.2 Diseases caused by microorganisms in animals

Animal diseases	Causative microorganisms	Mode of transmission	Symptoms	Preventive measures/Treatment
Anthrax (also affects humans)	<i>Bacillus anthracis</i> (Bacteria)	Through contaminated soil and food	Difficulty in breathing, unconsciousness, loss of appetite	Anthrax vaccine
Foot and mouth disease	<i>Aphthovirus</i> (Virus)	Through air and animal vectors	Fever, blisters in mouth, weight loss, decreased milk production	FMD vaccine

Table 16.3 Diseases caused by microorganisms in humans

Human diseases	Causative microorganisms	Mode of transmission	Symptoms	Preventive measures/Treatment
Tuberculosis	<i>Mycobacterium tuberculosis</i> (Bacteria)	Through air and sputum of infected person	Persistent cough, blood mucus, loss of weight, breathlessness	BCG Vaccine
Cholera	<i>Vibrio cholera</i> (Bacteria)	By flies and contaminated food and water	Watery diarrhoea, vomiting, rapid dehydration.	Anticholera vaccine, maintaining personal hygiene.
Common cold	<i>Influenza</i> (virus)	Through air	Running nose, sneezing	Isolation of patient
Rabies	<i>Rhabdo viridae</i> (Virus)	Animal bite	Fever, hallucination, paralysis, inability to swallow	Anti-rabies vaccine
Amoebic dysentery	<i>Entamoeba histolytica</i> (Protozoa)	Food water and flies	Severe diarrhea and blood in stool	Proper sanitation to be followed and metronidazole antibiotic to be administered
Malaria	<i>Plasmodium</i> (Protozoa)	Female anopheles mosquito	Nausea, vomiting, high fever	Antimalarial drugs like quinine and chloroquine to be taken and usage of mosquito repellents and nets.

16.10 Relationship Between Man and Microbes- Balances, Imbalances and Uses

Thousands of bacteria, fungi and other microbes that live in our gut are essential contributors to a good health. They break down toxins, manufacture some vitamins and essential amino acids and form a barrier against invaders. Gut microbes are the bacteria in human gut.

They are one of the most important allies in our overall health and well being. Gut ensures that the body is absorbing all the important nutrients, to function at its highest level. Many different aspects of health are attached to it.

Points to Remember

- The organisms which can be seen only with the help of microscope are called microorganisms.

- Virus show both living and non living characteristics.
- Bacteria is a prokaryotic, single celled organism.
- Fungi is a eukaryotic, non-photosynthetic, spore-forming organism. They range from single celled organisms to very complex multicellular organisms.
- Algae is a single-celled or multicellular eukaryotic, photosynthetic organism.
- Protozoa is a eukaryotic, single celled organism that usually lacks chlorophyll.

A-Z GLOSSARY

Antibiotic	A chemical that kills or inhibits the growth of micro organism and is used to treat infections.
Bacteria	A prokaryotic, single celled organism.
Capsid	The protein coat surrounding a virus.
Fermentation	Conversion of organic compounds such as carbohydrate into simpler substances by microbes, usually under anaerobic conditions (with no oxygen present).
Hyphae	A very fine thread that is the basic structure of fungi.
Microorganism	A small living thing which includes bacteria, protozoa, algae, fungi and viruses.
Pathogen	An organism that causes disease.
Vaccine	A special type of medicine that is given to both people and animals to artificially increase immunity to a particular disease and to prevent an infectious disease from developing.



TEXTBOOK EXERCISES



I. Choose the best answer.

- Microorganisms are measured in _____.
a) cm b) mm c) micron d) meter.
- _____ shows both living and nonliving characteristics.
a) Protozoa b) Virus c) Bacteria d) Fungi
- _____ is a prokaryotic microorganisms.
a) Virus b) Algae c) Fungi d) Bacteria
- Based on shape, the bacteria are classified into _____ types.
a) two b) three c) four d) five
- Common cold in human is caused by _____.
a) plasmodium b) influenza
c) vibrio cholera d) apthovirus

II. Fill in the blanks.

- _____ is prepared from a mould called penicillium.
- _____ are the infectious protein particles.
- The infecting virus particle found outside the host cell is _____.
- Microorganism can be seen with the help of a _____.
- Bacteria, which has a flagellum at one end is classified as _____.

III. State true or false. If false, correct the statement.

- Disease causing microorganisms are called pathogens.

- Female anopheles mosquito is a carrier of dengue virus.
- Chicken pox is a communicable disease.
- Citrus canker is transmitted by insects.
- Yeast is used in the large scale production of alcohol.

IV. Match the following.

Nitrogen fixing bacteria	Vaccine
Tuberculosis	Prion
Kuru	Lactobacillus acidophilus
Probiotics	Bacteria
Edward Jenner	Rhizobium

V. Answer the following questions.

Mark the correct one as:

- If both assertion and reason are true and reason is the correct explanation of assertion.
 - If both assertion and reason are true and reason is not the correct explanation of assertion.
 - If assertion is true but reason is false.
 - If both assertion and reason are false.
- Assertion: Malaria is caused by Protozoa.
Reason: The disease is transmitted by mosquito.
 - Assertion: Algae are heterotrophic.
Reason: They do not have chlorophyll.

VI. Answer very briefly.

- Write the name of any nitrogen fixing bacteria.
- Name the bacteria used in the production of vinegar.
- Write the names of any three protozoans.

- Who discovered penicillin?
- Which diseases can be prevented by vaccination?

VII. Answer briefly.

- Write the four types of bacteria, based on their shape.
- What are antibiotics?
- What are pathogens?
- How disease causing microorganisms enter into human beings?
- Why microorganisms are essential for agriculture?

VIII. Answer in detail.

- Write a short note on bacteria and its structure.
- How microorganisms are useful in the field of medicine?
- Write a short note on common human diseases caused by microorganisms.
- How can we improve the beneficial bacterial count in human beings?
- Write a short note on probiotics.



REFERENCE BOOKS

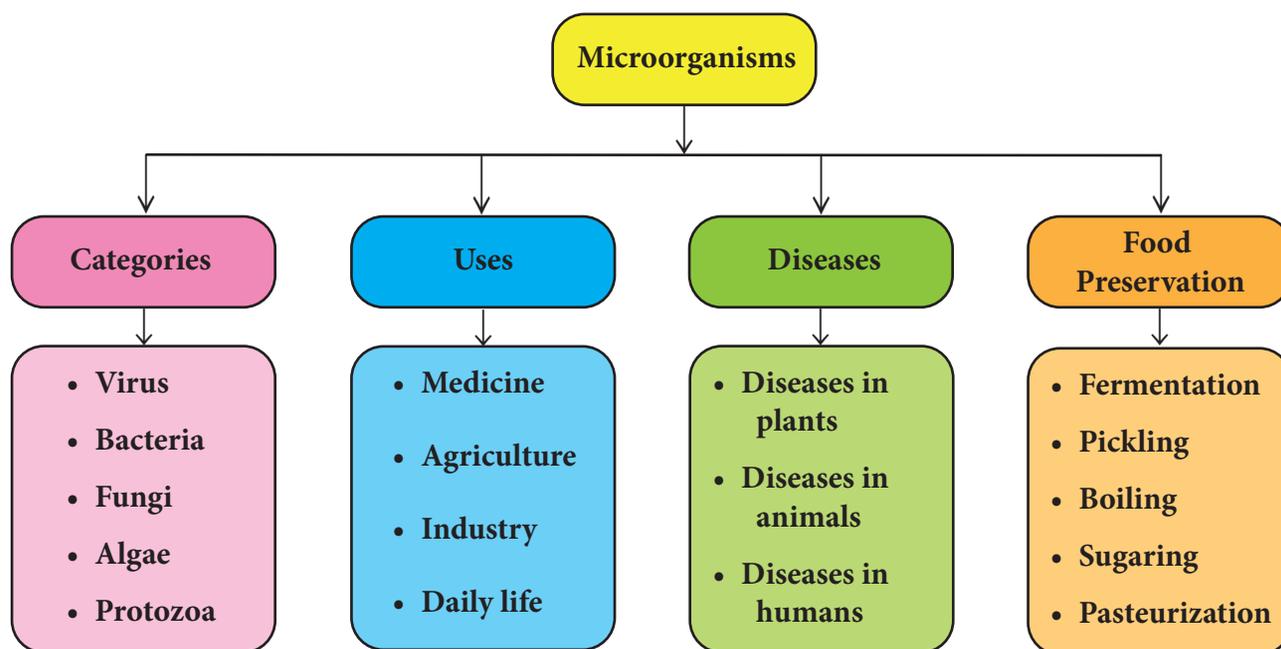
- Ananthnarayan and Panicker's-Textbook of Medical Microbiology. Edited by C.K.J.Panicker.
- Essential Microbiology - Stuart Hogg.
- Textbook of Microbiology - Surinder Kumar.



INTERNET RESOURCES

- <https://en.wikipedia.org/wiki/Microorganism>
- <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/microorganisms>

Concept Map





ICT CORNER

MICROORGANISMS

This activity enables the students to know about the Classification of Micro organisms



Steps

- Open the Browser and type the given URL (or) Scan the QR Code.
- Options will be given. Select the “Classification of Microorganisms”
- Click and touch the button slides one by one
- To know about the “Classification of Microorganisms”



Step1



Step2



Step3



Step4

Web link: <https://www.slideshare.net/mgcnkedahsc/11-classification-of-microorganisms>

(or) scan the QR Code



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UNIT

17

PLANT KINGDOM



Learning Objectives



HX6682

After the completion of this lesson, students will be able to:

- ◆ know the general characteristics of algae.
- ◆ classify the types of algae based on the pigmentation.
- ◆ know about the salient features, mode of nutrition, classification and the uses of fungi.
- ◆ differentiate bryophytes from pteridophytes.
- ◆ list out the importance of medicinal plants and their uses.
- ◆ understand the classes of angiosperms and their characteristics.
- ◆ tabulate Bentham and Hooker's classification of seeded plants.

Introduction

The living organisms found on the earth differ in their structures, habit, habitat, mode of nutrition and physiology. The estimated number of plant species on the earth is 8.7 million (1 million = 10 lakhs). Among them 6.5 million species are living on land and 2.2 million species are living in the ocean. Out of them 4,00,000 species are flowering plants. The living organisms show lot of similarities and differences so that they can be arranged into many groups systematically. In traditional system of classification, plant kingdom is divided into two sub-kingdoms called non flowering plants (Cryptogams) and flowering plants (Phanerogams). Thalophyta, bryophyta and pteridophyt are non flowering plants. In this lesson, we will study about algae, fungi, bryophytes, pteridophytes and classification of plants.

17.1 Algae

Algae is a latin word (Algae - Sea weeds). They are chlorophyll bearing, simple and primitive plants. These plants are autotrophs. Algae belongs to thallophyta and the plant body

of algae is called thallus. i.e. the plant body is not differentiated into root, stem and leaf.

Most of the algae are living in aquatic region. It may be fresh water or marine water. Very few algae can survive in wet soil. Some algae are very minute and float on the surface of the water. These algae are called **phytoplankton**. Some of the algae are symbionts (Algae living with fungi and they both are mutually benefitted). E.g. Lichen. A few species of algae are epiphytes. The branch of study of algae is called phycology or algology. Algae reproduces by three methods. They are:

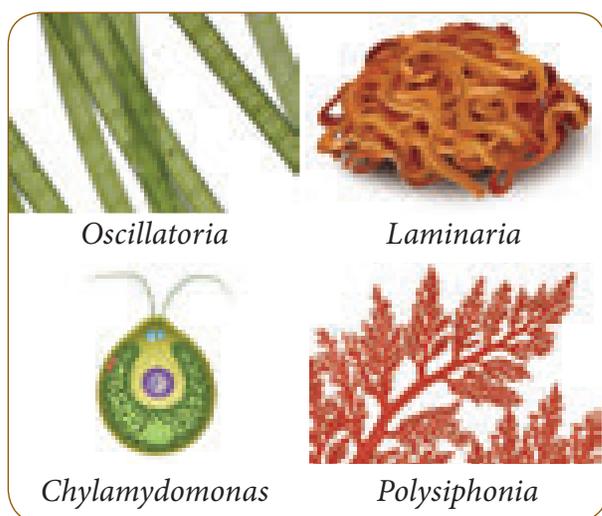
- Vegetative reproduction takes place by fragmentation. E.g. *Spirogyra*.
- Asexual reproduction takes place by spore formation. E.g. *Chlamydomonos*.
- Sexual reproduction takes place by means of fusion of gametes. E.g. *Spirogyra*, *Chara*.

17.1.1 Clarification of Algae

Algae are classified into different classes based on the pigments. They are given in Table 17.1.

Table 17.1 Classification of algae based on pigments

Class	Example	Types of Pigments	Reserve food material
Bluegreen algae (Cyanophyceae)	<i>Ocillatoria</i>	Phycocyanin	Cyanophycean Starch
Green algae (Chlorophyceae)	<i>Chlamydomonas</i>	Chlorophyll	Starch
Brown algae (Phaeophyceae)	<i>Laminaria</i>	Fucoxanthin	Laminarian starch and Manitol
Red algae (Rhodophyceae)	<i>Polysiphonia</i>	Phycoerythrin	Floridian Starch

**Figure 17.1** Algae

17.1.2 Economic importance

Food

Algae are consumed as food by people in Japan, England and also in India. E.g. *Ulva*, *Spirulina*, *Chlorella* etc. Some algae are used as food for domestic animals. E.g. *Laminaria*, *Ascophyllum*.



Agriculture

Some of the blue green algae are essential for the fixing of atmospheric nitrogen into the soil, which increases the fertility of the soil. E.g. *Nostoc*, *Anabaena*.

Agar Agar

Agar agar is extracted from some red algae, namely *Gelidium* and *Gracillaria*. It is used to prepare growth medium in laboratories.

Iodine

Iodine is obtained from brown algae like *Laminaria*.

Space travel

Chlorella pyrenoidosa is used in space travel to get rid of CO₂ and to decompose human wastes.

Single Cell Protein (SCP)

Some of the single cell algae and blue green algae are used to produce protein. E.g. *Chlorella*, *Spirulina*.

17.2 Fungi

Fungi (Singular – Fungus) belongs to thallophyta. Its plant body is not differentiated into root, stem, and leaves. The plant body of fungus consists of filament like structures called **hyphae**. Several hyphae are arranged in the form of network called **mycelium**. The cells of fungi are multicellular and eukaryotic. Some species of fungi like yeast are unicellular and eukaryotic. Cell wall of fungi is made up of a chemical substance called chitin.

The reserve food materials of fungi are glycogen and oil. They have no starch because they have no chlorophyll pigments. So, they are heterotrophs. Heterotrophs are of three types namely, parasites, saprophytes and symbionts.

Some species of fungus live as parasites. They absorb food from the living organisms with the help of special root called haustoria. E.g. *Cercospora personata*. It affects groundnut plants and cause Tikka disease.



The branch of study of fungus is called **mycology**.



Figure 17.2 Tikka disease in groundnut leaves

Some species of fungi live as saprophytes. They grow upon the dead and decaying organic matters and get food from them. E.g. *Rhizopus*.

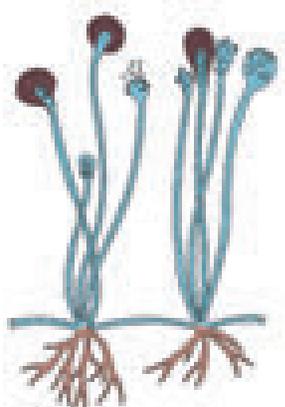
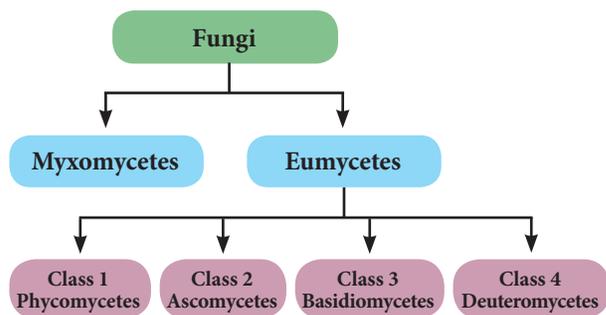


Figure 17.3 Rhizopus

Some species of fungi are living with algae and mutually benefitted. E.g. *Lichen*. Some of them live symbiotically with higher plants in their roots called *Mycorrhizae*

17.2.1 Classification of Fungi

Fungi are classified into different classes as given below.



17.2.2 Economic importance of Fungi

Fungi are useful to us in many ways. The importance of fungi are given below.

Antibiotic

Penicillin (*Penicillium notatum*) and Cephalosporin which cure different diseases are obtained from fungi.



Figure 17.4 *Penicillium notatum*

Food

Mushroom contains rich protein and minerals. The most common edible mushroom is *Agaricus* (Button mushroom).



Figure 17.5 *Agaricus*

Vitamins

Fungus like *Ashbya gossypii* and *Eremothecium goshbyii* are used to produce vitamin B₂ (riboflavin).

Alcohol

Fungus like yeast contain enzymes invertase and zymase, which ferment the sugar molasses into alcohol.



Figure 17.6 Yeast

17.2.3 Harmful effects of Fungi

Fungi cause various diseases in plants and animals. They are given in the tables below.

Table 17.2 Diseases caused by fungi in plants

Pathogen	Name of the Disease
<i>Fusarium oxysporum</i>	Wilt disease in cotton
<i>Cercospora personata</i>	Tikka disease in ground nut
<i>Colletotrichum falcatum</i>	Red rot in sugar cane
<i>Pyricularia oryzae</i>	Blast disease in paddy
<i>Albugo candida</i>	White rust in radish

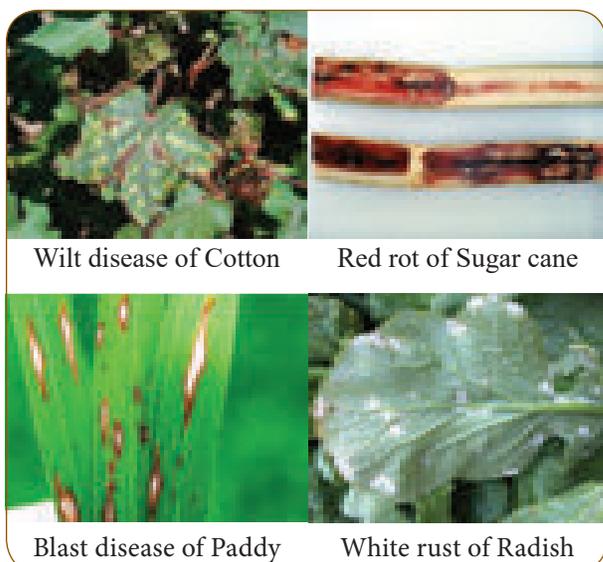


Figure.17.7 Diseases caused by fungi in plants

Info bits

Fungi are placed as third kingdom in R.H. Wittekar's five kingdom of classification because of absence of chlorophyll and starch.

Activity 1

Take a piece of bread, pour some water on it and cover it for four days. After four days place the bread on a slide and observe it through microscope. What will you see? Name the organisms which you see in the slide.

Table 17.3 Diseases caused by fungi in human

Name of the Fungi	Name of the Disease
<i>Trichophyton sp.</i>	Ring worm (Circular rash on the skin)
<i>Microsporum furfur</i>	Dandruff
<i>Tinea pedis</i>	Athletes foot

More to Know

Claviceps purpuriya is the hallucinogenic fungi which causes greatest damages to the frustrated youth by giving unreal, extraordinary lightness and hovering sensations.

Aspergillus species cause allergy to children while *Cladosporium* protects against allergy.

Table 17.4 Difference between algae and fungi

Algae	Fungi
Algae are autotrophs.	Fungi are heterotrophs.
They have pigments.	They have no pigments
Reserve food material is starch.	Reserve food materials are glycogen and oil.
Some algae are prokaryotic in nature E.g: <i>Cyanobacteria</i> (<i>Nostac, Anabenae</i>)	All are eukaryotic nature. E.g: <i>Agaricus</i>



Figure 17.8 Diseases caused by Fungi in human

DO
YOU
KNOW?

Penicillin is known as Queen of Medicine. It was discovered by Sir Alexander Fleming in 1928.

17.3 Bryophytes

Bryophytes are the primitive and simplest group of plants. These are terrestrial and non-vascular cryptogams (They have no vascular tissues like xylem and phloem). Bryophytes live on land and in water. Therefore, they are named as amphibians of plant kingdom. Water is essential to complete their life cycle.

Bryophytes have distinct alternation of generation. Gametophyte generation is dominant and sporophytic generation is small. Sporophytic generation depends on the gametophytic generation. The gametophytic plant can be either thalloid (liverworts) or leafy (mosses). The plant remains fixed to the substratum with the help of root like structure called rhizoid.

Sexual reproduction is oogamous type. They have well developed sex organs like antheridia and archegonia. The male sex organ is antheridium, which produces antherozoid. The female sex organ is archegonium which contains an egg. Antherozoid swims with the help of water and reaches the archegonium. It fertilizes the egg and forms zygote (2n). Zygote is the first cell which develops into sporophytic generation and produces haploid spore (n) by meiosis. Spore is the first cell of the gametophytic generation.

17.3.1 Classification of Bryophytes

Bryophytes are classified into three classes. They are:

1. Hepaticae (Liverworts)
2. Anthocerotae (Hornworts)
3. Musci (Mosses)

Hepaticae (E.g. *Riccia*)

- These are lower forms of bryophytes. They are simple in structure than moss.
- Sporophyte is very simple and short lived.

Anthocerotae (E.g. *Anthoceros*)

- Gametophyte is undifferentiated thallus. Rhizoids are unicellular and unbranched.
- Protonemal stage is absent. Sporophyte is differentiated into foot and capsule only.

Musci (E.g. *Funaria*)

- These are higher forms in which the gametophyte is differentiated into stem, leaf and root like parts.
- Protonemal stage is present.
- Sporophytes are differentiated into foot, seta, and capsule.

17.3.2 Economic importance

- Bryophytes prevent soil erosion.
- *Sphagnum* can absorb large amount of water. Hence, it is used by the gardeners in nursery.
- Peat which is a valuable fuel like coal is obtained from *Sphagnum*.



Anthoceros

Riccia

Funaria

Figure 17.9 Bryophytes

Activity 2

Visit a nearby nursery and observe how *Sphagnum* is used in horticulture and make a note on it.

17.4 Pteridophytes

Pteridophytes are the first true land plants with xylem and phloem. Hence, they are called vascular cryptogams. The main plant body is differentiated into true root, stem and leaves.

Pteridophytes also exhibit alternation of generation. The diploid sporophytic phase alternates with the haploid gametophytic phase. Sporophyte is the dominant phase. Sporophytes reproduce by means of spores. Spores are produced in sporangium. The sporangia bearing leaves are called sporophyll. Most of the plants produce only one type of spore either microspore or megaspore (homosporous). In some plants both microspore and megaspore are produced (heterosporous).

Spores give rise to gametophytic generation called *prothallus*, which is short lived and independent. The gametophytes produce the multicellular sex organs, antheridium which produces antherozoid (male gamete) and archegonium which contains an egg (female gamete). The antherozoid fertilizes with egg and form diploid zygote. It develops into an embryo which is differentiated into sporophyte.

17.4.1 Classification of Pteridophytes

Pteridophytes are classified into four classes. They are:

1. Psilopsida (Eg. *Psilotum*)
2. Lycopsida (Eg. *Lycopodium*)
3. Sphenopsida (Eg. *Equisetum*)
4. Pteropsida (Eg. *Nephrolepis*)

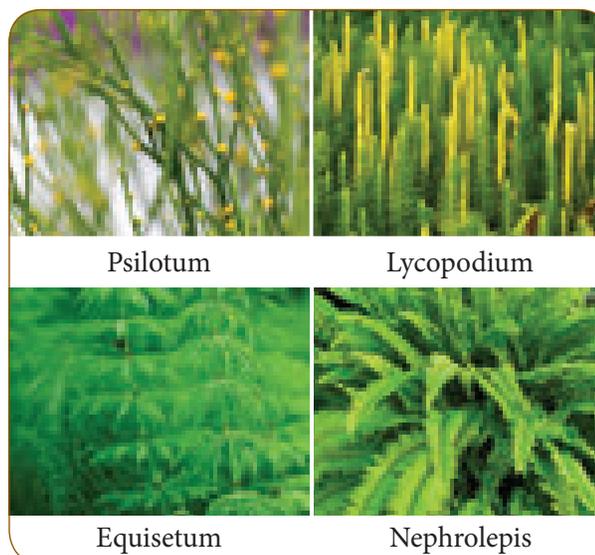


Figure 17.10 Pteridophytes

More to Know

Lycopodium, is known as club moss.

Equisetum is known as horse tail.

17.4.2 Economic importance of Pteridophytes

- Ferns are used as ornamental plants.
- The rhizome and petioles of *Dryopteris* yield the vermifuge drug.
- The sporocarp of *Marsilea* (Water fern) is used as food by some people.

Table 17.5 Difference between Bryophytes and Pteridophytes

Bryophytes	Pteridophytes
Plant body cannot be differentiated into root, stem and leaf.	Plant body can be differentiated into root, stem and leaf.
Bryophytes are amphibians.	Pteridophytes are true land plants.
Vascular tissues are absent.	Vascular tissues are present.
The dominant phase of the plant body is gametophyte.	The dominant phase of the plant body is sporophyte.
Sporophytic generation depends on the gametophytic generation. E.g. <i>Riccia</i>	Gametophytic generation does not depend on sporophytic generation. Eg. <i>Selaginella</i>

17.5 Gymnosperms

Gymnosperm are naked seed plant, i.e. the ovule is not enclosed by ovary. Gymnosperms have two phases in its life cycle (Gametophytic and Sporophytic). Sporophytic plant body is dominant and it is differentiated into root, stem and leaf. They have well developed vascular tissues (xylem and phloem). The water conducting tissue is tracheid and the food conducting tissue is sieve cell. They have cone in which sporangia and spores are produced.

17.5.1 Classification of Gymnosperms

Gymnosperm are classified into four different types. They are:

1. Cycadales
2. Ginkgoales
3. Coniferales
4. Gnetales

Cycadales

These are palm like small plants (erect and unbranched). Leaves are pinnately compound forming a crown. They have tap root system and coralloid root. E.g. *Cycas* sps.

Ginkgoales

These are large trees with fan shaped leaves. *Ginkgo biloba* is the only living species in the group. They produce unpleasant smell.

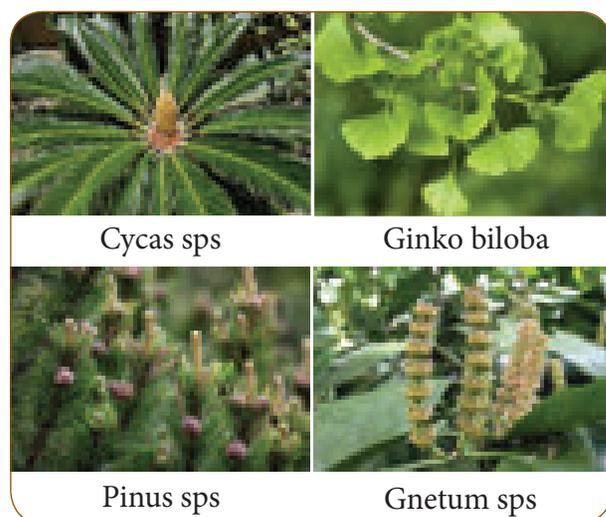


Figure 17.11 Gymnosperms

Coniferales

These are evergreen trees with cone like appearance. They have needle like leaves or scale leaves. Seeds are winged and produced in female cone. E.g. *Pinus* sps.

Gnetales

Gnetales are small group of plants. They possess advanced characters like angiosperm. Ovules are naked but, developed on flower like shoot. E.g. *Gnetum* sps.

17.5.2 Economic importance of Gymnosperms

- Woods of many conifers are used in the paper industries. E.g. *Pinus*, *Agathis*
- Conifers are the sources of soft wood for construction, packing and plywood industry. E.g. *Cedrus*, *Agathis*
- Turpentine, an essential oil, extracted from the resin of *Pinus* is used for paint preparation. It is also used medicinally to get relief from pain, bronchitis etc.,
- Seeds of *Pinus gerardiana* are edible.
- Ephedrine is an alkaloid extracted from *Ephedra*. It cures asthma and respiratory problems.
- *Araucaria bidwillii* is an ornamental plant.

17.6 Angiosperms

The term 'Angiosperm' is derived from two Greek words, i.e. 'angio' which means box or closed and 'sperma' which means seed. Habit of the plants may be herb (*Solanum melongena*), shrub (*Hibiscus rosasinensis*) and tree (*Mangifera indica* - Mango). They have well developed vascular tissues called xylem and phloem. Xylem contains vessel, tracheid, xylem parenchyma and xylem fibre. Phloem contains sieve tubes, phloem parenchyma, companion cells and phloem fibres.

17.6.1 Classification of Angiosperms

Angiosperms are divided into two classes. They are:

- Dicotyledons
- Monocotyledons

Characteristic features of Dicotyledons

- Seed has two cotyledons.
- Plants have tap root system and leaves are with reticulate venation.
- Flowers are tetramerous or pentamerous. Calyx and corolla are well differentiated.
- Pollination occurs mostly by insects.
- Examples are: Bean, Mango, Neem

Characteristic features of Monocotyledons

- Seed has only one cotyledon.
- Plants have fibrous root system, and leaves are with parallel venation.
- Flowers are trimerous and not differentiated into calyx and corolla.
- Pollination occurs mostly by wind.
- Examples are: Grass, Paddy, Banana.

Activity 3

Collect some flowering plants from your surrounding and classify them as monocot or dicot based on their root system and venation.

1. Artificial system of classification

This is the earliest system of classification in plants. Plants are classified on the basis of one or few morphological characters. The most famous artificial system of classification is Linnaeus classification which was proposed by **Carolus Linnaeus** in his book **Species plantarum**.

2. Natural system of classification

In this system, plants are classified on the basis of several characters. Bentham and Hooker's classification is an example of natural system of classification. This system of classification is based on morphological and reproductive characters of the seeded plants. **Bentham** and **Hooker** published their natural system of classification in their book named **General Plantarum** in three volumes. This classification is widely used in many herbaria and botanical gardens all over the world.



Herbarium is the collection of pressed, dried plants pasted on a sheet and arranged according to any one of the accepted systems of classification.

17.7 Taxonomy

Taxonomy is the branch of biology that deals with the study of identification, classification, description and nomenclature of living organisms. The word **taxonomy** is derived from two Greek words (**Taxis** means arrangement and **Nomos** means laws). The word 'taxonomy' was first coined by **Augustin-Pyramus de Candolle**.

17.7.1 Classification

Plants are arranged into different groups and categories on the basis of similarities and differences. It is called classification. There are four types of classification.

1. Artificial system of classification
2. Natural system of classification
3. Phylogenetic system of classification
4. Modern system of classification

17.8 Binomial Nomenclature

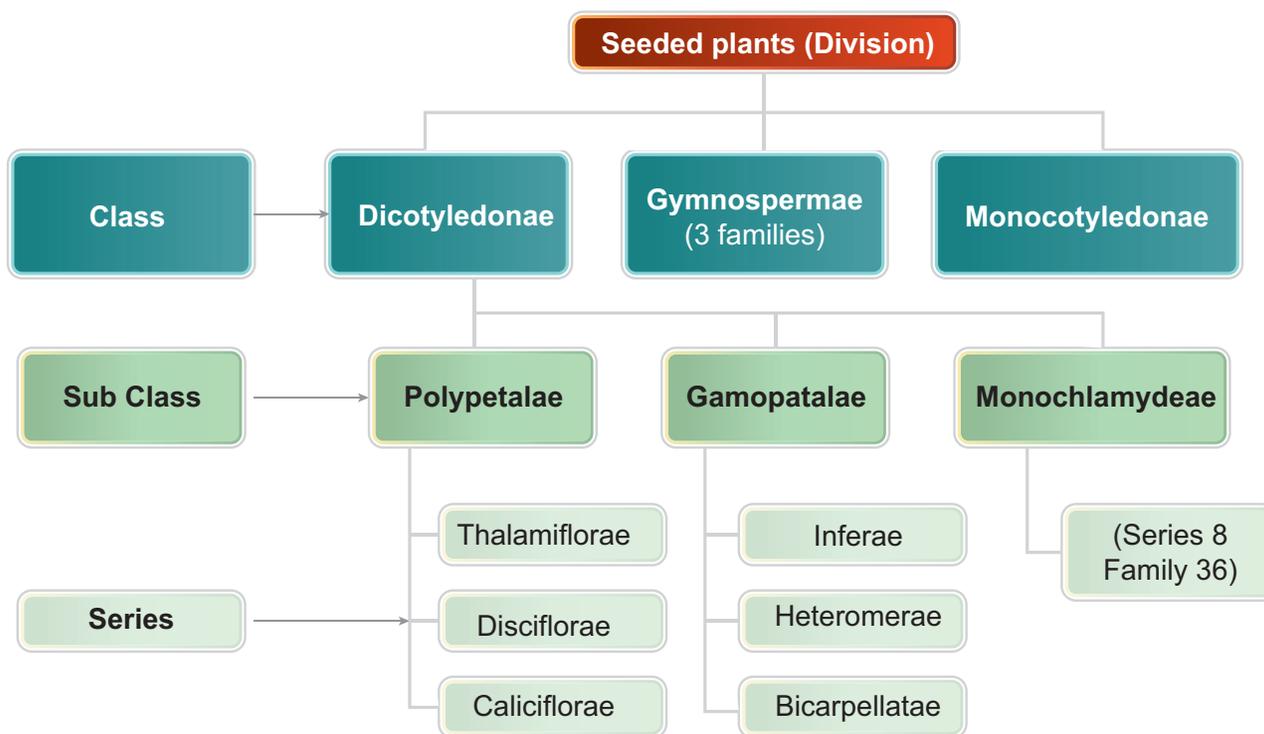
The naming of an organisms with two words is known as Binomial Nomenclature. For example, the binomial name of mango is *Mangifera indica*. Here the first word *Mangifera* refers to the genus name and the second word *indica* refers to the species name.

Binomial name was first introduced by **Gaspard Bauhin** in the year of 1623. Binomial system was implemented by **Linnaeus** in his book, **Species Plantarum**. The system of naming the plants on scientific basis is known as **Botanical nomenclature**.



Largest Herbarium of India is in Kolkata, which has more than 10,00,000 (one million) species of herbarium specimens.

Outline of Bentham and Hooker's System of Classification



Info bits

The rules and recommendations regarding binomial nomenclature were found in ICBN (International Code of Botanical Nomenclature). Now it is known as ICN (International Code of Nomenclature).

Activity 4

Collect some plants which are growing inside your school area. Write their vernacular name, binomial name and classify them into dicotyledons or monocotyledons in the given table.

Vernacular name	Binomial name	Monocotyledons/ Dicotyledons

17.9 Uses of medicinal plants

Plants are useful to us in many ways. Some plants along with their parts are used as medicines. Uses of some medicinal plants are given below.

Acalypha indica (Kuppaimeni)

- It belongs to the family Euphorbiaceae.
- The paste obtained from the leaves of this plant is used to cure the burns on the skin.
- The juice of this plant leaves is mixed with lemon juice to cure ringworm.



Figure 17.12 *Acalypha indica*

***Aegle marmelos* (Vilvam)**

- It belongs to the family Rutaceae.
- The unripe fruit of this tree is used to treat indigestion.
- It is used to cure chronic diarrhoea and dysentery.

Figure 17.13 *Aegle marmelos****Solanum trilobatum* (Thoodhuvalai)**

- It belongs to the family Solanaceae.
- The leaves and fruits of this plant cure cough and cold.
- It is widely used in the treatment of tuberculosis and bronchial asthma.

Figure 17.14 *Solanum trilobatum****Phyllanthus amarus* (Keezhanelli)**

- It belongs to the family Euphorbiaceae.
- The entire plant is used for the treatment of jaundice.
- It gives additional strength to human liver and it is used to treat other liver disorders.

Figure 17.15 *Phyllanthus amarus****Aloe vera* (Sothu Katrazhai)**

- It belongs to the family Liliaceae.
- Leaves of this plant is used to cure piles and inflammations on the skin.
- It cures peptic ulcer.

Fig.17.16 *Aloe vera***Points to Remember**

- Algae are chlorophyll bearing, simple, primitive plants and they are autotrophs.
- Gametophytic thallus is dominant phase in Bryophytes
- Parasites have special roots called haustoria.
- Pteridophytes are the first true land plants. They are vascular cryptogams.
- Gymnosperms are the naked seeded plants.
- Angiosperms are the closed seeded plants (Ovules are enclosed by the ovary).
- Angiosperms are divided into two classes, namely dicotyledons and monocotyledons.
- Scientific method of naming the plants with two words is known as Binomial Nomenclature.
- The paste obtained from the leaves of *Acalypha indica* cures burns on the skin.
- The leaves, flowers and fruits of *Solanum trilobatum* cure cough and cold.

A-Z GLOSSARY

Haustoria	Special roots present in parasites.
Mycorrhiza	Symbiotic association of fungi with higher plant roots.
Epiphytes	Plants growing upon other plants.
Autotrophs	Organisms which prepare their own food.
Heterotrophs	Organisms which depend on other organisms for their nutrition.
Vascular tissues	Tissues which conduct water and minerals.
Polypetalae	Petals which are many but not united.
Gamopetalae	United petal
Monochlamydeae	Flower with single whorl of perianth which can not be differentiated into calyx and corolla.

**TEXTBOOK EXERCISES****I. Choose the best answer.**

- Solanum trilobatum* is the binomial name of Thoothuvalai. The word 'Solanum' refers to
 - Species
 - Genus
 - Class
 - Orders
- Floridian starch is a reserve food material of
 - Chlorophyceae
 - Phaeophyceae
 - Rhodophyceae
 - Cyanophyceae
- An example for colonial form of algae is
 - Oscillatoria*
 - Nostoc*
 - Volvox*
 - Chlorella*
- One of the following is an edible mushroom
 - Polyporus*
 - Agaricus*
 - Penicillium*
 - Aspergillus*
- Plants that prevent soil erosion are
 - algae
 - fungi
 - bryophytes
 - pteridophytes
- The first land plants are
 - bryophytes
 - pteridophytes
 - gymnosperm
 - angiosperm
- The well-developed sporophytic plant body is seen in
 - bryophytes
 - pteridophytes
 - gymnosperms
 - angiosperms

- Binominal Nomenclature was first introduced in the year
 - 1970
 - 1975
 - 1978
 - 1623
- Penicillin is an antibiotic which is extracted from
 - algae
 - fungi
 - bryophytes
 - pteridophytes

II. Fill in the blanks.

- The word 'Taxonomy' is derived from _____
- Binomial nomenclature was first introduced by _____
- The book 'Genera Plantarum' was published by _____
- Monocotyledon seed bears only _____ cotyledon.
- Brown algae belongs to _____ class.
- Agar Agar is obtained from _____ algae.
- The reserve food material of fungi are _____ and _____
- The first true land plant is _____
- Xylem and phloem are absent in _____ plants.
- Reticulate venation is present in _____ plants.

III. State true or false. If false, correct the statement.

1. In polypetalae, the petals are free.
2. Binomial name should contain more than two words.
3. Artificial system of classification is based on a few characters of the plant.
4. Cell wall of fungi is made up of chitin.
5. Pinus is a closed seeded plant.
6. All bryophytes are hydrophytes.
7. Dicotyledons have well developed characters than the gymnosperms.
8. Mosses are the well developed plant in bryophytes.
9. The dominant phase of the bryophytes is sporophyte.
10. The dominant phase of the pteridophyte is gametophytic phase.

IV. Match the following.

Cyanophyceae	Green algae
Chlorophyceae	Blue green algae
Phaeophyceae	Red algae
Rhodophyceae	Brown algae

V. Answer very briefly.

1. Define - Thallus.
2. What is meant by binomial nomenclature? Give example.
3. Write any two characters of dicotyledons.
4. Seeds of gymnosperm plants are naked. Why?
5. Write any two economic importance of fungi.

VI. Answer briefly.

1. Write a short note on natural system of classification.
2. Write any three economic importance of algae.

3. Write the differences between algae and fungi.
4. How many classes are there in bryophytes? What are they?
5. Write any four characters of pteridophytes.

VII. Answer in detail.

1. Draw the outline of Bentham and Hooker's system of classification.
2. Write any five differences between monocot and dicot plants.
3. Write the differences between gymnosperm and angiosperm.
4. Write the economic importance of gymnosperms.
5. Write the names of medicinal plants and explain their uses.



REFERENCE BOOKS

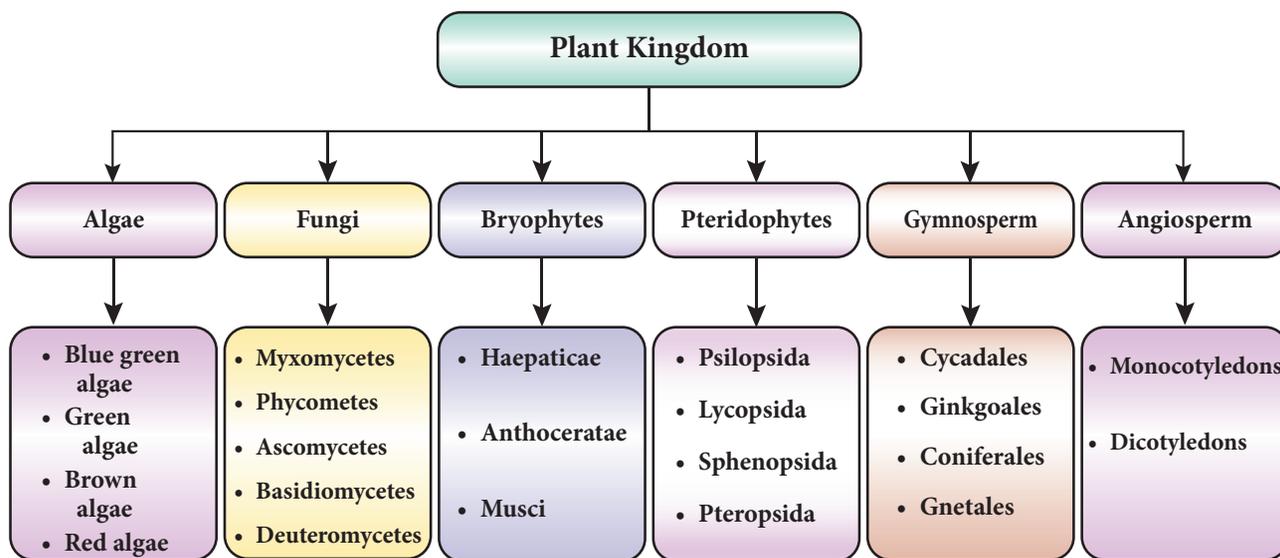
1. Algae - A.V.S.S Sambamurty. I.K International publishing house.
2. Bryophyta - Afroz Alam. I.K International publishing house.
3. Pteridophyta - O.P.Sharma. Mc Graw Hill Educations.
4. Gymnosperms - S.P.Bhatnagar. New Age Publishers.
5. Taxonomy of Angiosperms - B.P.Pandey. S.Chand Publishers.
6. Plant Kingdom - Theresa Greenaway. Hodder Wayland Publishers.



INTERNET RESOURCES

1. <https://www.topper.com>guides>biology>
2. <https://www.britannica.com>science>
3. <https://topper.com.>plant-kingdam>
4. <https://merriam-webster.com>binomial>

Concept Map



ICT CORNER

Plant Kingdom

Through this activity the students will learn about Medicinal plants and their uses

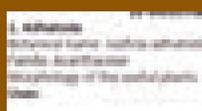


Steps

- Open the Browser and type the URL link (or) Scan the QR Code.
- Click the title “Medicinal plants and their uses
- Select and view the images of Medicinal plants and their uses
- Through this image u can identify the uses of medicinal plants



Step1



Step2



Step3



Step4

Web link : <https://www.plantscience4u.com/2018/08/10-medicinal-plants-and-their-uses-with.html#.XHZnyogzaM8>

(or) scan the QR Code

*Pictures are indicative only



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UNIT

18

ORGANISATION OF LIFE



Learning Objectives



After the completion of this lesson, students will be able to:

- ◆ understand the different levels of organization seen in the animal world.
- ◆ know about the structure of cells.
- ◆ understand the types of tissues.
- ◆ know about the structure of eye as an example for organ level of organization.
- ◆ understand the respiratory system as an example for system level of organization.
- ◆ understand the physiological functions of organizational setup with reference to homeostasis, diffusion, osmosis, osmoregulation, cellular respiration and metabolism.

Introduction

If you look around your surrounding, you will be able to observe numerous varieties of animals. There are animals like amoeba which cannot be seen by our naked eye. There are also animals like elephants and blue whale which are of huge size. The variations in animal are not only seen in size but also in the complexity of the cells, tissues and the body structure.

Based on the structural organization, organisms can be classified into prokaryotes and eukaryotes. In some organisms like bacteria, cyanobacteria and mycoplasma, the true nucleus is absent. These organisms are called prokaryotes. However, organisms like plants and animals have cells with a well-defined nucleus covered by membrane. These organisms are called eukaryotes. Some organisms have a single cell body and they are called as **unicellular organisms**. Eg. Yeasts and amoeba. Organisms such as plants, animals and human beings are made of a large number of cells and they are called **multicellular organisms**. In this lesson, let us learn about different levels of organizations of living organism with suitable example.

18.1 Biological Organisation

Biological organisation starts with submicroscopic molecular level and passes through microscopic cellular level and the microscopic or macroscopic organismic level. Finally it ends in ecosystem and the biosphere. Thus, biological organisation shows the hierarchy in organisation level from simple to more complex. The hierarchy in biological organisation reveals that atoms are the lowest unit at the submicroscopic level while the cells are the smallest unit at the microscopic level.

Atoms combine to form molecule which undergo chemical reaction to form organelles of the cells. Several organelles are contained in the cell. A group of cells which are similar and meant for a specific function constitutes a tissue. Several tissues together contributing to some specific function inside the body constitute an organ. Many organs acting together to perform a specific life process constitute an organ system. Several organ systems together constitute the organism. We see that several systems are present in an organism and they are required to perform diverse life process in

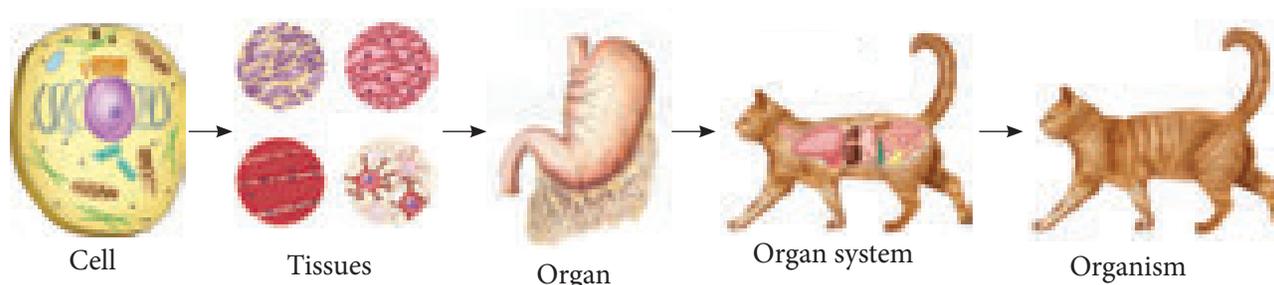


Figure 18.1 Different levels of organization

a multicellular organism. From lower organism to higher organism life has passed through simple to complex structural hierarchical level. The pictorial representation of biological organisation is shown in Figure 18.1.

18.2 Cells

Cell is the **structural and functional unit of life**. Cells are often called as 'building blocks of life'. The study of cells is called **cell biology**. Cells consist of cytoplasm enclosed within a membrane, which contains many biomolecules such as proteins and nucleic acids. Cells vary widely in shape and size. There is a central spherical **nucleus** and a variety of cytoplasmic living **cell organelles** like the endoplasmic reticulum, mitochondria, golgi bodies, centrioles, ribosomes, lysosomes, etc., present in an animal cell. Each cell organelle performs a specific function.

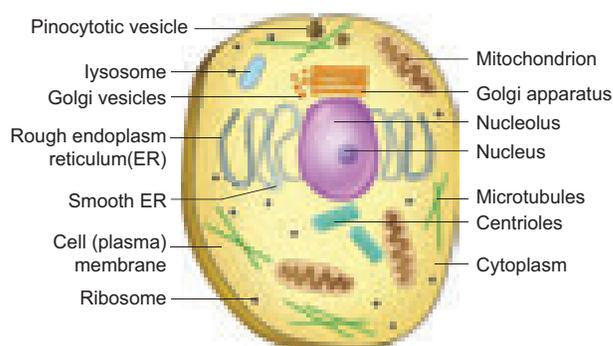


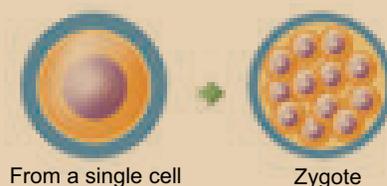
Figure 18.2 Animal cell

The size of cells varies in different animals and they which are measured in units of micron (μm). One micron is equal to $1/1000000$ meter. The average cell size varies from 0.5 to $20 \mu\text{m}$ in diameter. The cells of bacteria are the smallest in size ($1-2 \mu\text{m}$). In human body, the smallest cell is red blood cells ($7 \mu\text{m}$ in diameter) and

the longest one is the nerve cell which reaches a length of about $90 - 100 \text{ cm}$. Human egg (Ovum) is $100 \mu\text{m}$ in size. Among multicellular animals, the largest cell is, egg of an ostrich. Mycoplasma with a diameter of 0.0001 mm is the smallest bacterium.

DO YOU KNOW?

Our body is developed from a single cell called zygote. The zygote undergoes continuous mitotic division and forms the foetus consisting multitude of cells of different shape, size and content. Foetal cells gradually attain change in structure and function. This process is known as cell differentiation.



18.2.1 Shape of cells

Cells are of different shapes. Normally they are correlated with their functions. Some cells are oval or round, while certain others are elongated. Some are branched like the nerve cell or a neuron. Some of our white blood cells are amoeba like with irregular boundaries.

Activity 1

Boil a hen's egg and remove the shell. What do you observe? A white material surrounds the yellow part. White material is albumin which solidifies on boiling. The yellow part is yolk. It is a part of the single cell. You can observe this single cell without any magnifying devices.

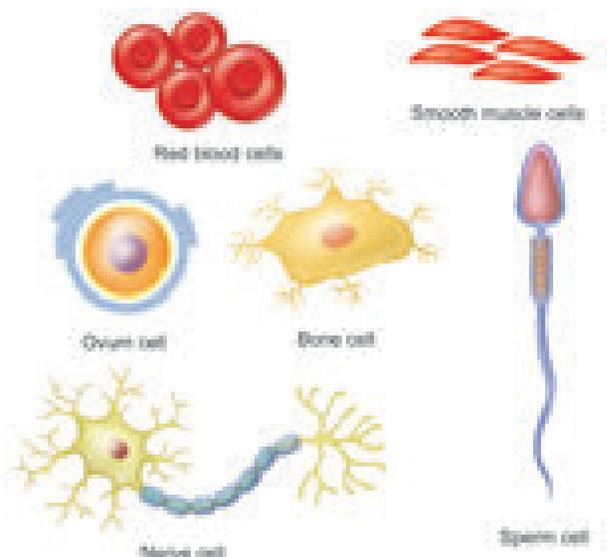


Figure 18.3 Shapes and sizes of some cells

18.3 Tissues

Tissues are groups of cells that have a similar structure and act together to perform a specific function. They are of two types: **simple tissues** and **complex tissues**. Simple tissues are made up of cells of same type or kind. E.g. Glandular tissue. Complex tissues are made up of different kind of tissues. E.g. Tissues of dry skin. Hence, simple tissue is homogeneous and complex tissue is heterogeneous.

18.3.1 Types of Tissues

Depending on the basis of their structure and function, tissues can be classified into four types:

1. **Epithelial** (Covering) tissue for protection.
2. **Muscular** (Contractile) tissue for movements and locomotion.

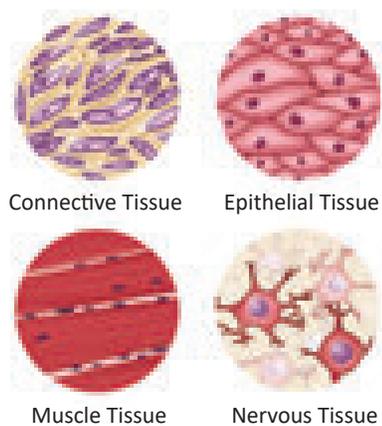


Figure 18.4 Types of animal tissues

3. **Connective** (Supporting) tissue for binding different structures of body.
4. **Nervous** tissue for conduction of nerve impulses.

All the complex organisms consist of only four basic types of tissues.

18.4 Organ

Organs are the structures made up of two or more types of tissues, organized to carry out a particular function. Example: Brain, heart, lungs, kidneys, liver etc., Each of them has specific functions.

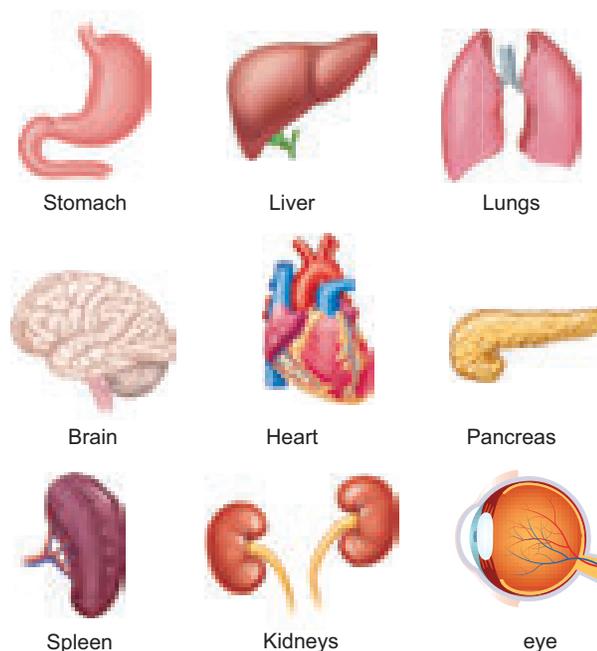


Figure 18.5 Organs present in human body

Most organs are made up of four types of tissues. For example, the intestine, is made of epithelial tissue as the inner lining, which helps in enzyme secretion and nutrient absorption. Epithelial tissue is covered by layers of muscle tissue, which help in peristaltic movements to move the food. The intestine is also supplied by blood tissue (connective tissue) which helps in transporting nutrients absorbed by the intestine, and is connected to the brain through the nerve tissue, which conveys instructions from the brain.

Now let us study in detail about the structure of an eye.

18.4.1 The eyes - Photoreceptor

The eye is one of the important sensory organs in the human body. It is composed of muscular tissue, connective tissue and neural tissue. It is mainly responsible **for vision, differentiation of color** (the human eye can differentiate approximately 10 – 12 million colors) and **maintaining the biological clock of the human body**. The human eye can be compared to a camera as both functions by gathering, focusing, and transmitting the light through the lens for creating an image of an object.

To understand more about our eye and how our eye functions, we need to look into the structure of the human eye. The human eyes are the most complicated sense organ in the human body, with several parts fixed together forming a spherical structure. Every part of the human eye is mainly responsible for a certain action. The structure of a human eye can be broadly classified into external structure and internal structure.

a. External structure of an Eye

The parts of the eye that are visible externally comprise of the external structure of the eye.

Sclera

It is a tough and thick white sheath that protects the inner parts of the eye. We know it as the **'white of the eye'**.

Conjunctiva

It is a thin transparent membrane that is spread across the sclera. It keeps the eyes moist and clear by secreting small amounts of mucus and tears.

Cornea

It is the transparent layer of membrane that is spread over the pupil and the iris. The main role of the cornea is to refract the light that enters the eyes.

Iris

It is a pigmented layer of tissues that make up the colored portion of the eye. Its primary

function is to control the size of the pupil, depending on the amount of light entering it.

Pupil

It is the small opening located at the middle of the iris. It allows light to come in.

b. Internal structure of an Eye

The internal structure of the eye includes the following parts.

Lens

It is a transparent, biconvex, and an adjustable part of an eye, made up of protein. The lens with the help of the cornea refracts light which converges on the retina and creates images on it.

Retina

It is the layer present at the back of the eye where all the images are formed. The retina functions by converting the light rays into impulses and sending the signals to the brain through the optic nerve.

Optic nerve

It is located at the end of the eyes, behind the retina. The optic nerve is mainly responsible for carrying all the nerve impulses from the retina to the human brain.

Aqueous Humour

It is a watery fluid that is present in the area between the lens and the cornea. It is

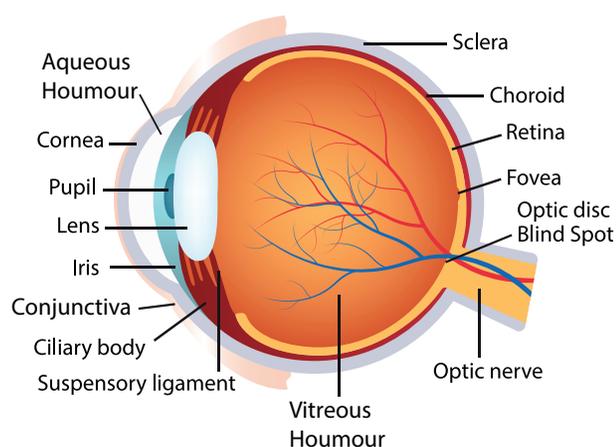


Figure 18.6 Structure of Human Eye

responsible for the nourishment of both the lens and the cornea.

Vitreous Humour

It is a semi-solid, transparent, jelly-like substance that covers the interior portion of the eyes. It plays an important role in maintaining the shape of the eye and also causes refraction of light before it reaches the retina.

18.5 Organ System

A group of organs form the organ system, and together they perform a particular function. The heart and the blood vessels together make the cardiovascular system. Organs such as nose, pharynx, trachea, lungs and diaphragm work together as the respiratory system. The mouth, oesophagus, stomach, duodenum, and the intestines together form the digestive system. Other examples of organ system include the endocrine system, integumentary system, muscular system, reproductive system, skeletal system, urinary system, immune system, etc. Let us see the respiratory system as an example for organ system elaborately.

18.5.1 The Respiratory System

Our respiratory system consists of organs like trachea, bronchus and lungs which are responsible for exchange of air between the atmosphere and the blood. Let us see the organs of the respiratory system in detail.

The nose

We inhale air through the nostrils, which lead to the nasal cavity. The inner surface of this cavity is lined with cilia and mucous producing cells, which make it sticky and moist. The cilia and mucous trap dust and germs to prevent them from going deeper into the respiratory tract. The blood vessels in the nose help to warm the inhaled air.

The windpipe

After passing through the nasal cavity, the air enters the pharynx. Then it goes into the trachea or the windpipe which is an elastic tube extending down the length of the neck and partly into the chest cavity. Between the pharynx and the trachea lies a small air passage called the larynx commonly known as the **voice box**. The larynx has fold of tissue which vibrate with the passage of air to produce sound.

Bronchi

The trachea divides into two branches called **bronchi (Singular: bronchus)**. Each bronchus leads to a lung, where it divides and redivides to finally form air passages called bronchioles.

Lungs

The lungs are the organs present in the chest cavity that allow our body to exchange gases (oxygen and carbon dioxide). The lungs are two spongy elastic bags, on each side of the thoracic cavity. The thoracic cavity is bound dorsally by the vertebral column and ventrally by the sternum, laterally by the ribs and on the lower side by the dome shaped diaphragm. The left lung is slightly smaller than the right lung (allows room for the heart). Within the lungs, each bronchiole leads to a bunch of air sacs called alveoli (Singular: Alveolus).



On an average, an adult human being at rest breathes in and out 15 – 18 times in a minute.

During heavy exercise, breathing rate can increase upto 25 times per minute.

Smoking damages lungs. Smoking is also linked to cancer. It must be avoided.

When you sneeze, you should cover your nose so that the foreign particles you expel are not inhaled by others.

Alveoli

Alveoli are tiny air sacs in the lungs that are located at the end of bronchial tubes, which is microscopic in nature. It is meant for the exchange of oxygen and carbon dioxide.

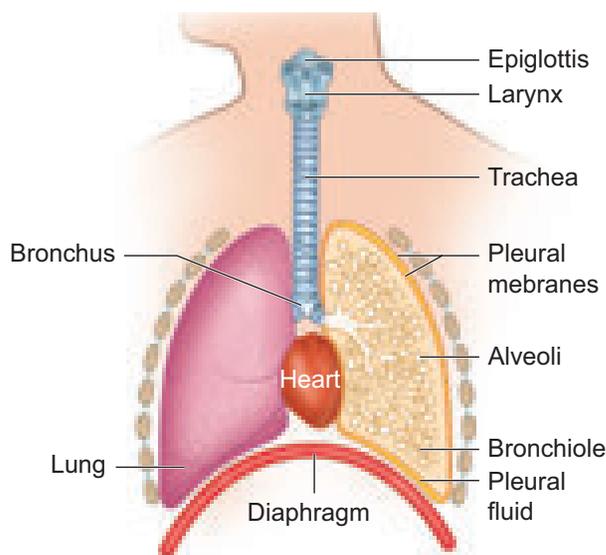


Figure 18.7 Human respiratory system

18.5.2 Mechanism of Breathing

Inspiration (Inhalation)

The process of taking air into the lungs is called **inspiration** or inhalation. During inspiration, the sternum is pushed up and outward and the diaphragm is pulled down. This increases the volume of the thoracic cavity and thus the pressure decreases. The air outside the body flows into the lungs. Here exchange of gases takes place between the air and the blood.

Expiration (Exhalation)

The process of expelling air from the lungs is called **expiration or exhalation**. Upon exhalation, the lungs recoil to force the air out of the lungs. The inter costal muscles relax, returning the chest wall to its original position. During exhalation, the diaphragm also relaxes, moving higher into the thoracic cavity. This increases the pressure within the thoracic cavity relative to the environment. Air rushes out of the lungs due to the pressure gradient. This movement of air out of the lungs is a passive event.

Exchange of gases in the Alveoli

The content of oxygen in the inhaled air in alveoli is more than the blood flowing through the capillaries. So, the oxygen moves into the blood by simple **diffusion**. **Haemoglobin** in the blood combines with **oxygen** to form **oxyhaemoglobin**. The blood carrying oxygen reaches the heart through blood vessels. The heart pumps it to all the tissues in the body. The tissues release carbon dioxide which is carried back to alveoli by the blood. Carbon dioxide diffuses from the blood to the air in the alveoli and is sent out of the body when the air is exhaled.

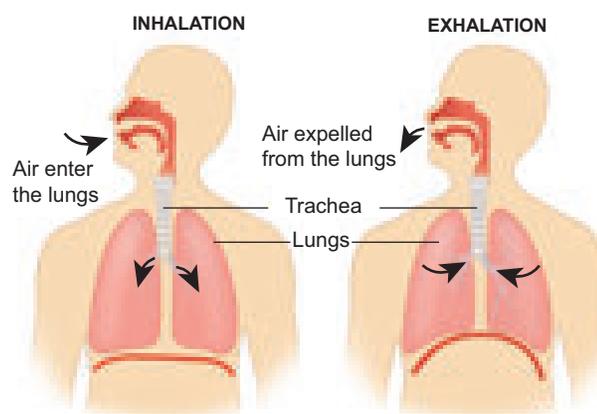


Figure 18.8 Inhalation and Exhalation

Table 18.1 Difference between inhalation and exhalation

Inhalation	Exhalation
The muscles of the diaphragm contract.	The muscles of the diaphragm relax.
The diaphragm goes downward.	The diaphragm goes upward.
The ribs move upwards and outwards.	The ribs move downwards.
The volume of thoracic (chest) cavity increases.	The volume of thoracic (chest) cavity decreases.
Air enters the lungs through the nose.	Air goes out of the lungs through the nose.

Activity 2

Stand erect and wave your hands in side wards. Take a deep breath and feel your rib movements. Then run some 100 metres and observe the rib movements. Discuss in the class room about what you observed.

Activity 3

Constructing a model of lungs.

Materials required

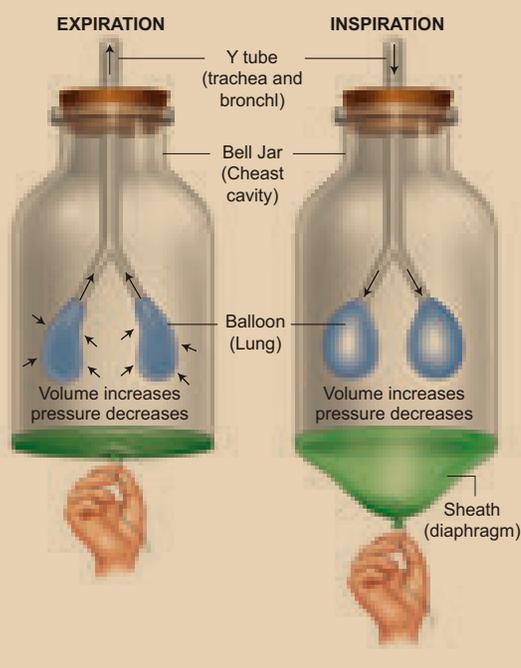
Y shaped tube, a large balloon, two small balloons, a one litre plastic bottle, cork.

Method of Construction

Cut off the plastic bottle in the middle. Fix two small balloons in both the ends of the Y-tube. Make a hole in the cork and fix the y-tube. Make a small hole in the cork and fix the y-tube through the hole as shown in the picture. Cut a large balloon into two halves and fix one half tightly around the open part of the bottle.

Method of Working

Hold the large balloon in the middle and pull it slowly downwards as shown in the picture. Observe the change in the balloons inside the bottle. Now leave the balloon free.



18.6 Physiological Processes

The ways in which biomolecules, cells, tissues, organs and organs systems work together to accomplish the complex goal of sustaining life are called physiological processes. Let us study about some of them here.

18.6.1 Homeostasis

Homeostasis is a property of human biological system where the **self-regulating** process tends to maintain the balance for the survival. The regulation takes place in a defined internal environment. Mammals are capable of maintaining constant body temperature despite the changes in the external temperature. Behavioural and physiological responses are the two important regulating mechanisms that maintain the stability of homeostasis.

In simple terms, it could be referred as a balance in a system to maintain a stable internal environment for the survival of the animal. If the homeostasis regulates successfully, life continues or if unsuccessful, death or disaster occurs.

All the processes of integration and co-ordination of function are mediated by nervous and hormonal system. The liver, kidney, and brain (hypothalamus), autonomic nervous system and the endocrine system help to maintain homeostasis.

Maintenance of body fluid concentrations, body temperature are done by various bio-physical and bio-chemical methods. Human beings are warm blooded in nature i.e, they maintain their body temperature as constant. When the body temperature raises sweat is produced to bring the temperature down. When the body temperature lowers heat is produced by the muscular work by shivering. This is an example for homeostasis.

The control of blood glucose level is another example in which insulin hormone is secreted whenever the blood glucose level raises and glucagon hormone is secreted whenever the blood glucose level reduces.

18.6.2 Diffusion

Diffusion is the movement of particles from an area of **higher concentration to lower concentration**. The overall effect is to equalize concentration throughout the medium.

Examples for diffusion include, perfume filling a whole room and the movement of small molecules across a cell membrane. One of the simplest demonstrations of diffusion is adding a drop of ink to water.

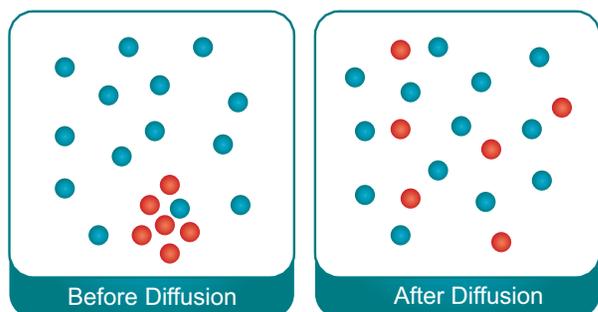


Figure 18.9 Diffusion of gases

What will happen when an incense stick is lit up in a room? How do we feel? The fragrance spreads over the entire room. The movement of molecules or ions is from a region of higher concentration to region of lower concentration. You can smell incense stick after lighting because the smoke diffuses in the air and makes its way to your nose. Let us think of the following. How does the smell spread in the entire room? Does the smell spread uniformly in the entire room? Can you give any other examples?

There are other processes in which substances move in liquid medium. For an example when a tea pack is immersed in a cup



Figure 18.10 Diffusion through liquid medium

of hot water the tea powder particles disperse in to water by diffusion.



The mixing of foodstuffs and digestive juices in the gut occurs by diffusion. Exchange of respiratory gases (Oxygen and Carbon dioxide) between blood and tissue fluids between tissue fluid and cells also occurs by diffusion.

18.6.3 Osmosis

Osmosis is the movement of solvent particles across a semipermeable membrane from a dilute solution into a concentrated solution. The solvent moves to dilute the concentrated solution and equalize the concentration on both sides of the membrane.

The movement of liquids in and out of cells is dependent on the concentration of the solution surrounding it. There are three types of situations in which this could vary.

Isotonic

Here the concentration of external and internal solution of the organism are the same.

Hypotonic

Here the external solution concentration is less compared to the concentration of the inner solution of an organism. In this case water will rush into the organism.

Hypertonic

Here the external solution concentration is greater than the concentration of the inner solution of an organism. In this case the water will rush out of the organism.

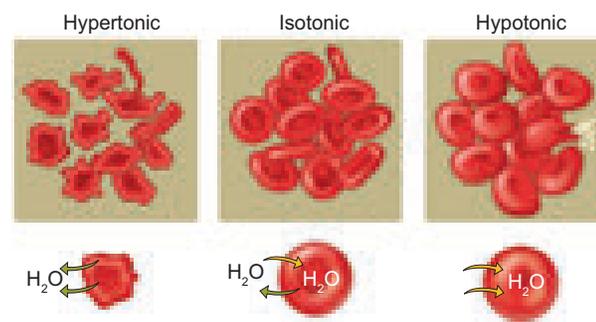


Figure 18.11 Osmosis in red blood cells

18.6.4 Osmoregulation

The term osmoregulation was coined by **Hober** in 1902. Osmoregulation is the process by which an organism regulates the water balance in its body and maintains the homeostasis of the body. It includes controlling excess water loss or gain and maintaining the fluid balance and the osmotic concentration, that is, the concentration of electrolytes. It ensures that the fluids in the body do not get too diluted or concentrated.

Organisms are divided into two types based on osmoregulation. They are Osmoconformers and Osmoregulator.

Osmoconformers

These organisms try to maintain the osmolality of their body matching with their surroundings. Most of the invertebrates, marine organisms are osmoconformers.

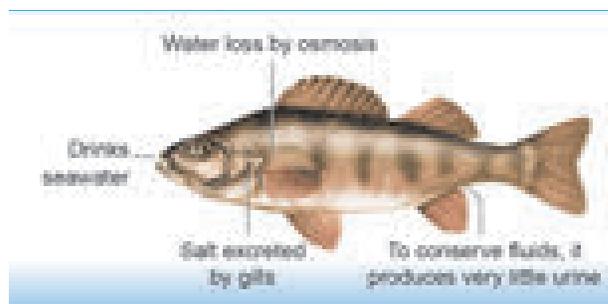


Figure 18.13 Osmoregulation by a marine fish

Osmoregulators

These organisms maintain their internal osmolality, which can be extremely different from that of the surrounding environment, through physiological processes



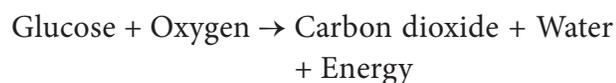
Figure 18.14 Osmoregulation by a freshwater fish

18.6.5 Cellular respiration

Cellular respiration is the process by which organisms break down glucose into a form that the cell can use as energy. This energy is then made available to living cells in the form of **ATP**. Cellular respiration takes place in the cytoplasm and mitochondria of the cells. The cellular respiration is classified into two types: **aerobic** respiration and **anaerobic** respiration.

a. Aerobic respiration

In this type of respiration, the food substances are completely oxidized into H_2O and CO_2 with the release of energy. It requires atmospheric oxygen and all higher organisms respire aerobically. This reaction releases a large amount of energy.



b. Anaerobic respiration

In this type of respiration, partial oxidation of food takes place and the organisms release energy in the absence of oxygen. This type of respiration occurs in organisms like yeast. Ethyl alcohol or lactic acid and carbon dioxide are the by-products of this process. This reaction releases very little energy because glucose is not completely oxidized.

Table 18.2 Differences between aerobic and anaerobic respiration

Aerobic	Anaerobic
Aerobic respiration takes place in the presence of oxygen.	Anaerobic respiration takes place in the absence of oxygen.
The end products of aerobic respiration are carbon dioxide and water.	The end products of anaerobic respiration are CO_2 and ethanol or lactic acid.
Common in all higher plants and animals.	Common in certain micro organisms and human muscle cell.

For example, yeast cells convert glucose into carbon dioxide and ethanol, with the release of energy, without using oxygen.

Glucose → Ethanol + Carbon dioxide + Energy

18.6.6 Metabolism

Metabolism is the sum of chemical reactions by which living organisms sustain their life. Metabolism consists of anabolism (the buildup of substances) and catabolism (the breakdown of substances). The term metabolism is commonly used to refer specifically to the breakdown of food and its transformation into energy, cellular products and waste elimination.

More to know

Aerobic respiration releases 19 times more energy than anaerobic respiration from the same amount of glucose.

In aerobic respiration each glucose molecules produce 36 ATPs.

a. Anabolism

Anabolism or constructive metabolism, is all about building and storing. It supports the growth of new cells, the maintenance of body tissues, and the storage of energy for use in the future. During anabolism, small molecules are changed into larger, more complex molecules of carbohydrate, protein, and fat.

Example

Glucose → Glycogen and other sugars

Amino acids → Enzymes, hormones, proteins

Fatty acids → Cholesterol and other steroids

b. Catabolism

Catabolism or destructive metabolism, is the process that produces the energy required for all activity in the cells. In this process, cells break down large molecules (mostly carbohydrates and fats) to release energy. This energy release

provides fuel for anabolism, heats the body, and enables the muscles to contract and the body to move. As complex chemical units are broken down into more simple substances, the waste products released in the process of catabolism are removed from the body through the skin, kidneys, lungs, and intestines.

Example

Carbohydrates → Glucose

Glucose → CO₂, Water and Heat

Protein → Amino acid

The repeated anabolism and catabolism reactions maintain the homeostatic condition in the organism. The metabolic process is the cause for maintaining ionic balance in the body. It is also responsible for movement, growth, development, maintenance and repair of the cells, tissues and the human body. These metabolic reactions occur in different organs of living species.

More to know

Basal metabolism refers to the minimum energy required to maintain the normal activities of the body during complete rest in a warm atmosphere, 12–18 hours after the intake of food

Points to Remember

- Cell is the basic structural and functional unit of living organisms. All living organisms are made up of cells.
- Cells vary in shapes and size. The size of a cell is measured in micrometers (μm).
- Cells are combined together to form tissues. The tissues are combined together to form organs. Many organs are combined together to form the organ system.
- The sense organ eye is concerned with vision.
- Respiration is the process in which energy is released while food is oxidised. It consists of external respiration and internal respiration (cellular respiration).

- There are two types of respiration depending upon the availability of oxygen. They are aerobic respiration and anaerobic respiration.
- Selective permeability of plasma membrane enables the cell to maintain homeostasis.
- Diffusion involves movement of molecules from the region of their higher concentration to the region of their lower concentration which can occur without a semi permeable membrane.
- Osmosis involves movement of solvent molecules from the region of their higher concentration to the region of their lower concentration which can take place through a semi permeable membrane.
- Homeostasis is the maintenance of a constant internal environment of the body.
- Metabolism involves release and utilisation of energy or energy exchange within the organisms. It can be divided into two categories namely anabolism and catabolism.
- The repeated anabolic and catabolic reactions in the metabolic process maintain the homeostatic condition of the body.

A-Z GLOSSARY

Alveoli	Tiny air sacs of the lungs which allow for rapid gaseous exchange.
Eukaryotic	An organism having cells each with a distinct nucleus within which the genetic material is contained.
Organelles	Specialized structures within a cell that perform a specific function.
Micron	Small unit of measurement that measures length which is one thousand of a millimetre.
Haemoglobin	Iron containing red pigment of red blood cells of vertebrates, which gives red colour to blood.
Prokaryotic	Typically unicellular microorganism that lack a distinct nucleus and membrane bound organelles.
Diaphragm	The muscle that separates the chest (muscle) cavity from the abdomen.
Pleura	Protective covering of the lungs.
Metabolism	The sum of all chemical reactions by which living organisms sustain their life.



TEXTBOOK EXERCISES



I. Choose the best answer.

1. _____ is tough and thick white sheath that protects the inner parts of the eye.
 - a) Sclera
 - b) Conjunctiva
 - c) Cornea
 - d) Iris
2. _____ cells are specialised cells that can be transformed into any kind of cells.
 - a) Nerve
 - b) Stem
 - c) Heart
 - d) Bone
3. Maintenance of constant internal environment of the body is known as _____.
 - a) homeostasis
 - b) homeophytes
 - c) homeokinesis
 - d) homeophilics
4. In the absence of oxygen, glucose is broken down in to _____.
 - a) lactic acid
 - b) citric acid
 - c) acetic acid
 - d) nitric acid

5. The process of air passing in and out the lungs is called _____.
 - a) inhalation b) exhalation
 - c) breathing d) None of these
6. Osmosis is the movement of water molecules from _____.
 - a) higher concentration to a region of lower concentration.
 - b) lower concentration to a region of higher concentration.
 - c) Both of these d) None of these
7. The erythrocyte is placed in _____ solution which has lesser concentration of solutes and greater concentration of water than in the cytoplasm.
 - a) hypotonic b) hypertonic
 - c) neutral d) acidic
- 2) Diffusion is the movement of particles from an area of lower concentration to higher concentration .
- 3) Human beings are warm blooded in nature.
- 4) The larynx has fold of tissue which vibrate with the passage of air to produce sound.
- 5) Aqueous humour plays an important role in maintaining the shape of the eye.

V. Answer very briefly.

1. What is cell differentiation?
2. State different types of tissues.
3. Mention the function of 'Alveoli'.
4. Name the processes by which air enters and comes out of our lungs.
5. Differentiate osmoconformers and osmoregulators.
6. Define - Metabolism.

II. Fill in the blanks.

1. _____ is the structural and functional unit of living organisms.
2. The largest cell is egg of an _____.
3. _____ is a good example for anaerobic respiration.
4. _____ nerve is located at the end of the eyes behind the retina.
5. The size of the cells are measured in units of _____

III. Match the following.

Carbohydrates	CO ₂ , Water and Heat
Glucose	Amino acid
Protein	Glucose
Amino acids	Cholesterol and other steroid
Fatty acids	Enzymes, hormone, protein

IV. State true or false. If false, correct the statement.

- 1) In hypotonic condition, concentration of the external and the internal solution of the organism are same .

VI. Answer briefly.

1. Define - Prokaryotic cell.
2. Tabulate the differences between aerobic and anaerobic respiration.
3. Why the human eye is compared with camera?
4. Which organ and organ system help to maintain homeostasis?

VII. Answer in detail.

1. Draw the struture of human eye and label its parts.
2. Explain osmosis with an example.
3. Differentiate between inhalation and exhalation.
4. List out the different types of metabolism with an example.
5. Explain the mechanism of breathing.

VIII. Higher Order Thinking Questions.

1. Why do we need instant energy? Does glucose give that energy? Explain.
2. How are we preparing pickles? What are the steps involved in that?

IX. Value based questions.

- Dr. Usha is a pulmonologist (Doctor for respiratory diseases). One day, a school student named Arjun, met her with respiratory problems. After diagnosis, the doctor advised him to go to playground daily and play football or basketball. She also advised him to do *pranayamam* in the morning.
 - Why did the doctor advise him to go to the playground?
 - What is the use of *pranayamam*?
- Explain why you are not able to breathe normally when you are in closed and crowded places?
- Shylesh is a school going kid studying standard VIII. He is crazy about playing video games in mobile phones. After couple of months, his eyes turned red and he felt severe pain in his eyes. His science teacher enquired about this and advised his parents to take him to an eye doctor.

- How does excessive usage of mobile phone affect our eyes?
- What are the values shown by the teacher?



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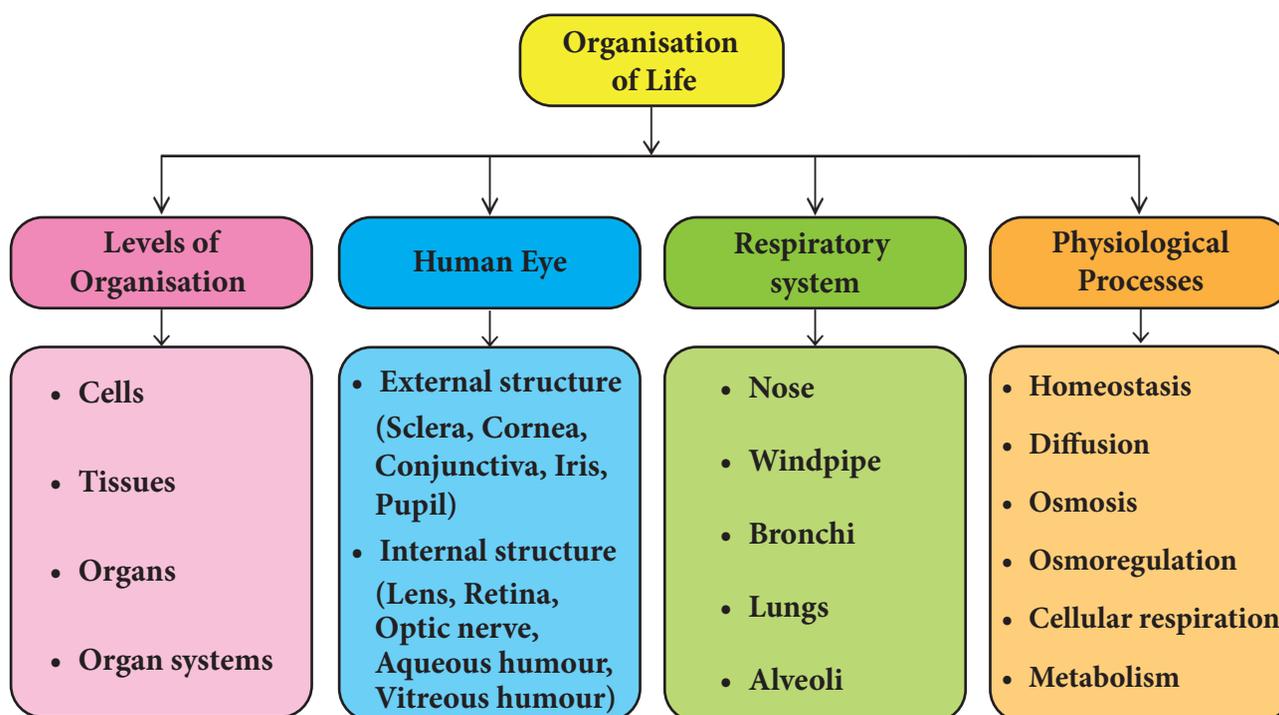
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- <http://www.biologyreference.com/A-Ar/Animalia.html>

Concept Map



UNIT

19

MOVEMENTS IN ANIMALS



Learning Objectives

After the completion of this lesson, students will be able to:

- ◆ know about the movements of different animals.
- ◆ differentiate between movement and locomotion.
- ◆ recall the types of movements.
- ◆ know about human body and its movements.
- ◆ summarise the significance and types of joints.
- ◆ identify the components of the skeleton.
- ◆ understand muscle movements and its types.



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Introduction

There are so many movements that happen in our bodies. Sit absolutely still and observe the movements taking place in your body. You must be blinking your eyes from time to time. There will be movements in your body as you breathe. Different parts of your body move while you remain at the same place. There are different ways how animals move from place to place. For example, a cow uses its legs to walk, a snake uses its whole body to slither or crawl, a bird uses its wings to fly, a fish uses its fins to swim and human uses legs to walk. Walking, crawling, flying and swimming - these are only few ways in which animals move from one place to another. Let us learn in detail how these movements take place.

19.1 Movement and Locomotion

Although both movement and locomotion sound similar in their meaning, there are

few interesting differences between the two terms. Movement is generally defined “*as the act of changing the place or position by one or more parts of the body*”. Movement helps to perform necessary functions such as pumping of blood to different parts of the body in an organism. Movement can be both **voluntary** and **involuntary**. For example, walking is a voluntary movement, while breathing is an involuntary movement.

The movement of an organism from one place to another is known as locomotion. Locomotion helps an organism to find food, avoid harsh weather conditions, escape from their predator etc. Walking, running and swimming are few examples for different types of locomotion. In this process, there is the action of appendages such as limbs, wings, flagella and cilia. In most of the aquatic animals such as fish, whales, and shark, the locomotion results from a series of wave-like muscle contractions. Table 19.1 gives the differences between locomotion and movement.

Table 19.1 Locomotion and Movement.

Locomotion	Movement
Locomotion is the movement of an organism from one place to another.	Movement is the act of changing the place or position by one or more parts of the body.
It is always voluntary.	It can either be voluntary or involuntary.
Locomotion takes place at the organism level.	A movement takes place at the biological level.
Locomotion doesn't necessarily require energy.	Movement requires energy.

19.2 Movement in different Animals

Movement is one of the significant features of living beings. This is the basic mechanism used in majority of the vertebrates including human. Animals exhibit a wide range of movements. In this part let us study about movements in different animals.

19.2.1 Earthworm

The body of earthworm is made up of many rings joined end to end. It has muscles which help to extend and shorten the body. Under its body it has large number of bristles called setae which are connected with muscles. These bristles help to get grip on the ground. During movement, the earthworm first extends the front part of the body, keeping

Activity 1

Observe an earthworm moving on soil in the garden. Gently lift it and place it on a piece of blotting or filter paper. Observe its movement now. In which of the above two surfaces do you find that the earthworm is able to move easily?

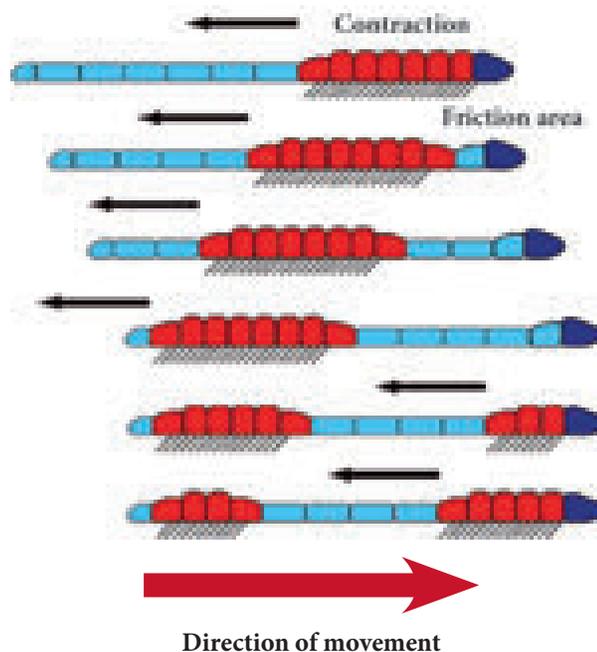


Figure 19.1 Movements in Earthworm

the rear portion fixed to the ground. Then it fixes the front end and releases the rear end. It then shortens the body and pulls the rear end forward. This makes it move forward by small distances. Repeating such muscle contraction and relaxation the earthworm can move through soil. A slimy substance secreted by its body helps this movement.

19.2.2 Cockroach

A cockroach has three pairs of jointed legs, which help it to walk, run and climb. It also has two pairs of wings for flying. Large and strong muscles help in the movement of legs. The body is covered by chitin, a light protective material. Chitin is shed regularly so that the body can grow.

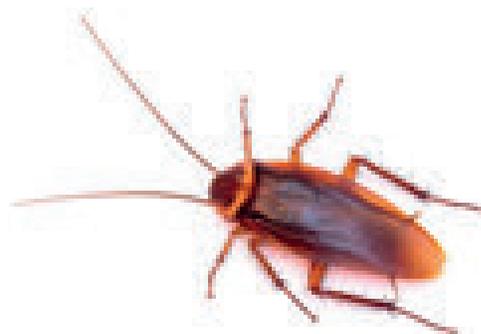


Figure 19.2 Cockroach

Activity 2

Observe a cockroach and identify its legs and wings. Try to know more about other parts of cockroach with the help of your teacher.

19.2.3 Birds

Birds can walk on the ground and fly as well. Some birds can also swim in the water. A bird has streamlined body. Its bones are light and strong. They are hollow and have air spaces between them. The lower portion of limbs are modified as claws, which help them to walk and to perch. The breast bones are modified to hold massive flight muscles which help in moving wings up and down. Birds have special flight muscles and the forelimbs are modified as wings. The wings and tail have long feathers, which help in flying. Birds show two types of flight: **gliding** and **flapping**.

During gliding the bird has its wings and tail spread out. In this movement the bird uses air currents for going up and down. Flapping is an active flight. The bird beats the air by flapping its wings. They use flight feathers for this purpose.



Figure 19.3 Movement in birds

Activity 3

Observe a hen and crow. How do they move? Write about the similarities and dissimilarities found among them, in your note book.

19.2.4 Snake

The body of snake consists of a large number of vertebrae. The adjoining vertebrae, ribs and skin are inter-connected with slender body muscles. When the snake moves, it makes many loops on its sides. The forward push of the loops against the surface makes the snake move forward. Movement of snake is called **slithering movement**. Many snakes can swim in water also.



Figure 19.4 Movement in Snakes

DO YOU KNOW?

Since snakes do not have legs, they use their muscles and their scales to move.

19.2.5 Fish

Fish swims with the help of fins. They have two paired fins and an unpaired fin. The body of a fish is streamlined to reduce friction while moving in water. They have strong muscles, which help in swimming. When a fish swims its front part curves to one side and the tail part stays in the opposite direction. In the next move, the front part curves to the opposite side and the tail part also changes its position to another side. The caudal or tail fin helps in changing direction.



Fish have streamlined body structure which helps them to move smoothly with the flow of water. Muscles and fins on the body and the tail help to keep the balance.

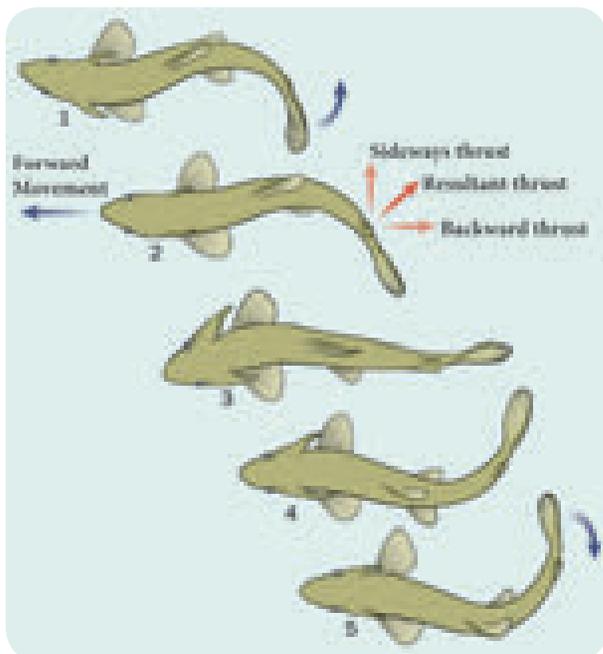


Figure 19.5 Movement in Fish (Swimming)

Activity 4

Make a paper boat; put it in water and push it with narrow end pointing forward. Now hold the boat sideways and push it into water from the broad side. What did you observe? In which process was it easy to move the boat? Have you noticed that the shape of a boat is somewhat like a fish?

19.2.6 Movements in Human body

Humans can move some parts of their body in different directions; however some body parts can be moved only in one direction. Our body is made up of a frame work of bones called **skeleton** which helps in the movement of the body. Some of the movements in body parts of human are:

- Movement of eyelids.
- Movement of the heart muscles.
- Movement of teeth and jaw.

- Movement of arms and legs.
- Movements of head.
- Movements of neck.

Movement of some organs happens because of the combined action of bones and muscles. In such cases, movement is possible along a point where two or more bones meet.



- Cheetah can run 76 kilometre per hour.
- Hippopotamus can run faster than a man.
- Cockroach is the fastest animal with 6 legs covering a metre per second.
- The fastest mammal, the Dolphin can swim upto 35 miles per hours.

19.3 Types of Movements

When we talk about locomotion and movement, there are three types of movements.

19.3.1 Amoeboid movement

It is brought about by pseudopodia which are appendages which move with movement of protoplasm within a cell.

19.3.2 Ciliary movement

This movement is brought about by appendages called as cilia which are the hair-like extensions of the epithelium. Both these kinds of movements are seen with cells of the lymphatic system.

19.3.3 Muscular movement

It is a more complex movement which is brought about by the musculoskeletal system. This type of movement is seen in the higher vertebrates.

To understand more about the movements brought about by the musculoskeletal system, we need to understand the joints, skeleton and types of muscles.

19.4 Joints

The point at which two separate bones meet is called a joint. Depending on the type of movement they allow, joints can be of three types: fixed, slightly movable and movable joints.

19.4.1 Fixed or Immoveable joints

In this type of joint no movement is possible between the two bones. The structures between the bones of the skull box are examples of immoveable joints.

19.4.2 Slightly movable joints

Here, only very little (partial) movement occurs between the two bones. The joint between



Joints are the place where two bones meet or connect. Ligaments are short bands of tough fibrous connective tissues that function to connect one bone to another, forming the joint. Tendons are made of elastic tissues and they also play a key role in the functioning of joints.

a rib and the breast bone or between the vertebrae is the example for slightly movable joint.

19.4.3 Freely movable joints

In this type, varying degree of movements is possible between the two bones forming the joint. There are six major types of movable joints. They are given below in Table 19.2.

Table 19.2 Types of movable joints.

Joint	Examples	Description	Mobility
Ball and Socket	Shoulder Hip	A ball shaped head of one bone articulates with a cup like socket of an adjacent bone.	Movement can occur in three planes. This joint allows the greatest range of movement.
Hinge	Elbow, Knee, Ankle	A cylindrical protrusion of one bone articulates with a trough-shaped depression of an adjacent bone.	Movement is restricted to one plane. This joint allows bending and straightening only.
Pivot	Spine (Atlas / Axis joint at the top)	A rounded or pointed structure of one bone articulates with a ring-shaped structure of Radius Ulna-an adjacent bone.	Movement is restricted to one plane. This joint allows rotation about its longitudinal axis only.
Condyloid	Wrist	Similar to a ball and socket joint but with much flatter articulating surfaces forming a much shallower joint.	Movement can occur in two planes. This joint allows the second greatest range of movement.
Gliding	Spine (between the bony processes of the vertebrae)	Articulating surfaces are almost flat and of a similar size.	Gliding allows movement in three planes, but it is severely limited.
Saddle	Thumb, shoulder and inner ear.	One part is concave (turned inward) at one end and looks like a saddle . The other end is convex (turned outward), and looks like a rider in a saddle .	Flexion-extension and abduction-adduction movements are seen

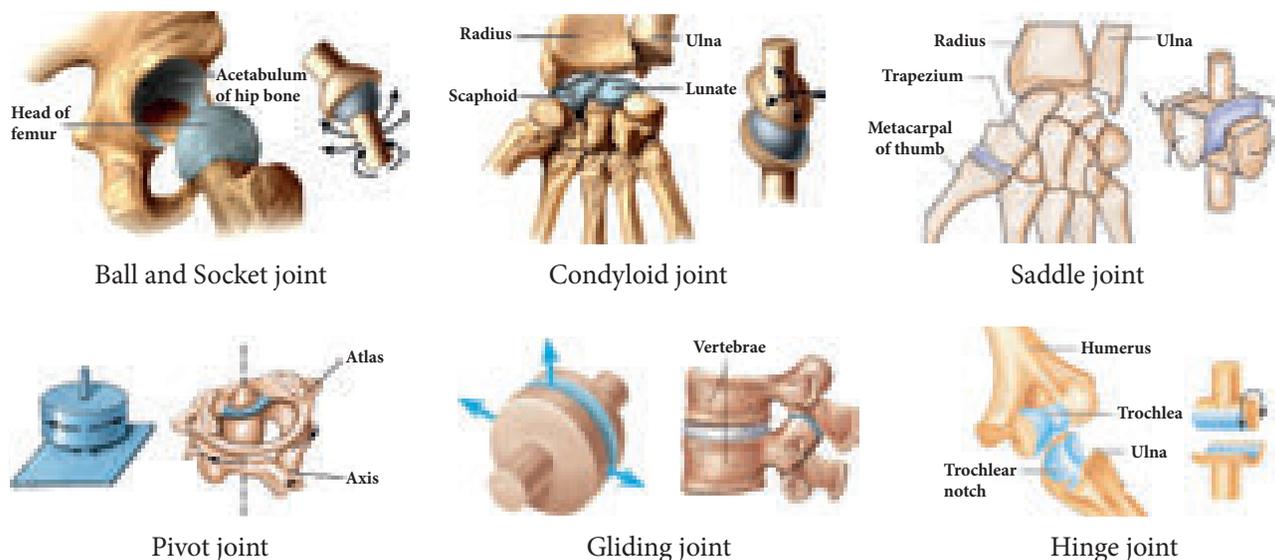


Figure 19.6 Types of joints in human

19.4.4 Synovial joints

A synovial joint is a joint which makes connection between two bones consisting of a cartilage lined cavity filled with fluid, which is known as a *diarthrosis* joint. These are the most

flexible type of joint between bones, because the bones are not physically connected and can move more freely in relation to each other. Synovial joints have four main distinguishing features. They are shown in Table 19.3.

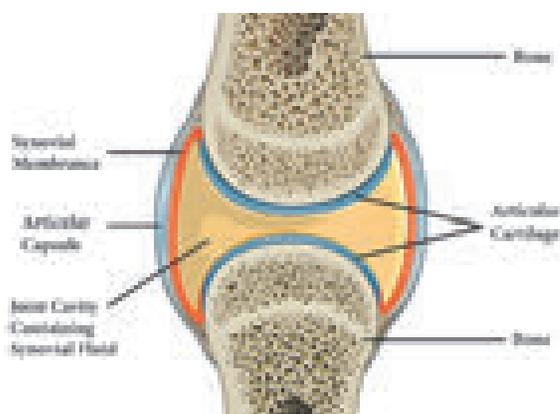


Figure 19.7 Synovial joint in human.

DO YOU KNOW?

Inflammation of joints is a condition that usually results either due to friction of articulating cartilage or due to lack of synovial fluid in the joint. During this condition, the person feels acute pain in joints particularly while moving joints. This disease is referred to as arthritis. Arthritis is however also caused due to the deposition of uric acid crystals in the joints.

Table 19.3 Feature of synovial joint

Feature	Structure	Function
Ligament	A band of strong fibrous tissue.	To connect bone to bone.
Synovial fluid	A slippery fluid with the consistency of egg-whites that is contained within the joint cavity.	To reduce friction between the articular cartilage in the joint.
Articular cartilage	Glassy-smooth cartilage that is spongy and covers the ends of the bones in the joint.	To absorb shock and to prevent friction between the ends of the bones in the joint.
Joint Capsule	A tough fibrous tissue that has two layers, with the fibrous capsule lying outside the synovial membrane.	The fibrous capsule helps to strengthen the joint, while the synovial membrane lines the joint and secretes synovial fluid.

19.5 Skeleton System

The skeleton system provides the hard structure or framework to the human body which supports and protects the body. It is composed of connective tissues like bones, cartilage, tendons and ligaments. If the skeleton is without joints, no movement would take place and the significance of human body will be no more than a stone. On the basis of presence in the body, skeleton is of two types.

Exoskeleton

It is the skeleton that is found on the exterior layer of the body and it basically originates from embryonic ectoderm or mesoderm. Like scales in the fishes, outer hard layer of the tortoise and feathers of the birds it protects and preserves the inner organs.

Endoskeleton

It is the skeleton that is found inside the human body and it originates from the mesoderm. These are found in almost all vertebrates and form the main body structure.

19.5.1 Functions of skeleton

The skeletal system serves five important functions in the human body.

1. It provides structure and shape to the body.
2. It supports and surrounds the internal organs of the body.
3. Calcium and phosphorus, the two minerals that the body needs for important regulatory functions, are stored inside the bones.
4. Red blood cells are produced in the bone marrow.
5. The bones of the skeletal system act as levers for muscular action. Muscular movement would not be possible without **tendons** (fibrous cords of tissue that attach muscle to bone) and **ligaments** (fibrous cords of tissue that attach bone to bone).



- The femur or thighbone is the longest and strongest bone of the human skeleton.
- The stapes in the middle ear is the smallest and lightest bone of the human skeleton.

19.5.2 Constituents of skeleton

Human skeleton consists of bone, cartilages and ligaments. Bones comprise the hard framework of the body. Cartilages are the supporting and connecting structures. For example, the cartilage supports the projecting external ears and the tip of the nose. Ligaments bind the bones together. There are different types of bones in human skeletal system. They are:

Long bones: Found in arms and legs.

Short bones: Found in wrist ankle, vertebral column.

Flat bones: Found in skull, ribs, shoulder and hips.

Irregular bones: Found in spine and vertebral column, mandible, palatine, inferior nasal concha, and hyoid.

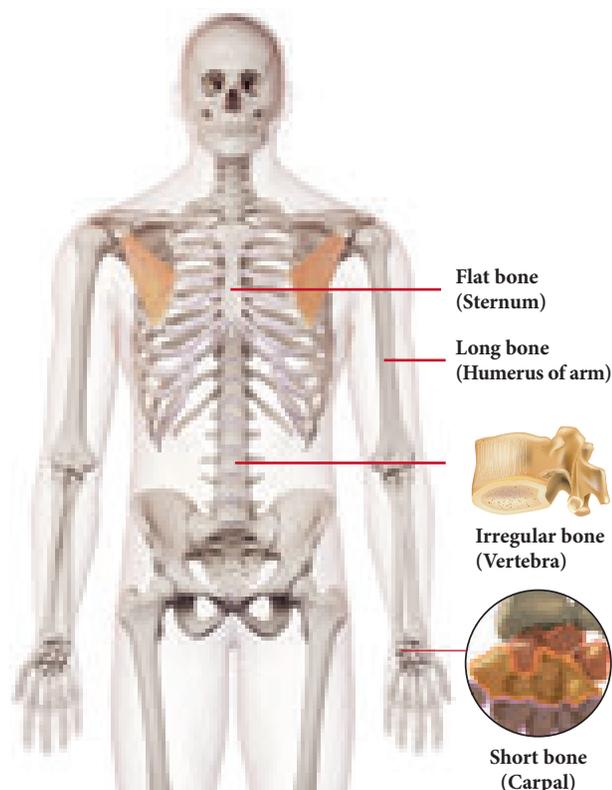


Figure 19.8 Types of bones in human

19.5.3 Parts of skeleton

The skeletal system is composed of bones and the related structures that aid body movement. It is divided into two major parts: the axial skeleton and the appendicular skeleton.



I. Axial skeleton

The **axial skeleton** consists of the bones along the *axis*, or central line of the human body. The axial skeleton consists of the skull, facial bones, sternum, ribs, and vertebral column.

a. Skull

Skull is a hard structure made up of small bones. It is formed by 22 bones out of which 8 bones are fixed together to form the cranium and 14 bones fuse to form the face. The only bone which has movable joint is the lower jaw. This movable joint is supported by muscles

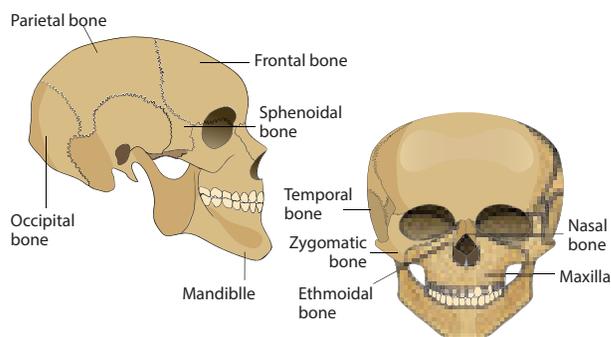


Figure 19.9 Skull bone in human

and ligaments. Skull placed on the top of the backbone can be moved up, down and sideways.

b. Vertebral column

Vertebral column running at the back of the body is also called as spine or the backbone. It is in the trunk region to offer support to the upper part of the body. Vertebral column is made up of individual bones called as vertebrae. Total vertebral column consists of 7 cervical vertebrae, 12 lumbar vertebrae, 5 fused sacral and 3 fused coccygeal vertebrae. Vertebral column runs from the base of the skull to the hip bone forming a tube. Spinal cord passes through this hollow tube. Vertebrae are joined by gliding points which allow the body to be bent back, front or side wards.

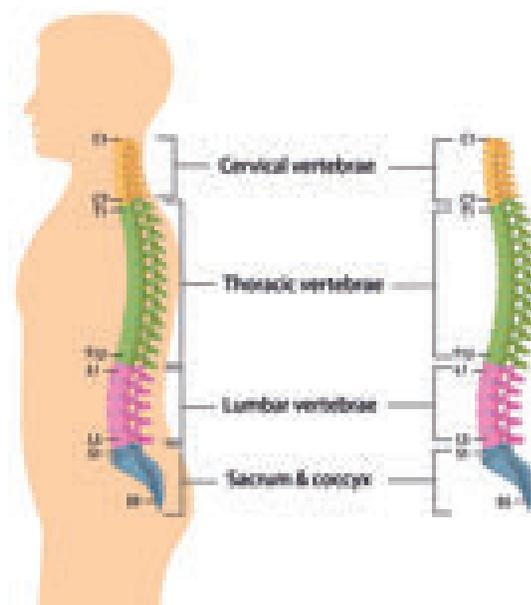
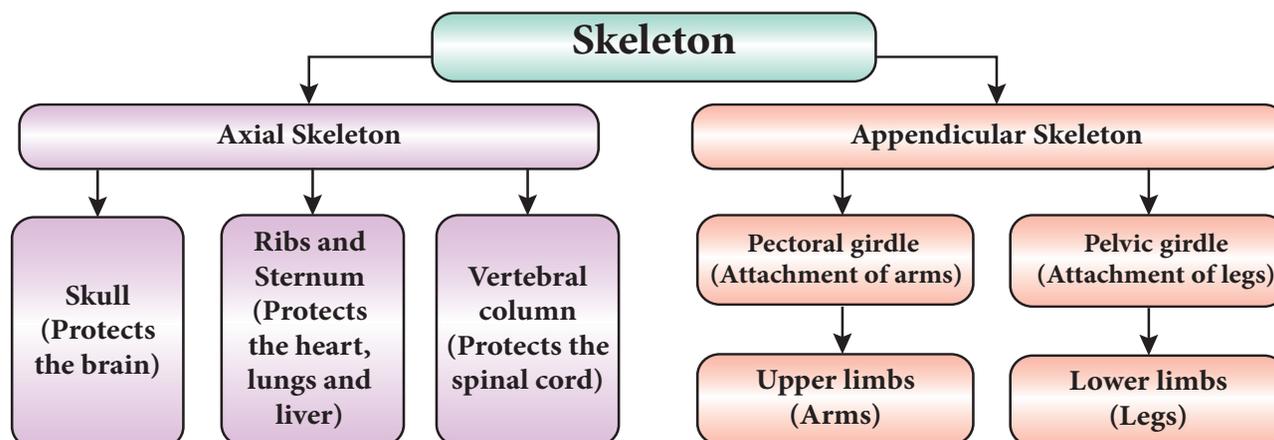


Figure 19.10 Vertebral column in human.



The functions of vertebral column are given below.

- It protects the spinal cord.
- It supports the head.
- It serves as an attachment for the ribs.
- It provides support and place of attachment for the pectoral and pelvic girdle.
- It provides movement for the human skeleton.
- It helps in walking and standing erect with correct posture.

c. Sternum or Rib cage

Rib cage occupies the chest region. It is a cone-shaped structure made up of Twelve pairs of ribs. Ribs are attached to vertebrae at the back which curve around to form a cage. Ten pairs of ribs are attached to the breast bone at the front. Two pairs of lower ribs are free at front. These are called as free-floating ribs. Rib cage is set up in such a way that it can contract and expand during the process of breathing. Rib cage protects the underlying lungs, heart and some part of liver.

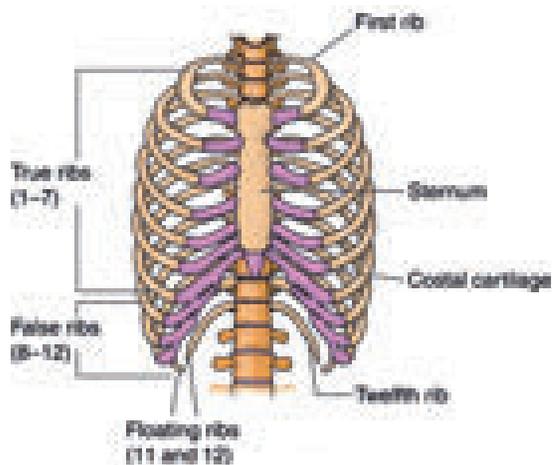


Figure 19.11 Rib cage in human.



Humans and giraffes have the same number of bones in the necks, but the vertebrae in a giraffe's neck are much, much larger.

II. Appendicular skeleton

The **appendicular skeleton** contains the bones in the *appendages* of the body, as well as

the structures that connect the appendages to the axial skeleton. Specifically, the appendicular skeleton comprises the shoulder girdle; the arm, wrist, and hand bones; the pelvic girdle; and the leg, ankle, and foot bones.

a. Shoulder bone or Pectoral bone

Shoulder bone is formed by collar bone at the front and the shoulder blade at the back. The collar bone is supported by breast bone at one end and the shoulder blade at the other end. The shoulder bone encloses a socket like cavity into which fixes the ball of the upper arm. This forms a ball and socket joint. This girdle is also called as pectoral girdle.

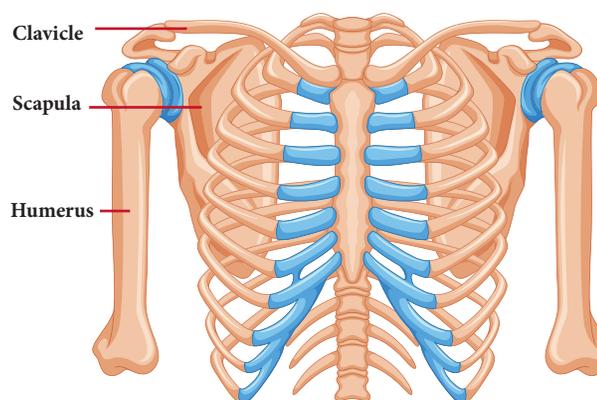


Figure 19.12 Pectoral girdles

b. Pelvic bone

Pelvic bone is also called as pelvic girdle. It is made up of strong bones to balance entire weight of the body. Pelvic girdle is formed by five fused vertebrae at the back and form a

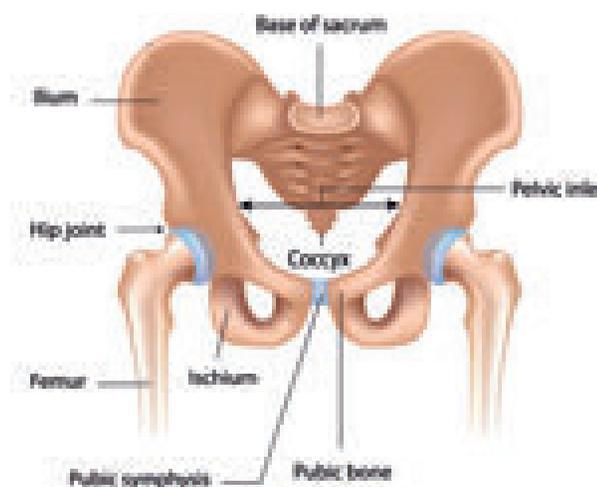


Figure 19.13 Pelvic bones

cavity in the centre while reaching the front part. The thigh bones are attached to either side of the girdle with a ball and socket joint.

c. Arm bone

Arm bone is the upper limb made up of humerus, radius, ulna, carpals, metacarpals and phalanges. All these bones are joined by hinge joints which allow the limb to move only in one direction. Humerus makes up the upper arm. Fore-arm is made up of radius and ulna. Wrist is made up of carpals. Palm is made up of metacarpals. Fingers are made up of phalanges.

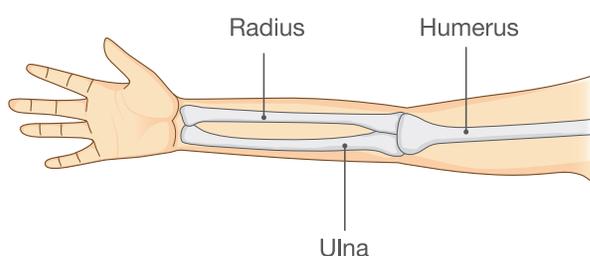


Figure 19.14 Arm bone

d. Leg bone

Leg bone is the lower limb made up of femur, tibia, fibula, tarsals, metatarsals and phalanges. All these bones are joined by hinge

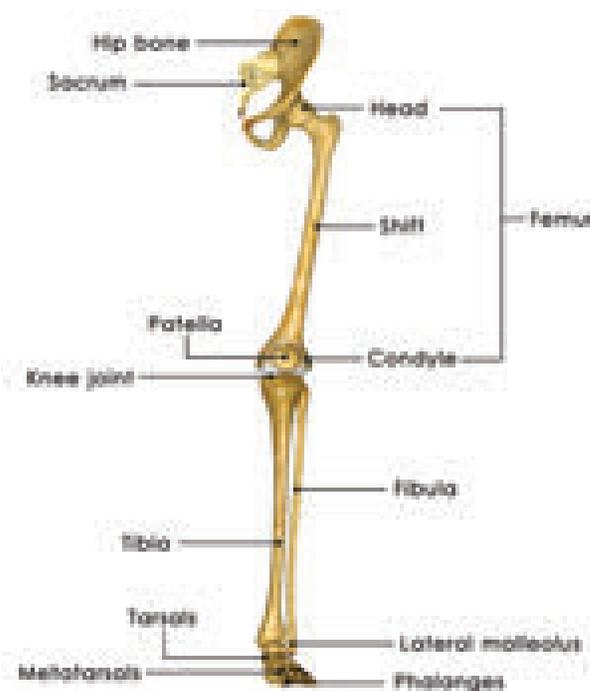


Figure 19.15 Leg bone

joints which allow the limb to move only in one direction. Knee is covered by a cap like structure called as patella or a knee cap. Femur makes up the thigh bone. Leg is made up of tibia and fibula. Ankle is made up of tarsals. Foot is made up of metatarsals. Toes are made up of phalanges.

19.6 Muscles

The muscles in the body provide the means of all movements. They cover the skeletal framework and also give shape to the body. Muscles help to maintain body posture while sitting, standing or walking. Most muscles are long bundles of contractile tissue. Each muscle usually has two ends - a **fixed end** where the muscle originates and a **movable end** which pulls some other part. This **movable end** is drawn out to form a tough structure the **tendon** which is attached to the bone. When stimulated by a nerve the muscle contracts to become shorter and thicker and thus it pulls the bone at the movable end. Muscles can only contract and relax, they cannot lengthen.

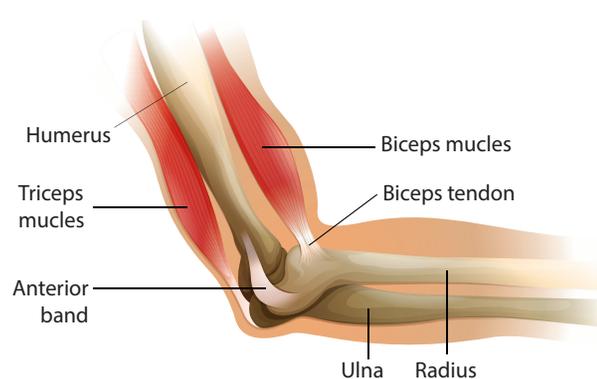


Figure 19.16 Tendon and muscle attachment to the bone in human.



- There are muscles in the root of your hair that give you goose bumps.
- It takes 17 muscles to smile and 42 muscles to frown.
- The hardest working muscle is in eye.

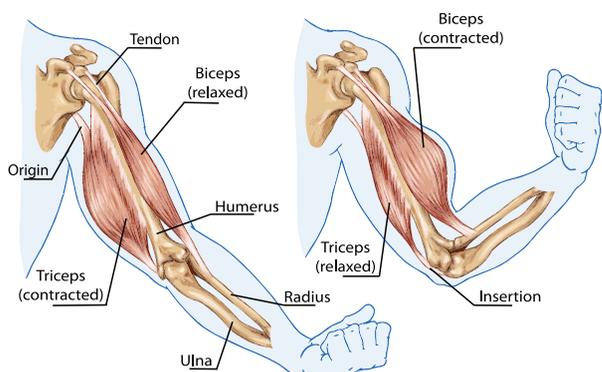


Figure 19.17 Antagonistic pairs of muscle in human (Biceps and Triceps)

Muscles often work in pairs which work against each other. These are called *antagonistic* pairs. The muscles in the upper arm control the bending and straightening of the arm. The two muscles, the biceps and triceps are working against each other. When the biceps contracts the lower arm is raised and the arm bends. In this position the triceps muscle is relaxed. To straighten the arm the reverse happens. The triceps contracts straightening the arm, while the biceps relaxes. Antagonistic muscles can be found all over the body. In the iris of the eye there are two sets of muscle. There are radial muscles which radiate from the pupil like spokes of a bicycle and there are circular muscles. The radial muscles make the pupil of the eye wider, while the circular muscles make the pupil smaller.

Activity 5

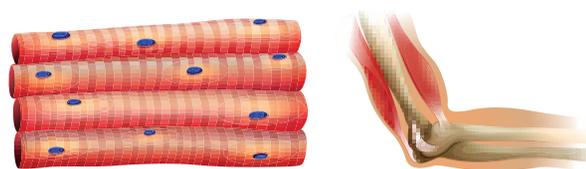
Measure the size of your biceps and also ask your friends to do. Take turns lifting a bottle with water as many times as you can. Record the number of lifts each student was able to do. Compare each pair's results with the rest of the class and determine whether those with larger biceps were able to do more lifts.

19.6.1 Types of Muscles

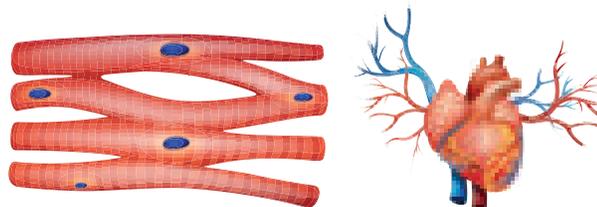
Muscles found in higher vertebrates are of three types:

- Striated or skeletal muscles or voluntary muscles.

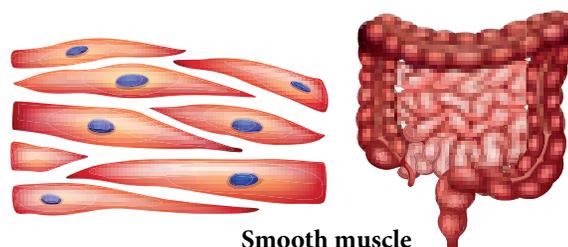
- Unstriated or smooth muscles or involuntary muscles
- Cardiac muscles



Skeletal muscle



Cardiac muscle



Smooth muscle

Figure 19.18 Different types of muscle present in the human body

Table 19.4 Types of muscles

Muscle	Location	Characteristics
Striated / Skeletal / Voluntary muscle	Attached to bones. Found in arms, legs, neck.	Multinucleate, Unbranched, Voluntary.
Non striated / Smooth / Involuntary muscle	Attached to soft parts of the body like blood vessels, iris, bronchi and the skin.	Single, central nucleus Involuntary
Cardiac muscle	Heart	Branched, 1 -3 central nuclei Involuntary

19.6.2 Coordination of Muscles

Most actions in our body like standing, walking, running, playing tennis etc., require combined action of several muscles. To a great extent the muscles have to be coordinated for a particular kind of movement.

Muscles move body parts by contracting and then relaxing. Muscles can pull bones, but they can't push them back to the original position. So they work in pairs of flexors and extensors. The flexor contracts to bend a limb at a joint. Then, when the movement is completed, the flexor relaxes and the extensor contracts to extend or straighten the limb at the same joint. For example, the biceps muscle, in the front of the upper arm, is a flexor, and the triceps, at the back of the upper arm, is an extensor. When you bend your elbow, the biceps contracts. Then the biceps relaxes and the triceps contracts to straighten the elbow.

Points to Remember

- Movement helps to perform necessary functions in an organism. It can be both **voluntary** and **involuntary**.
- Strong muscles and light bones work together to help the birds fly. They fly by flapping their wings.
- Fish swim by forming loops alternately on two sides of the body.
- Snakes slither on the ground by looping sideways. A large number of bones and associated muscles push the body forward.
- The body and legs of cockroaches have hard coverings forming an outer skeleton. The muscles of the breast connected with three pairs of legs and two pairs of wings help the cockroach to walk and fly.
- Earthworms move by alternate extension and contraction of the body using muscles. Tiny bristles on the underside of the body help in gripping the ground.
- Bones and cartilage form the skeleton of the human body. They give the frame and shape to the body and help in movement. It protects the inner organs.
- The skeleton comprises of the skull, the back bone, ribs and the breast bone, shoulder and hip bones, and the bones of hands and legs.
- The bones are moved by alternate contractions and relaxations of two sets of muscles.
- The bone joints are of various kinds depending on the nature of joints and direction of movement they allow.

A-Z GLOSSARY

Antagonist muscle	Muscles that oppose the action of one another.
Appendicular	The arms and legs.
Axial	The trunk and head.
Biceps	Any skeletal muscle having two origins.
Cardiac muscle	Involuntary, striated muscle that constitutes the main tissue of the walls of the heart.
Cartilage	Tough elastic tissue, mostly converted to bone in adults.
Femur	The thigh bone of the human skeleton.
Ligaments	Bands of tough, elastic connective tissue that surround a joint to give support and limit the joint's movement.
Pectoral girdle	The skeletal framework which provides attachment for the forelimbs of or relating to the chest or thorax.
Pelvic girdle	Hips, a foundation for the lower limb.
Skeletal muscle	Voluntary muscles that move bones and produce movement.
Sternum	Long flat bone located in the central part of the chest.
Tendon	Tough band of fibrous connective tissue that usually connects muscle to bone and is capable of withstanding tension.



TEXTBOOK EXERCISES



I. Choose the best answer.

- Which of the following parts of our body help us in movement?
(i) Bones (ii) Skin (iii) Muscles (iv) Organs
Choose the correct answer from the options below.
(a) (i) and (iii) (b) (ii) and (iv)
(c) (i) and (iv) (d) (iii) and (ii)
- Which one of the following organisms lack muscles and skeleton for movement?
(a) Dog (b) Snail
(c) Earthworm (d) Human being
- _____ joints are immovable.
(a) Shoulder and arm
(b) Knee and joint
(c) Upper jaw and skull
(d) Lower jaw and upper jaw
- Why do underwater divers wear fin-like flippers on their feet ?
(a) To swim easily in water.
(b) To look like a fish.
(c) To walk on water surface.
(d) To walk over the bottom of the sea (sea bed).
- External ear (pinna)is supported by
(a) bone (b) cartilage
(c) tendon (d) capsule
- Cockroach moves with the help of its
(a) leg (b) bone
(c) muscular foot (d) whole body
- Which one of the following categories of vertebrae are correctly numbered?
(a) Cervical-7 (b) Thoracic-10
(c) Lumbar - 4 (d) Sacral - 4

II. Fill in the blanks.

- Movement of organisms from place to place is called _____.
- _____ refers to change in position of the part of an organism's body.
- A structure which provides rigid frame work to the body is called _____
- Axial skeleton in human consists of _____, _____, _____ and _____.
- Appendicular skeleton in human consists of _____ and _____.
- The place where two bones meet is termed as _____.
- _____ is attached to soft parts of the body like blood vessels, iris, bronchi and the skin
- _____ muscle makes pupil of eyes wider.

III. State true or false. If false, correct the statement.

- Skull in humans consists of 22 bones.
- There are 12 pairs of ribs in human body.
- Pelvic girdle is a part of axial skeleton.
- Hinge joint is slightly movable joint.
- Cardiac muscle is a voluntary muscle.
- The flexor and extensor muscle of the arm are antagonistic muscles.

IV. Answer very briefly.

- What is skeleton?
- What is cranium?
- Why our backbone is slightly moveable?
- Differentiate axial and appendicular skeleton.
- What is ligament?

6. Define muscle.
7. Differentiate tendons and ligament.

V. Answer briefly.

1. Differentiate between the following.
 - a) Movement and Locomotion.
 - b) Endoskeleton and Exoskeleton
 - c) Pectoral and Pelvic girdle
 - d) Ball and socket Joint and hinge Joint
 - e) Voluntary and Involuntary muscle
2. What are antagonistic muscles? Give one example.
3. How is the skeleton of a bird well-suited for flying?
4. What are the functions of skeleton in human body?

VI Answer in detail.

1. Name the different types of joints? Give one example for each type.
2. Write about the human axial skeleton, giving suitable labelled diagram.
3. Discuss various types of movements seen in living organisms.

4. What is a streamlined body? How does it help in the movement of animals that fly or swim in water?
5. Write a short note on different types of muscles.



REFERENCE BOOKS

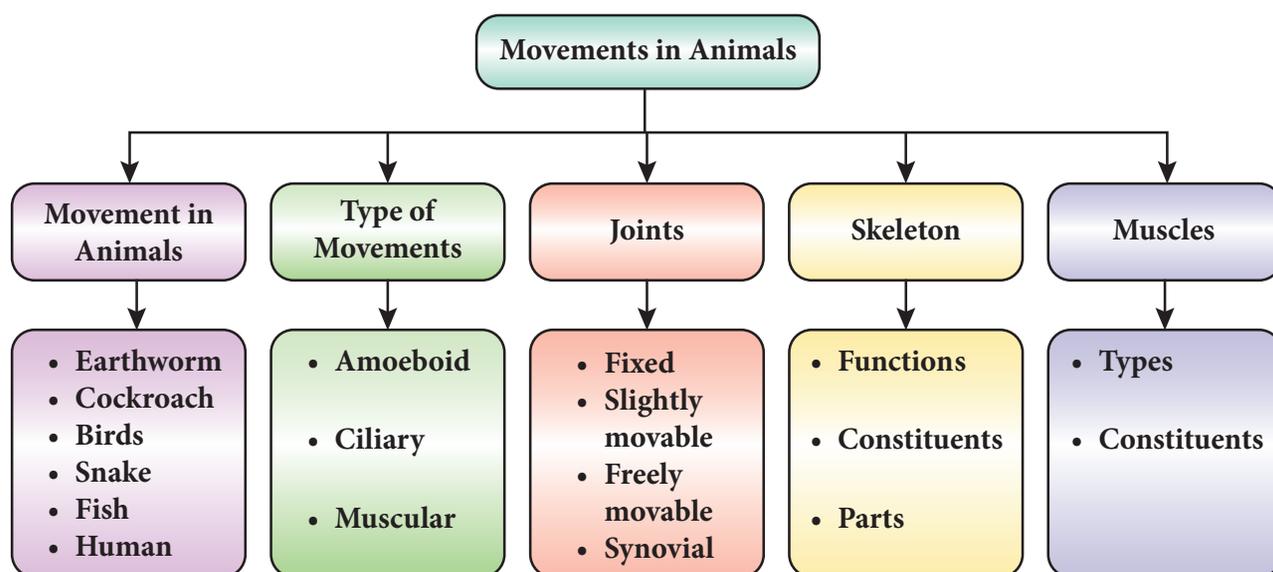
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INTERNET RESOURCES

1. https://kids.kiddle.co/Muscular_system
2. <https://kidshealth.org/en/kids/muscles.html>
3. <https://www.innerbody.com>
4. <https://www.visiblebody.com>

Concept Map



UNIT

20

REACHING THE AGE OF ADOLESCENCE



Learning Objectives



T2H1J6

After the completion of this lesson, students will be able to:

- ◆ understand the body changes that take place during adolescence.
- ◆ differentiate the secondary sexual characteristics of boys and girls.
- ◆ know about the role of hormones in reproduction.
- ◆ explain the reproductive phases of life in human.
- ◆ understand the nutritional needs of adolescents.

Introduction

Growing up is a natural process that takes place in all living organisms. All living organisms grow up to maturity which is the ability to respond to a particular environment. Maturity along with experiences produces a progressive series of changes in an organism. These series of changes are called development. Different phases of human development are called developmental stages. Human developmental stages include infancy, childhood, adolescence, adulthood, middle age and old age. Among all these stages, adolescence is the most crucial and significant period in an individual's life. It is the period of transition from childhood to adulthood. This period starts at the age of about 10 to 13 and ends at the age of 19 (commonly known as teenage). Almost all of you would have entered this period now. In this lesson you are going to study about the changes that take place in you (which are normal) as you enter the age of adolescence. You will also study about the reproductive phases of human life, reproductive health, nutritional needs of adolescents and personal hygiene during adolescence.

20.1 Adolescence and Puberty

The term adolescence is derived from the Latin word 'adolescere' meaning 'to grow' or 'grow to maturity'. During this period changes occur in height, weight, sex organs, muscle mass as well as in brain structure and function. Biologically it is a physical transition marked by the onset of puberty and termination of physical growth in an individual.

20.1.1 Puberty

Puberty is a period of few years in which rapid physical; physiological and psychological changes occur resulting in sexual maturity. We can predict the sequence of physical changes that will take place but the age of beginning of puberty varies from individual to individual. The average age for the onset of puberty is 10 or 11 for girls and 12 or 13 for boys. But, factors like genetic and biological influences, life events, socio-economic status, nutrition and diet and the amount of body fat also affect the onset and progression of puberty.

Hormones play an important role at the time of puberty. Changes in hormones during this period trigger physical and behavioural changes. Sex hormones secreted at the time of puberty activate the male and female sex glands to produce necessary secretions in the body. The male sex glands, testes release the testosterone and the female sex gland, the ovaries release the estrogen. These result in changes in the primary and secondary sexual characteristics of the male and female.

20.1.2 Body changes at Puberty

Four important changes that occur during puberty transform the body of a child into that of an adult. These changes are:

- Changes in body size
- Changes in body proportion
- Development of primary sex characteristics
- Development of secondary sex characteristics

a. Changes in body size

The first major change at the time of puberty is growth which is the increase in body height and weight. It usually begins at the age of 10 to 12 in girls and 12 to 13 in boys. It is almost complete at around the age of 17 to 19 in girls and 19 to 20 in boys. During adolescence

both boys and girls add around 23 cm to 26 cm in the height. In addition to height, they also experience significant increase in weight. But increase in weight is influenced by various factors like diet, exercise and life style. The average weight gain during this period is about 17kg to 19kg. During this period, increase in fat is seen in girls in contrast to muscle development in boys.

b. Changes in body proportion

Certain body areas which are small proportionately grow big. This can be seen in feet and hands. During childhood, legs grow proportionately more than the trunk. But at the time of puberty trunk also lengthens. Also, trunk broadens at the hip and shoulder thus giving the adult proportion to the body.

Activity 1

Divide the students in your class into different groups (Form separate groups for boys and girls). Measure the height and weight of all the students in each group and find out the average. Record your observations in your notebook.

c. Primary sex characteristics

Reproductive organs of boys and girls become fully functional at the time of puberty. In boys, testes grow larger followed by that



Figure 20.1 Adolescent growth

length and size of the reproductive organ increase. Similarly, female reproductive organ also grows during puberty. Thus, the size of the uterus and the weight of the ovaries increase during this time.

DO YOU KNOW?

Testes and ovaries are called primary sex organs of the male and female respectively.

20.2 Secondary Sex Characteristics

Secondary sex characteristics are the physical features which distinguish male from female. After the progression of puberty, boys and girls become dissimilar in appearance. The secondary sex characters are regulated by the hormones the testosterone or androgen secreted by the testes of the males and estrogen secreted by the ovaries of the females. Androgens cause the growth of the larynx, muscle development, skeletal size and distribution of body and pubic hair, and stimulation of sweat glands. Estrogen and progesterone are the female sex hormones. Estrogen stimulates the development of the breast, the external genitalia, pubic and axillary hairs, and the distribution of body fat.

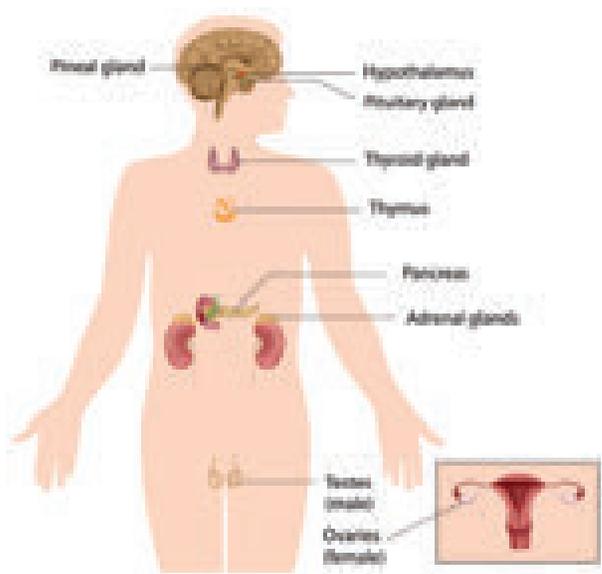


Figure 20.2 The endocrine system

20.2.1 Secondary Sex Characteristics of Boys

The following are the secondary sex characteristics of boys.

a. Hair

Immediately after the development of primary sex characteristics, pubic hair appears followed by axillary and facial hair.

b. Skin

The skin becomes coarse and the pores in the skin enlarge.

c. Glands

The oil producing glands in the skin enlarge and due to this acne may appear on the faces.

d. Muscle

The strength of the muscle increases and it gives shape to arms, legs and shoulders.

e. Voice

During this period voice changes occur and the voice becomes husky. Then its pitch drops and the volume increases.

DO YOU KNOW?

At puberty, the growth of the larynx is larger in boys than that of girls. The growing voice box in boys can be seen as a protruding part of the throat called Adam's apple, so that the voice becomes deep and harsh. This is caused mainly by male hormone (regulatory chemicals) during adolescence. As a result of this, muscles (chords) attached to the cartilage get loosened and thickened. When air passes through these loosened and thickened chords a hoarse sound is produced. In girls larynx is hardly visible from outside because of its small size and the voice becomes high pitched.

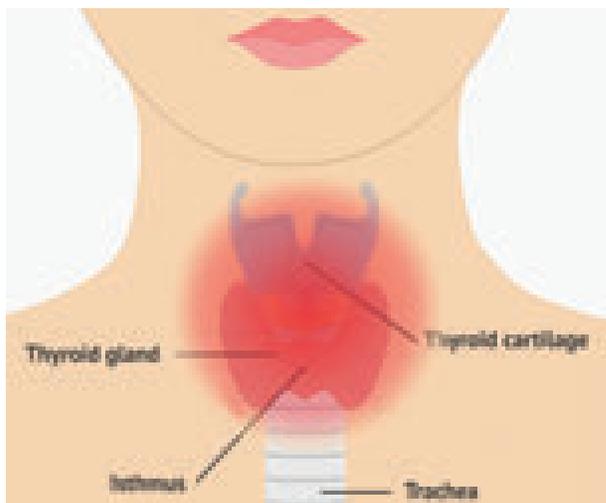


Figure 20.3 Adam's apple

20.2.2 Secondary Sex Characteristics of Girls

Girls show the following secondary sex characteristics at the time of puberty.

a. Hips

Due to the enlargement of the pelvic bone and the development of subcutaneous fat, the hip becomes wider and rounder.

b. Breast

After the enlargement of hips, the breasts begin to develop during this time.

c. Hair

Pubic hair appears followed by axillary and body hair on the limbs.

d. Muscles

Increase in muscles takes place which gives shape to shoulders, arms and legs.

e. Voice

Voice becomes shrill and voice breaks are rare among girls.

f. Skin

The skin becomes coarser and the pores enlarge as in the case of boys.

g. Gland

Oil producing glands become active causing acne on the face.



The secretions of sweat and sebaceous or subcutaneous glands (Oil glands) are very active during adolescence. Many adolescent boys and girls get pimples on face because of increased activity of these glands in the skin. Owing to extra secretions sometimes a distinctive odour is also produced from the bodies.

Table 20.1 Secondary sex characteristics in boys and girls.

Girls	Boys
Height and weight increase.	Height and weight increase.
Fatty and subcutaneous tissues develop.	Muscles develop.
Hip broadens.	Shoulder broadens.
Hair grows in arm pits and pubic area.	Hair grows in the arm pits and pubic area, and facial hair also appears.
Voice becomes shrill.	Voice break takes place due to lengthening of vocal cord and enlarging of larynx.
Breast develops.	Size of the penis increases.

Activity 2

Answer the following questions.

- Has your voice changed?
- Are there pimples or acne on your face?
- Do you feel that some changes have taken place in your body?

These changes are normal in your development. Discuss with your teacher or counsellor in your school and clarify your doubts.

20.3 Role of Hormones in Reproduction

The primary hormones that regulate reproduction are the steroids such as androgens, estrogens and progesterone which have masculinizing, feminizing and gestational effects respectively. These hormones are secreted from the gonads which are regulated by the anterior pituitary (adenohypophysis). In male and female, reproductive behaviour and reproduction are mainly under the control of LH (Luteinizing Hormone) and FSH (Follicle Stimulating Hormone). LH stimulates the testes to produce androgens, the male sex hormone. Sperms are then actively produced. In man sperm production starts at sexual puberty and may continue throughout his life.

Follicle Stimulating Hormone (FSH)

FSH in the female influences the development of the Graafian follicle and secretion of estrogens. In the male it is necessary for the development of seminiferous tubules, and for spermatogenesis.

Luteinizing Hormone (LH)

In the female, it is the hormone necessary for ovulation, and the secretion of the luteal hormone progesterone, and for the final maturation of the Graafian follicle. In the male it stimulates the interstitial (Leydig) cells of testes and the secretion of testosterone, and is referred to as the Interstitial Cell Stimulating Hormone (ICSH).



Estrogen is not a single hormone but a collection of related steroid hormones.

Prolactin (PRL) or Lactogenic Hormone

The main function of this hormone is milk secretion during lactation.

Oxytocin Hormone

Oxytocin causes expulsion of milk from the breast and it is also involved in the contraction of smooth muscles of uterus during child birth.

20.4 Reproductive phase of life in Human

Reproduction is more important for the continuation of human race. The phase in an individual's life during which there is production of gametes is called reproductive phase.



In females, the reproductive phase of life begins at puberty (10 to 12 years of age) and generally lasts till the age of approximately 45 to 50 years, and in males, it is from the age of 13 to life long. The reproductive age may vary from person to person. The following are the reproductive phases in the life of a female.

Menarche

The first menstrual flow begins at puberty and is termed menarche. The ova begin to mature with the onset of puberty. It is the beginning of adolescence, during which mental and emotional maturation occurs and physical growth becomes pronounced.

Ovulation

Ovulation occurs approximately 14 days before the next ovarian cycle commences. Thus in a 28 days cycle ovulation occurs about day 14. One ovum matures and is released by one of the ovaries once in about 28 to 30 days. The release of ovum from the ovary is called ovulation. During this period, the wall of the uterus becomes thick so as to receive the fertilized egg. This results in pregnancy.

Pregnancy

After ovulation the ovum reaches the fallopian tube and fertilization takes place.

The fertilized egg undergoes development and it is implanted in the uterus. The corpus luteum continues to grow and produces large amount of progesterone. This results in pregnancy. Normally, it lasts for 280 days, at the end of which parturition takes place.

Menstruation

If the ovum is not fertilized, the corpus luteum begins to degenerate and the production of hormones progesterone and estrogen ceases. The unfertilized egg and the thickened lining of the uterus along with its blood vessels are shed off. This causes bleeding in woman's reproductive tract which is called menstruation. Menstruation occurs once in about 28 to 30 days. It takes about 3 to 5 days. In some cases, initially menstrual cycle may be irregular. It takes some time to become regular. If it remains irregular for over a year, then it is better to consult a doctor.

Menopause

Menopause marks the end of the reproductive phase of a woman's life. At 45 to 50 years of age, the menstrual cycle stops. Stoppage of menstruation is termed as 'menopause'. During menopause psychological symptoms such as anxiety, irritability, fatigue and loss of concentration may occur. Menopause may be induced by surgical removal of the ovaries, or by pelvic irradiation in a woman of any age.



Now-a-days girls attain puberty at very early age. This is due to food habits. As you eat lot of junk food, the body growth increases and it looks like adults.

20.5 Menstrual Cycle

The beginning of the menstrual cycle marks the onset of puberty in human females. The menstrual cycle begins with the casting off of endometrial lining of the uterus and

bleeding. The casting of endometrium can be considered as periodic preparation for pregnancy. Menstruation occurs if an ovum released by the ovary of a woman is not fertilized during ovulation. This is described below.

1. When a girl reaches puberty at the age of about 10, the sex hormones released into her blood cause some of the ova (or egg cells) in her ovaries to become mature (or ripe).
2. Usually one mature ovum (or egg) is released from one of the ovaries into the oviduct once in every 28 days. This is called ovulation.
3. Before ovulation (or release of ovum), the inner wall of uterus becomes thick and spongy, and full of tiny blood vessels (or blood capillaries). It prepares itself to receive the fertilized ovum.
4. If the ovum does not get fertilized then the thick and soft inner lining of uterus is no longer needed and hence it breaks. So, the thick and soft inner lining of uterus along with the blood vessels and the dead ovum comes out of the vagina in the form of a bleeding called menstruation.

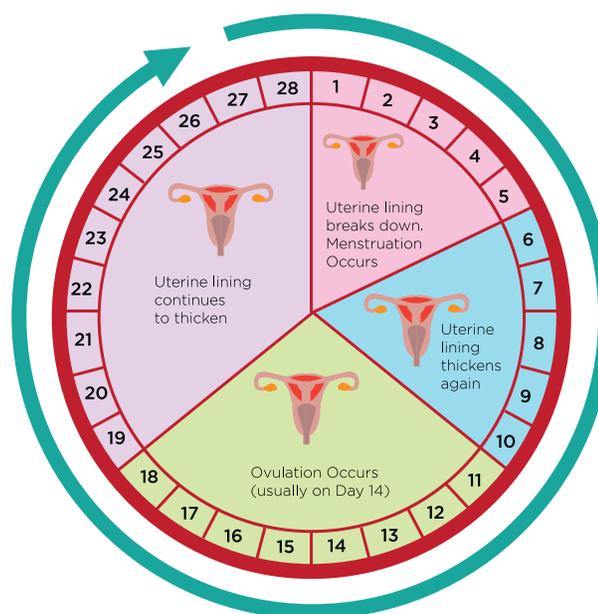


Figure 20.4 Menstrual Cycle

- Menstruation usually occurs 14 days after ovulation and usually lasts for about 3 to 5 days.
- After menstruation is over, the inner lining of the uterus starts building up again so that it may become ready to receive the next ovum.
- If the ovum does not get fertilized even now, then menstruation takes place again. This cycle of menstruation is repeated again and again in women after every 28 days. The menstrual cycle is controlled by hormones.
- For teenagers, the increased activity of sweat glands sometimes enhances body odour. If cleanliness is not maintained there are chances of having fungal, bacterial and other infections.

Menstrual Hygiene

Girls should take special care of cleanliness during the time of menstrual cycle. Making use of disposable napkins or tampons may reduce chances of infections. First of all, girls should realize that menstruation is as natural as any regular physiological activities like breathing, drinking, eating, urinating and defecation. Girls are advised to use sanitary napkins or tampons rather than cloth. It should be changed frequently depending upon the menstrual flow. If a cloth is being used repeatedly, it should be cleaned with soap and hot water and dried in sunlight for reuse.

Menstruation stops temporarily when the ovum gets fertilized and the woman gets pregnant. This is because, in this case the thick and soft lining of the uterus containing lot of blood vessels is needed for the growth and development of the fertilized ovum to form a baby. Menstruation restarts after the birth of the baby. Menstruation also stops due to nutritional deficiencies, low body weight, stress, eating disorder, excessive weight gain etc.

20.6 Reproductive Health

The physical and mental well-being of an individual is regarded as an individual's health. The World Health Organisation (WHO) has defined the reproductive health as the total well-being of behavioural, emotional, physical and social aspects of adolescence. To keep the body healthy, every human being, at any age, needs to have a diet, exercise and personal hygiene. The following are some of the measures that girls and boys need to take.

Cleanliness

- Have bath once or twice a day, paying special attention to underarms, groins and genitals.
- Change the underwear daily. It should be made of cotton and washed and cleaned everyday.



Sleep is vital to the well-being of adolescents. It can even help you to come out of the stress you experience during this period. During this period about 8 to 10 hours of sleep each night is necessary. But most teens do not have enough sleep which affects their physical and mental health.

Physical Exercise

Walking and playing in fresh air keeps the body fit and healthy. All young boys and girls should take a walk, exercise and play outdoor games. Physical activity leads to the conditions of better health, sound sleep and thereby mental peace. Mental peace promotes happiness in day to day existence.



Activity 3

Collect data on the number of students in your class who exercise regularly and who do not exercise regularly. Do you notice any difference in their fitness and health? Prepare a report on the benefits of regular exercise.

20.7 Nutritional needs of Adolescents

Adolescence is a stage of rapid growth and development. Hence a diet with proper calories and other nutrients is needed for proper growth and physical activity. Balanced diet is very much important during adolescence. Balanced diet includes proteins, carbohydrates, fats and vitamins in requisite proportions. Our Indian meal of roti / rice, dal (pulses), milk, fruits and vegetables forms a balanced food.

The nutritional deficiencies during this period not only retard the physical growth, but also impair the intellectual development and may also delay sexual maturation. A very good amount of proteins and carbohydrates is necessary during this growth period. Apart from that, adolescents need the following dietary components.

Minerals

Since there is an increase in skeletal mass and blood volume during adolescence, the body needs calcium, phosphorus and iron.

Calcium

Calcium intake needs to be increased to prevent osteoporosis in later life. It is present in milk and milk products or other equivalents.

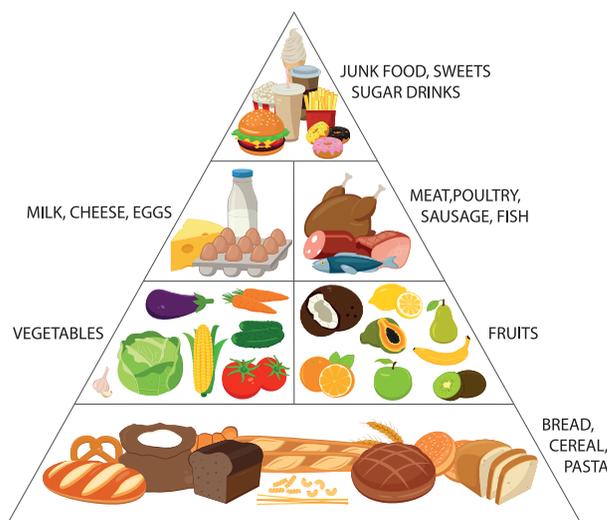


Figure 20.5 Balanced diet

Activity 4

Collect more information on balanced diet and prepare a chart. Display the chart in your class and discuss its importance.

Iodine

It helps to prevent thyroid gland related diseases.

Iron

Iron builds blood, and iron-rich foods such as green leafy vegetables, jaggery, meat, dates, fish, chicken, citrus, Indian gooseberry (Nelli) and whole pulses are good for adolescents. Lack of iron in the diet results in anemia. To make up for the loss of iron, adolescents need to have a diet rich in iron. In boys, iron deficiency occurs due to muscle spurt whereas in girls it occurs due to menstruation in addition to the muscular growth.



Women should take in more iron in their diet regularly to make up for the loss of blood during menstruation.

20.8 Personal hygiene for Adolescence

During adolescence, growing children need special attention towards diet, exercise and personal hygiene. Personal hygiene is a clear indicator of man's personality. Personal hygiene starts from the hair tip and ends down at the toes. Personal hygiene habits for the adolescence are as follows.

1. Shower or bath daily.
2. Always wash your hands before and after meals.
3. Keep finger nails clean and avoid nail polish.
4. Wash your teeth and mouth before and after each meal.

5. Avoid touching your face, nose or mouth while preparing food.
6. Avoid coughing or sneezing around food. Close your mouth by using hand kerchief while you cough in public places.
7. If you want to taste the food, use a clean spoon.
8. Change your clothes regularly and wash them cleanly, especially undergarments.
9. Do not defecate in open field. Use clean toilets for defecation.
10. If you are not well, avoid self-medication and consult a doctor.

Activity 5

Answer the following questions.

- Do you exercise regularly?
- Do you keep yourself clean?
- When do you go to bed?
- When do you get up?

Compare your response with that of your friends. Do you think you need to change yourself? Discuss with your teacher.

Points to Remember

- Adolescence is the period of reproductive maturity which lies usually between the ages of 11 to 19 years.
- Voice of boys becomes harsh as chords of voice box get loosened and thickened during adolescence.
- Hormones are the secretions of endocrine glands without ducts which secrete them directly into the bloodstream.
- Testosterone is the male hormone and estrogen is the female hormone that bring about development of several secondary sex characters.
- The uterine wall in female prepares itself to receive the developing fertilized eggs. In case there is no fertilization, the thickened lining of the uterus wall breaks down and goes out of the body along with the blood. This is called menstruation.
- It is important to take balanced diet for the overall growth and development during adolescence.

A-Z GLOSSARY

Adam's Apple	The protruding part of the throat.
Adolescence	The period of transition from childhood to adulthood.
Gland	Group of cells which secrete hormones.
Hormones	The chemical substances secreted in the body.
Menarche	The first menstrual flow at puberty.
Menopause	The stoppage of menstruation.
Menstruation	Bleeding in the reproductive tract of women.
Ovulation	The release of ovum from the ovary.
Primary sex characters	The characters which refer to changes in sex organs.
Puberty	The period at which an organism attains sexual maturity.
Secondary sex characters	The characters which help to distinguish the male from the female.



TEXTBOOK EXERCISES



I. Choose the best answer.

- Adolescence is the period of life between _____ years of age.
 - 10 to 16
 - 11 to 17
 - 11 to 19
 - 11 to 20
- The period at which an organism attains sexual maturity is called _____.
 - puberty
 - adolescence
 - growth
 - maturity
- During puberty, the region below the waist become wider in _____.
 - boys
 - girls
 - Both a and b
 - None of these
- Adam's apple is the growth of the _____.
 - pharynx
 - thyroid
 - larynx
 - parathyroid
- Many adolescent boys and girls get pimples on face, due to the secretions of _____ gland.
 - sweat
 - sebaceous
 - sweat and sebaceous
 - None of these
- The sperm is produced by _____.
 - penis
 - ovary
 - uterus
 - testes
- _____ are the chemical substances, secreted by endocrine glands.
 - Hormones
 - Enzymes
 - Proteins
 - Fatty acids
- Androgen production is regulated by _____.
 - GH hormone
 - LH hormone
 - TSH hormone
 - ACTH hormone
- During menstruation, the progesterone level is _____.
 - decreased
 - increased
 - ceased
 - normal
- _____ intake needs to be increased to prevent osteoporosis in later life.
 - Potassium
 - Phosphorus
 - Iron
 - Calcium

II. Fill in the blanks.

- _____ is secreted by the ovaries of female.
- The hormones secreted by the gonads are controlled by _____.
- Milk secretion during lactation is controlled by _____ hormone.
- The male and the female gamete fuse together and form _____.
- The first menstrual flow begins at puberty and it is termed as _____.
- _____ usually occurs 14 days after ovulation.
- _____ includes protein, carbohydrates, fats and vitamins in requisite proportion.
- _____ helps to prevent thyroid gland related diseases.
- Iron deficiency leads to _____.
- In women fertilization takes place at _____.

III. State true or false. If false, correct the statement.

- There is a sudden increase in the height of both boys and girls during puberty.

- The release of ovum from the uterus is called ovulation.
- During pregnancy, the corpus luteum continues to grow and produces large amount of estrogen and progesterone.
- Making use of disposable napkins or tampons may increase the chances of infections.
- Using clean toilets for defecation is a good practice.

IV. Match the following.

Puberty	Testosterone
Adam's apple	Muscle development
Androgen	at 45 to 50 years of age
ICSH	Sexual maturity
Menopause	Change in voice

V. Answer briefly.

- What is adolescence?
- List out the changes which occur during puberty.
- What do you mean by secondary sex characteristics?
- What is fertilization?
- Explain Menarche.
- Explain the process of pregnancy.
- Explain the importance of cleanliness during the time of menstrual cycle in girls.
- How is adolescence differ from childhood?

VI. Answer in detail.

- What are the physical changes that occur in boys and girls during adolescence?
- Explain the role of hormones in reproduction.

- Briefly describe the menstrual cycle.
- Explain the nutritional needs of adolescence in brief.

VII. Higher Order Thinking Questions.

- What can you suggest to your classmates to keep himself / herself clean and healthy?
- Adolescence is the energistic stage. What health and good habits you want to develop?



REFERENCE BOOKS

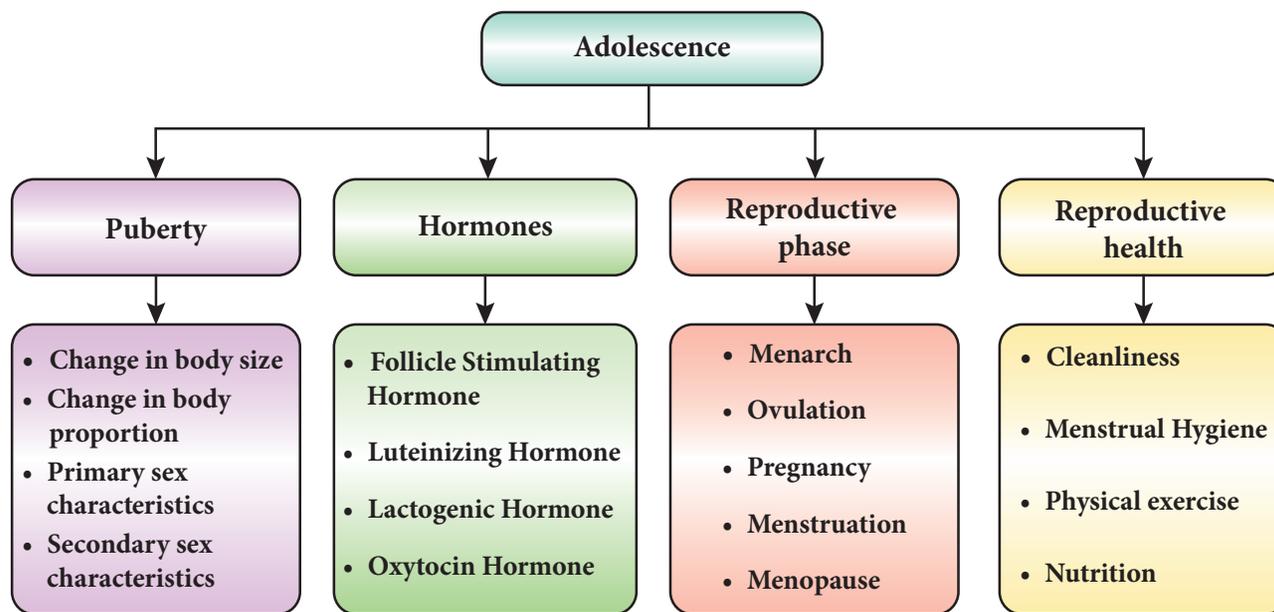
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INTERNET RESOURCES

- <https://eadership.ng/2018/04/08/toilet-hygiene>
- <https://www.boldsky.com/health/wellness/2018/world-menstrual-hygiene-day-9-basic-menstrual-hygiene-tips-122728.html>
- <https://www.boldsky.com/health/wellness/2018/world>

Concept Map





ICT CORNER

Adolescents

Through this activity you will learn about the age of adolescents.




Step 1 Open the Browser and type the URL given below

Step 2 You will see the pop up screen. You will see the video links of hormones, menstrual cycle etc...

Step 3 Click the Hormones video link. You will see the video.

Step 4 Likewise, you can see all the videos by clicking the links



Step1



Step2



Step3



Step4

Browse in the link:

<https://www.ticklinks.com/Domain/Open-Links-Library/Course/53/SSC-TN---Class-VIII/Subject/210/Biology/Classic/All/Links/Search>

*Pictures are indicatives only.

*If browser requires, allow Flash Player or Java Script to load the page.



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UNIT

21

CROP PRODUCTION AND
MANAGEMENT

Learning Objectives



K8T4L1

After the completion of this lesson, students will be able to:

- ◆ know about agricultural practices.
- ◆ understand the basic practices of crop production.
- ◆ know about the importance of rotation of crops.
- ◆ recognise the importance of seed bank, seed balls and preservation of seeds.
- ◆ know about the role of agriculture research institutions IARI, ICAR and KVK.
- ◆ list out the importance of bio control methods.

Introduction

All over the human history, we have been motivated to search and seek food. Green plants make their own food using a process called **photosynthesis**. Animals and humans cannot make their own food. Thus, humans and animals are directly or indirectly dependent on plants. Energy from the food is used by the organisms for carrying out their various body functions. Plants and animals are the main source of food for all the organisms. In order to provide food for a larger population, production, proper planning, management and distribution of food is needed. But, farmers are faced with the challenge of producing sufficient crops to meet the growing demand while maintaining the quality and quantity of resources for future generations. Agriculture research institutions are developing new technologies to help the farmers to increase productivity both in terms of quality or quantity. In this lesson we are going to learn about agricultural practices, rotation of crops, seeds, bio-fertilisers and the functions of agricultural research institutions.

21.1 Agricultural Practices

Agriculture has always been the backbone of our country's economy. Ever since the Green Revolution, we have been cultivating different types of crops to cater the increasing demand. In our country the following three categories of crops are grown.

Kharif Crops

The crops which are sown in the rainy season (i.e., from June to September) are called kharif crops. Paddy, maize, soya bean, groundnut and cotton are kharif crops.

Rabi Crops

The crops grown in winter season (i.e., from October to March) are called rabi crops. Examples of rabi crops are wheat, gram, pea, mustard, linseed.

Zaid Crops (Summer Crops)

The crops which are grown in summer season are called zaid crops. Muskmelon, watermelon and cucumber are examples for zaid crops.



Figure 21.1 Crops cultivated according to utility

According to utility, crops are classified as below.

Food crops

Paddy and maize are cultivated for human consumption.

Fodder crops

These are useful for livestock consumption. E.g. Sorghum, millets

Fibre crops

These crops are used for cordage and textile. E.g. Cotton and hemp

Oil crops

Oil crops are useful in a large scale for consumption or industrial uses. E.g. Ground nut and sesame.

Ornamental crops

These are utilized for landscape gardening. E.g- Croton and Bougainvillea.



Our country is the largest producer of bananas and mangoes in the world. It is also the second largest producer of wheat and rice.

Activity 1

Mention few examples for Kharif, Rabi and Zaid crops cultivated in your area.

Kharif	Rabi	Zaid

21.2 Basic Practices of Crop Production

Different activities in crop production are ploughing, sowing, applying fertilizers, harvesting and seed storage. All these activities collectively have an effect on the yield of crops.

21.2.1 Soil preparation

The most important aspect in agricultural process is to loosen the topsoil. The loosened soil helps in the growth of earthworm and soil microbes. These organisms add humus to the soil and are friendly to farmers. Plants absorb water, minerals, nutrients and air from the soil through their roots. Hence it is essential to prepare the soil in a proper way before starting the cultivation practice. The soil preparation methods are given below.

a. Ploughing

Ploughing or tilling is the process of loosening and turning the soil up and down to facilitate the availability of nutrients in the root zone of the cultivating crop.



Manual ploughing Machine ploughing

Figure 21.2 Ploughing

The following are the few important agricultural implements generally used in the field preparation.

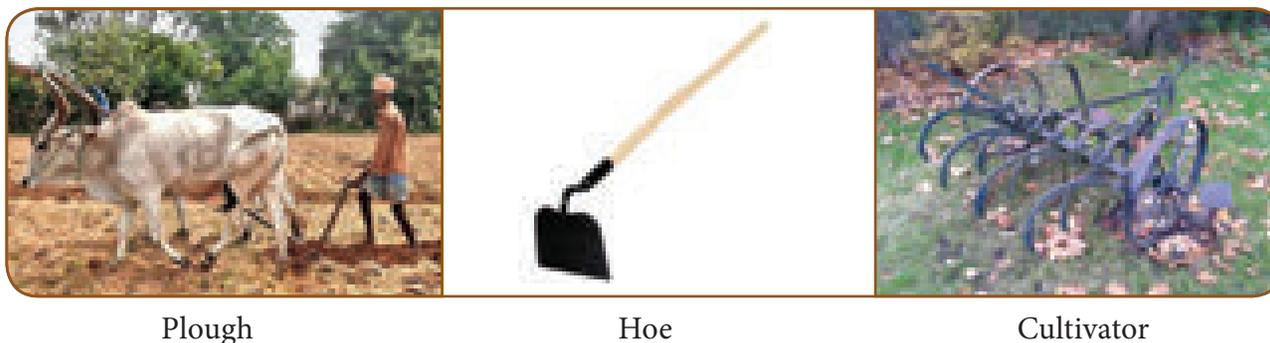


Figure 21.3 Agricultural implements

Plough

Plough is mainly used for tilling the soil, to add fertilisers to the crop, remove weeds and other waste materials from the field and also to turn the soil. A plough is made of wood and is drawn by a pair of bulls or horses. It contains a strong and a sharp triangular iron strip known as ploughshare. The main part of the plough is a long log of wood which is called plough shaft. The other end is attached to a beam which is placed on the bull's neck.

Hoe

It is a simple tool which is used to till the land, remove weeds and dig up soil. It has a long wooden rod with a bent iron plate at one end. The other end may be attached to an animal.

Cultivator

Cultivators are driven by tractor. Cultivators also kill weeds and dig up unwanted vegetation available in the field. Nowadays ploughing is done by tractor-driven cultivator. The use of cultivator saves labour and time.

b. Leveling

Once the field is ploughed, the topsoil is quite loose. The levelling of soil is done with an implement called the leveller, which is a heavy wooden or iron plank. Levelling of the field also helps in uniform distribution of water during irrigation.

c. Basal Manuring

Manuring means adding manure to the soil. Manure contains many nutrients required

for the growth of crop plants. To increase the fertility of the soil, we add manure to the soil even before sowing because it gets properly incorporated into the soil. Application of green manure and farmyard manure will always enhance the growth and yield of the crops.

21.2.2 Sowing of Seeds

This is the second step in crop production. Once the soil preparation is over, sowing of the seeds can be done. Sowing is the actual process of planting the seeds in the soil. The seeds that are sown have to be selected very carefully to have high quality. Various methods are followed for sowing the seeds.

a. Sowing by hand

The scattering of seeds by hand is the simplest method of sowing seeds. This is the most economical method of sowing seed.



Figure 21.4 Sowing by hand

b. Seed Drill

Seed drill is a modern method of sowing seeds. It is a better and more efficient method than sowing by hand. It is usually done by

attaching iron drills to a tractor. Seed drills ensure that the seeds are planted at equal intervals and at the correct depth in the soil.



Figure 21.5 Seed Drill

c. Dibbling

It is the placement of seed material in a furrow, pit or hole at predetermined spacing with a dibble, more commonly by hand. Soil around the hole is pressed with hand or leg for moist soil contact.



Figure 21.6 Dibbling

More to know

Transplanting is removal of an actively growing seedling from one place (usually nursery bed) and planting it in the main field for further growth till harvest. Transplanting makes use of pre-grown plants, seedlings or vegetative propagated clones.



21.2.3 Adding Manure and Fertilisers

The substances which are added to the soil in the form of nutrients to enhance the growth of plants are called **manure** and **fertilisers**. The term fertility refers to the inherent capacity of a soil to supply nutrients to crop plants in adequate amounts and in suitable proportions. These nutrients are essential for the growth of plants.

Manure is an organic substance obtained from the decomposition of plants or animal wastes. Farmers dump plant and animal waste in pits at open places and allow it to decompose. The decomposed matter is used as organic manure. Regular addition of organic manures helps to maintain the soil fertility, protecting them from wind and water erosion and preventing nutrient losses through runoff and leaching. This also increases water-holding capacity, soil aggregation, soil aeration and permeability.

Activity 2

Set up a compost pit within your school compound. Put all the organic wastes like food waste and plant leaf in your school campus, cover it with soil. Wait for three weeks and then you can use this as manure for the plants in your school.

Fertilizer is a substance which is added to the soil to improve plants' growth and yield. Fertilizers are composed mainly of Urea, Ammonium sulphate, Super phosphate, Potash and NPK (Nitrogen, Phosphorus, Potassium). The use of synthetic fertilizers has significantly improved the quantity of the food available today, although their long-term use is debated by environmentalists.



Manure

Fertilizer

Figure 21.7 Manure and Fertilizer

21.2.4 Irrigation

Water is important for the proper growth and development of plants. Plants absorb water from their surrounding with the help of the root system. The supply of water to crops at regular intervals is called **irrigation**. The time and frequency of irrigation varies from crop to crop, soil to soil and season to season. Fertilizers can also be applied through the irrigation. The various sources of irrigation are wells, tube wells, ponds, lakes, rivers, dams and canal. Effective irrigation is the controlled and uniform supply of water to crops, in the required amount at the right time with the minimum expenditure. Irrigation can be carried out by two different methods.

- a. Traditional Methods
- b. Modern Methods

a. Traditional Methods

In these methods, irrigation is done manually. Here, a farmer pulls out water from wells or canals by himself or using cattle and carries to farming fields. Pumps are also commonly used for lifting water from various sources. Diesel, biogas, electricity and solar energy are the few important sources of energy needed to run these pumps. The method of pulling water may vary from one place to other

Activity 3

Find out the irrigation system followed in your area. Also, debate on the advantages and disadvantages of modern irrigation systems like sprinkler system and drip system.

place. The main advantage of this method is that it is cheaper. But its efficiency is poor because of the uneven distribution of water. It also leads to heavy water loss.

b. Modern Methods

The modern irrigation methods help to overcome the problems exist in the traditional methods. It also facilitates the even distribution of moisture in the field.

The modern methods involve two systems. They are:

- Sprinkler system
- Drip system

Sprinkler System

A sprinkler system sprinkles water over the crop and helps in an even distribution of water. This method is much advisable in areas facing water scarcity. Here a pump which generates pressure is connected to pipes, and water is sprinkled through the fine nozzles of pipes.



Figure 21.9 Sprinkler irrigation system

Drip System

In drip system, water is released drop by drop exactly at the root zone using a hose or pipe.



Figure 21.8 Traditional irrigation methods

This method is considered as the effective one in regions where the availability of water is less.



Figure 21.10 Drip Irrigation System



The global population is expected to be 9 billion by the year 2050. But, agriculture activities alone utilize 70% of the available fresh water resources. So, efficient and sustainable water use is needed for our own generation and future generations. Drip irrigation is a better solution for economical use of water.

21.2.5 Weeding

In an agriculture field, many other undesirable plants may grow naturally along with the main crop. These undesirable plants are called **weeds**. The removal of weeds is called weeding. Weeding is an important process because weeds compete with the crop plants for the nutrients, sunlight, water, space and other resources. It results in the under nourishment of crops and leads to low yield. It is mandatory to remove seeds from the field to achieve the expected yield. Farmers adopt many ways to remove weeds and control their growth. Some of them are explained below.

Mechanical methods

This is the most common method in which weeds are destroyed physically. Hand pulling or weeding with the help of weeding hoe is the oldest and most efficient method for controlling weeds.

Tillage methods

It is one of the practical methods of destroying weeds of all categories. Weeds are buried in the soil and also exposed to sun heat by deep ploughing.

Crop rotation

In this method, proper rotation of crops is followed for controlling crop associated and parasitic weeds.

Summer tillage

Deep ploughing after harvest of rabi crop and exposing underground parts of weeds to strong sunlight during summer months is useful for destroying many annual and perennial weeds.

Biological weed control

In this method, bio agents like insects and pathogens are used to control weeds. The objectives of biological control are not eradication, but reduction and regulation of the weed population.

Chemical methods

Chemical methods are very effective in certain cases and have great scope in weed control. The chemicals used for killing the weeds or inhibiting their growth are called **herbicides**. These chemicals are mixed with water and sprayed over the crops.



Figure 21.11 Weeding methods

DO YOU KNOW?

There are over 30000 species of weeds around the world. Out of these 18000 species cause serious losses to crops. The continuous use of the same method leads to building up of tolerant species. Therefore, a suitable combination of different methods of weed control should be practiced.

Integrated weed management

Integrated weed management combines different agronomic practices and herbicides use to manage weeds, so that the reliance on any one weed control technique is reduced. Mechanical, biological, cultural and chemical methods are included in integrated weed managements.

21.2.6 Harvesting of Crops

The process of cutting and gathering a crop is called **harvesting**. Different methods are used for harvesting.

Manual harvesting

This is the major method of harvesting in India. Certain crops are harvested without using tools. Crops like ground nut, green gram, black gram and horse gram can be harvested by uprooting with hand, provided soil moisture is adequate for hand pulling.

Mechanical method

Harvesting in our country is generally done by employing the labours with the help of farm instruments like sickle. This method is a laborious and time-consuming one and it is suitable for small-sized farms only.



Figure 21.12 Mechanical method

Machine harvesting

This harvesting method is used in large sized agriculture fields.



Figure 21.13 Machine harvesting

The term harvesting also includes the immediate post-harvest practices such as threshing and winnowing.

The process of separating the grains from their chaffs or pods is threshing. After threshing, we must separate the grains from the chaffs. Winnowing is the process of separating the grains.



Threshing Winnowing

Figure 21.14 Separation of grains

21.2.7 Storage of food grains

Storage is an important aspect of post-harvest technology, because the crop is seasonally produced but consumed through out the year. Therefore, supply of the produce has to be maintained by proper storage. Before storing, harvested grains should be made free from moisture. Any moisture in the stored grains will lead to the growth of microorganism. So they need to be dried in the sun before storing. Food grains are collected in gunny bags and then stored in godowns. Silos and grains are



Silos

Figure 21.15 Storage of food grains

used for the storage of grains on large scale. Chemical vapours are sprayed to minimize pest and insects in godowns. This is called **fumigation**. The stored grains are inspected from time to time to make sure that they are free from diseases and pests. In our country, grains are stored on a large scale in government-owned godowns. The different categories of agricultural produce needing storage are food grains, oil seeds, seeds and fodder.



Food Corporation of India (FCI) was set up on 14th January 1965 at Chennai with the objective of distribution of food grains throughout the country for Public Distribution System (PDS) and maintaining a satisfactory level of operational and buffer stocks of food grains to ensure national food security. Its capital is in New Delhi now.

Activity 4

Visit a food storage godown in your area and know about the methods followed to preserve the food. Also discuss in the class room about the importance of preserving and protecting food grains.

21.3 Rotation of Crops

Crop rotation is planting a series of different crops in the same field following a defined order. Mono cropping and mixed cropping are the two methods used in crop production. Mono cropping is the repeated planting of the same crop in the same field year after year. Mixed cropping is the cultivation of two or more than two crops simultaneously on the same land without any pattern.



Figure 21.16 Monocropping (Maize)

Crop rotation has many advantages. Many crops like legumes may have positive effects on succeeding crops in the rotation, leading to greater production over all. A shallow rooted grain crop, deep rooted cash crop and restorative crop (legume crop) should be included in the rotation for maintaining soil productivity. The leguminous crops should follow non leguminous crops to have atmospheric nitrogen to succeeding crops. It helps in maintaining a better balance of nutrients in the soil. Weed problem is less in intercropping system compared to their sole crops.



Figure 21.17 Intercropping (Maize + Black Gram)



Leguminous plants have symbiotic relation with the *Rhizobium* bacteria found in the root nodules of these plants. These plants have the ability to fix atmospheric nitrogen in their roots with the help of these bacteria. The fruits of this plant are called legumes. Examples of legumes include alfalfa, clover, peas, beans, lentils, lupins, mesquite, carob, soy, and peanuts. These plants are used in crop rotation to multiply soil nitrogen.

21.4 Seed Bank

Seed bank is a place where seeds are stored in order to preserve genetic diversity. Seeds may be viable for hundreds and even thousands of years. Seed banks are like seed libraries that contain valuable information about evolution strategies of plants.

The Royal Botanical Gardens located in Kolkatta first started collecting seeds formally as seed bank. Seed banks were created to store native varieties of seeds. With this initiative farmers have started preserving indigenous seeds and reducing their dependence on hybrid seeds from seed companies. The simple and healthiest method of seed storage is in the air tight earthen pots. Navadanya Seed Bank, a nongovernmental organization located in New Delhi conserve around 50,000 crop varieties, with the primary focus on preservation of grain species.



Figure 21.18 Navadanya Seed Bank



Acharya Jagadish Chandra Bose Indian Botanic Garden located in Kolkatta was earlier called Royal Botanic Garden. This garden exhibits a wide variety of rare plants and a total collection of over 12,000 specimens. The area of this garden spreads over 109 hectares.

21.4.1 Seed balls

Seed balls are a mixture of soil, compost and plant seeds. These balls are thrown into land areas. With the monsoon set in, these planted seed balls will germinate into seedling. Making seed ball is a step towards conserving the natural ecosystems.

Seed balls are prepared by non-government organization and enthusiastic school children to grow tree for ecosystem restoration. The concept of seed ball has potential to increase tree cover and also to improve the awareness among the people about conserving plants.



Figure 21.19 Seed ball

Activity 5

Take some seeds of the fruits you eat and mix it with compost. Add some clay with them and roll them into small balls. Allow them to dry under the sun for two or three days. Take these balls and drop them in dry and arid areas. This will help new plants to grow. You can throw those balls while you are travelling. This will help grow plants in areas where there is no plant cover.

21.4.2 Heirloom seed

An heirloom seed is the seed of plant that has been carefully cultivated and passed down through many generations. Heirlooms are usually planted in small, isolated communities and they generally offer something of value to the grower. Heirloom seeds are also called organic seeds. These seeds are generally produced from open-pollinated plants and they transfer their unique characteristics to the descendants. Heirloom seed are harvested, dried and stored so that one can replant them in the following season.

The goal of preserving heirloom seed is to prevent any type of change due to outside influence. Most vegetable and flower varieties must be kept protected or isolated from other similar varieties during flowering to avoid cross pollinating plants and mixing their genes. Some vegetable varieties are self-pollinated and are grown with virtually no danger of crossing. Synthetic fertilizers, herbicides or pesticides are not used for organic seeds but conventional fertilizer, herbicides and pesticides are used.

21.5 Bio-indicators

A bio-indicator or biological indicator is any species or group of species whose function or status reveals the qualitative status of the environment. Biological indicators are used to document and understand changes in earth's living systems especially changes caused by the activities of an expanding human population. Bio-indicators of soil health give us information about soil structure, development, nutrient storage and biological activities.

Biological indicator characterises the state of an ecosystem and brings its modifications. *Lichen* is a natural bio-indicator of climate change and air pollution effect. It is a combination of an alga and a fungus which live together in symbiotic association. *Lichen*

is a sensitive environmental parameter like temperature, humidity, wind and air pollutants. It gives information about changes in climate, air quality and biological process.



Figure 21.20 Lichen

21.6 Agriculture Research Institutions

Agricultural research institutions formulate the agricultural practices based on recent research results and farmers' needs. Using suitable media and methods, they disseminate those information for the welfare of the people. Indian Agricultural Research Institute and Indian Council of Agricultural Research are some of the institutions which are involved in agricultural research.

21.6.1 Indian Agricultural Research Institute (IARI)

The Indian Agricultural Research Institute is a national institute for agricultural research, education and extension. IARI is commonly known as the Pusa Institute.



Figure 21.21 The Indian Agricultural Research Institute

It is financed and administrated by the ICAR (Indian Council of Agricultural Research). This was responsible for research leading to the green revolution in India during 1970s. The policies, plans and programs of IARI have helped to meet the needs of the nation. Several popular high yielding varieties of major crops have been developed by IARI.

21.6.2 Indian Council of Agricultural Research (ICAR)

The Indian Council of Agricultural Research is an autonomous body responsible for co-ordinating agricultural education and research in India. The union minister of agriculture serves as its president. It functions under the Department of Agricultural Research and Education, Ministry of Agriculture. It is the largest network of agricultural research and education institutes in the world.



Figure 21.22 Indian Council of Agricultural Research

21.6.3 Krishi Vigyan Kendra

Krishi Vigyan Kendra is a farm science centre. These centres serve as the ultimate link between ICAR (Indian council of Agricultural research) and farmers. Their aim is to apply agricultural research findings in practical localized settings. The first KVK was established in 1974 at Pondicherry. Since then, KVKs have been established in all states and the number continues to grow. KVKs are expected to undertake their own projects. They are also expected to serve as a resource center for extending government initiative to local areas.

KVKs can be formed under a variety of host institutions, including agricultural universities, state departments, ICAR institutes and other educational institutions or non government organisations.

a. Responsibilities of KVK

Each KVK operates a small farm to test new technologies, such as seed varieties or innovative farming methods developed by ICAR institutes. This allows new technologies to be tested at the local level before being transferred to farmers. It also organizes programs to show the efficacy of new technologies on farmer's fields. KVKs organise workshops to discuss modern farming techniques with groups of farmers. KVKs provide advisory service to the farmers about weather and market pricing through radio and mobile phones. It focuses on crops and cultivation methods. It also facilitates rapport between the institution and the local community.

Activity 6

Visit a Krishi Vigyan Kendra in your area with your teacher. Find out the activities carried out in those centres.

21.7 Foliar Sprays

Foliar feeding is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Plants are able to absorb essential elements through the stomata in their leaves. But total absorption takes place through epidermis.



Figure 21.23 Foliar spraying on trees

Sea-based plant mixes from kelp contains trace nutrients and some hormones which are useful for the development of plant leaves, flowers and fruit. Foliar feeding is generally done in the early morning or late evening.



Plant shows quick response to the nutrients applied by foliar feedings. The efficiency of nutrients uptake is considered to be higher when nutrients are applied to the leaves, when compared with nutrients applied to soil. A foliar feeding is recommended when environmental conditions limit the uptake of nutrients by roots.

21.7.1 Effective Microorganisms (EM) Technology

Effective microorganisms are a culture of different effective microbes, commonly occurring in nature. Nitrogen fixers, phosphate stabilizers, photosynthetic micro organisms, lactic acid bacteria, yeast, Rhizo bacteria and various fungi and actinomycetes are used as effective microorganisms. In this consortium, each micro organisms has its own beneficial role in nutrient recycling, plant protection and soil health and fertility enrichment.

21.7.2 Panchgavya

Panchgavya is a promoter with a combination of five products obtained from the cow, which includes cow dung, cow's urine, milk, curd and ghee. All the five products are

collectively termed as panchgavya. It has the potential to play the role of promoting growth and providing immunity booster. It provides resistance to pests and increases the overall yield. It can be prepared by the farmers themselves with the materials available on the farm.

Pachgavya can be used for seed treatment also. For this, seeds are soaked for 20 minutes before sowing. The present form of panchgavya is a single organic input which can act as a potentialator. The products of local breed of cow is said to have more potency than the products of exotic breeds.

21.7.3 Vermiwash

Vermiwash is a liquid that is collected after the passage of water through a column of worm action. It is a collection of excretory product and mucus secretion of earthworms along with micronutrients from the soil organic molecules. Vermiwash is used as a foliar spray for crops.

21.8 Bio-control Methods

Bio-control or biological control is a method of controlling pests such as insects, mites, weed and plant diseases using other organisms.



Bio-predators, bio-pesticides, bio-repellents and bio-fertilizers are used for controlling microorganisms which cause damage to the crops, pests and insects.



Figure 21.24 Ingredients of Panchgavya

21.8.1 Bio-predators

These are naturally occurring insects that use pests for feeding or multiplication. These are called bio-predators. By introducing large numbers of predators in a greenhouse we can destroy the pest. Predators like *Chrysopa* spp. and *Menochilus* spp. are highly useful in controlling pests like aphids, white flies, cotton bollworms, leaf insects etc.

DO YOU KNOW?

The black knee capsid is an insect found on fruit trees. It eats more than 1000 fruit tree red spider mites per year.



Figure 21.25 Predatory Lady bird beetle feeding on Aphid

21.8.2 Bio-pesticide

Bio-pesticides are living organism or their derived parts which are used as bio-control agents to protect crops against insect pests. Bio-pesticides are of different types based on their origin.

a. Fungal bio-pesticides

Trichoderma viride is a fungus used as a biological pesticide. It is useful to control various disease caused by fungi such as wilt, rusting of leaves and root disease.

b. Bacterial bio-pesticide

A culture of *Bacillus thuringiensis* bacteria is effectively used to control the pest *Lepidoptera* that attack cotton and maize plants. Panchagavya and leaves decoction of some plants are also used as bio-pesticides.

21.8.3 Bio-repellant

Compound Azadirachtin obtained from seeds of neem serves as a good insect-repellant. One of the earliest pesticides used by man was margosa leaves. The dried leaves repel the pests from stored grains.

21.8.4 Bio-fertilizer

Bio-fertilizers are organisms which can bring about soil nutrient enrichment. Nitrogen fixing microorganisms have the capability of converting free nitrogen into nitrogenous compounds and make the soil fertile. The main source of bio-fertilizers is cyano bacteria and certain fungi. Free living cyano bacterium involves in nitrogen fixation along with photosynthesis. Eg. *Anabaena*, *Nostoc*. Symbiotic bacteria also fix atmospheric nitrogen. E.g. *Rhizobium*. Although the chemical fertilizers increase food production, they degrade the natural habitat.



Figure 21.26 Bio-fertilizer

Activity 7

Take a leguminous plant like pea and find out if there are any nodes. *Rhizobium* bacteria live in such nodes.



Points to Remember

- Kharif, Rabi and Zaid are the main crops cultivated in our country.
- Ploughing, sowing, applying fertilizers, harvesting and storage are the different activities in crop production.
- Sowing by hand, seed drill and dibbling are the methods of sowing seeds.
- The various sources of irrigation are wells, tube wells, ponds, lakes, rivers, dams and canal.
- Sprinkler and drip system are the modern methods of irrigation.
- The process of cutting and gathering a crop is called harvesting.
- The term harvesting also includes the immediate post-harvest practices such as threshing and winnowing.
- Mono cropping and mixed cropping are the two methods used in crop production.
- Seed bank is a place where seeds are stored in order to preserve genetic diversity.
- A bio-indicator or biological indicator is any species or group of species whose function or status reveals the qualitative status of the environment.
- Bio-predators, bio-pesticides, bio-repellents' and bio-fertilizers are used for controlling microorganisms which cause damage to the crops, pests and insects.

A-Z GLOSSARY

Ploughing	The process of loosening and turning of the soil.
Broadcasting	The process of scattering of seeds on soil surface with hand.
Dibbling	Placement of seed material in a furrow, pit or hole at predetermined spacing.
Sprinkler irrigation	Method of applying irrigation water which is similar to natural rainfall.
Monoculture	Planting of the same crop in the same field year after year.
Seed bank	A place where seeds are stored in order to preserve genetic diversity.
ICAR	Indian Council of Agricultural Research
KVK	Krishi Vigyan Kendra (Farm Science Center)
Vermiwash	A liquid that is collected after the passage of water through a column of worm action.
Panchgavya	A promoter with a combination of five products obtained from the cow, which includes cow dung, cow's urine, milk, curd and ghee.
Bio fertilizers	Organisms which can bring about soil nutrient enrichment.



TEXTBOOK EXERCISES



I. Choose the best answer

- The process of placing seeds in the soil is called as
 - ploughing
 - sowing
 - crop production
 - crop rotation
- Organism that control insects and pests of plant crops is
 - bio-pesticides
 - bio-fertilizers
 - earthworms
 - neem leaves

- The method in which water flows over the soil surface and allow it to infiltrate is
 - irrigation
 - surface irrigation
 - springler irrigation
 - drip irrigation
- Effective microorganism preparation is not used in
 - seed treatment
 - foliar spray
 - soil treatment
 - bio-predators
- Which of the following is not present in Panchagavya?
 - Cow dung
 - Cow's urine
 - Curd
 - Sugar

II. Fill in the blanks

- The process of actively growing seedling from one place and planting in the main field for further growth is called _____.
- _____ is a plant growing in a place where it is not wanted.
- The chemicals used for killing the weeds or inhibiting their growth are called as _____.
- _____ seeds transfer their unique characteristics to the descents.
- _____ centers serve as the ultimate link between ICAR and farmers.
- Several popular high yielding varieties of major crops have been developed by _____.

III. Match the following.

Bio-pesticide	Neem Leaves
Bio-predators	Bacillus thuringiensis
Bio-fertilizer	Control white flies
Bio-indicators	Improve soil fertility
Bio-repellants	Quality of environment

IV. Answer briefly.

- Define ploughing.
- Name the methods of sowing.
- What is foliar spray?
- Give a brief account on Krishi Vigyan Kendra.
- What is bio-indicator? How does it help human beings?
- What do you mean by weeding?
- What is crop rotation?
- What is green manure?

V. Answer in detail.

- Explain the agricultural practices.
- Give a detailed account on irrigation.
- What is weed? Explain the different methods of weed control.



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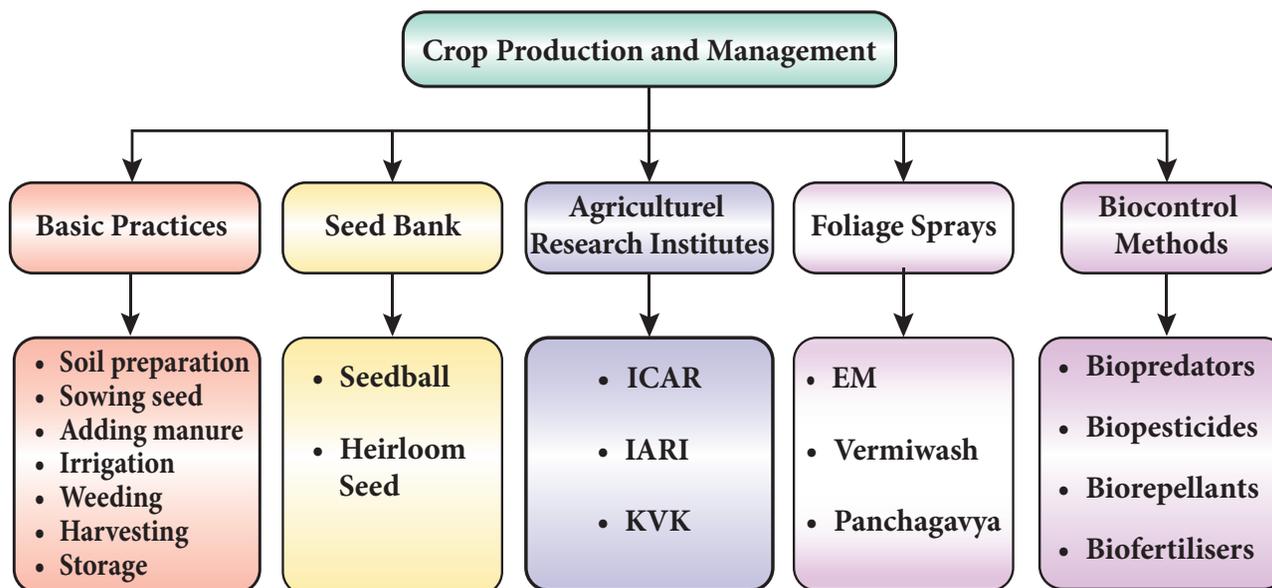
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Concept Map





ICT CORNER

Crop Protection

Lets enjoy and do agriculture in your mobile

➔


Step 1 Open the browser and type the URL or scan the QR code given below.

Step 2 click on the INSTALL icon displayed in the screen to install the game in your mobile.

Step 3 Click the button TOUCH TO BEGIN and enjoy doing agriculture.



Step 1



Step 2



Step 3

Web URL:
https://play.google.com/store/apps/details?id=com.giantssoftware.fs14&hl=en_IN

*Pictures are indicatives only.
 *If browser requires, allow Flash Player or Java Script to load the page



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UNIT

22

CONSERVATION OF PLANTS AND ANIMALS



Learning Objectives

After the completion of this lesson, students will be able to:

- ◆ understand deforestation, afforestation and reforestation.
- ◆ list out the endangered species.
- ◆ understand the importance of conservation of wildlife.
- ◆ know about Red Data Book and its advantages.
- ◆ list out the importance of Peoples' Biodiversity Register.
- ◆ know about the functions of animal welfare organisations.



W1H7K9

Introduction

Our planet earth is filled with so many species of plants and animals. According to the scientists there are about 70 – 100 lakh species on the earth. The sum total of all these animals is called biodiversity. Bio means life, diversity means variety or different. Thus, bio-diversity means variety of life forms on the earth and the essential interdependence of all living things. When you travel through the forests in the mountain ranges you can see variety of life forms. Forests are abundant with fruit trees and flowers and inhabited by chirping birds, prancing deer and plenty of other animals. All through the literature of ages, it has been mentioned that India is full of forests filled with wildlife. Unfortunately, from then to now, most of these forests have been cut down. This phenomenon is seen all across the world. Forests as a natural resource are decreasing in area in the recent years. In this lesson we are going to learn about deforestation, endangered species, conservation of plants and animals and wildlife sanctuaries and national parks.

22.1 Deforestation

Forests are the important renewable resources. They cover about 30 percent of the world's land surface. They produce oxygen and maintain the level of carbon dioxide in the atmosphere. Forests provide many important goods such as timber, paper and medicinal plants. They control water runoff, protect soil, and regulate climate changes. But the forests all around the world are being destroyed. Destruction of forests in order to make the land available for different uses is known as deforestation. Deforestation has resulted in several ecological imbalances such as increase in temperature, deficiency in rainfall etc. It has also resulted in the extinction of several species of animals and plants.

22.1.1 Causes of Deforestation

Deforestation may be caused by nature or it may be due to human activities. Fires and floods are the natural causes for deforestation. Human activities which are responsible for deforestation include agricultural expansion, cattle breeding,

illegal logging, mining, oil extraction, dam construction and infrastructure development. Let us study about some of them in this section.

a. Agricultural Expansion

With increasing population, there is an overgrowing demand for food production. Hence, large amount of trees are chopped down for crop production and for cattle grazing. More than 40% of the forests are cleaned to obtain land and to meet the needs of agriculture.

b. Urbanization

With the expansion of cities more land is needed to establish housing and settlement. Requirements like construction of roads, development of houses, mineral exploitation and expansion of industries also arise due to urbanisation. Forests are destroyed to meet all these needs.

c. Mining

Mining of coal, diamond and gold require a large amount of forest land. So, a large number of trees is cut down to clear the forest area. Moreover, the waste that comes out from mining pollutes the environment and affects the nearby plants.

d. Construction of dams

To provide water supply to the increasing population, large size dams are constructed. Hence, a great extend of forest area is being cleared.



Figure 22.1 Dam

e. Timber Production

We need wood to meet the needs of our daily life. Wood-based industries like paper,

match-sticks, furniture need a substantial amount of wood supply. Wood is the most commonly used fuel. Thus, a large number of trees are being cut down for fuel supplies. Some people are involved in illegal wood cutting and destroy more number of trees. This is the main reason for the destruction of some valuable plants.



Figure 22.2 Destruction of trees



Chipko Movement is primarily a forest conservation movement. The word 'Chipko' means 'to stick' or 'to hug'. Sunderlal Bahuguna was the founder of this movement. It was started in 1970s with the aim of protecting and conserving trees and preserving forest from being destroyed.



f. Forest fire

In many forests, fires are usually expected from time to time. They may be caused by humans, accidents or natural factors. Forest fires wipe out thousands of acres of forest land each year all over the world. This has tremendous effects on biodiversity and the economy as well.



Figure 22.3 Forest fire

g. Cyclones

Cyclones destroy the trees on a massive scale. They not only destroy the trees but also affect the livelihood of so many people who depend on them.

More to know

Name of the Cyclone	State	Year
Fani	Orissa	2019
Gaja	Tamil Nadu	2018
Phethai	Andhra Pradesh	2018
Ockhi	Tamil Nadu	2017
Vardah	Tamil Nadu	2016

22.1.2 Effects of Deforestation

There has been a long history of interdependence between man and the forests. Our survival without forest will be very difficult. They supply us the oxygen we need, cause rainfall and provide so many things needed for our life. But increase in population has resulted in the destruction of forests. Every year 1.1 crore hectares of forests have been cut down around the world. In India alone 10 lakh hectares of forests are destroyed which has resulted in so many harmful effects. Let us study about some of them.

a. Extinction of species

Deforestation has resulted in the loss of many wonderful species of plants and animals and many are on the verge of extinction. More than 80% of the world's species remain in the tropical rainforest. Reports say that about 50 - 100 species of animals are being lost each day as a result of destruction of their habitats.

b. Soil Erosion

Widespread trees in the forests protect the soil from the heat of the sun. When the trees are cut down, soils are exposed to



Long distance travel by birds to escape severe environmental conditions is called migration.

Many birds and many other animals migrate long distances during unfavourable season. Siberian Crane migrates from Siberia to India during winters to escape harsh conditions in Siberia and to get comfortable conditions and food in India. Siberian crane, on an average can travel 200 miles in a single day.



the sun's heat. Extreme temperature of the summer dries up the moisture and makes the nutrients to evaporate. It also affects the bacteria that helps in the breakdown of organic matter. The roots of the trees retain the water and the top soil which provides nutrients to the plants. When the trees are cut down, soil is eroded and washed away along with the nutrients.

c. Water cycle

Trees suck the water from the roots and release the water into the atmosphere in the form of vapour during transpiration. When trees are cut down the amount of water vapour released decreases and hence there is a decrease in the rainfall.

d. Floods

Trees absorb and store a large amount of water with the help of their roots. When the trees are cut down, the flow of water is disrupted and it leads to flooding in some areas.

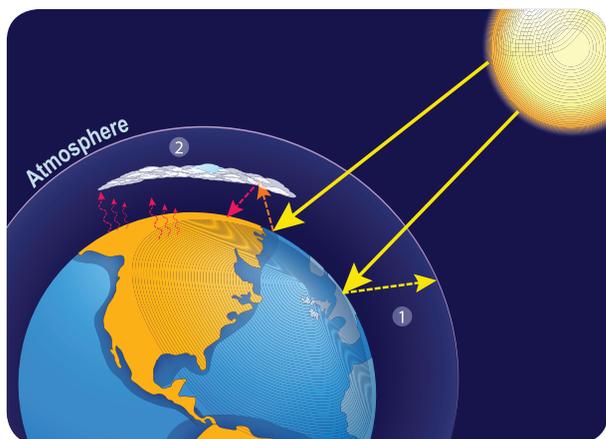


Figure 22.4 Global warming



Amazon forest is the largest rain forest in the world, located in Brazil. It covers 6000000 square km. It helps to stabilize the earth's climate and slow global warming by fixing CO_2 , and producing 20% of the world's oxygen in the process. It has about 390 billion trees. It is the lungs of the planet.



e. Global warming

We inhale oxygen present in the atmosphere and release carbon dioxide as waste. In turn trees absorb the carbon dioxide and provide us the oxygen during photosynthesis. Deforestation reduces the number of trees and hence more amount of carbon dioxide accumulates in the atmosphere. Carbon dioxide along with water vapor, methane, nitrous oxide and ozone forms the green house gases. These gases are responsible for global warming.

The solar energy falling on the earth's surface is reflected into the atmosphere. A part of this energy is reflected by the green house

gases back to the earth to keep it warm and a part goes into the space. But gases such as methane and carbon dioxide accumulating in the atmosphere trap the heat energy inside the atmosphere leading to increase in temperature. This is called global warming. This results in the melting of glaciers in the polar region and affects the living organisms like polar bear.

f. Destruction of home land

Indigenous people live in and depend on forests for their survival. They get their food and many other resources from the forests. Destruction of forests affects their livelihood .



Activity 1

Collect information about a nearby forest in your area and find out the rare species of plants and animals found there. Collect some pictures of plants and animals which you do not find around you and prepare an album.

22.2 Afforestation

As we all know due to deforestation the climate is changing alarmingly in these days and there is no seasonal rainfall. Because of this many cities are facing water scarcity and many of the lands are becoming barren. Water is needed for life to exist on the earth. So, we need to grow forests. Afforestation is the process of planting trees, or sowing seeds, in a barren land



The term social forestry was first used in 1976 by the then National Commission on Agriculture, Government of India. It means the management and protection of forests and afforestation on barren land with the purpose of helping the environment, social and rural development. It is to raise the plantations thereby reducing the pressure on the traditional forest area.

to create a forest. Afforestation helps us to create the forests differently from natural forests.



Figure 22.5 Afforestation programme

22.2.1 Importance of Afforestation

The world is experiencing a great change in the climate in the recent years than ever before. These changes in the climate have given an alarming signal to everyone. To protect our planet earth, afforestation would be a better solution. Importance of afforestation is given below.

- Afforestation helps the wild animals and even humans to have shelter and to find their food source.
- Through afforestation we can increase the supply of oxygen. Trees planted can increase the water vapour in the atmosphere to get the rainfall.
- By planting trees the amount of carbon dioxide in the atmosphere can be reduced and thus the effects of air pollution, green house gases and global warming can be controlled.
- Afforestation enables us to avoid desertification of land.



Wangari Maathai founded the Green Belt Movement in Kenya in the year 1977. GBM has planted over 51 million trees in Kenya. She was awarded the Nobel Peace Prize for 2004.



- Barren lands experience strong winds and it causes soil erosion. Top soil is washed away during rainfall. Afforestation helps to grow more trees so that they can hold the top soil along with the nutrients.
- Creating forests provides us fodder, fruits, firewood and many other resources.
- Industries need specific type of trees. Afforestation helps us to grow a particular type of trees.

Activity 2

Discuss about afforestation in the class and write a brief report on your discussion.

22.3 Reforestation

Reforestation is the natural or intentional replanting of the existing forests that have been destroyed through deforestation. Reforestation may sound similar to afforestation but both of them are not same. Reforestation is replanting of trees in a land area which had lost its forest cover for some reason. But afforestation is growing forest in an area which originally had no tree cover. Reforestation is an effective strategy to fight global warming. In addition to benefiting the climate, reforestation helps in protecting important species of animals. Reforestation helps to rebuild habitat loss and degradation which are the leading threats to the health and endangerment of species.

Activity 3

Observe the important days related to conservation of nature. Also organise a rally on protecting forest.

22.3.1 Importance of Reforestation

Both afforestation and reforestation are important for protecting the habitat, increasing the supply of forest products,

finding solution to climate changes and for many other reasons. Importance of reforestation is given below.

- Reforestation improves the quality of air we breathe by reducing carbon dioxide in it.
- The effects of deforestation can be checked and global warming can be reduced.
- Reforestation restores habitat loss, degradation and removes the threats to species.
- Forest restoration can reverse the damage done by soil erosion. Reforestation will revive the watersheds which are important aspects of environmental well-being.
- Reforestation maintains the water cycle of the area as trees absorb moisture through the leaves and roots.
- Transpiration of trees helps to restore the moisture of the atmosphere and to maintain the temperature in the local environment.

Table 22.1 Difference between Deforestation and Reforestation

Deforestation	Reforestation
When the plants or trees are cut down, it is called deforestation.	When the plants or trees are grown or planted, it is called reforestation.
Deforestation has a negative effect on the environment.	Reforestation has a very good effect on the nature, as it builds the environment.

Table 22.2 Differences between Afforestation and Reforestation

Afforestation	Reafforestation
Trees are planted in new areas where there was no forest cover.	It is practiced in areas where forests have been destroyed.
One sapling is planted to get one tree.	Two saplings are planted to replace every felled tree.
It is practiced to bring more area under forest.	It is practiced to avoid deforestation.

22.4 Endangered Species

Our country is a home for variety of species with rich flora and fauna. Flora is the plant life occurring in a particular area. Fauna is the animal life occurring in a particular area. The Royal Bengal Tigers, the Asiatic Cheetah and several other birds are found in India. But due to various reasons like environmental pollution, deforestation, loss of habitat, human interference, poaching and hunting many animals in India are extinct and many are endangered. Species which no longer exist on earth are called extinct species. E.g. Dinosaurs, Dodo. An endangered species is an animal or a plant that is considered to be at the risk of extinction. It means that there are only



Figure 22.6 Endangered Animals

Activity 4

Observe the following days in your school

- World Forest Day - March 21
- World Water Day - March 22
- Environmental Day - June 5
- World Nature Conservation Day - July 28
- Ozone Day - September 16

few of them left on the earth and soon they might extinct. It is reported that nearly 132 species of plants and animals are critically endangered in India. Snow leopard, Bengal tiger, Asiatic lion, Purple frog and Indian giant squirrel are some of the endangered animals in India.



Each year, 22nd May is celebrated as World Biodiversity Day. Biodiversity is a term used to describe the different plants, animals, marine life, microorganisms, insects, habitats, ecosystem etc. that make our planet so unique and so fascinating.

Many algae, fungi, bryophytes, ferns and gymnosperms are disappearing with the destruction of forests. And, each disappearing species may take away with it many species of animals and microbes which depend on them for food and shelter. Similarly, list of animals on the verge of being lost is endless. Prawns, oysters, lobsters, crabs, squid, octopus, cuttlefish, beetles, dragonfly, grasshoppers, fish and even frogs are dying by absorbing poisonous gases through their skin. Locust is one insect which has almost disappeared from India. Following animals are getting rare these days.

- Reptiles: Some lizards, turtles, crocodiles and gharials.
- Birds: Falcon, eagle, hawk, vulture, peacock-peahen, pigeon, duck.
- Mammals: Wild cats such as tigers, lions, deer such as chinkara and blackbuck, chiru (Tibetan goat), musk deer, rhino, elephants, blue whale, flying squirrel.

Table 22.3 Endangered plants and animals.

Endangered Plants	Endangered Animal
Umbrella tree	Snow Leopard
Malabar lily	Asiatic Lion
Rafflesia flower	Lion tailed macaque
Indian mallo	Indian Rhinoceros
Musli plant	Nilgiri Tahr

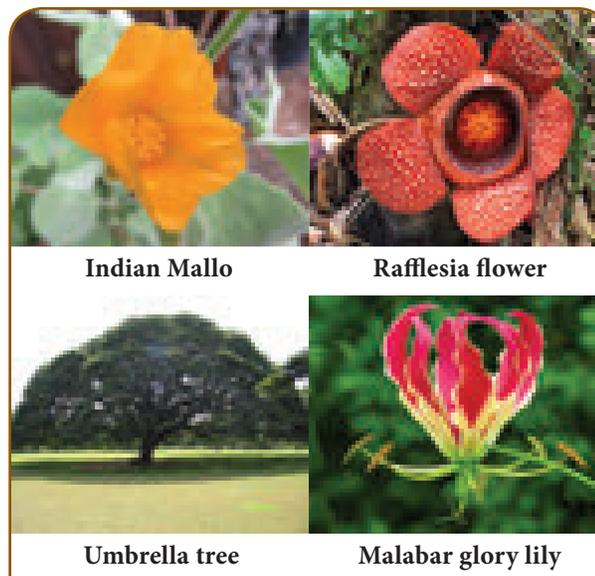


Figure 22.7 Endangered plants

Activity 5

Collect as many pictures of wild plants and wild animals as possible. Prepare a poster showing the endangered species separately.

22.4.1 Determination of Endangerment

Whether a particular species is endangered or not is determined by the following ways.

- When the geographical range of the species is limited.
- The population of the species is limited i.e., less than 50 adult individuals.
- When the population has decreased or will decrease by more than 80% in 10 years.
- If the population is less than 250 individuals and is continuously declining at 25% for the past three years.
- There is a high possibility of extinction in the wild.



Yeoman Butterfly has been declared state butterfly of Tamil Nadu. This species is endemic to Western Ghats. It is among 32 butterfly species found in Western Ghats.



22.4.2 Causes for Endangerment

There are various reasons why a species may become endangered or extinct. Some of them are explained below.

a. Loss of habitat

Trees that provide food and shelter to so many species are destroyed due to human intervention.

b. Over hunting and poaching

Large number of animals are hunted for their horns, skin, teeth and many other valuable products.

c. Pollution

Number of animals are affected by pollutions like air pollution and water pollution. In the recent years more number of animals is affected by wastes in the form of plastic.

d. New habitat

Sometimes animals are taken by people to new habitat where they do not naturally live. Some of them may extinct and some may survive. The new ones may also get attacked by the species already living there and cause their extinction.

e. Chemicals

We use pesticides and other chemicals to get rid of damaging insects, pests or weeds. But they can also poison desired plants and animals if we do not use them correctly.

DO YOU KNOW?

At one time Dinosaur, ferns and some gymnosperms were wide spread on the earth. They disappeared from the earth, may be due to shortage of space and food or due to climatic change.



f. Diseases

Diseases due to various unknown reasons may affect the animals and make them extinct.

g. Natural calamities

Animals may also be destroyed due to natural disasters like flood and fire.

22.4.3 Saving Endangered Species

Nature is beautiful and it is filled with different plants and animals. For maintaining healthy ecological balance on the earth, animal and plant species are important. They have medicinal, scientific, ecological and commercial value. Each organism on the earth has a unique place in food chain that contributes to the ecosystem. But they are endangered mainly due to human activity. We need to take certain measures to protect them and preserve them.

- Some of the animal species are endangered mainly because of hunting and poaching. If it is controlled there can be a significant change in the number of endangered animals.
- Controlling pollution can have a positive impact on animals, fish and birds all over the world.
- When we consume more, more pollutants are put into the environment. By consuming less, we can protect the ecosystems.
- Animals often mistake plastic for food and hence plastics harm and cause endangerment of many species. Limiting the amount of plastic and recycling it can save the endangered animals.
- Recycling things and buying eco friendly products will preserve the environment resources and hence the animals.
- Pesticides and chemicals which cause damage to the environment should be avoided.
- Planting native trees will provide food to the animals.

DO YOU KNOW?

Planting the native trees like Neem tree, Umbrella tree and Banyan tree in our surrounding will be helpful for the animals. Many birds and animals find shelter in those trees.

22.4.4 Government Initiatives

In order to preserve the plants and animals, government has taken lot of initiatives and some acts have also been passed to protect them. For example, Project Tiger is a wildlife conservation project initiated in India in 1972 to protect the Bengal Tiger. It was launched on 1st April 1973 and has become one of the most successful wildlife conservation ventures. Corbett National Park was the first National Park in India to be covered under project Tiger. Due to 'Project Tiger' the population of Tiger has increased in India from 1400 in 2006 to 2967 in 2018. Apart from this, government has enacted the following Acts.

1. Madras Wildlife Act, 1873.
2. All India Elephant Preservation Act, 1879.
3. The Wild Bird and Animal Protection Act, 1912.
4. Bengal Rhinoceros Preservation Act, 1932.
5. All India Wildlife Protection Act, 1972.
6. Environmental Protection Act, 1986.

22.5 Red Data Book

The Red Data Book is the file for recording rare and endangered species of animals, plants and fungi. Even some local sub-species that exist within the territory of a state or country are recorded in red data books. Red data book gives important data for observational studies and monitoring programmes on habits and habitats of rare and endangered species. This book is created to identify and protect the species which are about to extinct.

Red Data Book is maintained by the International Union for Conservation of Nature. It is an international organization working in the field of nature conservation and sustainable use of natural resources. It was founded in 1964 with the aim of maintaining a complete record of every species that ever lived. The Red Data Book classifies species mainly into three categories namely, threatened, not threatened and unknown. This book also has information as to why a species has become extinct along with the population trends and its distribution.

The Red Data Book contains colour-coded information sheets like black for species which are extinct, red for species that are endangered and so on. They are arranged according to the extinction risk of many species and subspecies. The following figure gives the colour coded information.

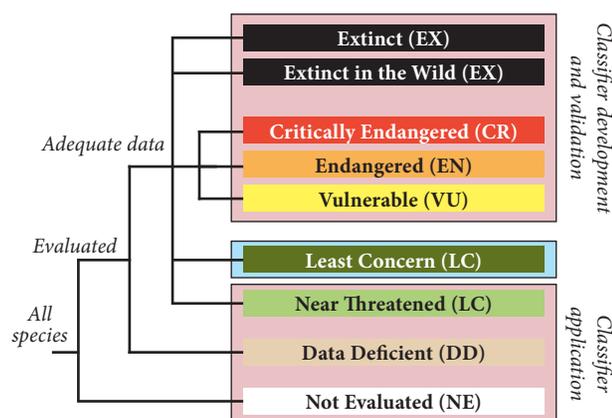


Figure 22.8 IUCN Red List Categories



WWF – World Wildlife Fund
ZSI – Zoological Survey of India

BRP – Biosphere Reserve Programme
CPCB – Central Pollution Control Board
IUCN – International Union for Conservation of Nature

22.5.1 Advantages of the Red Data Book

- It helps to evaluate the population of a particular species.
- The data given in this book can be used to evaluate the species at the global level.
- The risk of a species becoming globally extinct can be estimated with the help of this book.
- It provides guidelines for implementing measures for protecting endangered species.

22.5.2 Disadvantages of the Red Data Book

- The information available in the Red Data Book is incomplete. Many extinct species are not updated in this book.
- The source of the book's data has been speculated.

- This book maintains the complete record of all animals, plants, other species but it has no information about the microbes.



World Wildlife Day is observed on March 3rd every year.

22.5.3 Red Data Book of India

India, a mega-diverse country with only 2.4% of the world's land area, accounts for 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals. The country's diverse physical features and climatic conditions have resulted in a variety of ecosystems such as forests, wetlands, grasslands, deserts, coastal and marine ecosystems which harbour and sustain high biodiversity and contribute to human well being. Four out of 34 globally identified biodiversity hotspots, the Himalayas, the Western Ghats, the North-East, and the Nicobar Islands, can be found in India.

India became a state member of IUCN in 1969, through the Ministry of environment, Forest and Climate Change (MoEFCC). The IUCN India country office was established in 2007 in New Delhi. Red Data Book of India contains the conservation status of animals and plants which are found in the Indian subcontinent. Surveys conducted by the Zoological Survey of India and the Botanical Survey of India under the guidance of the Ministry of Environment, Forest and Climate Change provide the data for this book.

22.6 Conservation

According to WWF (World Wildlife Fund) there has been 60% decrease in the size of population of animals, birds, fish, reptiles and amphibians over the past 40 years. In order to leave something for the future generation, we need to conserve it now. Conservation is the protection, preservation, management of wildlife and natural resource such as forest and water. Conservation of biodiversity helps us to protect, maintain and recover endangered

animals and plant species. Conservation is of two types. They are:

- In-situ conservation (within habitat)
- Ex-situ conservation (outside the habitat)

22.6.1 In-situ conservation

It is nothing but conservation of living resources within the natural ecosystem in which they occur. This is achieved by protection of natural habitat and maintenance of endangered species in certain protected areas such as national parks, wildlife or bird sanctuaries and biosphere reserves. In India, there are about 73 national parks, 416 sanctuaries and 12 biosphere reserves.

a. National Parks

National park is an area which is strictly reserved for the betterment of the wildlife. Here, activities like forestry, grazing or cultivation are not permitted. Even private ownership rights are not allowed in these areas. The national parks cover an area of 100 – 500 square kilometers. In these parks a single plant or animal species are preserved.

Table 22.4 National Parks in India

Name	State	Established year
Jim Corbett National Park	Uttarakhand	1936
Dudhwa National Park	Uttar Pradesh	1977
Gir National Park	Gujarat	1975
Kanha National Park	Madhyapradesh	1955
Sundarbans National Park	West Bengal	1984



Figure 22.9 Tiger in Corbett National Park

Table 22.5 National Parks in Tamil Nadu

Name	District	Established year
Guindy National Park	Chennai	1976
Gulf of Mannar National Park	Ramanathapuram	1980
Indira Gandhi National Park	Coimbatore	1989
Mudumalai National Park	The Nilgiris	1990
Mukurthi National Park	The Nilgiris	1990

b. Wildlife sanctuaries

Sanctuary is a protected area which is reserved for the conservation of animals only. Human activities like harvesting of timber, collection of forest products and private ownership rights are allowed here. Controlled interference like tourist activity is also allowed. The differences between national parks and wildlife sanctuaries are given in Table 22.6

Table 22.6 Wildlife Sanctuaries in Tamil Nadu

Name	District	Established year
Meghamalai Wildlife Sanctuary	Theni	2016
Vandaloor Wildlife Sanctuary	Chennai	1991
Kalakad Wildlife Sanctuary	Thirunelveli	1976
Grizzled Squirrel Wildlife Sanctuary	Virudhunagar	1988
Vedanthangal Wildlife Sanctuary	Kanchipuram	1936

**Figure 22.10** Vedanthangal wildlife sanctuary**Table 22.7** Difference between National Parks and Wildlife Sanctuaries

Wildlife Sanctuary	National Parks
Human activities are allowed.	No human activities are allowed.
Main aim is to protect a particular flora or fauna.	Flora, fauna or any other objects of historical significance are protected.
There are no fixed boundaries.	Boundaries are fixed and defined.
It is open to the general public	Not usually open to the public.
Sanctuaries are usually formed by the order of central or the state government	National Parks are formed by the state or central legislature.
A sanctuary can be upgraded to a national park	A national park cannot be downgraded to a sanctuary.

c. Biosphere reserves

Biosphere is a protected area where human population also forms the part of the system. The area of these places will be around 5000 square kilometers. They conserve the eco system, species and genetic resources. These areas are set up mainly for economic development.

Table 22.8 Biosphere Reserves in India

Name of Biosphere	State / Union Territory
Nanda Devi	U.P
Nokrek	Meghalaya
Manas	Assam
Sunderbans	West Bengal
Gulf of Mannar	Tamil Nadu
Nilgiri	Tamil Nadu
Great Nicobars and Similipal	Andaman and Nicobar / Orissa

Activity 6

Find out the national parks and wildlife sanctuaries in Tamil Nadu. Visit those places and collect more information about them.

Advantages of In-situ conservation

- Species can be adapted to their habitat.
- Species can interact with each other.
- Natural habitat is maintained.
- It is less expensive and easy to manage.
- Needs of indigenous people are protected.

22.6.2 Ex-situ Conservation

It is the conservation of wildlife outside their habitat. Establishing zoos and botanical gardens, conservation of genes, seedling and tissue culture are some of the strategies followed in this method.

a. Botanical gardens

It is a place where flowers, fruits and vegetables are grown. These places provide a healthy and calm environment.

b. Zoological parks

Zoological parks are the areas where wild animals are conserved. In India there are about 800 zoological parks.



The oldest zoo is Schoenbrunn Zoo in Vienna, established in the year 1759. In India the first Zoo was established in Barrachpur in the year 1800.

c. Tissue Culture

It is a technique of growing plant cells, tissues, organs, seeds or other plant parts in a sterile environment on a nutrient medium.

d. Seed bank

The seed bank preserves dried seeds by storing them in a very low temperature. The largest seed bank in the world is the Millennium Seed Bank in England.

e. Cryo Bank

It is a technique by which a seed or embryo is preserved at a very low temperature. It is

usually preserved in liquid nitrogen at -196°C . This is helpful for the conservation of species facing extinction.

Advantages of Ex-situ conservation

- It prevents the decline of species.
- Endangered animals can be bred in these ways.
- Threatened species are bred and released in natural environment.
- It is useful for conducting research and scientific work.

22.7 PBR (People's Bio-diversity Register)

People's Bio-diversity Register is a document which contains comprehensive information on locally available bio-resources including landscape and demography of a particular area or village. Bio-resources mean plants, animals and microorganisms or parts thereof, their genetic material and by-products with actual or potential use or value. A Bio-diversity Management Committee is set up in each local body according to the provisions of Biological Diversity Act, 2002. This committee prepares the People's Biodiversity Registers with the guidance and technical support of National Biodiversity Authority and the State Biodiversity Boards.

Preparation of this register promotes conservation, preservation of habitats and breed of animals and gathering of knowledge relating to biological diversity. The register entails a complete documentation of biodiversity in the area related to the plant, food source, wildlife, medicinal source, traditional knowledge etc.

22.8 Biomagnification

Biomagnification is the increase in contaminated substances due to the intoxicating environment. The contaminants might be heavy metals such as mercury, arsenic, and pesticides such as polychlorinated biphenyls and DDT (Dichloro Diphenyl Trichloro ethane). These substances are taken up by the organisms through the food they

consume. When the organisms in the higher food chain feed on the organisms in the lower food chain containing these toxins, these toxins get accumulated in the higher organisms.

22.8.1 Causes of Bio-magnification

Following are the major causes of bio-magnification:

- The agricultural pesticides, insecticides, fertilizers and fungicides are very toxic and are released into the soil, rivers, lakes, and seas. These cause health issues in aquatic organisms and humans.
- Organic contaminants cause adverse impact on the health of humans, animals, and wildlife.
- Industrial activities release toxic substances which enter into the organism through food chain leading to bio-magnification.
- Mining activities generate a large amount of sulphide and selenium deposits in water. These toxic substances are absorbed by the aquatic organisms in the food chain.

22.8.2 Effects of Bio-magnification

Following are the effects of bio-magnification on living organisms and the environment:

- It has more impact on humans causing cancer, kidney problems, liver failure, birth defects, respiratory disorders, and heart diseases.
- It also affects the reproduction and development of marine organisms.
- The destruction of coral reefs affects the lives of many aquatic animals.
- The chemicals and toxins which are released into the water bodies disrupt the food chain.

More to know

Dr. K. Sakhila Banu, a scientist from Texas A & M University, USA has found out that the water contaminated by chromium metal induces infertility in female species and also causes oxidative stress in the human placenta which could affect the growth of the baby. She is from Pudupattinam village in Ramnad district, Tamil Nadu.

22.9 Animal Welfare Organisations

Animal welfare organizations are the group of people concerned with the health, safety and psychological wellness of animals. They include animal rescue groups which help animals in distress, and others which help animals suffering from some epidemic. In this section we will study about some of them.

22.9.1 Blue Cross

Blue Cross is a registered animal welfare charity in the United Kingdom, founded in 1897 as 'Our Dumb Friends League'. The vision of this charity is that every pet will enjoy a healthy life in a happy home. The charity provides support for pet owners who cannot afford private veterinary treatment, helps to find homes for unwanted animals, and educates the public in the responsibilities of animal ownership.



Blue cross was founded to care for working horses on the streets of London, UK. It opened its first animal hospital, in Victoria, London, on 15 May 1906.

Captain V. Sundaram founded the Blue Cross of India, the largest animal welfare organization of Asia in Chennai in the year 1959. He was an Indian pilot and animal welfare activist. Now, Blue Cross of India is country's largest animal welfare organizations and it runs several animal welfare events like pet adaptation and animal right awareness. Blue Cross of India has received several international and national awards. This organization is entirely looked after by volunteers. The main office is located at Guindy, Chennai, with all amenities like hospitals, shelters, ambulance services and animal birth controls, etc. Activities of the organization include, providing shelters, re-homing, adoption, animal birth control, maintaining hospitals and mobile dispensary and providing ambulance services.

22.9.2 CPCSEA

CPCSEA stands for 'The Committee for the Purpose of Control and Supervision of Experiments on Animals'. It is a statutory committee set up under the Prevention of Cruelty to Animals Act, 1960. It has been functioning since 1991 to ensure that animals are not subjected to unnecessary suffering during experiments on them.

Objectives of CPCSEA

- i) To avoid unnecessary pain before and after experiment.
- ii) To promote the human care of animal used in experiments.
- iii) To provide guidelines for animal housing, breeding and maintenances.
- iv) To promote the human care of animal used in biomedical and behavioural research and testing.

Functions of CPCSEA

- i) Approval of animal house facilities.
- ii) Permission for conducting experiments involving usage of animals
- iii) Action against establishments in case of established violation
- iv) Registration of establishments conducting animal experimentation or breeding of animals for this purpose.

Points to Remember

- Human activities which are responsible for deforestation include agricultural expansion, cattle breeding, illegal logging, mining, oil extraction, dam construction and infrastructure development.
- Afforestation helps the wild animals and even humans to have shelter and to find their food source.
- Reforestation will revive the watersheds which are important aspects of environmental well-being.
- Snow leopard, Bengal tiger, Asiatic Lion, Purple frog and Indian giant squirrel are some of the endangered animals in India.
- For maintaining healthy ecological balance on this earth, animal and plant species are important.
- Red Data Book gives important data for observational studies and monitoring programmes on habits and habitats of rare and endangered species.
- Conservation of biodiversity helps us to protect, maintain and recover endangered animals and plant species.
- When the organisms in the higher food chain feed on the organisms in the lower food chain containing these toxins, these toxins get accumulated in the higher organisms.

A-Z GLOSSARY

Biodiversity	Variety of life forms.
Bio magnification	Increasing concentration of substances such as toxic chemical in the tissues of organism at successively higher level in a food chain.
Deforestation	Removal of forest.
Extinct species	Species which have disappeared completely from the earth.
Endangered species	A species of plant or animal that is in immediate danger of biological extinction.
Endemic species	Plants and animals species that are found only in a particular area.
Flora	Plant life occurring in a particular region.
Fauna	Animal life occurring in a particular region.
National Park	Protected area of land in which a typical ecosystem with all its wild plants and animals are protected and preserved in natural surroundings.

Reforestation	Replanting of trees.
Red Data Book	Recording about endangered species.
Wildlife Sanctuary	Protected area of land, wetland or sea reserved for the conservation of wild animals, birds and plants.



TEXTBOOK EXERCISES



I. Choose the best answer.

- The plants found in a particular area are known as _____
a) fauna b) flora
c) endemic d) rare
- Deforestation means _____
a) cleaning of forest b) to grow plants
c) to look after plants d) None of these.
- The Red Data Book gives a list of _____
a) endemic species b) extinct species
c) natural species d) None of these
- In situ conservation is _____
a) off site conservation
b) on site conservation
c) Both a and b d) None of these
- Wildlife Protection Act was implemented in _____
a) 1986 b) 1972 c) 1973 d) 1971

II. Fill in the blanks.

- WWF stands for _____.
- The animal found in a particular area is known as _____.
- Red Data Book is maintained by _____.
- Mudhumalai Wildlife Sanctuary is located in _____ district.
- _____ is observed as 'World Wildlife Day'

III. Match the following.

Gir National Park	Madhya Pradesh
Sundarabans National Park	Uttara khand
Indira Gandhi National Park	West Bengal
Corbett National Park	Gujarat
Kanha National Park	Tamil Nadu

IV. Answer very briefly.

- What is global warming?
- What is known as extint species?
- Give few example for extinct species.
- Name two endangered animals.
- What is IUCN?

V. Answer briefly.

- What is biosphere reserve?
- What is tissue culture?
- What is endangered species? Give two examples.
- Write the advantages of the Red Data Book.
- Mention four main reasons for the conservation of forests.
- What do you understand by the term bio magnification?
- What is PBR?

VI. Answer in detail.

- What is deforestation? Explain the causes and effects of deforestation.

2. Discuss the advantages of in-situ and ex-situ conservation.
3. Write about the types of conservation.
4. Write a note on Blue Cross.



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1. Environmental biology- Verma P S – S Chand & co publisher
2. Indian wildlife –The great wildlife series- APApublishation
3. Endangered Animals of India – S M Nair – National book trust India

VII. Higher Order Thinking Questions.

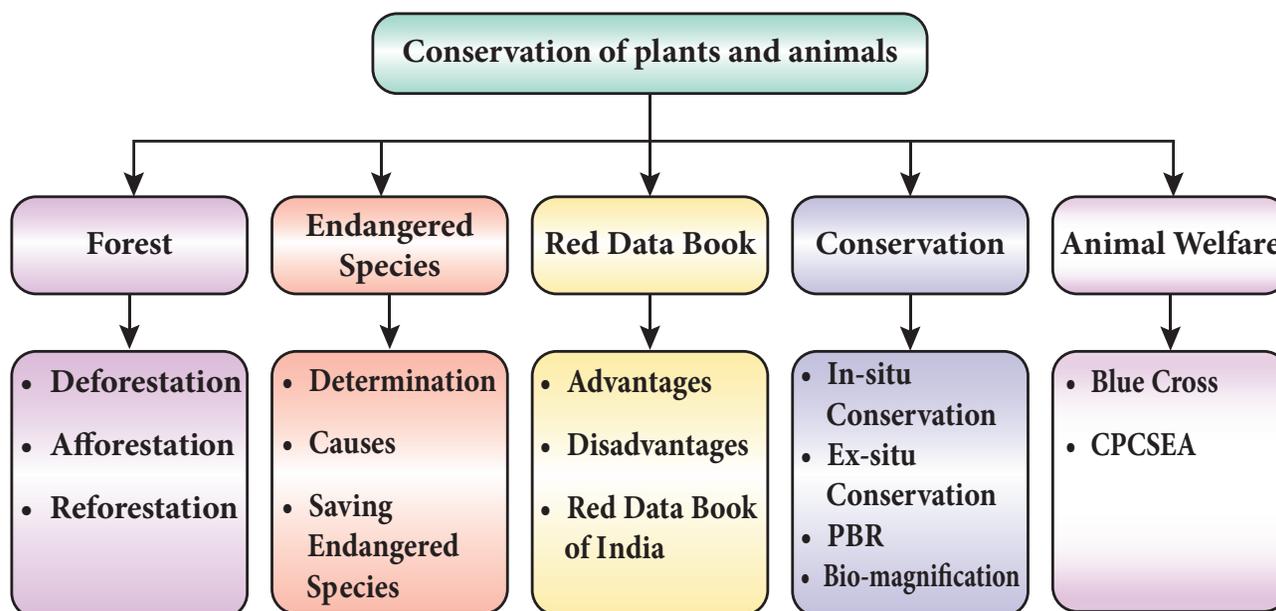
1. Is it possible to find dinosaurs today? Why?
2. Animals are affected by deforestation. How?
3. Why did the numbers of tiger and black buck decrease?



INTERNET RESOURCES

- www.Bluecrossofindia.org
 www.cpcsea.nic.in
 www.pbr.com

Concept Map



ICT CORNER

Conservation of Plants and Animals

Watch the wild animals lively from your screen



- Step 1** Open the browser and type the URL or scan the QR code given below. click on the LIVE ANIMAL YARD which is on the left of the page displayed.
- Step 2** The page will open with icons showing animals click on the animal you wish.
- Step 3** Click on the play button displayed on the screen.
- Step 4** Repete the action again by selecting the other animals or birds.

Web URL: <https://www.aazp.in/>



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