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Unit 6

Electricity in Everyday Life

After studying this chapter the students will be able to:

- Describe the characteristics and effects of static charges.
- Explain static charges in terms of electron transfer.
- Explain practical applications of static and current electricity (e.g., household appliances)
- Identify problems related to electrostatic charge in everyday situations and evaluate solutions (e.g., use of an electrostatic paint sprayer for uniform paint; use of static straps to reduce charge build-up in automobiles; use of electrostatic precipitators to decrease pollution; use of lightning rods to protect buildings.
- Describe household wiring and its typical components (e.g., parallel circuits with switches, fuses, circuit breakers, outlets)
- Develop a solution to a practical problem related to the use of electricity in home, school, or community (e.g., choose an appropriate fuse or circuit breaker for a specific circuit).
- Propose a plan for a self-contained system to generate energy, using renewable energy resources, to meet the energy requirements of a dwelling, farm, or community in Pakistan.
- Identify the safety measures to avoid and handle electric hazards.
- Describe careers that involve electrical technologies, and use print and electronic media to identify the knowledge and skill requirements of such careers.

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INTRODUCTION

In the previous classes you have already learnt that charge is produced when an ebonite rod is rubbed with a woolen cloth or glass rod with a silk. Similarly when a plastic comb is charged by moving it through dry hair, it remains charged until it is touched by something else. When objects are charged in such a way, we say that they have built up static charges. The buildup of static charges on objects is called static electricity. This phenomenon belongs to the branch of Physics called electrostatics. However if a conducting path is provided to the static charges they will flow and remain no more static charges. The study of flowing charges is called current electricity. In this chapter you will learn about the nature and applications of Static and Current electricity in your daily life.

6.1 Static Charges

Everything in nature is made up of atoms which in turn composed of protons, electrons and neutrons. The protons are positively charged, the electrons are negatively charged and neutrons are neutral. It means that every physical object has charges. You have learnt in previous classes that like charges repel each other and unlike charges attract each other. All the physical objects will be in a neutral state if the amount of positive charge is equal to the amount of negative charge present in them. However, if in an object there is an imbalance between negative and positive charges, there will be either net negative or net positive charge on the object. An object becomes negatively charged if it gains electrons and positively charged if it loses the electrons. The charges produced on objects by rubbing them together or by pressing and pulling them apart, are called static charges. As these charges are confined to the rubbed areas of objects and unable to move to other areas of the same objects so that is why they are called static charges.

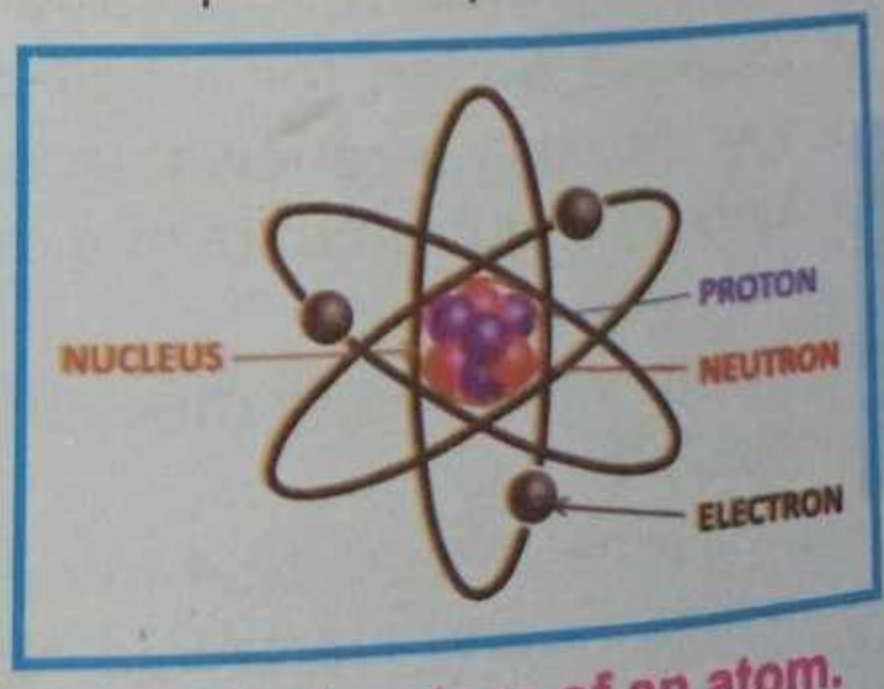


Fig:6.1 structure of an atom.

Static charges can also be produced on a conducting object by putting it in the vicinity of a charged object. The phenomenon of building up static charges on objects is called static electricity. The phenomenon of producing static charges on objects is called static electricity.

a. Building up Static Charges in Terms of Electrons Transfer

When certain materials (especially insulating) are rubbed together or when they are pressed and pulled apart, the electrons are transferred from one object to other. For example, when you rub your shoes vigorously on a wool rug, electrons are transferred from wool rug to your body, giving your body a net negative charge and the rug a net positive charge. The negative charge on your body can be sensed and removed by lightly touching a friend who can startle by feeling a light shock. Similarly, when you pull apart the cap from your hair, electrons are transferred from the cap to the hair. As all the hairs acquire the same charge so they repel each other and tend to get away from each other as much as possible. This is the reason you experience the "hair raising" phenomenon.

DO YOU KNOW?

When you rub a inflated balloon against your clothes; electrons are transferred from your clothes to the surface of the balloon. When this balloon is released it sticks to the wall or the ceiling of a room.



Charged balloon stuck with the wall.

b. Production of Static Charges in Terms of Electrostatic

Electrostatic induction is the mechanism of charging a conductor without any physical contact with a charged body. When a charged body is brought near an uncharged conducting body, the side of uncharged body close to charged body, becomes oppositely charged while its other side gains similarly charge as that of the charged body.

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Let a negatively charged ebonite rod be brought near a small metallic rod mounted on an insulated stand as shown in figures 6.2. Experiences show that near the ebonite rod positive charge accumulates at the end A while negative charge accumulates at end B of the metallic rod (that is electrons in the part of the metallic rod near to the ebonite rod shift to the opposite side of the metallic rod).

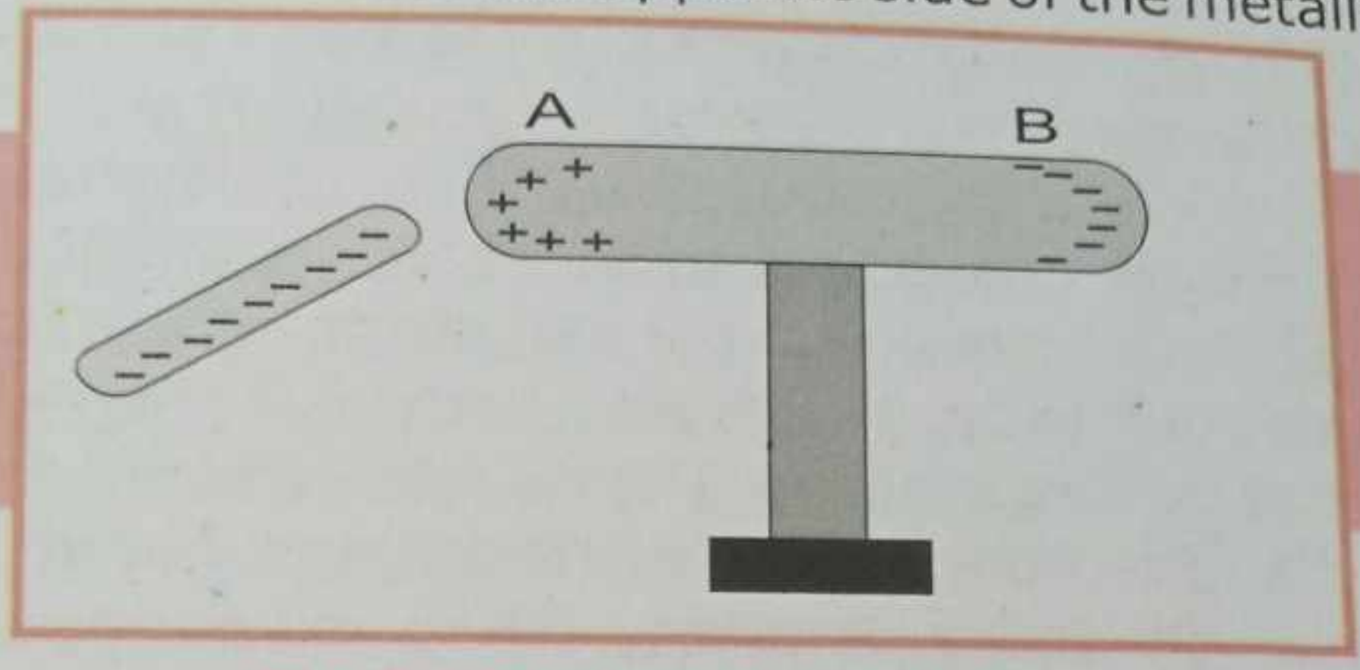


Fig. 6.2 Electrostatic induction.

This phenomenon of redistribution of charges on the surface or inside a neutral conducting body due to the presence of a charged body in its proximity is called electrostatic induction. In the neutral body the redistribution of charge persists till the charged body is kept in its proximity. When the charged body is moved away from the neutral body, it attains its original charge distribution.

TIDBIT

A spark of static electricity can measure thousands of volts, but has very little current and lasts for a short period of time. This means it has little power or energy.

6.2 CHARACTERISTICS AND EFFECTS OF STATIC CHARGES

You will learn more about static charges by studying the followin characteristics and effects of static charges.

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Characteristics of Static Charges

Some of the basic characteristics of static charges are given below:

i. Conservation of charges

Ordinarily objects are electrically neutral and contain equal number of negative charge particles (electrons) and positive charge particles (protons). When one body rubbed against another, charge is not created in the process. The electrified state is due to transfer of charge (electrons) from one body to the other. Therefore, one body gains some amount of negative charge while the other gains an equal amount of positive charge. In other words electric charge is always conserved. For example, when a glass rod is rubbed with silk, the silk obtains a negative charge that is equal in magnitude to the positive charge on the glass rod.

ii. Attraction

One of the characteristics of static charges is that they make certain materials to attract each other. For example, when you rub a glass rod with silk cloth or an ebonite rod with a woolen cloth, static charge is developed and these rods are able to attract small particles. Similarly another every day example of attraction due to static charges is that of a plastic comb which when moved in dry hair, gathers static charges and starts attracting small pieces of paper.



Fig:63 Using static charge to pick up pieces of paper with a comb.

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iii. Repulsion

Static charges also produce the ability of repulsion in objects. For example, when you comb your hair on a dry day or after using hair drier, negative charges builds up on the comb while positive charge on the hair. You know that like charges repel each other. As all the hair acquire the same charge so they repel each other. As a result the phenomenon of "flyaway of hair" occurs.

iv. The force of attraction or repulsion between charged bodies is inversely proportional to the square of distance between them.



Fig. 6.4 Repulsion of charges

Effects of Static Charges

Some of the effects of static charges are given below.

i. Electrostatic Sparks

The production of electrostatic spark is a common effect of static charges. A spark is produced due to heating up of air present between two highly charged bodies. If there are more positive charges on one object and equally negative charges on the surface of another object, then the attraction between the charges may be great enough. This condition can lead the electrons to jump the gap between these highly charged objects.

Once a few electrons start to move across the gap, they heat up the air and more electrons will jump across the gap quickly.

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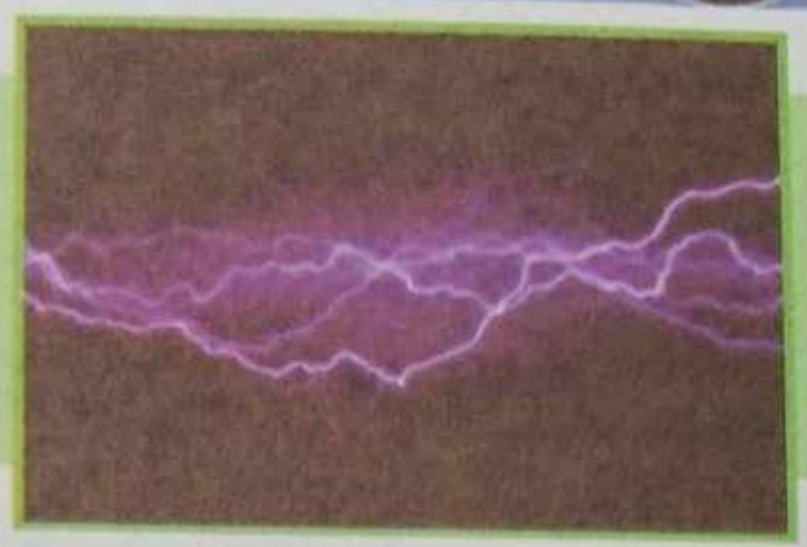


Fig. 6.5 Electrostatic Sparks

This heats up the air even more. The air gets so hot that for a very short period of time it glows and produces a spark which is known as an electrostatic spark. The same phenomenon is seen during thunderstorms when electrostatic sparks are produced on a much larger scale resulting in lightning.

ii. Polarization charges

In most neutral atoms or molecules, the center of positive charge coincides with the center of negative charge. However, in the presence of a charged object, these centers may shift slightly, resulting in positive charge on one side of the molecule and negative charge on the other side. This effect is known as polarization. Polarization of charges within individual molecules produces an induced charge on the surface of the insulator as shown in the figure 6.2. This effect explains why a comb that has been moved through hair, attracts bits of neutral paper.

6.3 Practical Applications of Static Electricity

Static electricity has many applications, e.g. photocopiers, inkjet printers, laser printers, high voltage generators, electrostatic painting, electrostatic precipitators etc. However, electrostatic painting and electrostatic precipitators are discussed here in detail.

i. Electrostatic or Electro painting

The principle of electrostatic is applied to paint uniformly the surfaces of metallic bodies such as refrigerator, metallic furniture, metallic boxes, automobiles etc.

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The surface of metallic body is earthed. The paint particles when emerge out of the nozzle of the spray machine, they acquire positive charge due to fraction. When these positively charged particles reach near the metallic body, induce negative charge on it. Thus due force of attraction between opposite charges a uniform coat of paint is formed on the surface of metallic body.



Fig: 6.6 Electro Painting.

FOR YOUR INFORMATION

The van de Graff generator is a very useful static charge generator. It can produce a potential difference or voltage up to 14 million volts. It is used in nuclear research to accelerate sub-atomic particles.



ii. Electrostatic Precipitators for Pollution Control

A device which is used for removing unwanted solid or liquid particles from gases by the application of principle of electrostatics, is called electrostatic precipitator. Large electrostatic precipitators are used in coal-burning power plants and in industrial plants that generate large quantities of smoke. They eliminate ash and dust particles from the smoke thereby reducing air pollution. Small electrostatic precipitators are used in homes in conjunction with heating and cooling systems for elimination of unwanted particles from the atmosphere. In this process static charge (usually positive) is produced on smoke dust and other unwanted particles passing through electrostatic precipitator. These charged particles are attracted by a plate having opposite charge thereby collected and are finally removed away.

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DO YOU KNOW?

a. Smokestacks



Principle of static electricity is applied in the extraction of smoke and dust particles from the gases coming out of the smoke-stacks of factories. When the smoky and dusty gases pass through smoke-stack, positive charge is induced on smoke and dust particles due to positively charged wire gauze fitted in the smoke-stack. Then negatively charged plates of the smoke-stack attract and deposit these positively charged particles, from where they are removed away. In this way, the outgoing gases from factories are cleaned from smoke and dust particles with the help of smoke-stack.

b. Air fresheners

Air freshener, also known as air ionizer, is a device, used to freshens and purify air in the homes. It works on the principle of static electricity. Usually, it strip off electrons from smoke, dust and pollen particles present in the air. Due to which these particles gain positive charge. These positively charged particles are attracted and deposited by negatively charged plate of the air freshener. In this way, air freshener freshens and purify the air.



6.4 Current Electricity

Electricity which is produced due to flow of charges (electrons or ions) through conducting material is called current electricity or electric current. Current electricity is of two types i.e. direct current and alternating current.

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The electric current which flows in one direction only, is called direct current (DC). While the electric current that regularly changes its direction, is called alternating current (AC). Alternating current supplied to our homes, changes its direction 100 times in one second.

a. Application of Current Electricity in Household Appliances

Most of practical applications of electricity deal with the current electricity. A variety of home appliances operate on it. We utilize electric current for different purposes e.g., lighting, heating, cooling, washing etc. at home. In all these situations electric current is converted into other forms of energies according to the need.

When an electric current passes through the filament of a bulb, it heats up as much as that it emits light. Here electric current is converted into heat and light energies. Electric room heater, electric iron, immersion rod, electric kettle etc. are such appliances which contain a high resistance metallic heating coils. When these appliances are switched on, the electric current is converted into heat energy in these coils. Similarly in clothes drier machine, hair drier, toaster, oven etc. electric current is converted into heat and mechanical energy.

In summer season we use electric fan, air cooler and air conditioner for cooling purpose. When electric current flows, their blades start rotating hence electric current is converted into mechanical energy. Similarly, in washing machine and electric motor, electric current is converted into mechanical energy. Other household appliances like refrigerator, television, computer etc. need electric current for their operation. In other words, current electricity has become necessity of our life.

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6.5 Problems Related to Electrostatic Charge and their Solutions

There are many problems related to electrostatic charge; here we discuss only two of them and their solutions.

i. Lightning and use of Lightning Rods

Lightning is a natural phenomenon which happens when electrons travel between two objects having different and large amount of static charges. Lightning can occur between or within clouds or between clouds and the earth. Electrons heat the air present between the charges so much that causes lightning. The heat also makes the air move away from the charge very fast. The air expands. When this occurs, a very loud sound, called the thunder, is produced. Lightning can be dangerous. It can strike trees, buildings, people and animals.

Lightning rods are used to protect the buildings from the hazard of lightning. Lightning rod is a metal rod attached to the roof of a house or a building. Its lower end is connected to a copper or aluminum wire which goes down to the earth and is grounded.

As lightning always follows the shortest way to the ground. So if it strikes a lightning rod on a building, it goes down along the wire to the earth. Thus in this way lightning rod protects the building from the hazard of lightning.

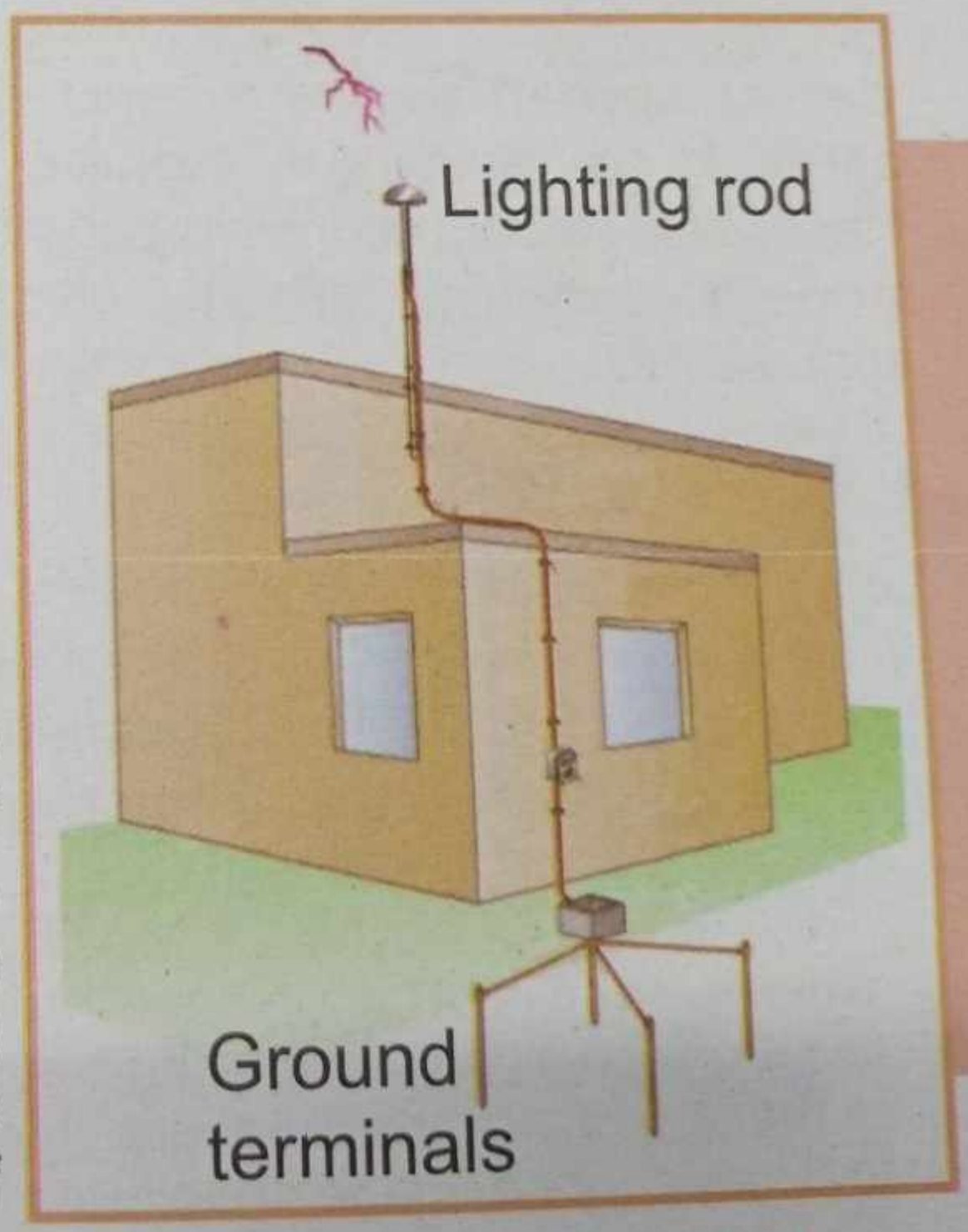


Fig: 6.7 Lightning Rod

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ii. Building up Electrostatic Charge on Vehicles & Use Static Straps



Fig: 6.8 Static straps in automobiles

In large vehicles which transport inflammable chemicals, fire and explosion may occur in them due to building up of very large static charges on their bodies. These charges are built up due to friction. To avoid these hazards, hanging metallic straps, called static straps are connected to the rear sides of vehicles. These straps touch the ground thereby providing a conducting path for the flow of static charges towards the ground. In this way Static straps prevent the accumulation of static charges on the bodies of the vehicles. These also help in reducing radio interference and electric shocks.

6.5 Household Wiring

Basically household wiring is an electric circuit in which different electric appliances are connected in parallel to a single source of electricity. Household wiring ensures smooth running of all electric appliances.

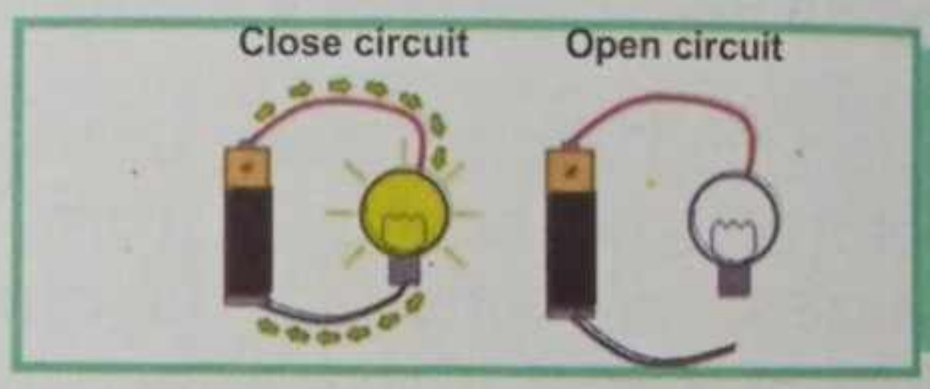


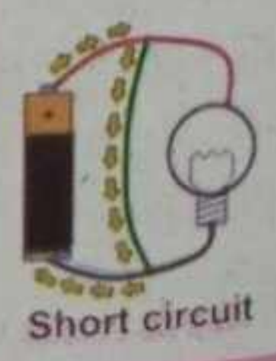
Fig: 6.9 Different types of circuits.

a. Electric Circuit

The path for the flow of electric current is called electric circuit. When switch is off or power supply is disconnected and no current flows in the circuit, then it is called open circuit. While if switch is on and current flows in the circuit then it is called closed circuit.

FOR YOUR INFORMATION

When live and neutral wires are interconnected accidently or otherwise, it provides a short and low resistance path to the flow of current. This condition is called short circuit and may cause damage to electric meter.



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b. Components of Household Wiring

Following are the typical components of household wiring:

I. Resistors

The opposition offered by a conductor to the flow of electric current is called its resistance while the conductor is called a resistor. The electrical appliances which are connected in a circuit, act as resistors. The basic function of a resistor is to control the magnitude of current flowing in a circuit. Resistors in a circuit can be connected in a series or in parallel.

a. Resistors in Series

In a series circuit, there is only one path for the flow of current and same amount of current flows through all the resistors. The total voltage across the circuit is equal to the sum of voltages across all the resistors. The total resistance is equal to the sum of resistances of all the resistors. An example of series circuit is a string of decoration lights. If any one of the bulb is missing or burnt out, no current will flow and none of lights will work.

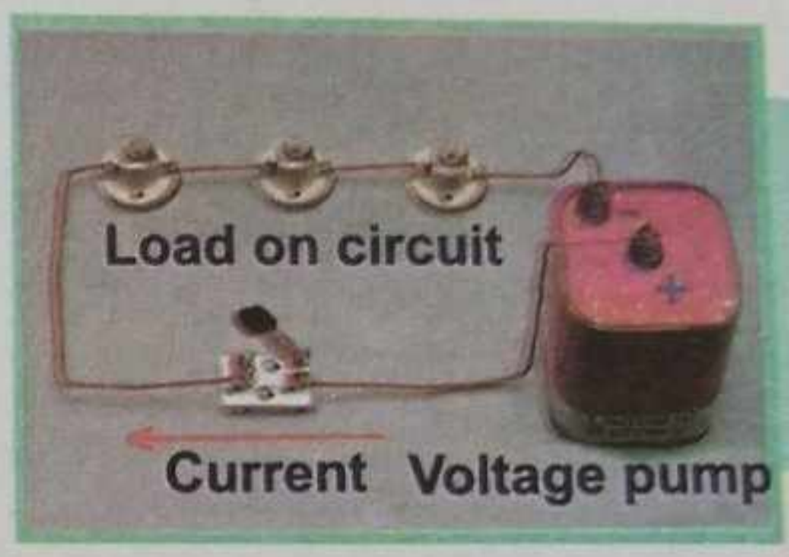


Fig: 6.10 Series circuit

b. Resistors in Parallel

In a parallel circuit, there is two or more paths for the flow of current and different amounts of current flows through each resistor. The voltage of the circuit is equal to the voltage across each resistor.



Fig: 6.11 Parallel circuit.

An example of parallel circuit is wiring system of a house. If one of the appliances stops working, current still flows through other appliances. However, in case of short circuit, the voltage drops almost to zero and the circuit stops working.

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II. Switch

Switch is commonly used to close or open the circuit and to turn on or off an electric appliance. Switch is fitted in the live wire. According to construction there are many types of switches e.g. single pole, main switch, push button etc.

i. Fuse



Fig: 6.12 Electrical fuse.

Fuse is a thin and small piece of metallic wire of low melting point. It is connected in the live wire, often as a cartridge. If a fault develops and current exceeds the limits, then fuse overheats and melts thereby breaks the circuit before the circuit catches fire. Fuse is connected in series along the main supply line so that entire current passes through the fuse.

ii. Circuit Breaker



Fig: 6.13 Circuit breaker.

A circuit breaker is modified form of fuse. It is in the form of a switch that automatically turns off circuit when the current exceeds the specified value. It can be reset by turning the switch on or by pressing a button.

iii. Outlets



Fig: 6.14 Outlets.

An outlet or socket is an electrical device that connects other electrical appliances to electric supply. It is a point along the circuit where an electrical device or portable appliances can be connected to the circuit. Modern outlets consists of three pins and a fuse. The fuse protects the appliance from any electrical fault.

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6.6 Electric Safety Measures

To avoid the hazards of electricity in homes and in your surroundings, the following safety measures should be adopted.

- Don't touch switches unnecessarily.
- Never use electrical equipment in or close to water.
- Never play near broken plugs or in areas with many electrical wires and appliances.
- Never pull out a plug by pulling its cable.
- Never touch any torn or taped cables or switches. keep them away from heat and water.
- Avoid touching electrical appliances with any metallic object.
- Never go near a declined power line.
- Avoid climbing electric poles, transmission towers or fences around power stations.
- Avoid climbing trees or poles that are near power lines.
- Always contact an electrician or relevant expert in case of any fault in circuit or in an electrical appliance.

6.7 Careers in Electrical Technology

Following are some of the careers one can choose in electrical technology.

Electrician

An electrician is responsible for the overall installation, maintenance and repair of electrical connections in a home, industry or any other building. An electrician connects wires to circuits and their components.

Line Worker

A line worker installs and maintains lines and cables that carry electricity from the distribution point to the homes, industries and other setups. Apart from this they also work in power grid stations.

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Electrical Installers

These persons are expert in installing various electrical appliances used in domestic as well as industrial setups. They also install and maintain main switch boards and power grids.

Power Plant Operators

Power plant operators work in electricity producing companies where they are responsible for operating and maintenance of power plants.

6.8 ENERGY GENERATION FROM RENEWABLE ENERGY RESOURCES

Energy is the basic need of our life. We utilize energy for different purposes e.g. for operating industries, running automobiles, stoves, heating, lighting, cooling etc. For these purposes one form of energy is converted into other form according to the need. In this regard, different sources are utilized e.g. coal, petroleum products, natural gas, electricity etc. Today a large amount of energy in the world, is obtained from coal , petroleum products and natural gas. However, these resources are gradually decreasing and ultimately will be depleted because these are not renewable. Moreover, these resources are not environment friendly, cause global warming and ozone layer depletion. This is the reason that today man is struggling to utilize maximum renewable energy resources like sunlight, flowing water, wind etc. These resources do not deplete on consumption. Such energy resources which do not deplete on consumption are called renewable energy resources.

There are a number of renewable energy resources such as sunlight, wind, flowing water, rain, tides, waves, biomass, geothermal heat etc. However, a few of them are described below.

1. Sunlight

The major renewable energy resource is sunlight. Large amount of energy in the form of light and heat receiving from sunlight is called

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solar energy. This energy is vital for human beings, animals and plants on the earth. In past, large spherical mirrors and lenses were used to concentrate sunlight and convert into heat energy. However, today solar cells are used to convert solar energy into heat and electrical energy.

Solar cell is a device that directly converts solar energy into electric energy. A single solar cell produces a small voltage. A number of solar cells are connected in series to generate large amount of voltage. This connection of solar cells is called a solar panel. Solar panels are installed according to need of electric energy.

Today, due to load shedding the use of solar panels has been started in offices and homes for lighting and other needs. Similarly solar panels are used in artificial satellites to meet their electrical need. Solar energy is utilized in different fields of agriculture. Moreover, today where conventional electric facility is not available, tube wells are operated by solar panels to irrigate agricultural lands.

2. Flowing Water

Flowing water is a very useful renewable energy resource of hydro energy. In ancient times, man used water mills to convert hydro energy into mechanical energy for milling grains and crushing sugar cane. Today, in most of the countries of the world hydro energy is utilized for generation of electricity. For this purpose water is stored in dams, from where it is passed through tunnels where it turns huge turbines whose rotating shafts connected to generators that generate electricity. It is then supplied to homes, offices, industries and other areas through cables.

3. Wind

Man has been using wind as a source of energy for centuries. In past people were utilizing wind energy for navigation of sail boats and sail ships. Similarly they used wind mills for milling grains and drawing water from wells.

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Winds blow from regions of high pressure towards regions of low pressure. Sea winds are stronger than land winds. In windy regions, wind mills convert wind energy into mechanical energy for operating tube wells and flour mills. In Pakistan, wind energy can be utilized in coastal areas and high mountainous areas like Chitral, Gilgit and swat. Now a days, wind energy is used for operating turbines which generate electricity.

4. Biomass

Biomass is a renewable energy source. It consists of organic materials like animal manure, sawdust of timber mills, plants and trees residues, crop residue and used tires. Energy from biomass can be obtained by using all these materials as a fuel either by direct burning or fermentation. In direct burning the solid waste are fed into a furnace producing heat which is used to boil the water and run the turbines and generators for generating electric energy. While in fermentation, biomass is enclosed in a tank and decomposes it by bacterial action. As a result methane gas is produced which is then utilized for different energy purposes.

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KEY POINTS

- Static charges are build up due to transfer of electrons in the process of rubbing two objects or due to electrostatic induction
- All things are composed of charges (protons and electrons). Electric charge on them is built up due to imbalance between positive (protons) and negative (electrons) charges.
- Opposite charges attract each other while like charges repel each other.
- Principle of static electricity is used in pollution control by applying a static charge to dirt particles in the air and then collecting those charged particles on a plate having opposite electrical charge.
- Electricity is a type of energy that can build up in one place or due to flow of charges from one place to other. In first case it is called static electricity while in second case it is called current electricity.
- An electric circuit is a path of flow of current. A closed circuit has a complete path for current flow while an open circuit does not have a complete path for current flow.
- The opposition offered by a conductor to the flow of current is called its resistance while the conductor is called a resistor.
- Lightning rods are used to protect the buildings from lightning.
- Static straps are used to the rear sides of vehicles to prevent building up static charge on their bodies due to friction.
- Renewable energy resources do not deplete on consumption.

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EXERCISE

A. Select the correct answers for the following questions.

1. **Opposite charges _____ each other.**
   a. Attract b. Repel c. Cancel d. None of them
2. **An object that is negatively charged has:**
   a. gained protons b. lost protons
   c. gained electrons d. lost electrons
3. **The term "electricity" in referring to static electricity, Means:**
   a. An imbalance of protons b. An equal number of atoms
   c. An imbalance of electrons d. An imbalance of neutrons
4. **Which one rod will become positively charged when rubbed with silk:**
   a. Glass rod b. Carbon rod c. Silver rod d. Ebonite rod
5. **If an ebonite rod and a glass rod are brought together after being rubbed with fur, which of the following will happen?**
   a. They will remain stationery b. They will attract each other
   c. They will repel each other d. None of them
6. **You are walking on a carpet and gain a positive charge. When you touch a neutral doorknob:**
   a. The electrons flow from the doorknob to your hand and you feel a shock.
   b. The electrons flow from your hand to the doorknob and you feel a shock
   c. The electrons do not flow and you feel no shock.
   d. The electrons do not flow but you still feel a shock.
7. **Why does lightning hit buildings and homes?**
   a. They are the closest point to thunder clouds.
   b. They are good insulators.
   c. Lightning clouds tend to form over buildings.
   d. None of these.
8. **Electrostatic precipitator is used.**
   a. In pollution control b. In electro painting
   c. In automobiles d. To protect from lightening

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9. **Which one phenomenon is not related to static electricity?**
   a. Both unlike and like charges attract
   b. Like charges repel
   c. Opposite charges attract
   d. Neutral objects are attracted to charged objects
10. **The path on which current flow is called _____.**
   a. Resistance b. Resistor c. Circuit d. none of these.

B. Write short answers of the following questions.

1. Why a metallic chain is hanging from the rear side of a petrol supply tanker.
2. Define electrostatic induction.
3. Describe fuse and its importance.
4. What is meant by circuit, closed circuit and open circuit?
5. What is a circuit breaker? Describe its importance.
6. What is meant by current electricity? Describe its types.
7. Why do your hair stand on ends when you pull apart your cap?
8. How does a lightning rod protect a building from a lightning strike?
9. Define static charges. Why are they called static?
10. What is meant by polarization of charge?

C. Write detail answers of the following questions.

1. What are the basic characteristics of static charges?
2. Describe the effects of static charges.
3. What is meant by resistance? How resistors are connected in a circuit?
4. Describe the practical applications of static electricity.
5. Write about practical uses of current electricity in household appliances?
6. What safety measures should be adopted to avoid hazards of electricity?
7. Write a note on energy generation from renewable resources.

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Unit 7

Chemical Reactions and their Practical Applications

After studying this chapter the students will be able to:

- Recognize those characteristics which indicate that a chemical reaction has taken place.
- Use scientific nomenclature to identify common consumer products (e.g., identify ingredients in food products or cosmetics from the labels).
- Investigate application of acid-base reactions in common products and processes (e.g., prepare soap from oil and sodium hydroxide and compare its lather formation with that of commercial soaps).
- Relate chemical reactions to familiar processes encountered in everyday life (e.g., reactions in film processing, food processing, fabric and hair dyeing, agriculture, pulp-and-paper and mineral processing) and identify careers that require knowledge of such processes.
- Research the methods, impact and safety consequences of chemical disposal in Pakistan, and recommend appropriate disposal methods (e.g., dumping car batteries, tyres, plastics, paints, or metals in landfill sites).

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INTRODUCTION

The ever increasing importance of chemistry has grown tremendously due to its application in all aspects of daily life. Our own existence is a result of various chemical processes. If any vital process ceases to function, even our survival becomes difficult. From diagnosis to the treatment of diseases, chemicals and chemical processes are of vital importance. Metallurgy is a process of extraction of metals from ores. It is a chemical process which has revolutionized the whole economy of the world. The big complicated machines which are the backbone of modern civilization, are the direct result of the present growth of iron and steel industry. Materials like cement, paints, varnishes, glass, fertilizers, synthetic fibers, plastics, soaps, dyes, preservatives and countless other useful and productive materials are because of different types of chemical reactions. In this chapter you will study various chemical reactions which we encounter in our daily life and their practical applications. you will also study methods for the disposal of waste chemicals.

7.1 CHEMICAL REACTIONS IN EVERY DAY LIFE AND THEIR PRACTICAL APPLICATIONS

When a chemical change occurs, a chemical reaction is said to have taken place. In chemical reactions atoms combine with each other forming new substances. The substances which take part in chemical reactions are called reactants. The new substances formed as a result of a chemical reaction are called products. Generally, the chemical properties of the reactants and products are different from each other.



Fig: 7.1 Car is being rusted.

An example of a chemical reaction is rusting of iron. Rusting occurs because the iron (Fe) reacts with oxygen (O_2) in the atmosphere. Chemical bonds are formed and broken to finally make iron oxide (Fe_2O_3) which is rust.

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In physical change only the physical state of matter is changed, for example, melting of ice. These changes are temporary and can be easily reversed. The substances retain the properties during a physical change. Thus, no new thing is formed in this type of change. On the other hand, a chemical change is permanent and it cannot be reversed easily. In a chemical change new things are formed which have chemical properties different from the original substances, for example, pure hydrogen gas (H_2) and pure oxygen gas react violently in the presence of spark to form water. This chemical reaction is exothermic and it will release energy.

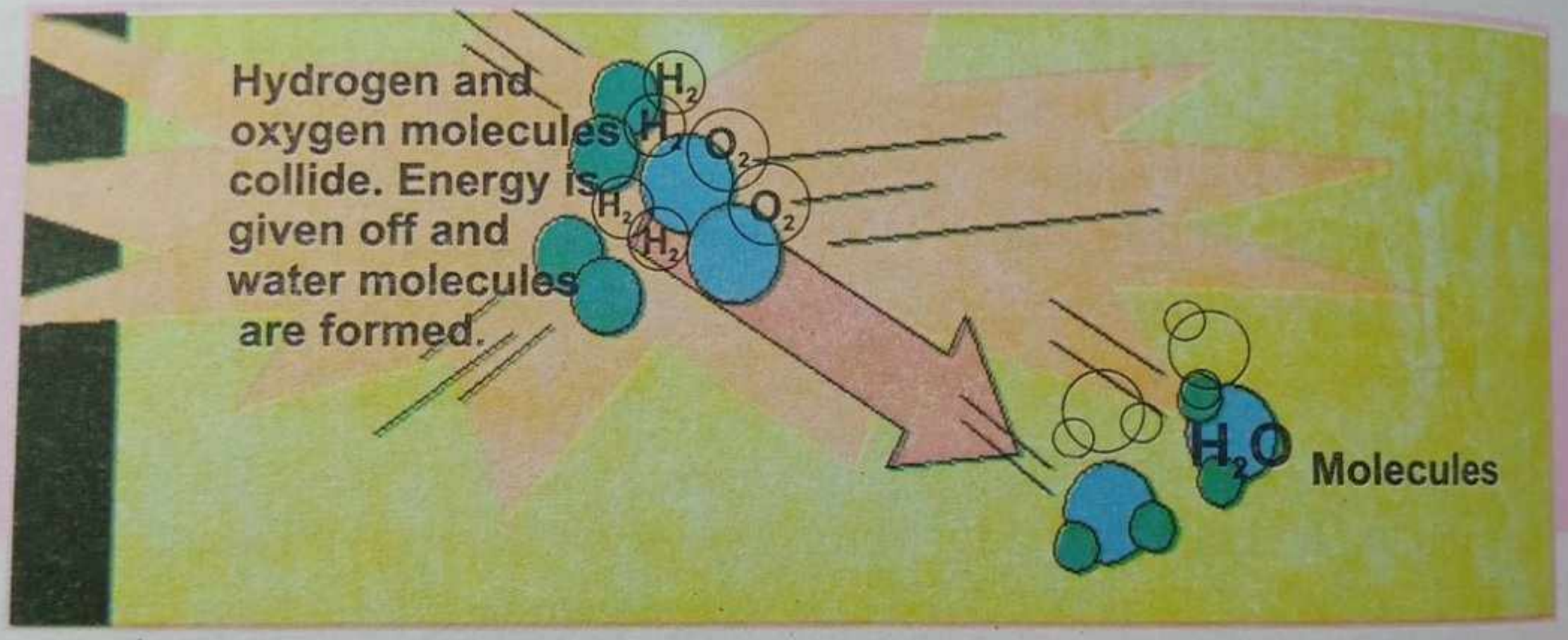


Fig: 7.2 Formation of water.

A. INDICATIONS OF A CHEMICAL REACTION

When a chemical reaction takes place, different types of changes occur. One or more of the following observations may indicate that a chemical reaction has taken place.

- A change in colour is seen.
- A solid (precipitate) forms on mixing liquids.
- A gas evolves on mixing two substances
- A change of temperature may occur.

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B. Some Chemical Reactions in Everyday Life

Different things that are being used by us in our day to day activities are products of chemical reactions. For example; toothpaste, soap, shampoo, washing powder etc. are all results of chemical reactions. Following are some of the significant examples of chemical reactions, which we encounter in everyday life.

i. Photosynthesis

You are familiar with the term photosynthesis. It is the process by which green plants manufacture their own food. Water and carbon dioxide act as raw materials in the process. The chlorophyll pigment, present in the leaves, traps energy from sunlight. Chemical reactions take place whereby raw materials are converted into glucose and oxygen gas.

The overall equation of the process of photosynthesis is given below.

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

Carbon dioxide + Water ⟹ Glucose + Oxygen



Fig: 7.3 Photosynthesis.

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ii. Rusting of Iron

You might have seen a layer of rust over unpainted iron surfaces. This layer gradually leads to disintegration of iron. In rusting process iron combines with oxygen in the presence of atmospheric moisture resulting in formation of iron oxide (Fe_2O_3) which is rust. The chemical reaction of the process can be simply represented as:

$$4Fe + 3O_2 + XH_2O \Longrightarrow 2Fe_2O_3.XH_2O$$

Iron + Oxygen + Moisture $\Longrightarrow$ (Rust)

iii. Burning of Coal/Natural Gas

Coal and natural gas are fossil fuels and are important means of energy. Coal mainly contains carbon and natural gas contains methane. The chemical reaction of burning of carbon in coal and methane in natural gas involves combustion process where carbon and methane react with oxygen to release energy used for domestic and industrial consumption. These chemical reactions are shown below.

$$CH_4 + 2O_2 \Longrightarrow CO_2 + 2H_2O + Energy$$

Methane + Oxygen $\Longrightarrow$ Carbon dioxide+ Water+Energy

$$C + O_2 \Longrightarrow CO_2 + Energy$$

Carbon (Coal) + Oxygen $\Longrightarrow$ Carbon dioxide+Energy



Fig: 7.4 Burning of coal.

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7.1.1 SCIENTIFIC NOMENCLATURE AND COMMON CONSUMER PRODUCTS

Different chemical compounds have scientific names based upon their chemical structure. Chemical nomenclature or scientific nomenclature is the term given to the naming of chemical compounds. Often, these names are complicated, long and understandable only to those who have background knowledge of chemistry. Commonly used chemical compounds may have several names. For example, Baking soda is white substance usually available in powder form. It is one of the important edible items used in every kitchen. Chemical name of this compound is sodium bicarbonate ($NaHCO_3$). Generally chemists use common chemical names more when it comes to mentioning certain ingredients in everyday consumer products.

Table: 7.1 Names of edible chemical compounds.

Common Name	Chemical Name
Vitamin B9	Folic acid
Vinegar	Acetic acid
Vitamin C	Ascorbic acid
Baking soda	Sodium bicarbonate
Vitamin D	Ergocalciferol
Aspirin	Acetylsalicylic acid
Margarine	Partially saturated fatty acid

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Table: 7.2 Names of chemical compounds and their use in cosmetics

Chemical name	Use in cosmetics
Lead	Used as a constituent in over 650 cosmetic products, including sunscreens, foundation, nail colors, lipsticks and whitening toothpaste.
Triclosan	Used in antibacterial soaps, deodorants and toothpastes.
Phthalates	Found in nail polish and in synthetic fragrance.
Ethylene Oxide	It is used in shampoos and body washes.
1,3-butadience	This chemical is used in Shaving creams, sprays sunscreens and foundations, and as anti-fungal.

A. How To Read a Label

You might have seen certain details written on canned and packaged food items. These are known as food labels. Food labels provide an important source of information about the food items present in the container especially, in terms of calories and the nutritional value of the foods you eat. Ingredient lists are a good way to know exactly what a packaged food contains.



Nutrition Facts	
1 Serving size: 250 ml	
2 Amount per serving	% Daily Value
3 Calories 140	
Fat 3.5 g	5%
4 Saturated 1g +Trans 0 g	5%
Cholesterol 10 mg	
5 Sodium 640 mg	
Potassium 400mg	11%
6 Carbohydrate 19 mg	6%
Dietary Fibre 3g	12%
Sugar 4g	
Protein 8g	
7 Vitamin A 20%	Vitamin C 2%
Calcium 5%	iron 10%

Fig: 7.5 Food label.

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similarly, in the cosmetic industry proper labeling is an important aspect for marketing a cosmetic or personal care product. Labeling is used to help inform consumers of the ingredients present in a particular cosmetic product. It also gives you information regarding its method of use and any other related warnings, expected allergies associated with its use. It also gives a list of ingredients and net quantity of contents, and its place of manufacture or distribution.

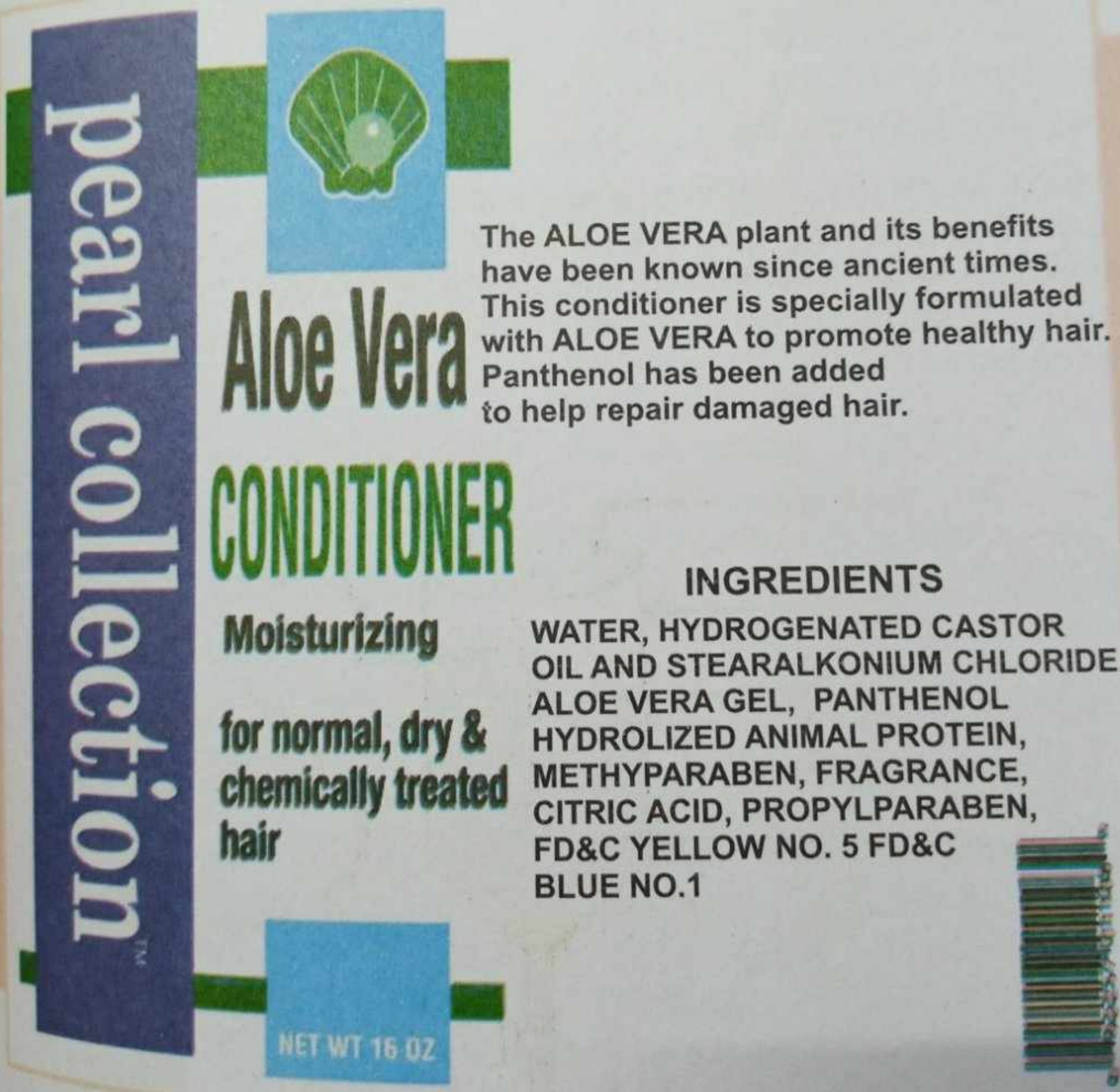


Fig: 7.6 A typical Cosmetic label.

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7.1.2 Application of Acid-Base Reactions in Common Products and Processes

Acid base reaction have a wide range of application in the preparation of useful daily life products. For example, soap preparation etc.

Preparation of Soap From Oil and Sodium Hydrooxide

Soaps are chemically sodium or potassium salts of long chain fatty acids, such as stearic, oleic or palmitic acid. These acids are present in vegetable oils or animals fats. When vegetable oils or animals fats are treated with sodium hydroxide, soaps are formed along with glycerin. This process is called saponification. Let's study this process in some detail.

The mixture of fat or vegetable oil and caustic soda (NaOH) is put in a steel tank fitted with steam coils. The tank has an outlet at the bottom. Steam is passed through the mixture. The heat of the steam first melts the fat. Sodium hydroxide then combines with fat or oil to form soap.

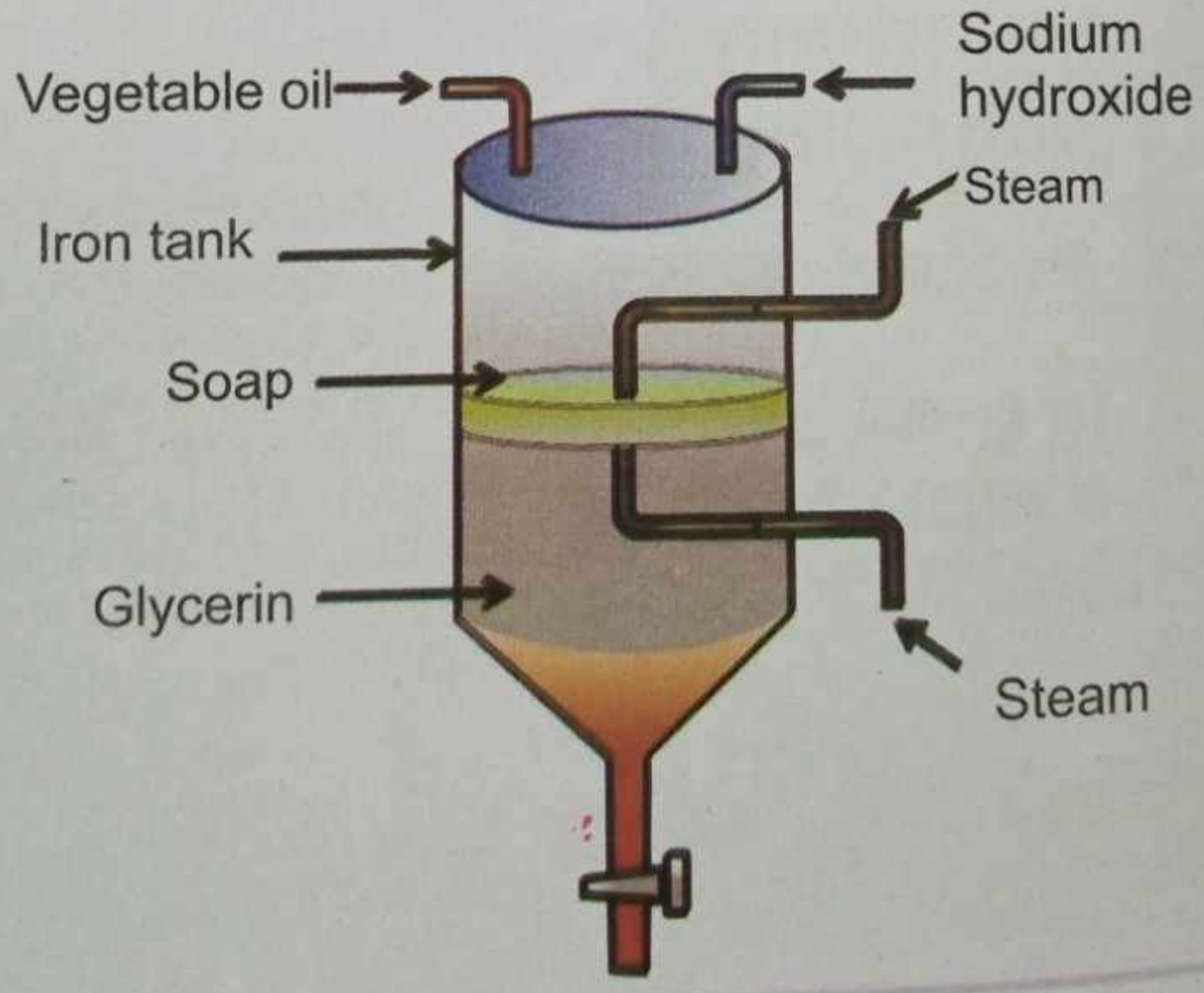


Fig: 7.7 Soap preparation tank.

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FOR YOUR INFORMATION

Protective equipment such as rubber gloves, safety clothing, face mask and eye protection should always be used when handling Sodium Hydroxide or its solutions. Proper ventilation should always be used when handling or reacting Sodium Hydroxide. Sodium Hydroxide should be stored in airtight containers because it readily absorbs the water in the air.



In order to separate glycerin from soap sodium chloride is added to the soap mixture. Glycerin dissolves in sodium chloride solution. Being heavier than the soap, the glycerin solution settles down at the bottom. The soap floats at the surface. The glycerin solution is removed by opening the tap at the bottom of the tank. Thus, soap is separated from the solution mixture. Soap produced for commercial purposes contain synthetic lathering agents, artificial colors, and a range of chemicals. The molecules that are found in soap play a large role in the lathering process. In fact, soap molecule is actually made up of two parts, those that are attracted to water and others that are attracted to oil. When soap molecules and water are combined with friction, lathering usually occurs.

7.2 CHEMICAL REACTIONS IN TECHNOLOGICAL PRODUCTS AND PROCESSES

Chemical industries have an important role to play in the development of a country. It is the use of various chemical reactions which have resulted in the production of some of the vital products used in our daily life. Pharmaceuticals, sugar, fertilizers, synthetic fibers, cement, glass, paints, steel etc are some of the examples in this regard. In the following section you will study some of the important technological products and processes.

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7.2.1 REACTIONS IN FILM PROCESSING

The photographic film on which image is to be produced is made up of silver halide salts, for example, silver bromide (AgBr). This compound is in the form of crystals. When light of a particular wavelength hits silver bromide crystals, chemical reaction starts and results in the formation of a free silver ion along with a free bromine atom.

$$A\check{g} + \bar{B}r \text{ (crystal)} + h\nu(\text{radiation}) \longrightarrow A\check{g} + Br + \bar{e}$$

The free silver ion can then combine with the electron to produce a silver atom.

$$A\check{g} + \bar{e} \longrightarrow Ag$$

In this process the free silver atoms produce a"latent image". This latent image is further refined in the development process.When an exposed film is placed in a developer solution, the grains containing silver ions are reduced much faster than those that do not. The more ions present in a given grain (i.e., the greater the exposure of that grain), the faster the reaction with developer and the darker the image at that site in the film.

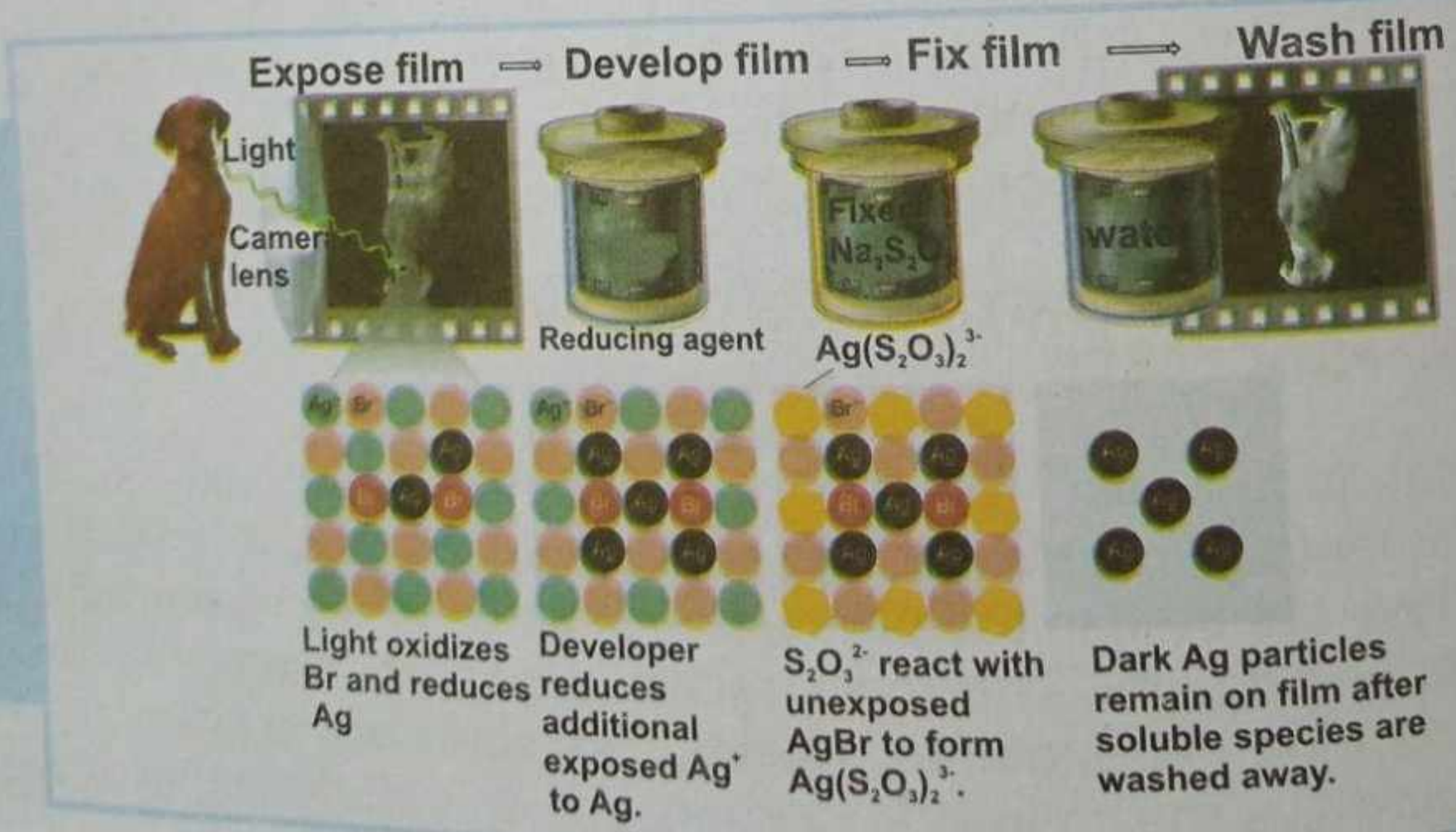


Fig: 7.8 Steps in film processing.

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Once the developed image is obtained, a large amount of unexposed and undeveloped silver halide remains in the emulsion. If that silver halide is not removed before the image is exposed to radiation capable of producing a latent image, the image will continue to darken. The process of removing the residual silver halide from the image is called "fixing."which is done by washing with Sodium thiosulfate before final print is obtained.

7.2.2 REACTIONS IN FOOD PROCESSING

Chemical reactions have an important role in the food processing industry. Processed food means a food transformed in a way suitable for better consumption and use. Sometime raw food items are not suitable for consumption. In food processing technique, food is fortified by the addition of vitamins and minerals. This improves its nutritional value. Sometimes addition of artificial flavors makes the food more tasty for consumption. A common example of food processing is the fermentation process which was first studied by Louis Pasteur. He demonstrated that during glucose metabolism yeast and certain bacteria can be employed in the formation of ethanol and carbon dioxide. Ethanol fermentation is used in the production of beer, wine and bread.



Fig: 7.9 Fermenters used in industries.

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This process can be represented by the following chemical equation:

$$C_6H_{12}O_6(\text{glucose}) \rightarrow 2C_2H_5OH(\text{ethanol}) + 2CO_2(\text{carbon dioxide})$$

The pyruvate molecules from glucose metabolism also may be fermented into lactic acid. Lactic acid fermentation is used to convert lactose into lactic acid in yogurt production.

$$C_6H_{12}O_6 \text{ (glucose)} \rightarrow 2\ CH_3CHOHCOOH \text{ (lactic acid)}$$

7.2.3 Fabric and Hair Dyeing

Different coloures and shades are employed in the process of dyeing fabrics to make them attractive and beautiful. Technically dyes are molecules which absorb and reflect light at specific wavelengths to give human eyes the sense of color.

One simple way of dyeing is to add dye in water and dissolve it completely. Now immerse the fabric within the dye solution for some period of time. Dye being a chemical sticks and forms chemical bonds with fabric. The chemical nature of the dye and the material to be dyed both have role in the dyeing process.

TIDBIT

The first synthetic dye used, mauveine, was discovered in 1856 by teenage William Henry Perkin. He created this dye out of coal tar.



Biologically hair provide insulation from the atmospheric conditions. It is also an important aspect of one's personality.

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Human hairs have natural colour and shades. From black to brown different types of colours are present. Although hair are mainly composed of a protein called keratin, the natural colour of hair depends on the ratio and quantities of two other proteins, phaeomelanin and eumelanin. Phaeomelanin controls the expression of golden blond, ginger, and red colors while eumelanin is responsible for brown to black hair shades. If one of these two proteins is lacking, hair colour turns white/grey. Hair dye provide every one with an option to gets hair dyed as per his or her desire.

7.2.4 AGRICULTURE

You have already studied the process of photosynthesis in the pervious section. Recall the chemical equation of the process. You will see plants convert six molecules of carbon dioxide and six molecules of water into one sugar molecule which provides the essential energy for different types of life activities and in the process releases six oxygen molecules into the atmosphere.

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

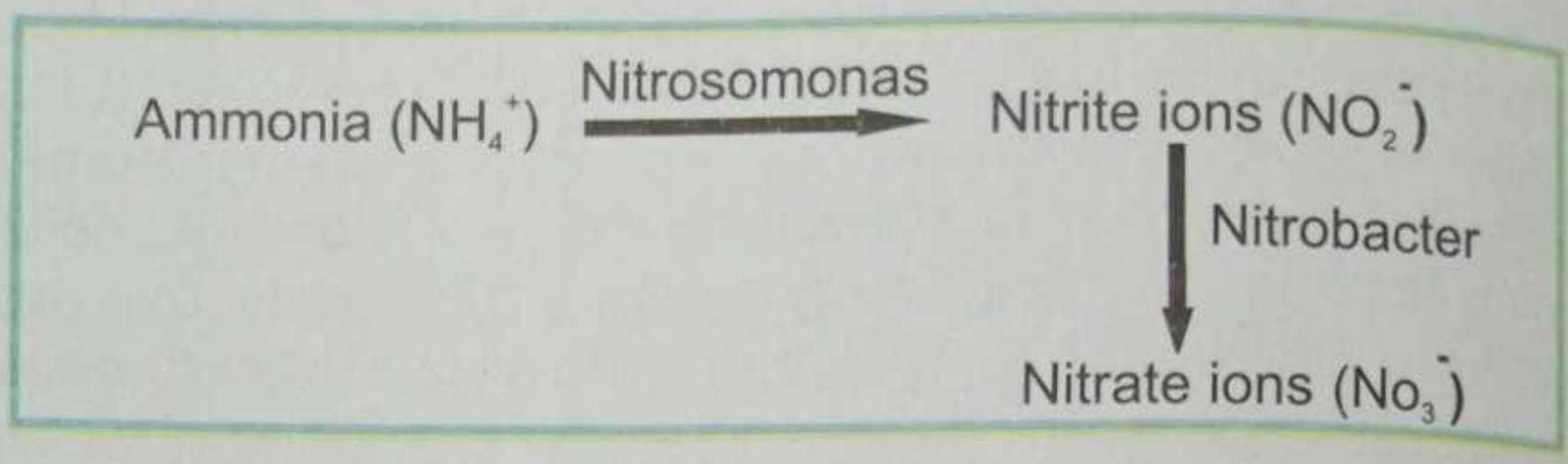
Plants need mineral nutrition for their growth and development. One of the essential element needed for this purpose is nitrogen. Plants are unable to consume free nitrogen present in the air. However, it is because of some vital chemical reactions which are helped by nitrogen-fixing bacteria that live in soil and in the roots of leguminous plants which ensure its availability to the plants in the form suitable for consumption.

These bacteria fix free nitrogen by using hydrogen ions found in the soil and form ammonia which is later converted to nitrite ions by

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the action of bacteria like *nitrosomonas*. Nitrite is then converted to nitrate ions by *nitrobacter*, another kind of bacterium. Plants can use nitrate for their growth and development.



FOR YOUR INFORMATION

The German scientist Fritz Haber synthesized the nitrogen-fixing reaction, which earned him Nobel Prize in chemistry in 1918. Haber process combines nitrogen and hydrogen gases at high temperatures and pressures to create ammonia used in chemical fertilizers.



7.2.5 PULP AND PAPER

Paper is one of the useful products obtained from trees. It has multidimensional usage. In the field of publishing it has a vital role in the production of books, note books, play cards, dairies and other related items. In the packaging industry card boards and brown paper are also obtained from the paper industry. Chemicals and chemical reactions play an important role in the production of paper from its raw material.

Bark of the tree is first removed from the tree trunks and it is cut into small pieces. Then these pieces are put in solution of NaOH and Na_2S to remove lignin.

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This material is heated in a pressure cooker where after sometime the pressure is suddenly released. This sudden release of pressure causes the wood pieces to fly apart into fibres. The material which is known as pulp is washed again treated with more NaOH in the presence of oxygen to remove any left over legnin. The fibres are bonded together and chemicals are added to make the paper water resistant and to give colour to the paper. From this material water is squeezed out and the pulp is rolled and dried. These rolls are further processed and paper is produced which is ready to be used for different purposes.



Fig: 7.10 Paper sheets.

7.2.6 MINERAL PROCESSING

Mineral is defined as any naturally occurring homogenous inorganic substance distributed in the earth crust. Chemical reactions are employed in the refinement and production of various useful products from minerals. For example gypsum or calcium sulphate dihydrate ($CaSO_4.2H_2O$) when ground into fine powder and this powder is heated at temperature between 150°C to 165°C, water content present in the gypsum is removed and hemi-hydrate plaster ($CaSO_4,1/2H_2O$), which is commonly known as the 'Plaster of Paris' is produced. This again changes into gypsum on adding water into it.

Sodium chloride commonly known as table salt occurs naturally as a mineral, also called rock salt. It can be processed into useful products with the help of chemical reactions. For example, chlorine and sodium hydroxide are manufactured by electrolysis of sodium chloride solution as shown in the following chemical reaction.

$$2\,NaCl\,(aq) + 2\,H_2O\,(l) \rightarrow 2\,NaOH\,(aq) + H_2(g) + Cl_2(g)$$

Sodium Chloride + Water ⟹ Sodium Hydroxide + Hydrogen +Chlorine

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FOR YOUR INFORMATION

Careers Related to Chemical Reactions in Technological Processes

Knowledge of chemical reactions and chemical processes open a door of opportunities for growth in career. Following are some of the careers related to chemical reactions in technological processes.

Film Developer

Film developers create photographic prints from raw film using chemicals, highly technical instruments and, in some cases, photographic processing machines.

Food processors

Food processors work to turn raw goods into finished products for grocers, wholesalers, restaurants, and institutional food services.

Textile dyeing technician

As a textile dyeing technician you would create dyes to colour fibres, yarns and fabrics.

Agriculture

A degree in agriculture provides you with the knowledge and skills to manage agricultural businesses. Jobs include:

Agricultural consultant, Farm manager, Fish farm manager Soil scientist etc.

Mineral Processing Operators

Mineral processing operators use equipment to process mineral ores until the final form or a concentrate is produced.

Sodium **metal** and chlorine gas results from the electrolysis of molten sodium chloride. This chemical reaction can be shown as:

$$2\ NaCl\ (l) \rightarrow 2Na\ (l) + Cl_2(g)$$

Sodium Chloride $\Longrightarrow$ Sodium + Chlorine

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7.3 Disposal of waste chemicals

Industrialization has brought tremendous economic development but globally people have to pay the price of this development in the form of environmental pollution. Consumption of chemicals and their products by the large industrial units and households have resulted in the generation of chemical wastes which pose great threats to the human health and environment. These wastes are known as hazardous wastes. Technically a chemical waste is regarded as hazardous waste if it is ignitable, corrosive, reactive and toxic. Hazardous waste is a serious threat if it is not properly managed or disposed. In Pakistan different types of industries produce large quantities of chemical waste which need proper management and disposal mechanism. Let's study various aspects of chemical disposal in Pakistan.

7.3.1 Methods of disposal of wastes in Pakistan

Like any other country in the world chemical industries in Pakistan generate large amounts of hazardous wastes. Unfortunately there is no proper mechanism and infra structure for the disposal of chemical wastes in Pakistan. The necessary infrastructure for the treatment, recycling and waste disposal facilities in the country are still in the developmental stage. In most cases hazardous wastes produced by the chemical industries are given to contractors who are least bothered about the safety precautions to be taken while dealing with such materials. So often these contractors release hazardous wastes in nearby water bodies, residential areas or cultivable lands from where these wastes manage their way to the food chain.



Fig: 7.11 A waste picker burns tires in order to retrieve wire to sell as scrap metal.

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In tanneries and textile industries different types of chemicals are used in various processes. These chemicals include bleaching agents, toxic and inflammable solvents, acids and alkalis. These chemicals are not treated properly and most often these are discharged in the nearby water bodies or in open land. As a result the people living in such localities are becoming victim of several dangerous diseases including cancer.

7.3.2 Impacts and Safety Consequences of Chemical Disposal

Industrial chemicals have a profound role to play in the production of various useful products like soaps, detergents, fertilizers, pesticides, paints, varnishes, plastic etc. However, the processing and production of these products have been associated with the release of harmful chemicals which have become a source for serious diseases. Improper disposal of these chemicals are also contributing to the creation of different environmental problems like different types of pollution, improper storage and management of chemical wastes and accidents during the transport and distribution of chemicals affecting a particular ecosystem etc. Agriculture has a key role in Pakistan's economy. Use of fertilizers, pesticides, insecticides and herbicides is common practice in our farmlands. Most of the time these practices are not properly used and managed. In this way these are contributing in producing health and environmental concerns.

Development demands that proper planning must be done for safe disposal of these harmful wastes. In the following section you will study about the disposal mechanism of some of these wastes.



Fig: 7.12 Pesticides are excessively used in agricultural activities.

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7.3.3 Effective Disposal Methods

Following are some of the effective disposal methods for hazardous wastes.

1. Reducing the use of hazardous materials

One of the option in minimizing the generation of hazardous waste is to minimize its consumption in different chemical industries. This in turn will generate less amount of hazardous waste.

2. Reuse and recycle

One of the effective strategies is to reuse and recycle the hazardous wastes if possible. Recycling is actually reusing materials in its original or changed forms rather than throwing them as wastes. This could ensure the safe disposal of the waste as well as it will be cost effective. For example acetone can be recovered from spent solvents, hydraulic fluids, used oils can be recovered from automobiles etc.

- Hazardous waste is produced from batteries used in automobiles. Lead-acid batteries also include batteries in motorcycles, emergency lighting etc. One of the safest ways of their disposal is to recycle them and reuse them. In Pakistan it is common to use recycled batteries in cars, and other automobiles.
- When rubber is reclaimed and recycled less energy is used than producing new rubber. Recovered rubber can cost half that of natural or synthetic rubber and the recovered rubber has some properties that are better than those of fresh rubber. At the same time recycling rubber would save the rubber tree plantations too. Tyres are one of the serious issue when rubber waste in landfill is concerned. At the international level rubber tyres are disposed by incineration, retreading, recycling or simply throwing in landfill. One of the better option for tyre recycling is the retreading where old tyres produce functional tyres.



Fig: 7.13 Retreading in process

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- Plastic is used in various daily use products. Plenty of plastic waste is generated on daily basis in almost every home. The good thing about plastic is that it can be recycled and reused again and again. On the recycling center different types of plastic are separated from the pile. It is then processed for recycling. Recycled plastic could be used in the manufacturing of various daily use items. In this way recycling and reuse of plastic makes it sure that the waste plastic is not thrown in open spaces or in drainage lines.
- There are many metals which are used in packaging materials. Of these aluminium, tin and steel are widely used. Once used these are part of waste and are useless. But proper collection and processing through the recycling units can make these metals to be used again without compromising quality and strength.

3. Disposal of wastes in land based disposal areas

One of the easiest way for the disposal of hazardous wastes is to throw them in a landfill, waste pile, injection well or other land based disposal areas. However, this disposal method must be supported by proper precautions and necessary regulations which can help protect the people living adjacent to it. And this method must ensure that the environment and natural resources of that locality are safe and protected.



Fig: 7.14 Waste being dumped in landfill.

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KEY POINTS

- A chemical change or chemical reaction is a process in which one or more substances are converted into one or more different substances.
- The starting substances used in the chemical reaction are collectively called reactants, while the final substances formed after the reaction are known as products.
- Indications of a chemical reaction include: a colour change, appearance of solid in solution, evolution of a gas and a change of temperature.
- Photosynthesis is the process by which green plants manufacture their own food.
- Iron combines with oxygen in presence of atmospheric moisture resulting in the formation of iron oxide (rust).
- Chemical nomenclature or scientific nomenclature is the term given to the naming of chemical compounds.
- Food label provides information about the food items present in a container.
- Proper labeling is an important aspect of marketing a cosmetic or personal care product.
- The reaction of acids and bases to form water and salts is called neutralization.
- Soaps containing sodium salts are formed by heating oil with aqueous sodium hydroxide solution in a reaction known as saponification.
- Chemicals are added to food for their preservation and processing, enhancing their appeal and adding nutritive value in them.

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- Dyes are molecules which absorb and reflect light at specific wavelengths to give human eyes the sense of colour.
- The nitrogen fixation process breaks apart free nitrogen and combines nitrogen atoms with other substances to form compounds plants can use.
- Minerals are not found just lying around waiting to be picked up, but rather are embedded in rocks and combined with other elements.
- Hazardous wastes can be potentially harmful to both the health of humans and animals as well as to the environment.
- In Pakistan the chemical industries regardless of their size generate huge quantities of hazardous waste. But proper chemical waste disposal facilities do not exist.

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EXERCISE

A. Select the correct answers of the following questions.

1. Which of these shows that a chemical reaction has taken place?

a. Change in state
b. Evolution of a gas
c. Change in color
d. All of these

2. What is rust?

a. Sodium Oxide
b. Iron oxide.
c. Copper Oxide
d. Silver Oxide.

3. In glucose metabolism the pyruvate molecules may be fermented into:

a. Ethanol
b. Carbonic acid
c. Lactic acid
d. none of the above

4. A chemical reaction involves:

a. Only breaking of bonds
b. Only formation of bonds
c. Both breaking and formation of bonds
d. None of these

5. Which among the following is not a chemical change?

a. Melting of ice
b. Soap making
c. Rusting of iron
d. Fermentation of substances

6. Formation of water needs:

a. Hydrogen
b. oxygen
c. a spark
d. All of them

7. Retreading is used for the recycling of:

a. Car batteries
b. Motor oils
c. Tyres
d. Metals

8. Chemical name of Vitamin C is:

a. Ascorbic acid
b. Magnesium silicate
c. Acetylsalicylic acid
d. Sodium bicarbonate

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B. Write short answers of the following questions.

1. Recognize those characteristics which indicate that a chemical reaction has taken place.
2. How iron get rusted?
3. Write the common names of four chemical compounds along with their scientific names.
4. Define saponification reaction.
5. What do you mean by fermentation process.

C. Write detailed answers of the following questions.

1. What do you mean by the term scientific nomenclature? Explain it with examples.
2. How soap is prepared from oil and sodium hydroxide?
3. Relate chemical reactions to familiar processes encountered in everyday life.
4. List the methods of chemical disposal and briefly describe each method.
5. Describe how old tyres can be recycled and reused.
6. Explain the impacts and safety consequences of chemical disposal in Pakistan.

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Unit

8

Biotechnology

After studying this chapter the students will be able to:

- Describe the structure and function of nucleus and the importance of hereditary material (Chromosomes, genes, RNA, DNA) found in it.
- Identify the relationships among nucleic acids (DNA and RNA), genes and chromosomes.
- Describe the molecular basis of heredity including DNA replication.
- Describe the purpose and processes of cellular reproduction.
- Explain the common genetic disorders
- Analyze the role of genetic engineering and biotechnology in the present world.
- Investigate careers that require an understanding of reproductive biology.

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INTRODUCTION

All living organisms have the ability to produce the organism of their own kind by sexual or asexual mode of reproduction. Genetic traits are transmitted to the next generation by the process of reproduction and this characteristic of living organisms is known as heredity. During sexual reproduction the union of male and female gametes occur. The offsprings produced by this method resemble their parents but are not exactly identical to them or to each other. In a sexually reproducing species, the offsprings inherit genes from their two parents and therefore, possess unique traits. Therefore, no two organisms are exactly alike. The unlimited differences among living organisms are known as variations.

The field of science dealing with heredity and variations is called genetics. With the advent of technological advancements in the field of biology, separate disciplines of investigation have arisen. Among these, biotechnology is one of the leading fields of biology which has tremendous implications on our day to day life.

Biotechnology is defined as the use of living microorganisms or biological processes for industrial, agricultural or medicinal processes for the welfare of man. Man has been using the ability of the microorganisms to carry out fermentation for hundreds of years to produce foods such as yogurt, cheese, bread, etc. All these substances are made by fermentation process brought about by yeast, bacteria or fungi. Citric acid is produced commercially by the action of bacteria or fungi whereas the antibiotic penicillin is produced by mould fungi or bacteria. In this chapter you will study the nature of genetic material and application of biotechnology and genetic engineering in your daily life.

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8.1 NATURE OF HEREDITARY MATERIAL

In the previous classes you have studied a brief description about the cell and its organelles. Recall that a typical cell consists of; cell wall (in case of plant cell), cell membrane, cytoplasm with organelles and the nucleus. In the following section you will study more about structure and function of nucleus and the importance of hereditary material found in it.

8.1.1 NUCLEUS

Nucleus is a spherical structure found in the center of animal cell and young plant cell but it occupies a peripheral position in a mature plant cell. Nucleus is the most prominent organelle in the cell which constitutes about 10 percent of the cell's volume. Nucleus is separated from the cytoplasm by the nuclear membrane. Generally a cell has only one nucleus (uninucleate). However, in some cells the nucleus is absent (enucleate), for example, red blood cells. Whereas some cells consist of two or more nuclei (multinucleate), for example, slime moulds.

Structure of Nucleus

A nucleus consists of a nuclear membrane, nucleoplasm, nucleolus and chromosomes. Nucleoplasm,(also known as karyoplasm) is the matrix present inside the nucleus.

Nuclear Membrane

Nuclear material is enclosed in a nuclear membrane which is double-layered membrane. The outer layer of this membrane is connected to the endoplasmic reticulum. A fluid-filled space is present between the two layers of a nuclear membrane. The nuclear membrane has several openings called nuclear pores. These pores provide a passage for exchange of materials like different types of proteins and ribonucleic acids between the nucleus and cytoplasm.

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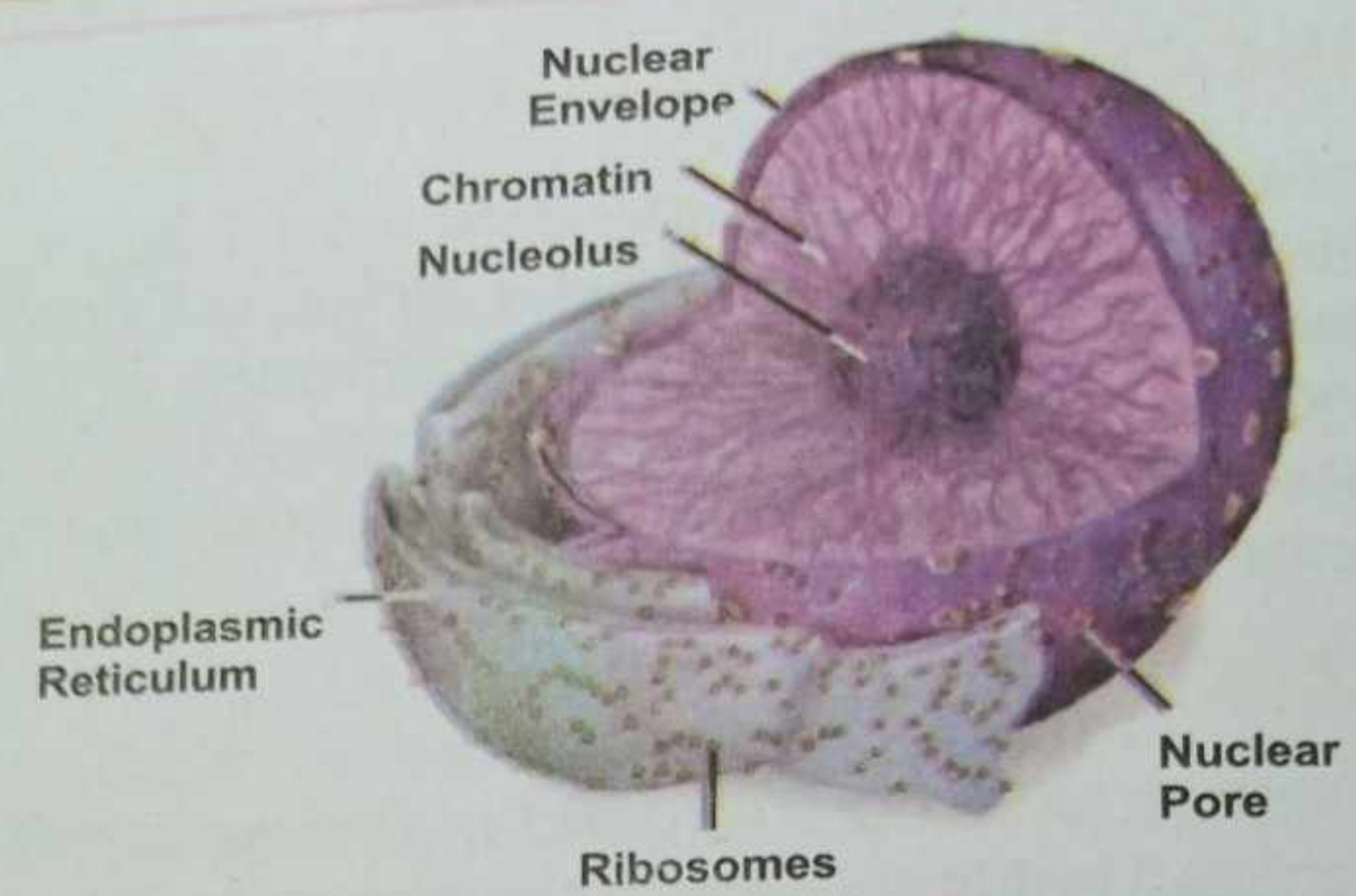
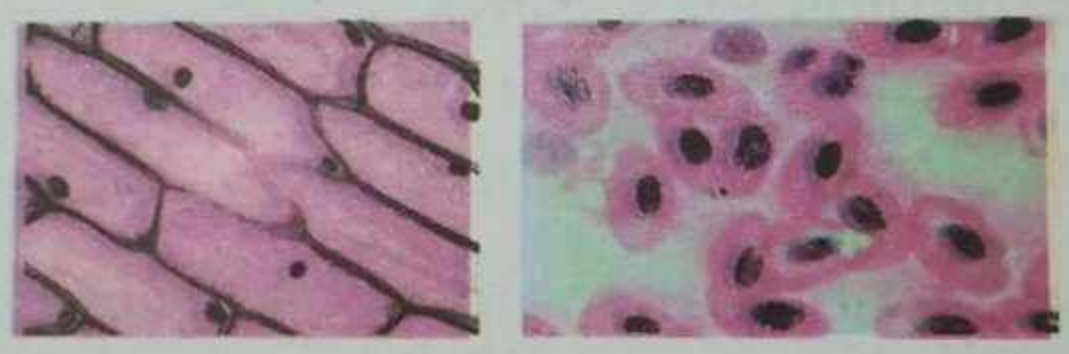


Fig: 8.1 Structure of nucleus.

ACTIVITY

Observe under the microscope peeled epidermal cell of onion and frog blood cells with the help of prepared slides.



FOR YOUR INFORMATION

Difference between Prokaryotic and Eukaryotic Cells

Biologists have divided cells into two types, namely prokaryotic and eukaryotic cell. The organisms made of prokaryotic cells are called prokaryotes. Prominent differences between prokaryotic cell and Eukaryotic cell is that prokaryotes are without a membrane bound nucleus and eukaryotic cells have membrane bound nucleus. Examples of Prokaryotes are bacteria and blue green algae. Examples of eukaryotes are all other unicellular and multicelluar organisms such as algae, plants and animals.

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Chromosomes

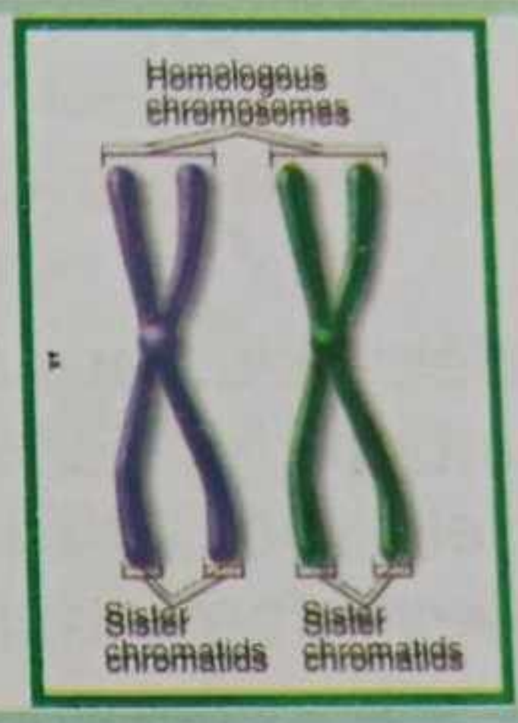
The nucleoplasm (protoplasm of the nucleus) contains chromatin network and one or two nucleoli. During cell division, the chromatin network is converted into thick, uncoiled thread like structures called chromosomes. Each chromosome is composed of deoxyribose nucleic acid (DNA) and a protein called histone.

Chromosome carry genetic information in the form of genes which are transmitted from one generation to another.

Number of chromosomes is specific in each species, for example, it is 46 in man, 26 in frog, 14 in pea, 48 in potato and so on.

FOR YOUR INFORMATION

Chromosomes in an organism are present in pairs and these pairs are called homologous chromosomes because in each pair shape and size of the chromosomes are identical.



Nucleolus

Besides chromosomes, the other prominent structures in the nucleus, are the nucleoli. They are dark staining bodies. There may be one or more nucleoli per nucleus, generally depending on the species. They are composed of DNA and protein. From the DNA of the nucleoli ribosomal RNA (rRNA) is made. Nucleoli are responsible for the manufacturing and exporting to the cytoplasm the material responsible for the production of the ribosomes on which protein are synthesized.

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Functions of Nucleus

Following are some of the important functions of the nucleus.

- Nucleus is the site of storage of hereditary material in the form of genes. It also stores different types of proteins and RNA in the nucleolus.
- Messenger RNA (mRNA) and ribosomes are formed in the nucleus which are responsible for protein synthesis.
- It is a site for the exchange of hereditary molecules (DNA and RNA) between the nucleus and the rest of the cell.
- When cell divides, chromatin network breaks into chromosomes which are then equally transmitted into offsprings.

8.1.2 Nucleic Acids, Genes and Chromosomes

Nucleic acids are a major class of organic compounds required to maintain life. Genes are the heredity material and are composed of nucleic acids. Nucleic acids are also the messenger substances that convey information from the genes to the rest of the cell.

Nucleic acid molecules are long polymers of smaller building-block units called nucleotides which are composed of still smaller parts; a 5-carbon sugar, a phosphate group, and a nitrogen- containing base.

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Nitrogenous bases are of four types namely, adenine, guanine, thymine and cytosine. Both the phosphate group and the nitrogenous base are covalently bonded to the sugar molecule.

DNA is a polynucleotide chain. The most important fact about DNA is that it has a specific sequence of nitrogenous bases, which carries information in the form of genes that can be transferred from generation to generation. This genetic information is needed to produce countless number of proteins from various combinations of twenty amino acids. The four different types of bases can be arranged in any linear order along a strand of DNA. Each sequence of bases represents a unique set of genetic instructions.

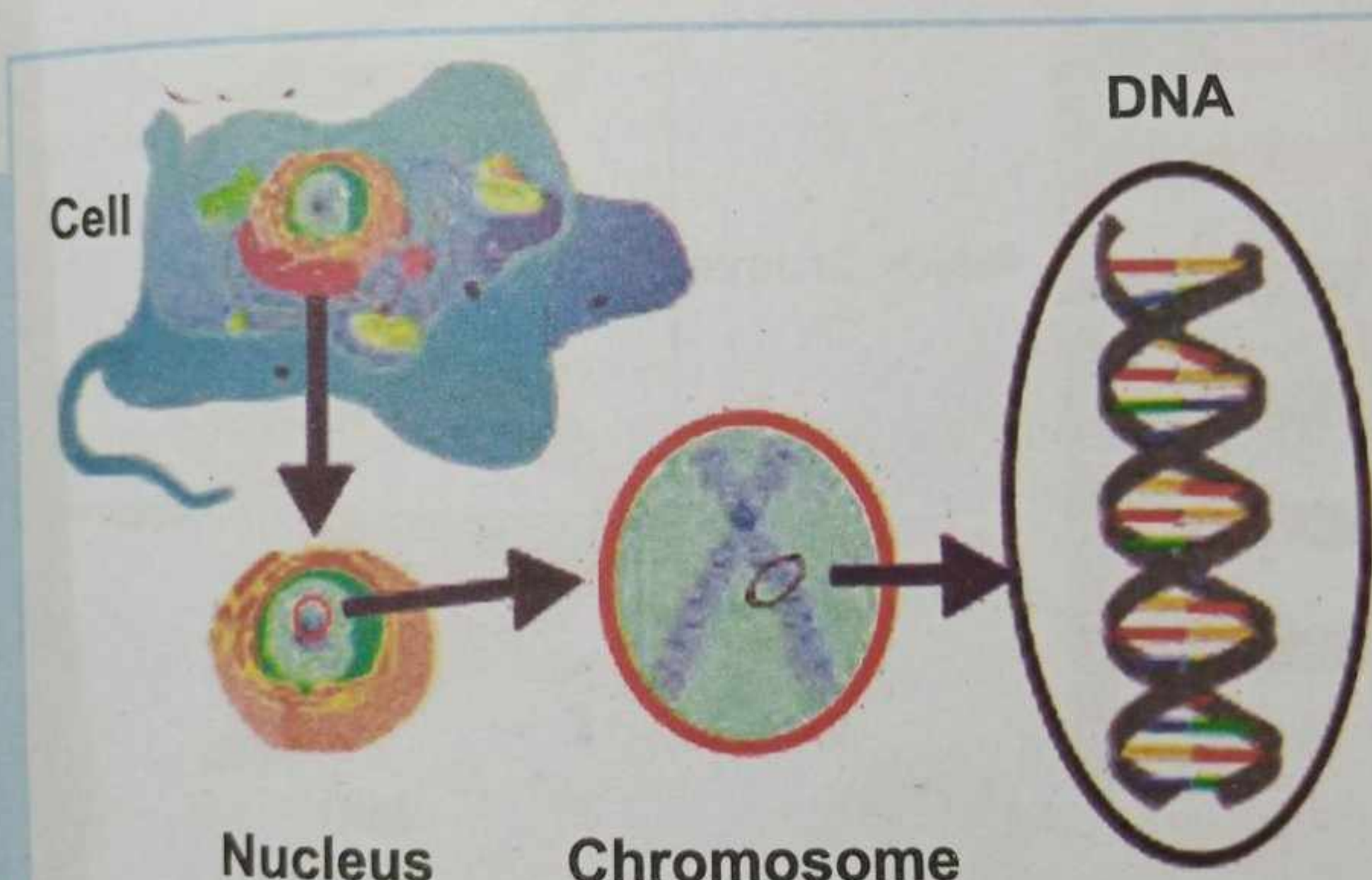


Fig: 8.2 Location of DNA in a cell.

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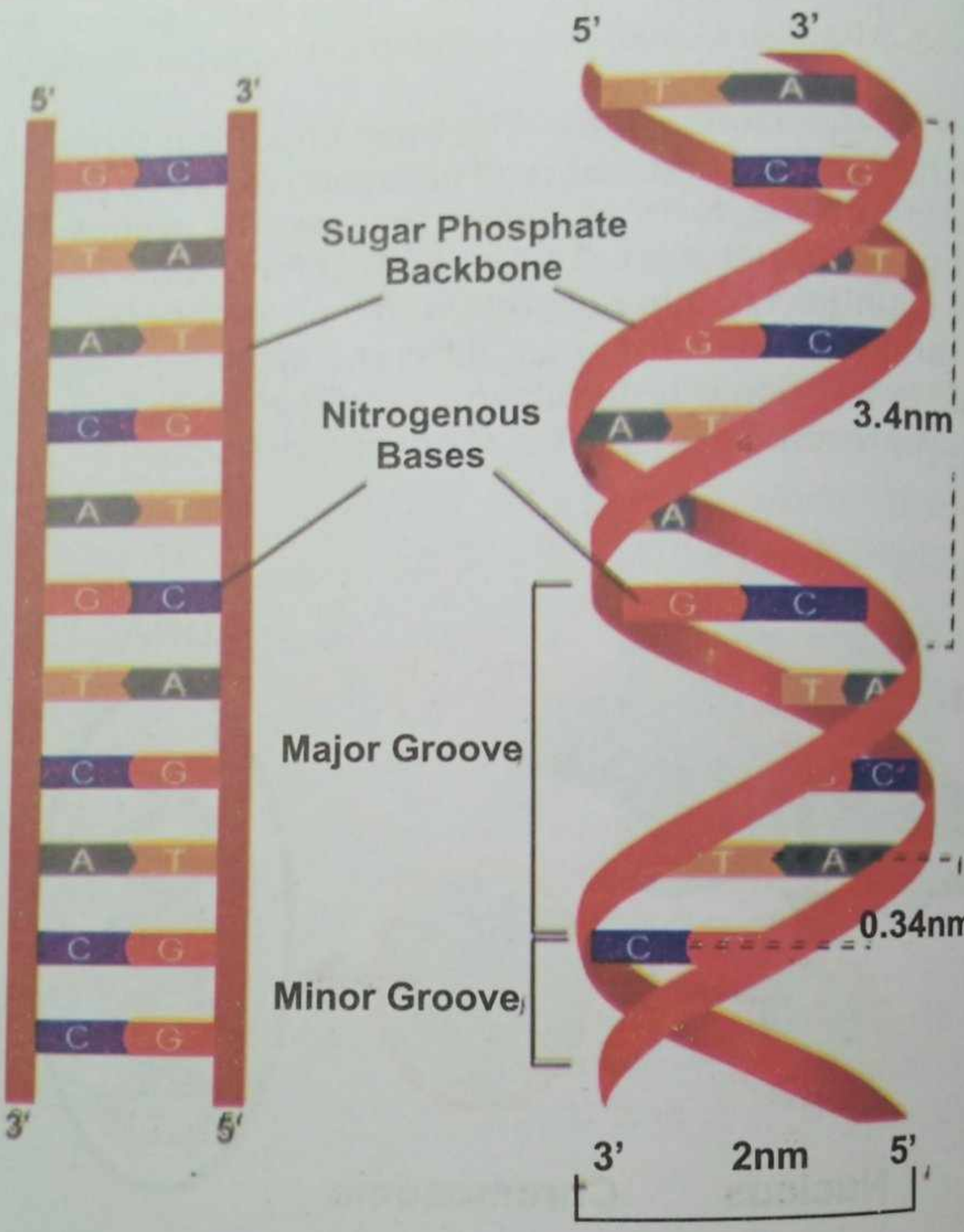


Fig: 8.3 Structure of DNA.

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RNA as a carrier of information

DNA is not directly involved in protein synthesis and is just the store house of genetic information that is transferred to RNA. There are three types of RNA i.e. messenger RNA or mRNA, transfer RNA or tRNA and ribosomal RNA or rRNA. Each has its own specific role in protein synthesis. The messenger RNA (mRNA) carries information from the DNA according to which protein is synthesized. The transport of amino acids to the site of protein synthesis is carried out by the transfer RNA (tRNA).

Ribosomal RNA (rRNA) in the ribosome cooperates with tRNAs to translate mRNAs into peptides. Genetic information from the DNA to mRNA and then to cytoplasm takes place in two steps i.e transcription and translation.

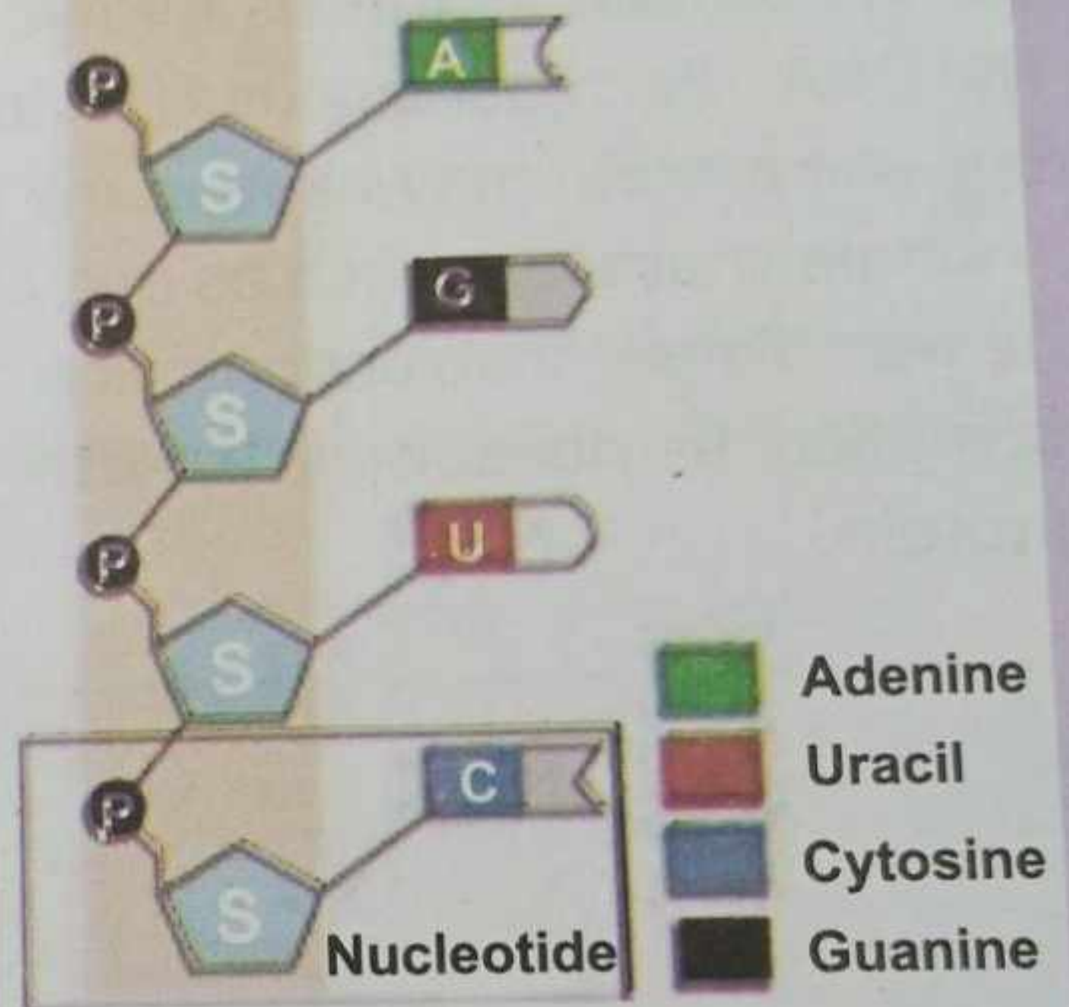


Fig: 8.4 Structure of RNA.

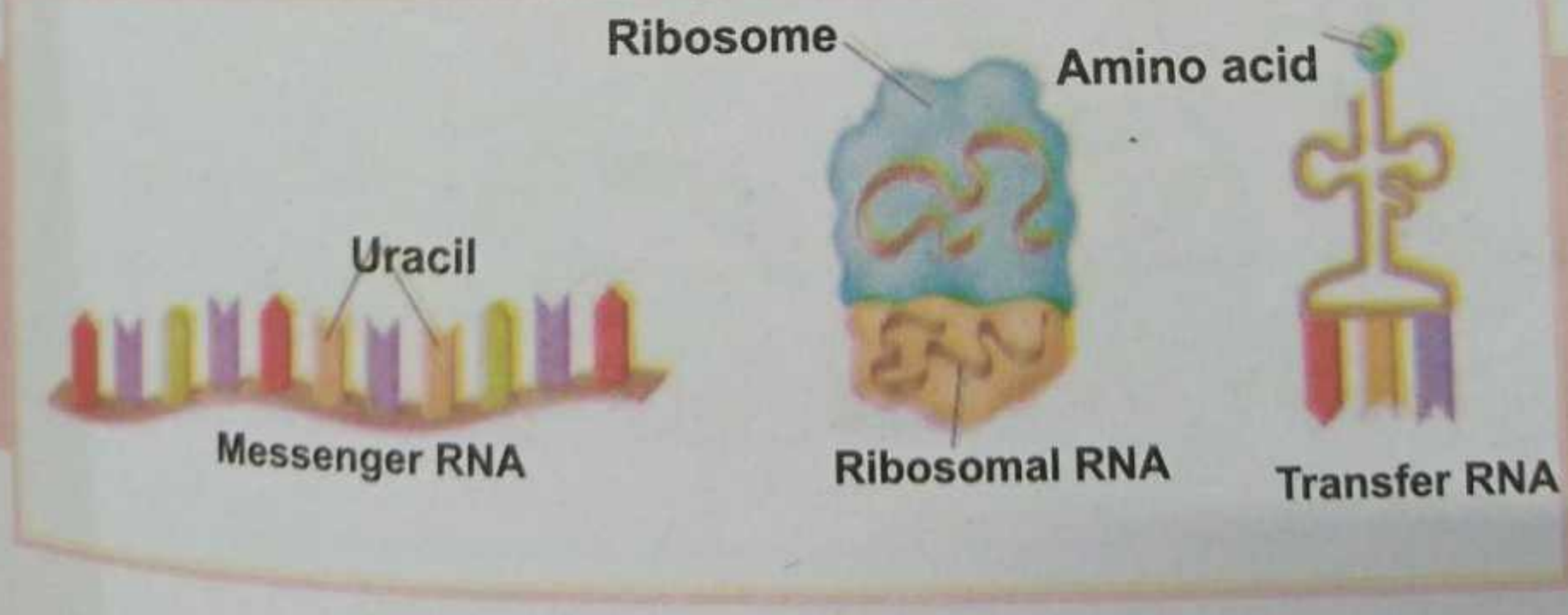


Fig: 8.5 Three types of RNA.

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Transfer of Genetic Information

You have learnt in the previous section that nucleus contains genes which are the carrier of information. All the characters of the living organisms are expressed through genes which are made up of DNA. Genes not only control our body characters but they also influence behavioural characteristics like intelligence.

During protein synthesis mRNA copies the instructions present in the DNA . Each gene codes the instruction for a single protein only, but one protein may have many different roles in the human body. A single character, such as eye colour, may be influenced by many genes. These instructions are transferred by tRNA and are compiled in ribosomes by rRNA into polypeptide chain for the protein.

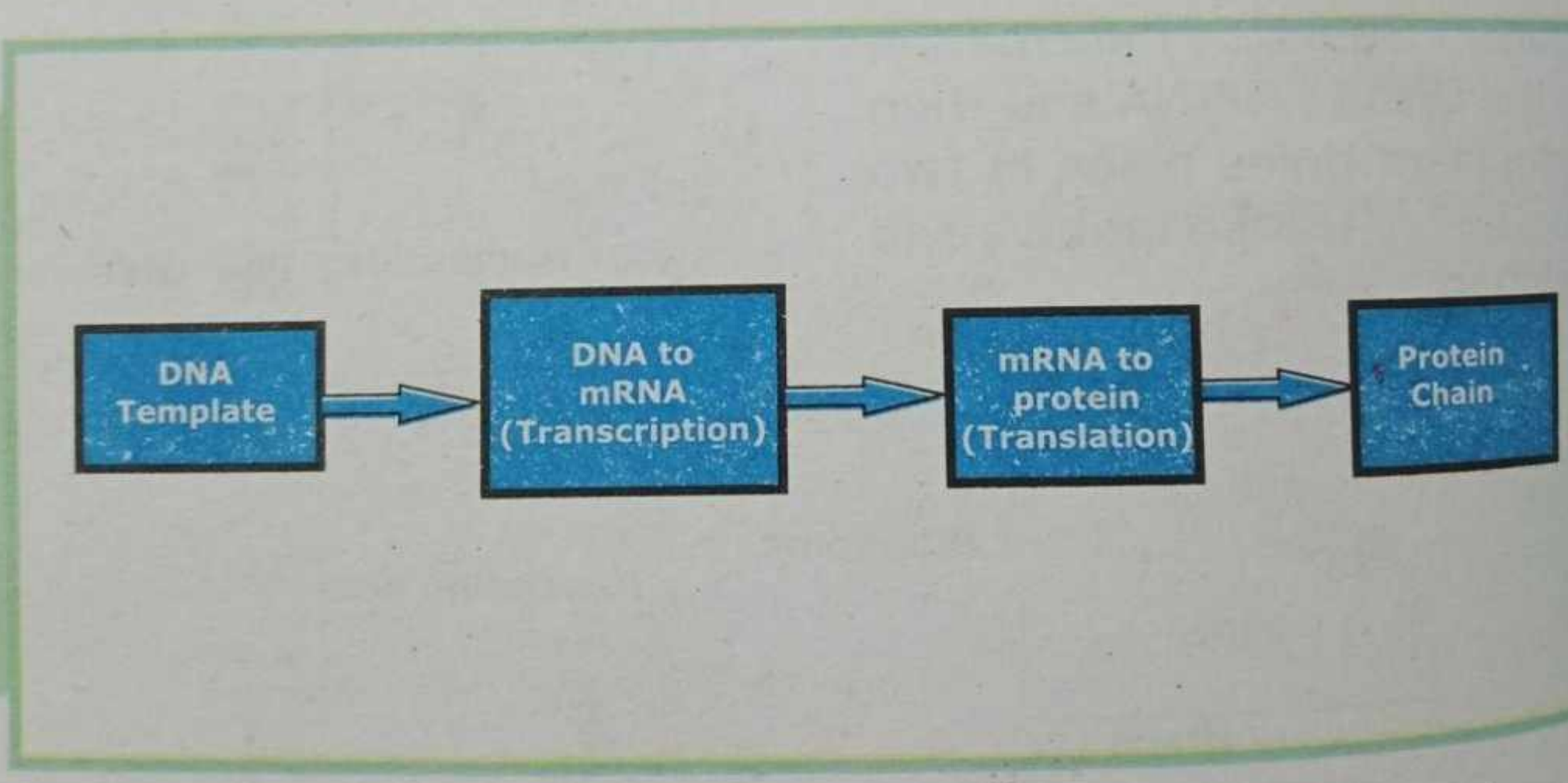


Fig: 8.6 Flow Chart of Transfer of Genetic Information.

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The encoding of instructions from the DNA to RNA takes place in the presence of specific enzymes. In this process the sequence of nucleotides of DNA with the corresponding sequence of nucleotides on mRNA is as follows.

DNA nucleotide	RNA nucleotide
Thymine	Adenine
Adenine	Uracil
Cytosine	Guanine
Guanine	Cytosine

It shows that mRNA serves as interpreter between DNA and the sequence of amino acid in a specific protein.

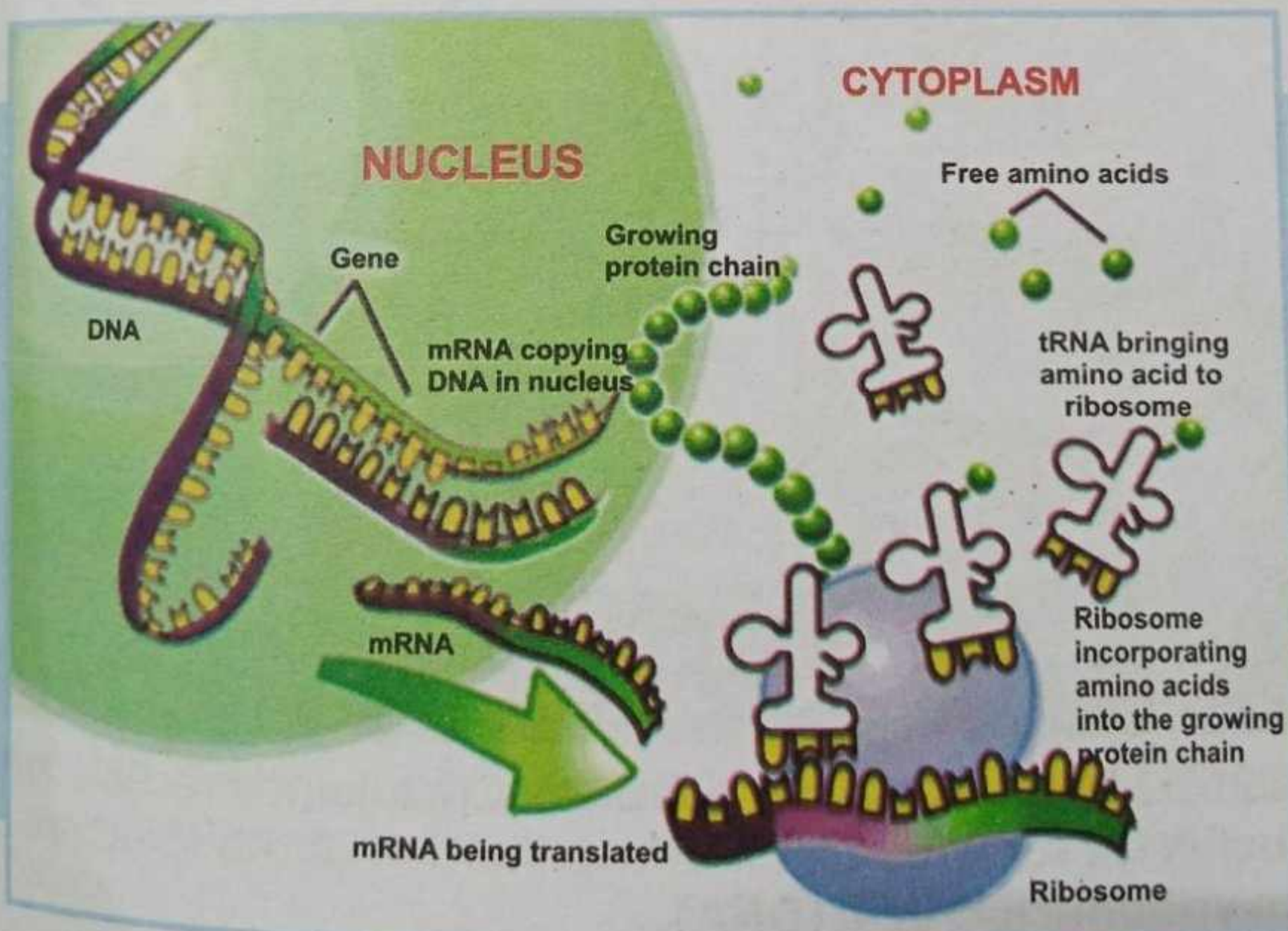


Fig: 8.7 An overview of protein synthesis process.

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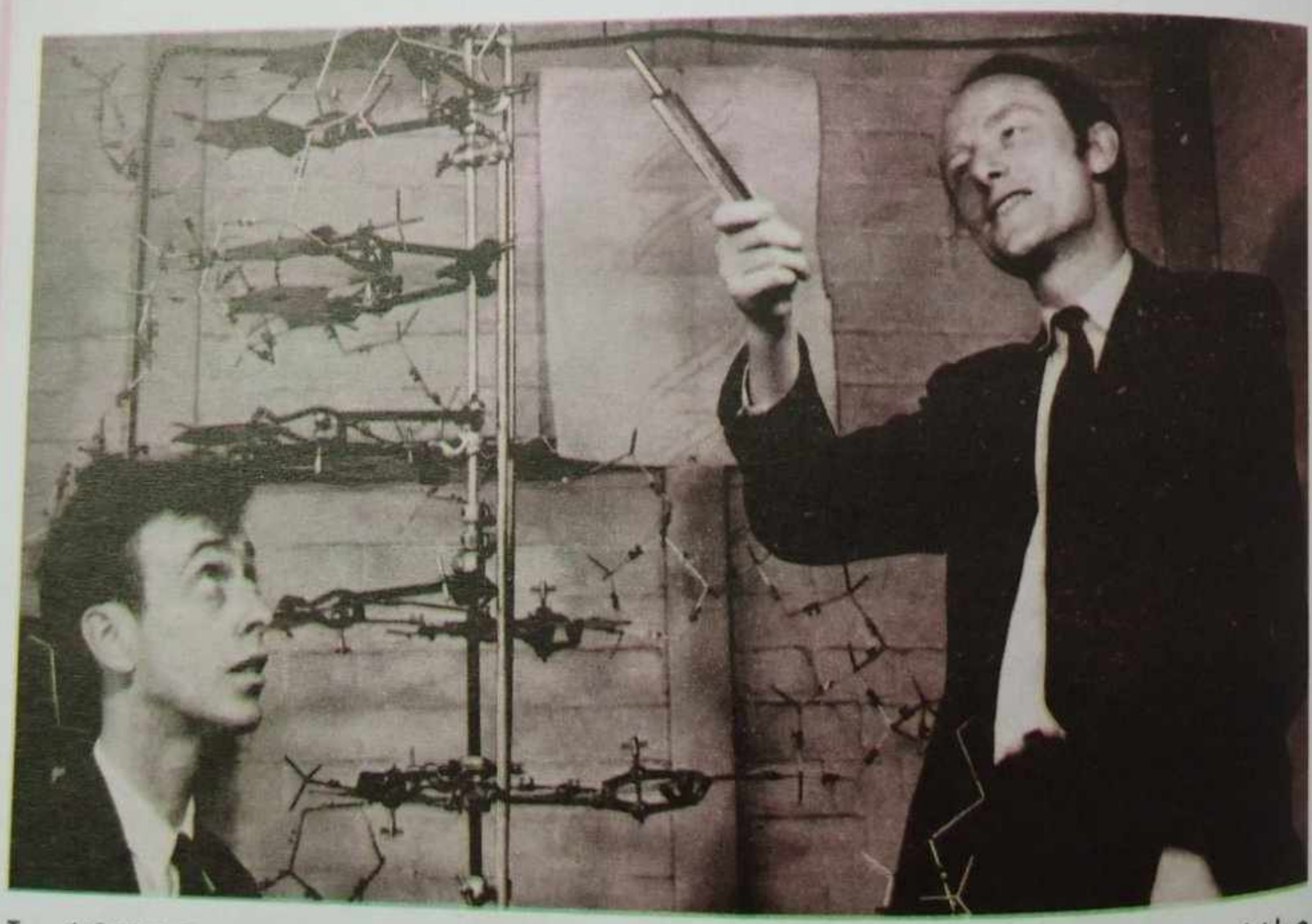
8.1.3 Molecular Basis of Heredity

Genetic information in the cell is present in the nucleus. In order to know the nature of this information present in the DNA we have to see the chemical nature of DNA.

Chemical composition of DNA

DNA is composed of chemical units known as nucleotides. Each nucleotide is composed of smaller parts; a 5-carbon sugar, a phosphate group, and a nitrogen- containing base. Both phosphate group and nitrogenous base are covalently bonded to the sugar.

FOR YOUR INFORMATION



In 1962 James Watson and Francis Crick jointly received the Nobel Prize for their 1953 determination of the structure of deoxyribonucleic acid (DNA).

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Structure of DNA

Watson and Crick proposed a model to explain the structure of DNA. According to this model each DNA molecule is composed of two strands that wind around each other. The sugar phosphate chain is located on outer side while the nitrogenous bases project towards the center.

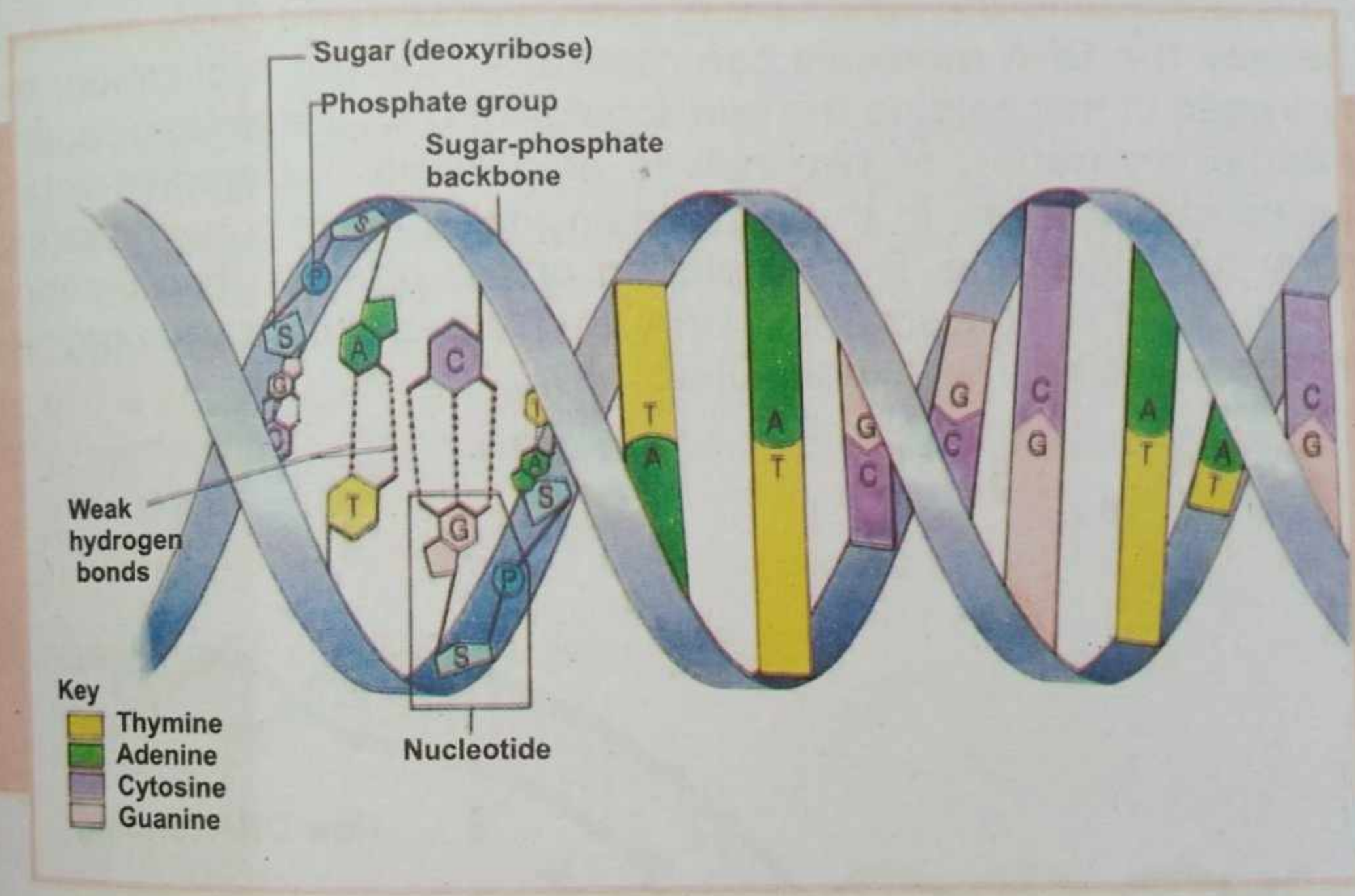


Fig: 8.8 Ladder like structure of DNA.

Nitrogenous bases of two strands are held together by hydrogen bonds. An Adenine on the chain always pairs with Thymine on the other chain, while Guanine always pairs with Cytosine. This relationship is known as complementarity, that is strands of the DNA molecule are complementary to each other and run in opposite directions.

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DNA has equal numbers of adenine and thymine (A=T) and equal numbers of guanine and cytosine bases (C=G). These relationships show that A+G=T+C. These relationships help in determining how genetic information is encoded in DNA and passed from one generation to the next.

Replication of DNA

While describing the structure of DNA, Watson and Crick proposed the way the DNA molecule can replicate. During replication, the hydrogen bonds holding the two strands of DNA are broken causing gradual separation of two halves of a zipper. Complementary nucleotides present in the cytoplasm join to form a new strained along the older one. By completion of the process, two identical molecules of double stranded DNA are formed. Replication process produces two new DNA molecules.

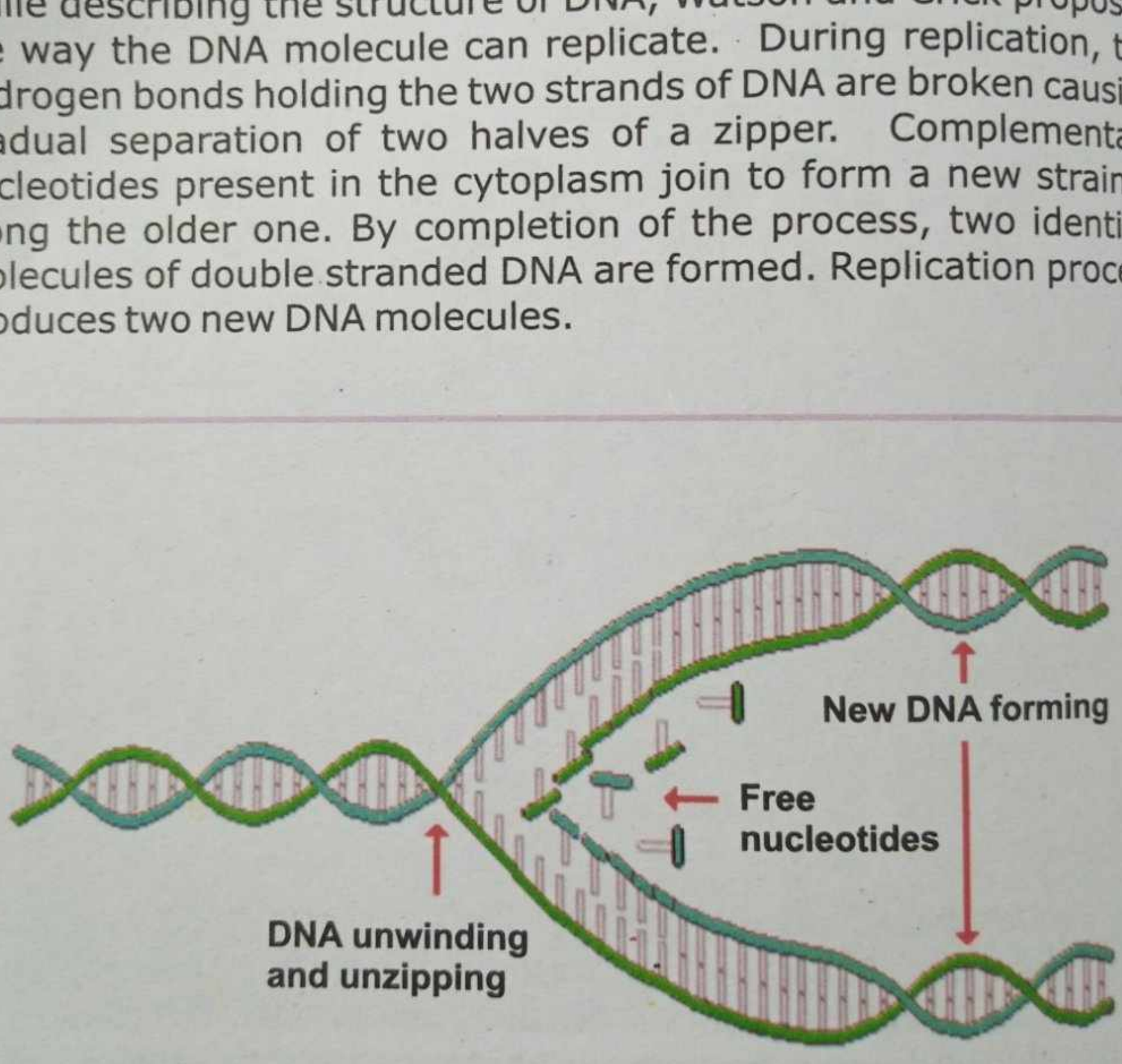


Fig: 8.9 replication of DNA .

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8.2 CELL DIVISION

Reproduction is defined as the ability of living organisms to produce offsprings like themselves. Reproduction is essential for continuity of life and survival of the species. Cell division ensures growth and development of an organism and at the same time it helps in the production of gametes (sperms spores and eggs) which are involved in sexual reproduction and in the continuity of a species generation after generation.

Every cell has the power of growth and multiplication. Cells reproduce themselves by cell division. In unicellular animals like Amoeba, the whole organism divides to produce two-daughter Amoebae. In multicellular organisms like human being, zygote (the fertilized egg) develops into an organism by repeated cell divisions. All cells of the body arise from pre-existing cells by cell division. Cell division provides basis for growth, reproduction and heredity.

8.2.1 Types of Cell division

There are two major types of cell division.

1. Mitosis
2. Meiosis

1. Mitosis (Somatic Cell Division)

Mitosis may be defined as the regular process of cell division by which each of the daughter cells receive exactly the same number and the same kind of chromosomes that a parent cell contains.

Mitosis is a common method. It occurs in the body cells of all animals and plants. As Mitosis occurs in the body (or soma) therefore, it is also called somatic cell division.

Mitosis is completed in six steps.

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1. Interphase

The resting phase between any two mitotic division is called interphase. During this phase nucleus and cytoplasm become active. The nucleus prepares itself for division.

2. Prophase

During prophase the centrosome divides into two halves and each half is surrounded by fine fibers called astral rays. This constitutes an aster. Now the two asters start moving away from each other and finally reach the opposite sides of the nucleus. Between the two asters appear fine fibres. These fibres form a spindle, which is broad in the middle to form the equator and narrow towards the asters which are now known as poles.

During this whole process the chromatin material of the nucleus is converted into chromosomes. The nucleolus and the nuclear membrane disappear and the chromosomes attach themselves to the spindle fibres.

3. Metaphase

During metaphase the centromere of each chromosome divides. The daughter chromosomes or chromatids so formed are attached to the half spindle fibers and arrange themselves on equator forming equatorial plate.

4. Anaphase

During anaphase the chromatids separate. At the same time the spindle fibers contract which results in the movement of chromatids towards their respective poles.

5. Telophase

During Telophase the chromatids reach the poles where they meet each other to form a chromatin network. In each network nucleolus reappears. Nuclear membrane is reformed around each chromatin network. Thus two daughter nuclei are formed. Each daughter nucleus contains the same number of chromosomes as in the parent cell. The spindle fibres and astral rays disappear.

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6. Cytokinesis

Division of cytoplasm is called Cytokinesis. After the formation of two daughter nuclei, a constriction appears in the middle of cytoplasm in the region of equator. This constriction is called cleavage furrow. This cleavage furrow deepens and divides the parent cell into two daughter cells. When the division of the cell is completed, two daughter cells are formed. These two daughter cells are the exact copies of the parent cell. The daughter cells pass into the interphase. During interphase they grow to their normal size.

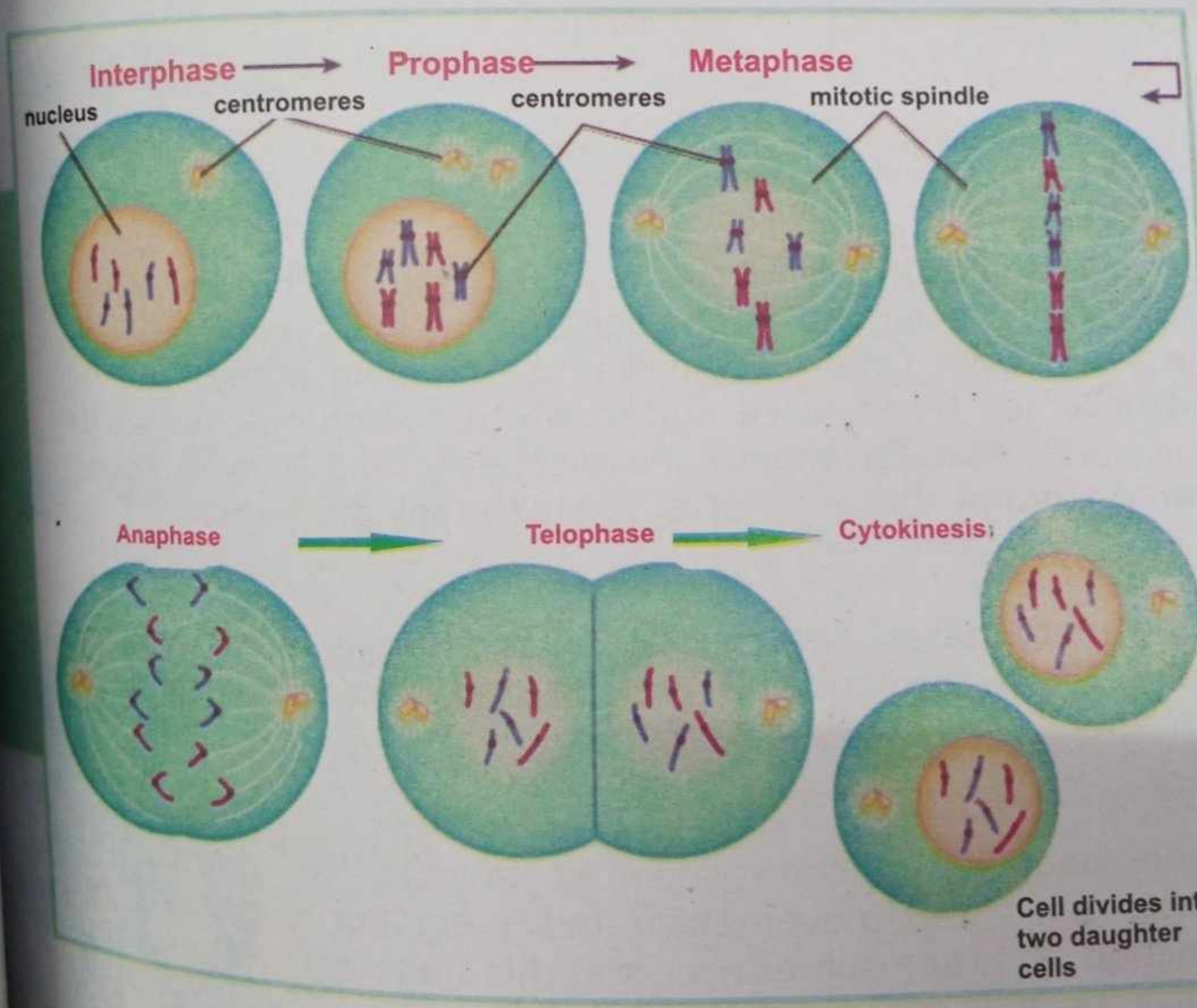


Fig: 8.10 Different stages of mitosis.

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Significance of Mitosis

Mitosis plays an important role in growth of an organism and keeps the number of chromosomes constant. The hereditary characters are equally transmitted into the daughter cells. It also helps in healing of wounds and formation of new cells.

2. Meiosis

The term "Meiosis" means reduction. In this type of cell division, the number of chromosomes is reduced to half. This process occurs in the reproductive organs (testes or ovaries). In animals, meiosis produces gametes while in plants it produces spores. During meiosis four daughter cells are formed from one parent cell. Meiosis is completed in two steps, Meiosis I and Meiosis II.

I. Meiosis I or Reduction Division

This stage is divided into the following sub phases.

A. Prophase I:

During this phase coiling and condensation of chromosomes take place. The homologous chromosomes form pairs and this process is called synapsis. Later on crossing over between the homologous chromosomes takes place during which the chromatids exchange their parts. Nuclear membrane disappear and spindle fibres are formed. Chromosomes are attached to the spindle fibres.

B. Metaphase-I:

During metaphase-I the chromosomes arrange themselves on the equator. These chromosomes are attached to the spindle fibres by the centromere.

C. Anaphase-I:

During anaphase-I contraction of spindle fibres occurs. The chromosomes start movement from the equator towards the poles. Reduction of chromosomes occurs at this stage as one from each pair of chromosomes move to each pole.

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D. Telophase - I:

During Telophase-I these chromosomes reach the poles. Chromosomes form a chromatin network. Nuclear membrane appears around the network. A new nucleolus appears. Thus two daughter nuclei are formed.

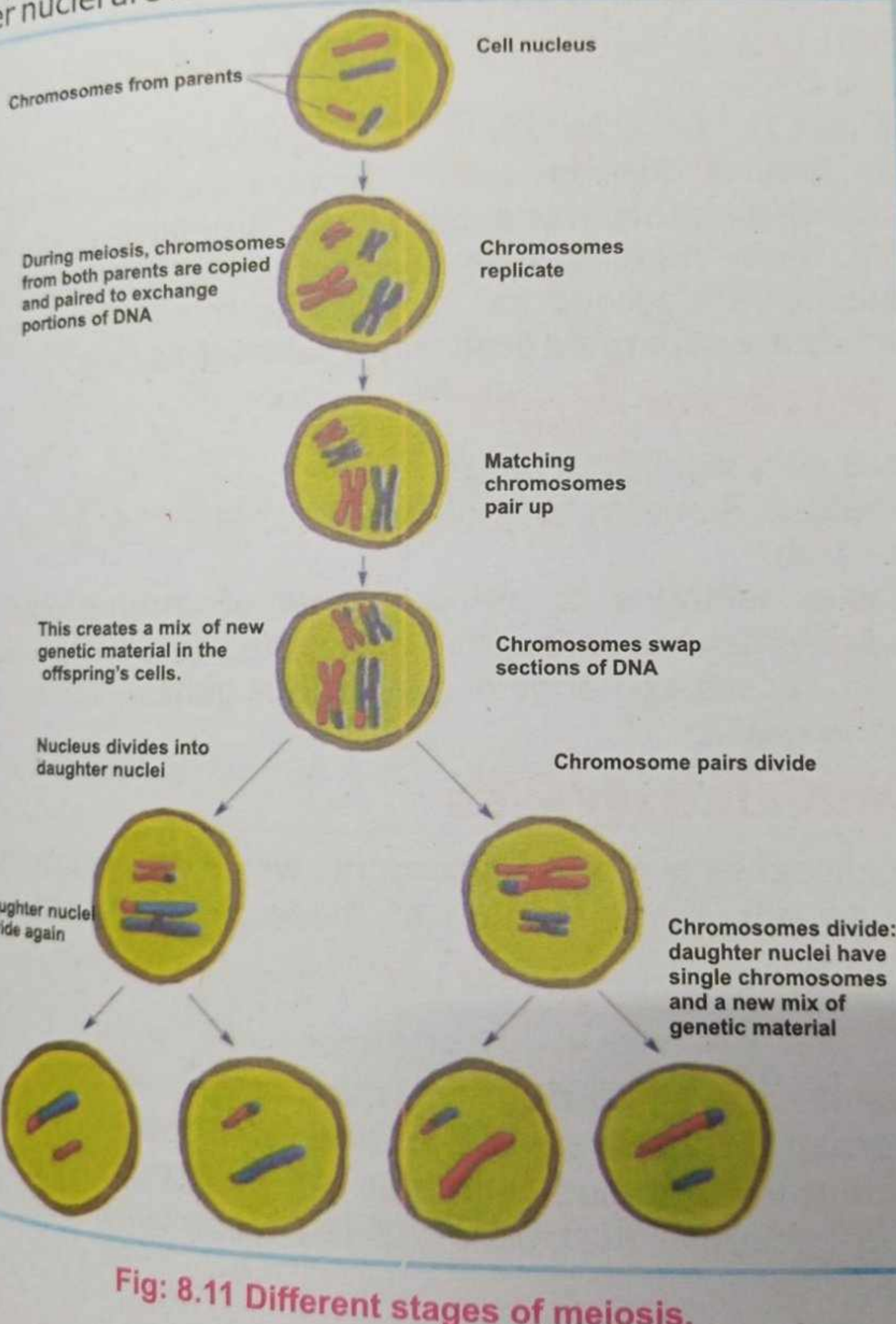


Fig: 8.11 Different stages of meiosis.

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Then a groove is formed in the cell membrane. This groove becomes deeper and deeper and divides the cell into two daughter cells. The spindle fibres and the astral rays disappear. The centriole persists in each daughter cell. In this way two daughter cells are formed.

ii. Meiosis II:

Meiosis II is just like mitosis. Meiosis II is completed through the following steps.

1. Prophase II 2. Metaphase II 3. Anaphase II 4. Telophase II

After the first cell division, each of the resulting cells contains a pair of sister chromatids—-one maternal chromatid and the other paternal. Unlike mitosis, meiosis does not end after one division; it continues with a second cell division. In this division, the sister chromatids are separated producing four haploid cells.

SIGNIFICANCE OF MEIOSIS

Meiosis is very significant because;

1. In meiosis gametes are formed which are the sexual units of reproduction.
2. Meiosis maintains constant number of chromosomes in the organism by the union of haploid cells during sexual reproduction.
3. Meiosis causes exchange of genes, thus genetic variation occurs among the species.

8.3 GENETIC DISEASES

Genetic diseases are those disorders which are transmitted from parents to offsprings. Some of these disorders are discussed below:

a. Thalassemia

Thalassemia is a blood disorder which is hereditary in nature. In this disorder the body makes an abnormal form of haemoglobin (the protein in red blood cells that carries oxygen). The disorder results in excessive destruction of red blood cells which leads to anaemia.

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Thalassemia occurs when there is a defect in a gene that controls the production of haemoglobin. Untreated thalassemia leads to heart failure and liver problems, and makes a person vulnerable to infections. Frequent blood transfusions can help control some symptoms. However it may result in accumulation of iron, which can damage heart, liver, and endocrine system.

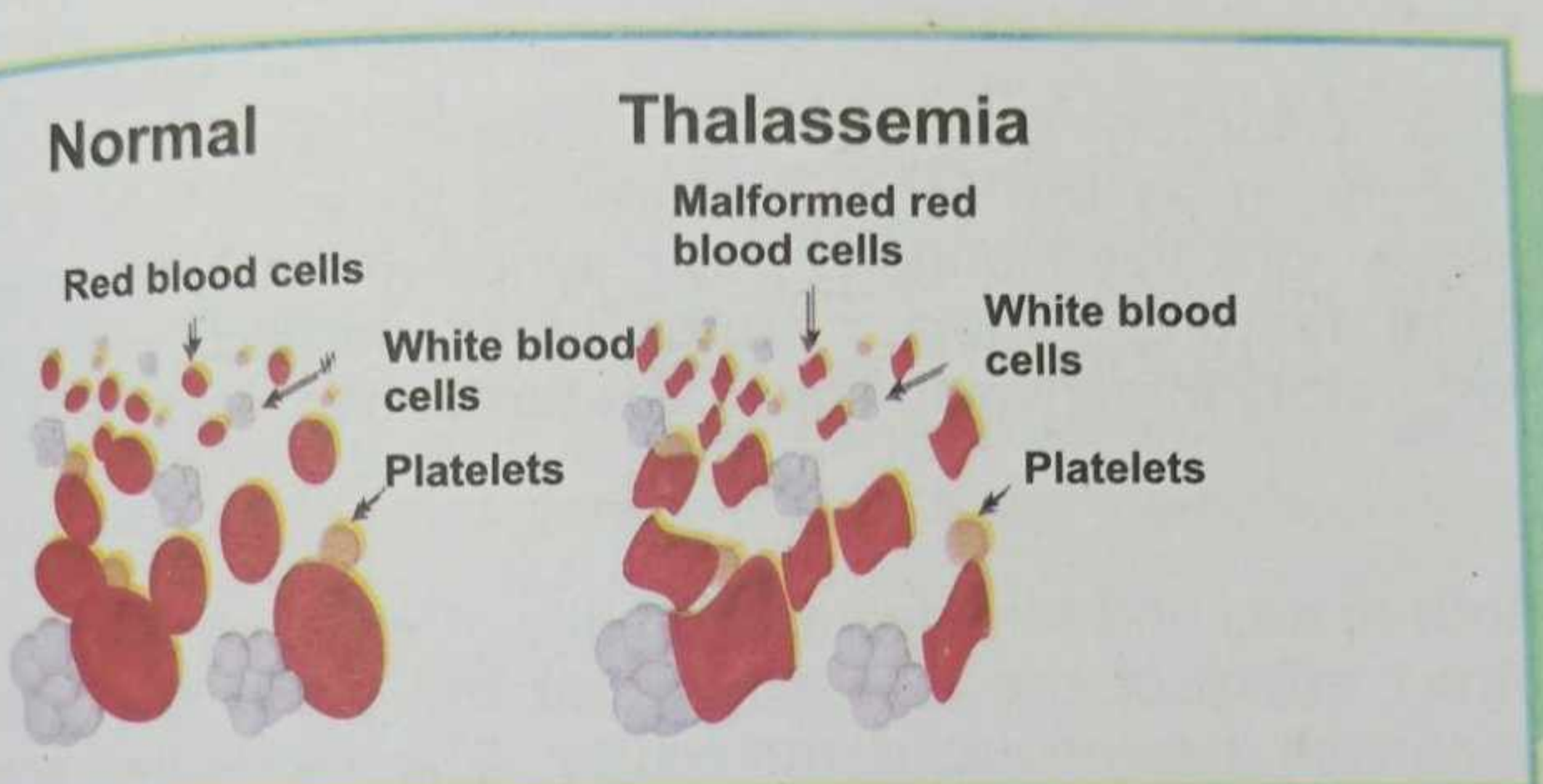


Fig: 8.12 Comparison of normal and malformed redblood cells.

Thalassemia is caused by mutations in the DNA of cells that make haemoglobin.

TIDBIT

Mutation is a sudden change in DNA, the hereditary material of life. Mutations can be beneficial, neutral, or harmful for the organism.

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b. Down's Syndrome

In human being there are 23 pairs of chromosome. Each chromosomal pair is numbered from 1 to 23. Down's Syndrome disorder is concerned with chromosome number 21 where instead of a pair there are three chromosomes. So an extra chromosome is present.

This disorder is commonly known as Mongolism as the facial features of these people look like Mongols. Down syndrome includes characteristic facial features, short stature, heart defects, susceptibility to respiratory infection and mental retardation.

TIDBIT

Anaemia is a condition in which the body does not have enough healthy red blood cells. Red blood cells provide oxygen to body tissues.

c. Sickle cell anaemia

Both males and females are equally affected by this disease. The direct effect of the disease is that the red cells produced have abnormal haemoglobin molecules. The molecules tend to link together and crystallize, especially when oxygen content of the blood is lower than usual. The shape of the cells become sickle-like, which are rapidly destroyed by the body. The cell count is rapidly decreased, causing anaemia and general weakness of the body. This disease is the most common inherited among people of Africa.

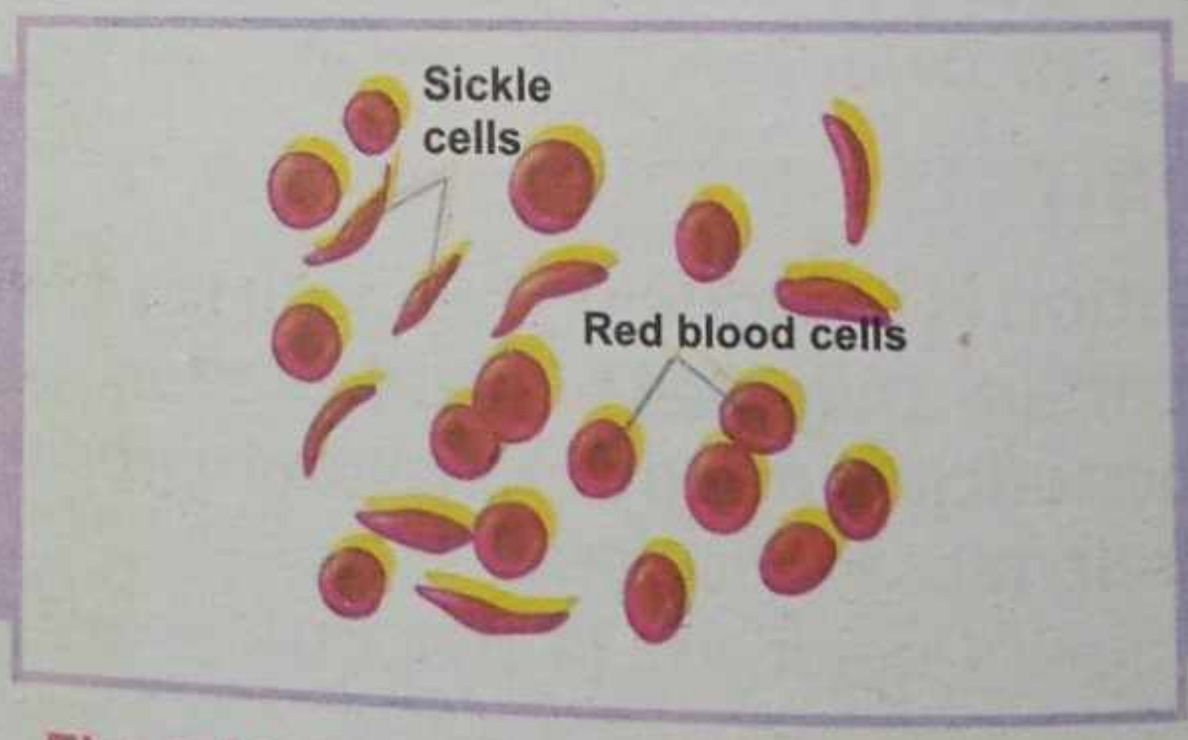


Fig: 8.13 Sickle shaped cells in blood.

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8.4 GENETIC ENGINEERING AND BIOTECHNOLOGY

Genetic engineering is a technique which is used for the transfer of genes from one organism to another. It allows genetic information to be transferred between organisms belonging to the same or different species.

Biotechnology has been practiced by human society since the beginning of recorded history in such activities as baking bread, brewing alcoholic beverages, or breeding food crops or domestic animals. Biotechnology is "the commercial application of living organisms or their products which involves the deliberate manipulation of their DNA molecules". Biotechnology deals with different technologies such as gene manipulation and gene transfer, DNA typing and cloning of plants and animals.

FOR YOUR INFORMATION

Mechanism of Genetic Engineering

In genetic engineering, the genes of choice of an organism are cut off by restriction enzymes and inserted into the cells of another organism of the same or different species. For the transfer of gene, a victor usually a plasmid, is used which is small circular DNA molecule carrying genes found in bacterium. The gene, once transplanted inside the bacterium, begins to express itself and start producing the protein specified by the gene for example Insulin.



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8.4.1 Cloning

Cloning is the production of multiple identical offsprings. A clone is an animal who is genetically identical to its donor "parent". Cloning can be achieved using cells derived from a microscopic embryo, a fetus, or from an adult animal.

Cloning from adult animals was introduced to the public in 1997 when scientists announced the birth of Dolly, the first animal cloned in this way. Since Dolly, several scientists have cloned other animals including cows and mice.



Fig: 8.14 Dolly: The First cloned sheep.

Dolly is the result of cloning of only one parent. Scientists transferred genetic material from the nucleus of an adult sheep's udder cell to an egg whose nucleus had been removed. There have now been hundreds of clones produced from skin cells taken from adult sheep, cattle, goats, and mice.

8.4.2 Transgenic Animals and Plants

Genes or genetic material can be transferred naturally, or by a number of genetic engineering techniques from one organism to another. A transgenic organism (plant or animal) is one that carries a foreign gene that has been deliberately inserted into its DNA. This inserted gene can create proteins which are useful for the mankind.

Transgenic animals are created to study human diseases and to develop and identify the drug useful to treat these diseases. Gene transfer is done in animals to increase the milk production and to produce useful proteins.

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presently, traditional method of plant breeding is replaced by the creation of transgenic plants. Such transgenic plants have genes for resisting infections and attacking insects.

FOR YOUR INFORMATION



Responsible scientists, farmers, food manufacturers, and policy makers recognize that the use of transgenic organisms should be considered very carefully to ensure that they pose no environmental and health risks. Society should be provided with a balanced view of the fundamentals of biotechnology and genetic engineering and the benefits and risks of the new technology.

8.5 Application of Biotechnology and Genetic Engineering

Biotechnology and genetic engineering have wide range of applications in the present world.

The two significant features of genetic engineering are:

- production of beneficial proteins and enzymes in surplus quantities
- creation of genetically modified organisms with useful characters

Some of the applications of biotechnology and genetic engineering in present world are as follows.

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i. Biotechnology and Genetic Engineering in the field of Agriculture

Agricultural biotechnology is the area of biotechnology involving applications to agriculture. Agricultural biotechnology has been practiced for a long time, as people have sought to improve agriculturally important plants by selective breeding. An example of traditional agricultural biotechnology is the development of disease-resistant wheat varieties by cross-breeding different wheat types.

Today, this technology has reached a stage where scientists can take one or more specific genes from nearly any organism including plants, animals, bacteria or viruses, and to introduce those genes into plants to get the required characteristics in those plants.



Fig: 8.15 Biotech crops are profitable.

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ii. Biotechnology and Genetic Engineering in the field of Live stock and dairy products

Biotechnology is being used to speed up breeding programmes for livestock and fish and to extend the range of useful traits. Animal feeds and feeding practices are being changed by biotechnology to improve animal nutrition and to reduce environmental wastes.

Biotechnology is used in the diagnosis of various diseases. It is also being used in the production of vaccines which help animals to fight against several diseases. Biotechnology has made possible the production of enzymes, single-cell proteins and antibiotic feed additives. These products have been widely used to improve the availability of nutrients from feeds and the productivity of livestock and aquaculture.

Gene-based technologies are used to improve animal nutrition. This is done either through modifying the feeds to make them more digestible or through modifying the digestive and metabolic systems of animals to enable them to make better use of the available feeds.

One example of commercial success is the use of somatotropin, a hormone that results in increased milk production and accelerated growth in dairy cows.

iii. Biotechnology and Genetic Engineering in the field of food processing

Biotechnology has found its role in food processing techniques. This has helped us to convert relatively bulky, perishable and typically inedible raw materials into more useful and edible foods and drinks. Food is also processed in order to improve its quality and safety.

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Collecting DNA samples

Blood is an excellent source of DNA. It is collected from the white blood cells (mature red blood cells do not contain DNA). DNA can also be obtained from hair follicles, or from any other cellular tissue.



iv. Biotechnology and Genetic Engineering in the Field of Pharmaceuticals

Micro-organisms have been used for decades as living factories for the production of life-saving antibiotics including



Fig: 8.16 *Penicillium*.

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penicillin, from the fungus *Penicillium*, and streptomycin from the bacterium *Streptomyces*. Human insulin for diabetics is now being produced using biotechnology.

Genetically engineered vaccines are being developed to protect fish and livestock against pathogens and parasites.

FOR YOUR INFORMATION

Forensic analysis using biotechnology methods is important in criminal investigations. Analysis of proteins in blood (serology), other body fluids and body tissues has a long tradition in forensic analysis in criminal investigation.



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KEY POINTS

- Genetic traits are transmitted to the next generation by the processes of reproduction and this characteristic of living organisms is known as heredity.
- A typical cell consists of; cell wall (in case of plant cell), cell membrane, cytoplasm with organelles and the nucleus.
- Cytoplasm contains about 90 percent water and the remaining 10 percent are the fundamental molecules of life such as insoluble waste products and storage products.
- The nucleus is the most prominent organelle as compared to other cell organelles.
- Nucleus consists of a nuclear membrane (nuclear envelope), nucleoplasm, nucleolus and chromosomes. Nucleoplasm, also known as karyoplasm, is the matrix present inside the nucleus.
- The nucleus communicates with the remaining of the cell or the cytoplasm through several openings called nuclear pores.
- Genes are the heredity material and are composed of nucleic acids. These acids are also the messenger substances that convey information from the genes to the rest of the cell.
- DNA has a specific sequence of nitrogenous bases, which carries information in the form of genes that can be transferred from generation to generation.

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- RNAs are of three types i.e. messenger RNA or mRNA, transfer RNA or tRNA and ribosomal RNA or rRNA. These RNAs have specific role in protein synthesis.
- DNA has equal numbers of adenine and thymine (A=T) and equal numbers of guanine and cytosine residues (C=G).
- Cell division ensures growth and development of an organism and at the same time it helps in the production of gametes and in the continuity of a species generation after generation.
- Mitosis is a cell division by which each of the daughter cells receive exactly the same number and the same kind of chromosomes as in the parent cell.
- Meiosis maintains constant number of chromosomes in the organism by the union of haploid sperm with the haploid egg during sexual reproduction.
- Genetic diseases are those disorders which are transmitted from parents to the offsprings.
- In thalassemia the body makes abnormal form of haemoglobin, the protein in red blood cells that carries oxygen.
- Biotechnology can be broadly defined as using living organisms or their products for commercial purposes.
- A clone is an animal who is genetically identical to its donor "parent".

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EXERCISE

A. Select the correct answers in the following questions.

1. **The normal human chromosome diploid number is:**
   a. 23
   b. 24
   c. 46
   d. 48

2. **In meiosis, crossing over occurs in:**
   a. Metaphase I
   b. Prophase I
   c. Metaphase II
   d. Prophase II

3. **Each section of information necessary for the synthesis of a single polypeptide is:**
   a. Chromosome
   b. DNA
   c. Gene
   d. Protein

4. **A highly coiled, condensed form of chromatin formed in the cell nucleus during meiosis and mitosis is:**
   a. Chromosome
   b. Spindle fibers
   c. DNA
   d. centromere

5. **A double helical molecule, consisting of two strands of four different nucleotides containing a genetic information is:**
   a. Chromosome
   b. DNA
   c. Gene
   d. Aster

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6. **Proteins are synthesized in:**
   a. Lysosome
   b. Mitochondrion
   c. Plasmid
   d. Ribosomes

7. **A process of cell division where each of the two daughter cells receives a complete set of chromosomes is called:**
   a. Cytokinesis
   b. Amitosis
   c. Mitosis
   d. Meiosis

8. **A specialized protein that binds to DNA and organize its structure in the nucleus**
   a. Chromosome
   b. Histone
   c. Hormone
   d. Enzyme

9. **Chromosomes can be counted best at the stage of:**
   a. Metaphase
   b. Anaphase
   c. Telophase
   d. Prophase

10. **The stage in which daughter chromosomes move toward the poles of the spindle is:**
    a. Anaphase
    b. Metaphase
    c. Prophase
    d. Telophase

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11. **Which of the following cellular structures always disappears during mitosis and meiosis?**
    a. Plasma membrane
    b. Nucleolus and nuclear envelope
    c. Plastids
    d. none of these

12. **During meiosis I, the number of chromosomes is:**
    a. Halved
    b. Tripled
    c. Doubled
    d. Quadrupled

13. **The diploid chromosome number for the house fly is 12. The haploid number of chromosomes found in their gametes would be:**
    a. 1 b. 3
    c. 6 d. 12

14. **Which of the following is NOT a function of cell division?**
    a. growth of multicellular organisms
    b. repair of multicellular organisms
    c. reproduction of single-celled organisms
    d. aerobic cellular respiration of multicellular organisms

15. **Which of the following statements about mitosis is NOT correct?**
    a. Mitosis is cell division that produces two daughter cells.
    b. Each daughter cell formed by mitosis has the same number of chromosomes as the parent cell.
    c. The parent cell and the daughter cells are genetically identical.
    d. During mitosis, the centromeres divide and the sister chromatids stay together.

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16. **Which of the following is the correct sequence of phases of mitosis?**
   a. Anaphase, prophase, metaphase, telophase
   b. Prophase, anaphase, metaphase, telophase
   c. Prophase, metaphase, anaphase, telophase
   d. Prophase, metaphase, telophase, anaphase

17. **Which of the following statements is NOT correct when cells undergo meiosis?**
   a. Meiosis ensures that the chromosome number remains constant generation after generation.
   b. Meiosis ensures that each generation has a different genetic makeup than the previous one.
   c. Meiosis ensures that each newly formed daughter cell receives the same number and kinds of chromosomes.
   d. Meiosis results in four daughter cells.

18. **Thalassemia is due to**
   a. abnormal blood
   b. abnormal haemoglobin
   c. abnormal white blood cell
   d. abnormal platelets in the blood

B. Write short answers of the following questions.

1. What is the role of nuclear pores in the nucleus?
2. List down four major functions of nucleus.
3. Write the role of RNA as a carrier of information?
4. Name the four types of nitrogenous bases found in the DNA molecule.
5. Define interphase.
6. Briefly write about the significance of mitosis.
7. What do you mean by genetic disorders?

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C. Write detail answers of the following questions.

1. Describe the structure and function of nucleus.
2. Describe the importance of hereditary material found in nucleus.
3. Identify the relationships among nucleic acids (DNA and RNA), genes and chromosomes.
4. Describe the molecular basis of heredity.
5. Give an overview of the process of DNA replication.
6. Describe the process of mitosis in detail.
7. Describe the process of meiosis in detail.
8. Explain thalassemia and Down's syndrome as common genetic disorders.
9. Analyze the role of genetic engineering and biotechnology in the fields of agriculture and food processing.

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Unit 9

Water Resources

After studying this chapter the students will be able to:

- Recognize the various forms of water available on Earth.
- Identify the amount of fresh water available on Earth with an emphasis on Pakistan.
- Describe the existing ways of utilization of water resources in Pakistan and explain the issues and problems Pakistan is facing in utilizing the water resources effectively for its people.
- Identify the methods for reclamation and conservation of water.
- Explain the water resources are facing serious threats such as pollution, climate change, urban growth and landscape changes (deforestation) that are mainly caused by human activities.
- Describe the implication of the growing demand of water in the world.
- Suggest ideas for the sustainable development of water resources in Pakistan.

NOT FOR SALE

INTRODUCTION

Water is an important resource for all living organisms. It is the most abundant compound found in all living organisms. Water cycle operates in nature . It is a renewable resource as its supply is not affected by its use. It is used in various ways, for example in domestic and industrial activities, agriculture, hydro power generation, recreation, navigation, etc.

Access to water is regarded as a basic human right. Availability of clean drinking water reduces the occurrence of water-related diseases. Ecological conditions of an area can be affected due to large-scale withdrawals or transfers of water. Water is a shared resource in most parts of the world and is becoming a reason for conflict and tension between countries especially in the context of rising population and developing economies. In this chapter you will study the distribution of water, issues and problems in effective utilization of water and threats faced by water resource due to ecological problems.

9.1 FORMS OF WATER PRESENT ON EARTH

Water is present all around us, in air as water vapors, in rivers and lakes, in icecaps and glaciers, in the ground as soil moisture and in aquifers. Water resources refer to the supply of groundwater and surface water in a given area.

About 71 percent of the Earth's surface is covered by water. About 96.5 percent of all Earth's water is present in the oceans. Approximately 30 percent of the world's fresh water is present in liquid form held in ground water. This water is available for human use and is managed for carrying out different activities. Rest of the fresh water is present as polar or glacial ice or water vapors. Let's study some major forms of water available on Earth.

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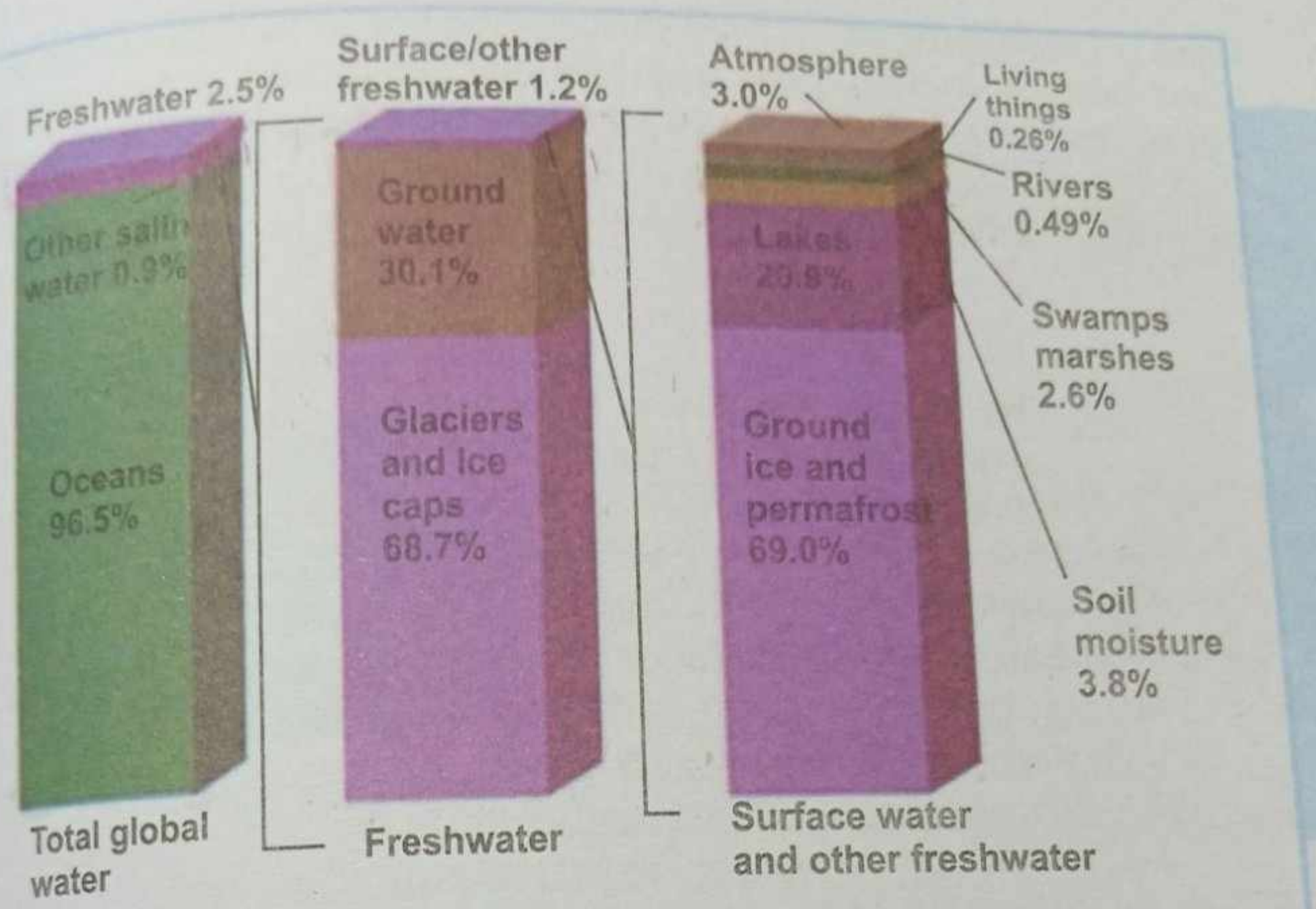


Fig: 9.1 Distribution of water resource in different forms.

9.1.1 Oceans and Seas

More than 70 percent of the Earth's surface is covered by water. Oceans are the largest bodies of water on Earth. These contain water which is saline or salty. All oceans present on the Earth are one large body. However, for geographic reference, this one large water body is divided into several sections geographically. The largest bodies of water on Earth are the Pacific ocean, Atlantic ocean, Indian ocean, Antarctic ocean, and Arctic ocean.

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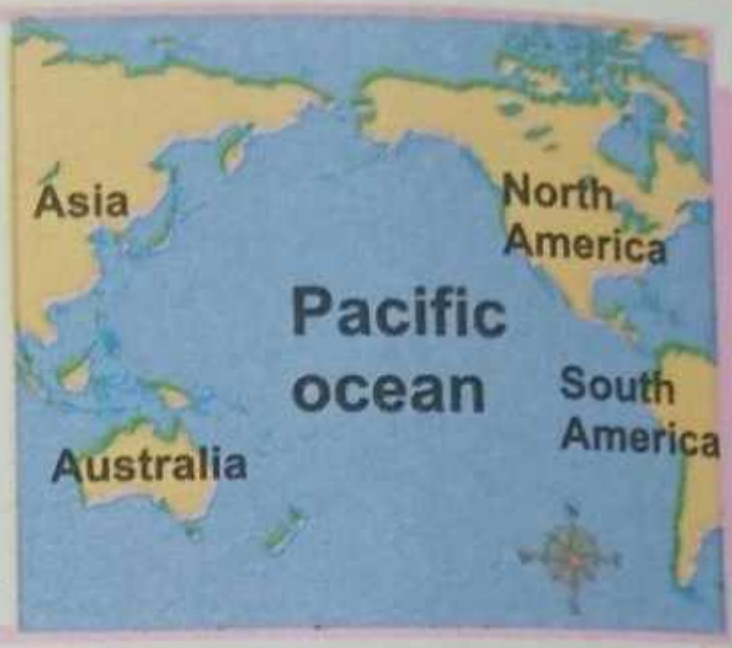
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9.1.2 Lakes

Lake can be defined as a small standing water body which is generally filled with a stream (source) and has an outlet for draining water. Lakes must have a constant source of water, otherwise continuous draining of water may result in the drying up of lake. Lakes are generally regarded as a source of fresh water.

DO YOU KNOW?

The Pacific Ocean is the largest ocean on Earth, covering more than one-third of the Earth's surface and nearly half of Earth's water surface.



BAIKAL LAKE DEEPEST LAKE IN THE WORLD

Not only the deepest lake in the world but also the oldest fresh water lake. Baikal, is the second most voluminous lake in the world. Its average depth is 744.4 meters. It is estimated that it contains 20% of world's fresh water. Known as "Pearl of Siberia" lake Baikal is located in Siberian region near the city of "Irkutsh".

Another unique fact about the lake is that it nourishes 1700 species of plants and animals and 1100 out of them are not found anywhere else in the world.



Lake Baikal

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9.1.3 Rivers

Rivers are regarded as the life line of a country. They are main source of water for irrigation in an area. Historically all successful civilizations were flourished beside some famous rivers of the world. Rivers are flowing bodies of waters. Rivers are an important part of the Earth's water cycle as they carry huge quantities of water from the land to the sea.

9.1.4 Springs

Springs are water resources which come out from certain points on the land and flow on the surface of the land. Springs are good source of drinking water. The impurities found in water are naturally filtered off when water passes through different layers of earth. Spring water contains dissolved minerals. For this reason spring water is used domestically for fulfilling the day to day needs. Spring water to some extent is also used for irrigation purposes. In Pakistan natural springs are found in almost every part of the country.

9.1.5 Glaciers



Fig: 9.2 Siachen glacier

At present, glaciers occupy about 10 percent of the world's total land area. Most of the glaciers are present in polar regions like Greenland, Antarctica, and the Canadian Arctic. Glaciers form when snow remains at a particular location for a longer period of time and is transformed into ice. Glaciers have an incredible quality of movement and for this reason they can move like slow rivers. Glaciers can be as small as a football ground and as big as a small town extended to hundreds of kilometers long. Allah has gifted us with a large number of glaciers which are a source of water when they melt in the summer season.

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In Pakistan Siachen glacier is one of the longest glacier and it is also a major source of water. It is located towards north of Pakistan and extends towards China and India.

9.1.6 Underground water

One of the most useful source of water is ground water which is found in the cracks and crevices in soil, sand and rocks. This water slowly moves through aquifers and is extracted from aquifers using water wells and tube wells. In the field of agriculture, ground water extracted through tube wells plays an important role in the irrigation of agricultural lands. Ground water is also used for domestic consumption and industrial use.

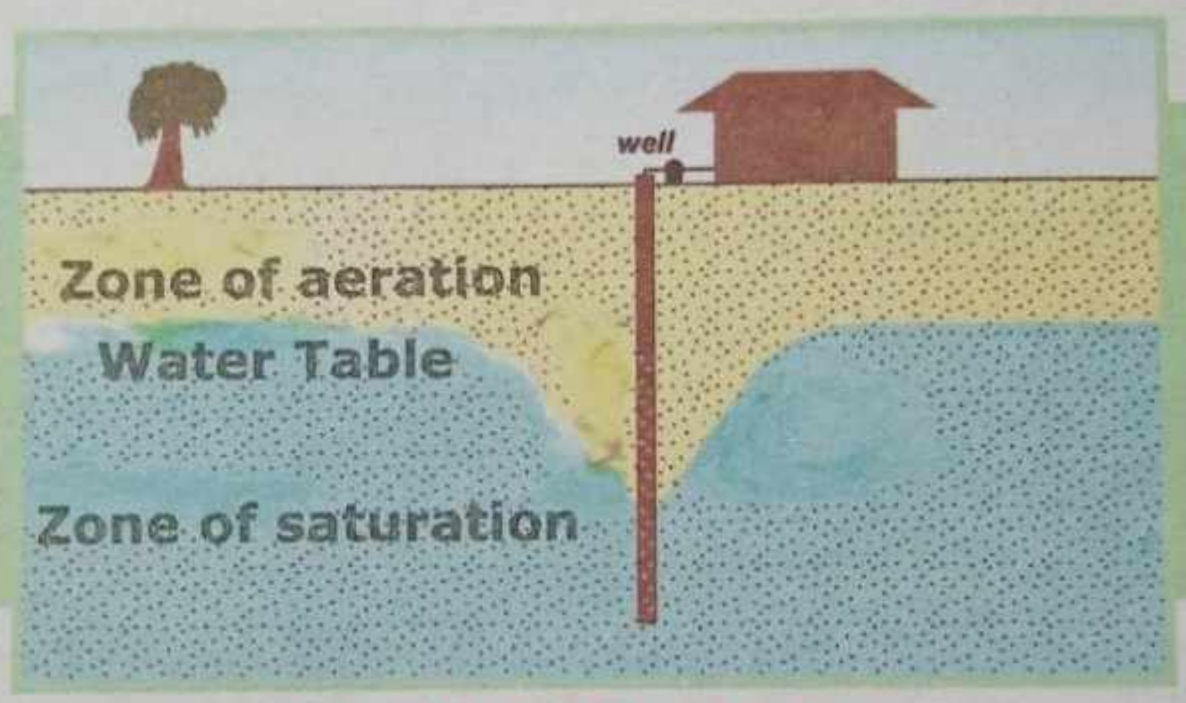


Fig: 9.3 Water Table.

Availability of ground water depends on the water table of the area which is defined as the upper level of an underground surface in which the soil or rocks are permanently saturated with water. The water table lies between the zone of saturation and zone of aeration.

DO YOU KNOW?

An aquifer is an underground layer of water-bearing permeable rocks or unconsolidated materials (gravel, sand, or silt) from which groundwater can be extracted using a water well. The study of water flow in aquifers and the characterization of aquifers is called hydrogeology.

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The availability of ground water depends upon the seasons and the quantity of rainfall recorded in a year. Climatic changes and amount of ground water used by the vegetation determines the status of water table and in turn the availability of ground water in an area.

9.2 AMOUNT OF FRESH WATER AVAILABLE ON EARTH

Freshwater can be defined as the water which containing less than 1000 milligrams per liter salts. As you have studied, in the pervious section, 97% of the global water supply is saline in nature and is found in the oceans. The remaining 3% is 'freshwater' which can be used for drinking purposes and domestic consumption. Of the total freshwater available on Earth about 69% is held by the glaciers and permanent ice sheets of arctic region. Underground water accounts for approximately 30% of the total freshwater supply. Fresh water is also present in lakes, streams, springs etc. Minute amounts of freshwater are also stored in the soil, the atmosphere and in biological organisms.

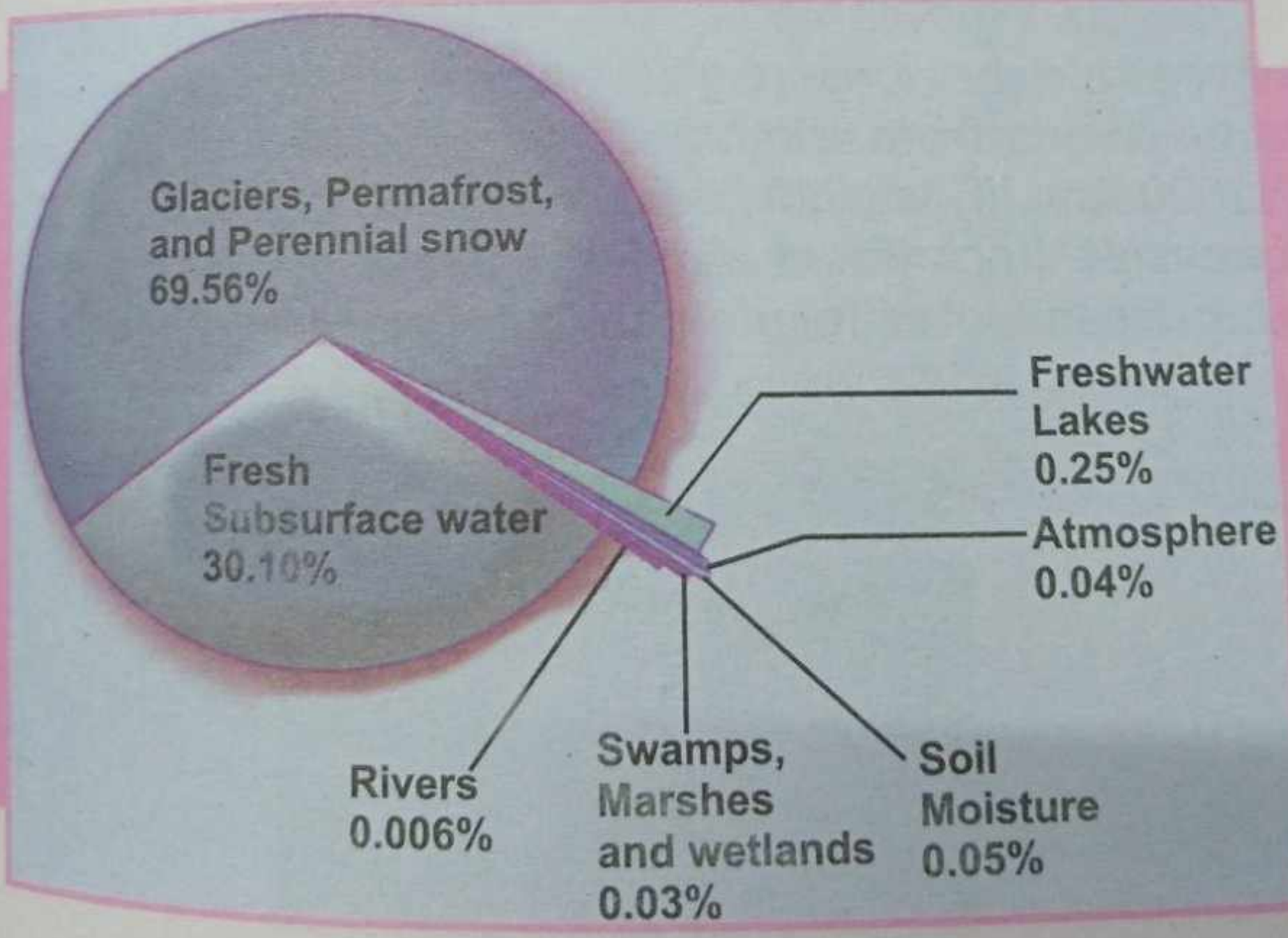


Fig: 9.4 Amount of freshwater on Earth.

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9.2.1 Freshwater Resources of Pakistan

Allah has gifted Pakistan with plenty of fresh water resources in the form of surface water, rainfall, and groundwater. Rivers and fresh water lakes constitute the surface water resources of Pakistan. Pakistan river system is mainly based on the flows of the Indus River and its tributaries. Five major tributaries join Indus on the eastern side are Jhelum, Chenab, Ravi, Beas and Sutlej; besides, three minor tributaries are the Soan, Harow, and Siran, which drain in mountainous areas. A number of small tributaries also join the Indus towards its western side. The biggest of such tributaries is River Kabul.

Monsoon rains constitute about 70 per cent of the annual rainfall that occurs in the months of June to September. These rains in most instances bring floods which damages our infrastructure, agriculture and overall economy of the people of Pakistan. If properly managed this rain water could be utilized for various productive activities. Unfortunately, we have not been able to utilize this precious resource and every year huge amount of flood water drains into the Arabian sea without giving any benefit.

Pakistan has a rich source of groundwater resources. Indus Plain in Pakistan extends from Himalayan foothills to Arabian Sea upto about 1,600 Km. This plain has rich alluvial deposits and is blessed with extensive unconfined aquifers. These aquifers are used for extracting fresh water for domestic consumption and it is also a useful source of irrigation.

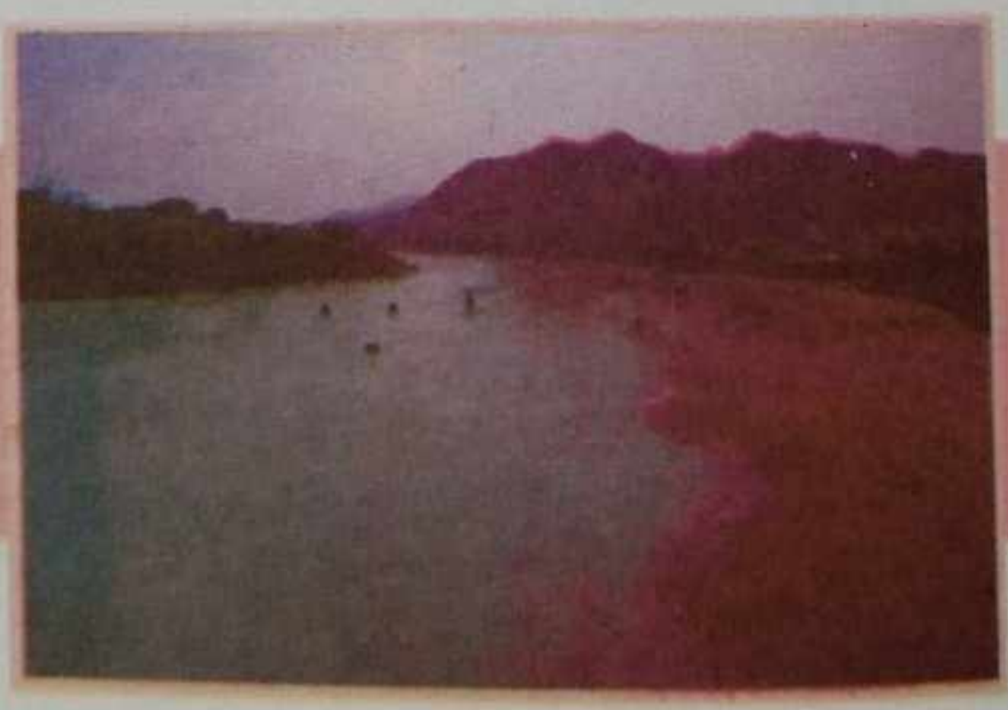


Fig: 9.5 River Kabul & Indus Merging at Attock.

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9.3 WAYS OF UTILIZATION OF WATER RESOURCES IN PAKISTAN

Allah has gifted Pakistan with abundant water resources. Rivers flow down from the Himalayan and Karakoram range. Melting water from mountainous glaciers adds to the flow of rivers.

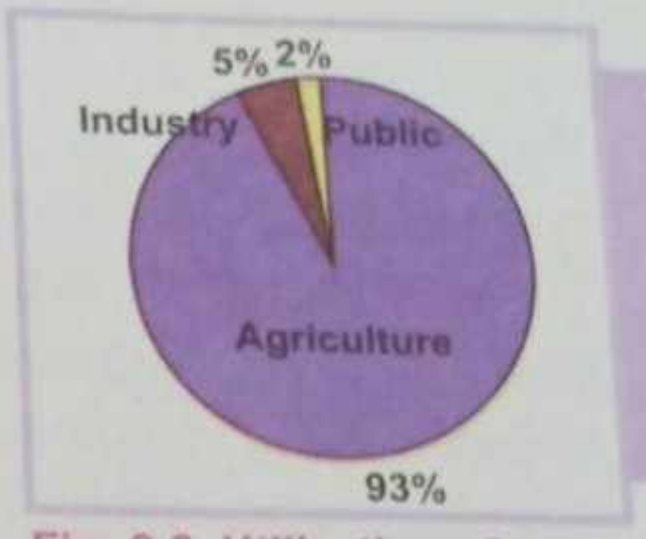


Fig: 9.6 Utilization of water by different sectors.

In Pakistan water resources are used in three broad categories. Firstly, water is being used in the domestic activities which include water being used for drinking , cooking, bathing, washing etc. Secondly, water has an important role to play in industrial and manufacturing sector, for example, industries related to metals production, wood and paper products, chemicals etc consume large quantities of water. In industries water is used in processing, washing, diluting, cooling, or transporting a product.

Thirdly, the agricultural sector of Pakistan is largest consumer of water. Pakistan has a total area of 79.6 million hectares. Out of this about 27 percent of the area is currently under cultivation. Almost, 80 percent of the current cropped area is irrigated with the help of canals. Pakistan has one of the largest canal system in the world and so has one of the highest proportions of irrigated cropped area in the world. Apart from these Pakistan has built several water reservoirs and dams. These reservoirs are not only producing energy but these have a key role in managing the irrigation system of Pakistan.



Water is used for irrigation.



Water is used in different industries.

Fig: 9.7

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9.3.1 Issues and Problems of water resource utilization in Pakistan

You have learnt in the pervious sections that Pakistan water resources heavily depend on winter snowfall and monsoon rains. This weather phenomenon is limited to certain areas and the rest of the country receives very little rainfall and people living in such areas have little or no access to surface water. Summer season brings along with it melting of ice and monsoon rains. Water from these sources is fed into our river system. As water flows down, it seeps into ground and makes its way to aquifers where it stays and is available for extraction. Currently, Pakistan water resources are declining and are being degraded because of various types of problems. These include over-exploitation of groundwater, misuse and wastage of surface water and vulnerability of water resources to different kinds of pollution.

In order to increase agricultural yield and feed the ever increasing population, groundwater is either pumped extensively or too much water is diverted from the rivers for irrigation purposes. Consequently these practices results in the formation of salinity and degradation of fertile land. All these factors can lead to the problem of food scarcity in the long run. Pakistan has one of the largest irrigation system in the world. Overall the available infrastructure of canal system has resulted in loss of about two-third of water due to poor transmission and seepage. This in turn has resulted in the problem of water logging and salinity.



Fig: 9.8 We need to use wisely our ground water resource.

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Lack of access to clean drinking water is one of the leading cause of different types of diseases, for example, diarrhea, typhoid, cholera, malaria, dysentery etc. Hydropower is the cheapest source of energy. Pakistan's topography has the capacity where large dams can be built and every year a huge amount of water can be saved . The water stored in the dams is not only used for the agricultural purposes but also to provide electricity. In addition to this, dams provide an effective barrier to floods. Pakistan is an agricultural country and water is the key for its survival. A big investment in the repair of existing dams and large scale construction of new water reservoirs is the first step in conserving water resources of Pakistan.

Pakistan is among the list of those countries which can be severely affected by the climatic changes. In the backdrop of this scenario water resources of the country would be vulnerable to harmful effects of climatic changes. So it is essential that proper water management strategy should be devised to tackle the challenges of water problems.

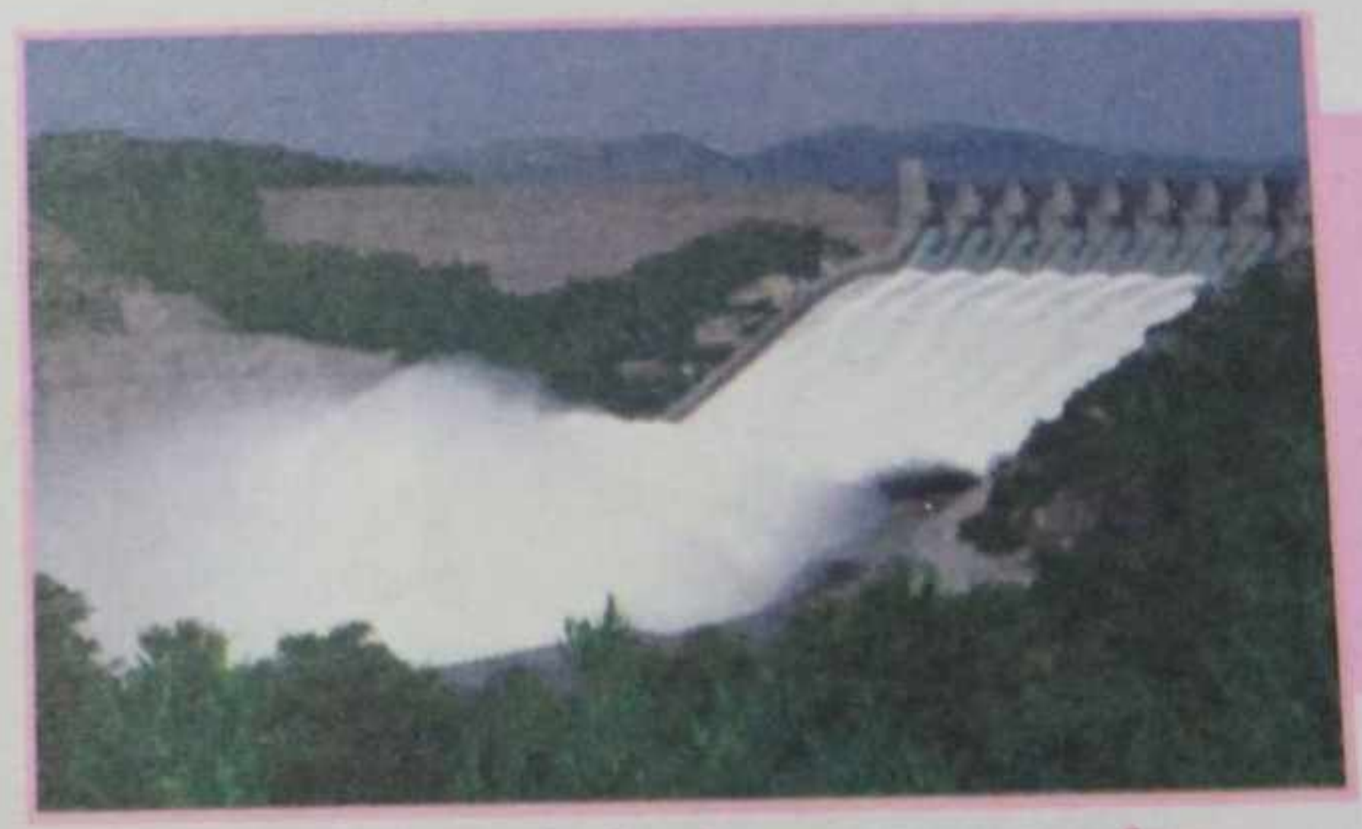


Fig: 9.9 Tarbela dam: a source for electricity and irrigation.

9.3.2 Methods for Reclamation and Conservation of Water

In today's water scarce environment reclamation and conservation strategy gain attention and is a well-established practice in many areas of the world. Historically water is being recycled for billions of years and every water molecule has been used countless times before it has reached us. Water continuously circulates through hydrological cycle, from the sea, to air and land, and back to the sea.

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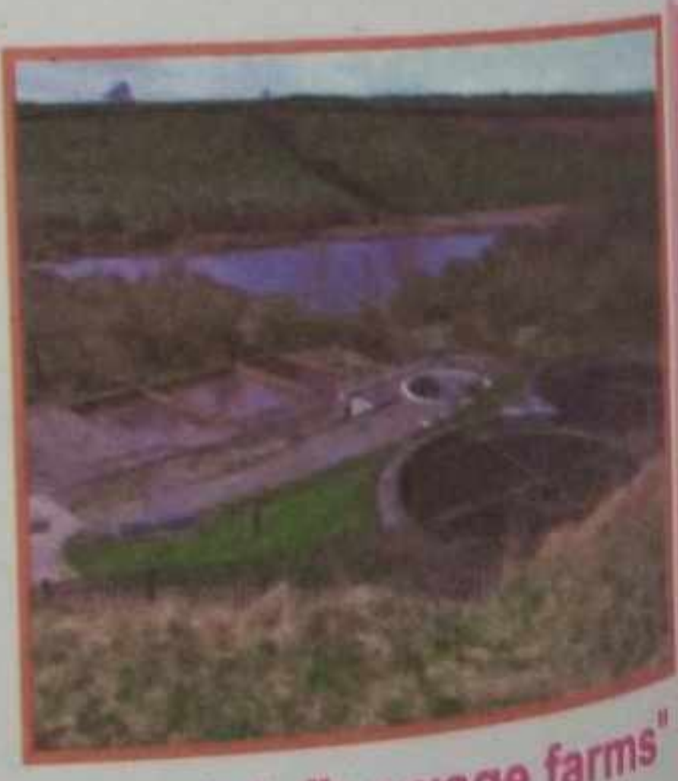
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The term reclamation of water means to reclaim usable water from waste waters and to use this water for irrigation and for other purposes. Reclamation strategies are initiated at places where abundant waste water is generated. There are a number of methods for the reclamation of water from waste water. One such strategy is given below:

1. Sewage is sent for primary treatment in which water is separated from large particles after which it enters sedimentation tanks. Solid particles settle at the bottom and waste water is separated.
2. After primary treatment waste water is sent for secondary treatment. Here bacteria are added to the waste water so that to ingest organic wastes.
3. In tertiary treatment waste water is filtered and is disinfected with chlorine, and any leftover salt is removed.
4. For recycled water to become drinkable, tertiary-treated water undergoes advanced water treatment technology. Water is then disinfected by ultra violet light (UV) or hydrogen peroxide. Finally it is added to groundwater or surface water reservoirs where it stays for several months to be further purified by natural processes.

FOR YOUR INFORMATION

The idea of applying waste water to cropland is not a new one. Scottish "sewage farms" were operating in 1650s and this practice also spread to other English cities. Today over 500,000 hectares (1,930 square miles) in fifteen countries are irrigated with municipal wastewaters. Australia's Werribbee Farm, in operation since 1897, is one of the largest reclaimed waste water operations utilizing system of waste water ponds.



Scottish "sewage farms"

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However, one of the best strategy in the natural resource management is to use the resource wisely and make strategies for its conservation so that the coming generations have the chance to take equal benefits from the resource too. Water being a key resource need serious efforts both at the individual and at the government level. Following are some of the measures which can be followed to achieve this objective.

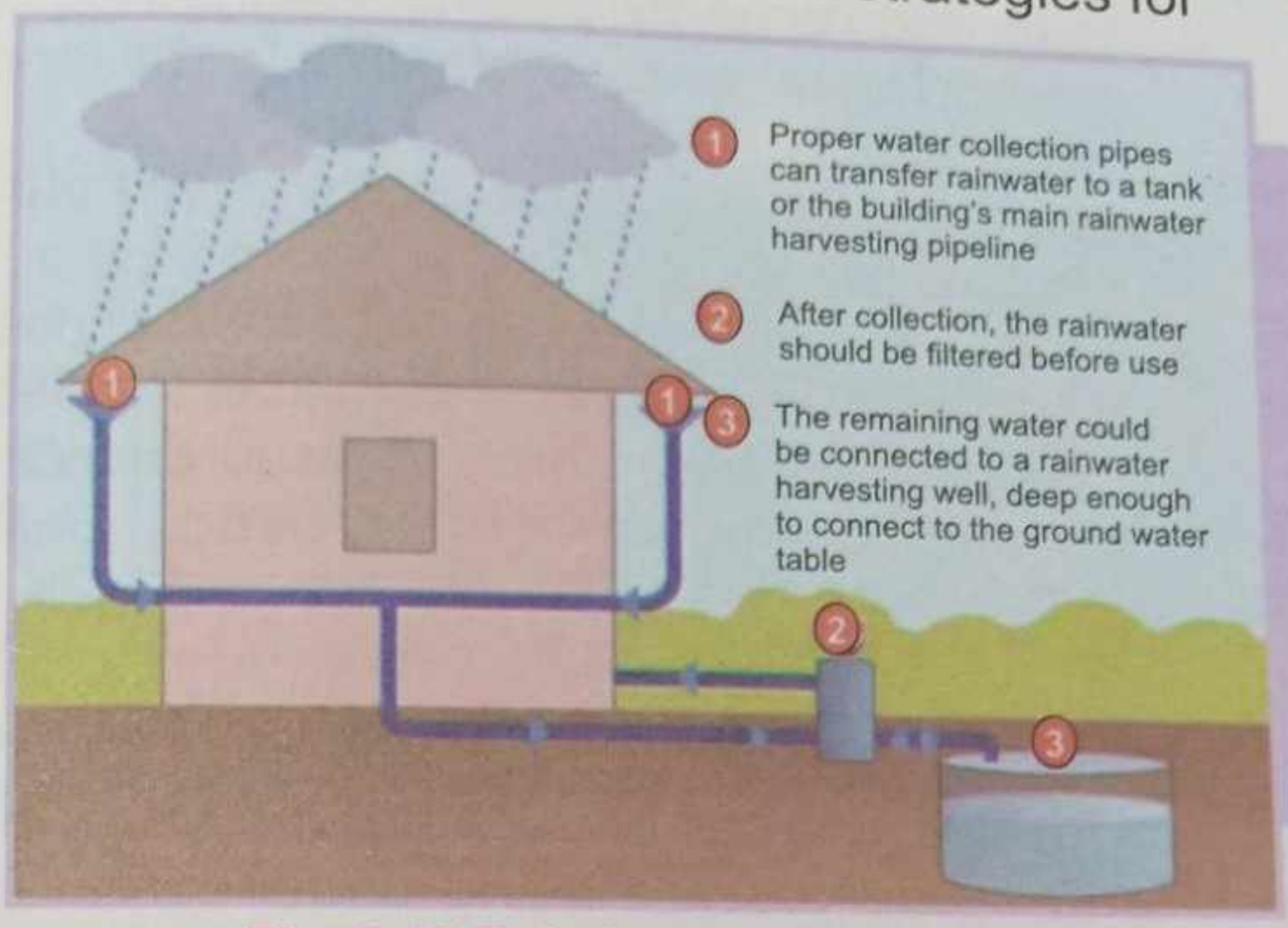


Fig: 9.10 Rain harvesting system

- You can save some precious water by following some simple measures like closing the tap while cleaning your teeth.
- In your home, make it sure that taps and showers are closed and do necessary repairs for leaking and damaged water pipes.
- Rain water can be collected and can be used for gardening and washing.
- In the field of agriculture water can be saved by the the use of efficient irrigation techniques for example, drip irrigation and overhead irrigation.



Fig: 9.11 Over head irrigation system.



Fig: 9.12 Drip irrigation.

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- One of the useful practice to recharge the underground water is to dug recharge pits for storing rainwater and stop runoff water. These give ample time to the land to recharge ground water supply.
- Increase in the vegetation cover and planting more trees can stop run off water.
- Storing surplus water in large water reserviors during rainfall season can make water available for use in the dry spells for irrigation purposes on one hand and control flooding during the rainy season on the other hand.

9.4 THREATS TO WATER RESOURCES

Although water is present in large quantities throughout the world, the sources of usable and drinkable water are limited. Water resources are being under threat due to unwise and unplanned human activities like growing trends of urbanization, over population, worldwide competition for controlling water resources and increasing pollution.

FOR YOUR INFORMATION

Point and Non Point Source Pollution

If the source of the pollution is stationary or immobile then that is point source of pollution. Domestic, municipal and industrial establishments are some examples of point sources. On the other hand, the pollution is non point if the origin of the pollutants is mobile or non-stationary. For example, means of transportation such as cars, buses, airplanes and ships.



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Recent adverse effects of climate change and changes in the overall ecological factors have made significant impacts on the water resources present on planet Earth. Let's study some of the major threats to water resources in some more detail.

9.4.1 Pollution

Human activities in one way or the other are a major reason for the pollution of water resources. Water pollution is brought about by industrial wastes, municipal wastes, agricultural wastes, fertilizers, pesticides etc. These wastes are dumped into the rivers. Industries pollute water by adding chemicals like acids, alkalis, salts, detergents, phenols and other compounds into it. This polluted water is highly toxic that may either kill the microorganisms that purify water or inhibit their growth.



Fig: 9.13 Water is contaminated by effluents from factories.

The chemical wastes degrade the water quality and are harmful to other aquatic organisms. D.D.T and other pesticides may pollute water thus decreasing the fish population and that of the fish eating birds. Other agents of water pollutants are bacteria, viruses, algae, faecal wastes and other pathogens of typhoid and cholera which make water unsafe for many purposes. Sewage and runoff from farms, contain nutrient elements like nitrogen and phosphorus. Sewage with these qualities can be a reason for the excessive aquatic plant growth, and result in a process called eutrophication which causes algal blooms and damage ecosystem of that particular habitat. Oil and petrol also cause water pollution which spread over the water surface and prevents penetration of sunlight and mixing of oxygen in the ocean water.

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DO YOU KNOW?

Eutrophication is a process in which water bodies such as lakes, ponds receive excess nutrients that stimulate excessive plant growth especially algae. Such condition reduces dissolved oxygen in the water.

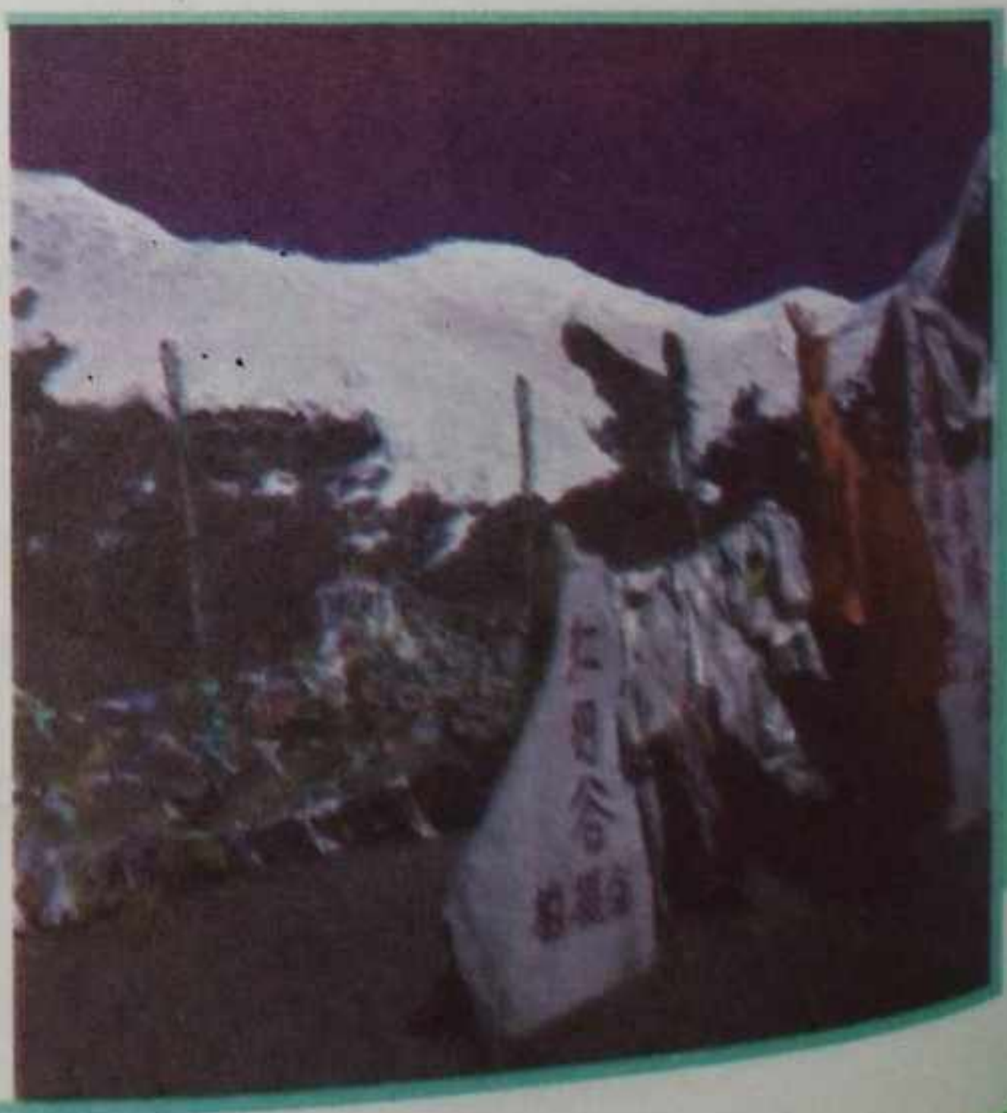


9.4.2 Climate change

Globally climate change has resulted in heavy rains causing floods and extreme hot and dry conditions. Although these two conditions are opposite to each other, a quick glance at the water cycle shows that during water cycle water evaporates from the sea and land and returns to the earth as rainfall and snow. Global warming and rise in temperature has resulted in higher rates of evaporation and warm air holding intense rainstorms, bringing large amount of water which flows down into the rivers and streams. The soil remains dry and it increases the risk of drought. One clear evidence of climate change is the shrinking and melting of glaciers which have already been noticed in many parts of the world.

FOR YOUR INFORMATION

It has been predicted that most glaciers in Tibet could melt by 2100. And while it was initially thought that the water released could benefit China's arid north and west regions, however, it now appears that the melting water will evaporates long before it reaches drought-effected regions.



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9.4.3 Urban growth and landscape changes

The process of urbanization has resulted in the haphazard development of residential and industrial areas in large cities. These areas are the main source of point-source pollution. Urbanization trends generally suggest more economic activities and development. Development of roads, infrastructure and other human activities put stress on precious natural resources including water resource of that area.

Domestic wastewater combined with untreated industrial waste pose a serious threat. Ill managed sanitation system and sewage treatment is the threat to water bodies. Often the nearby water bodies are used for releasing untreated water from urban areas and industries. Rivers in developing countries are more like open sewers than rivers. Garbage collection and disposal facilities are lacking in most cases. So one can see polythene bags and other solid wastes in streams and rivers. In these conditions fish population has almost become non- existent.



Fig: 9.13 Urbanization results in haphazard growth of urban landscape.

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Coastal Urban centres dump untreated sewage in the sea which results in the contamination of beaches. This not only affects the marine habitat but it also poses a serious threat to those who visit these beaches for recreational purposes.



Fig: 9.15 City beach being contaminated by sewage.

Yet another problem is deforestation or cutting of forest. Trees are cut to clear land for agriculture, for the establishment of industrial zones, infra structure and for the development of residential areas. Once the land is exposed it is open for all types of environmental hazards. Exposed land is vulnerable to the process of erosion which results in the loss of soil nutrients and consequently fertility of the land is lost.

Forests also play an important role in the regulation and maintenance of water cycle. Roots of the trees not only hold precious soil but allow more water to be absorbed by the soil and moves this water to the underground water reservoirs.

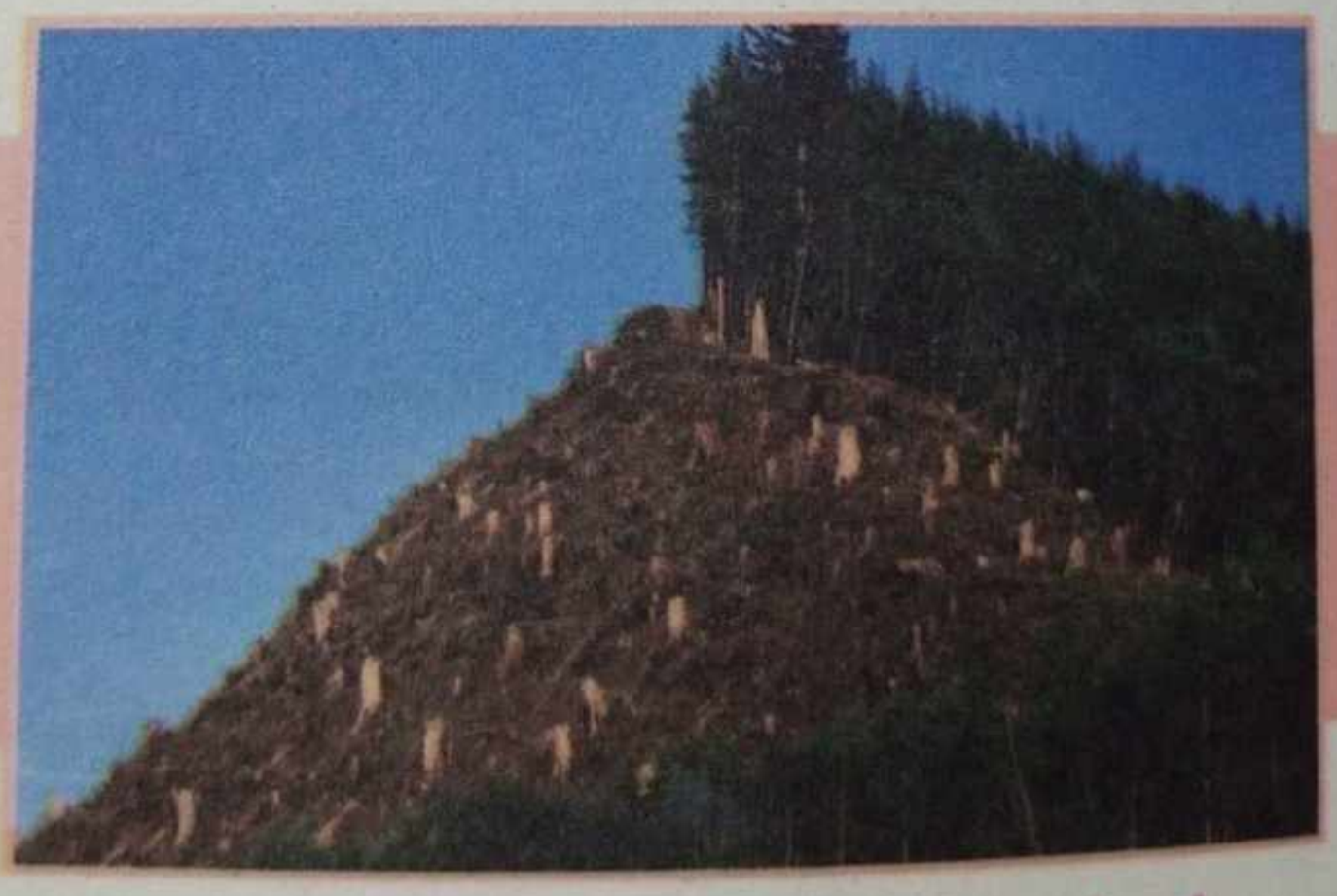


Fig: 9.16 Deforestation exposes land for erosion.

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The Earth is facing serious challenges in the form of climatic change, environmental degradation, as well as pressures due to human activities. All these problems in one way or the other are affecting the water resources. A strategy for the protection and conservation of water resources is the need of the hour for the future generations.

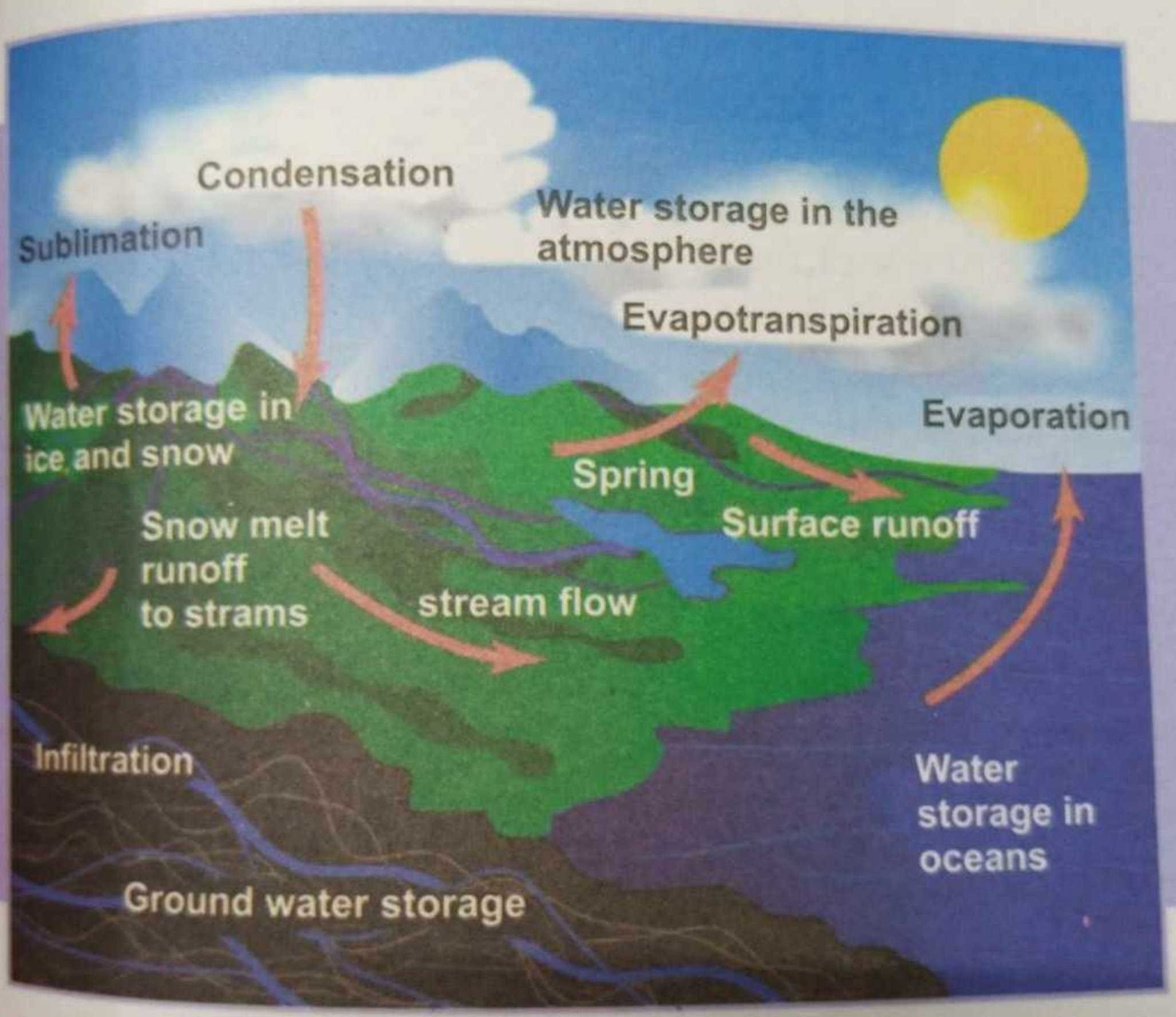


Fig: 9.17 The Water Cycle explains interactions between the atmosphere, hydrosphere, and lithosphere. Evaporation of water from the oceans, seas, rivers, and streams into the atmosphere produces precipitation. Water can take the form of ice caps and alpine glaciers. Ice melts, causing water runoff, that either percolates through the Earth to become part of the water table or makes its way back to the sea.

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9.5 IMPLICATION OF GROWING WATER DEMAND IN THE WORLD

You have learnt in the pervious sections that water used for human consumption is limited in quantity. Only 1% of the total amount of water present on planet Earth can be utilized. Due to this reason competition for water resources is growing and its effects are evident from the rising tensions between different countries and nations in different parts of the world.

Water is vital for our survival and its scarcity affects every sphere of life i.e social, political, economic and it even threatens the health of the ecological system. Water scarcity has already lead to growing pressure on freshwater resources in many places around the world. According to one of the estimates approximately 2 billion people are currently living in areas faced with water stress and its scarcity.

For the last many decades there has been a sharp rise in human population and this trend in human population growth has been a major contributor to water scarcity. Population growth limits the amount of water available per person. Growth in populations means mounting demand and competition for water in the field of agriculture, domestic, industrial, and municipal uses.

Population growth demands more food and more water is needed to produce that food. In agriculture sector water is mainly used for irrigation.



Fig: 9.18 Agriculture sector is a major consumer of water.

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FOR YOUR INFORMATION

Water is a precious resource. Countries around the world are making it sure that their water resources are safe and are available for use. Water shortage has become the cause of certain conflicts in many regions around the world. The bloody conflict in Darfur, (Sudan), that began in 2003 and killed as many as 400,000 Africans, started, in part, over access to a diminishing water supply in that region.



In this activity plenty of water is misused and is wasted. Overall agriculture accounts for about 70% of the total usable water present globally. Agricultural productivity determines the status of global food security. So the availability or scarcity of water directly impacts food security at the global level. Keeping in view the current trends in population growth it is expected that food demands at the global level will be almost double in the coming few decades. So food production will demand more water and put extra pressure on the already depleting water resources at the global level.

Yet another aspect of population growth is a rising trend towards industrialization. Water is used in industries for carrying out different activities, for example cooling, processing and disposal of waste products.

Another challenge to the water resources is growing trend of urbanization especially in the developing countries. Over populated cities put pressure on the water resources and increased levels of pollution deplete usable water resources thereby making people vulnerable to water shortages. At the same time it increases per capita consumption of water. These circumstances coupled with climate change could have negative implications on the livelihoods, health, and security of the people especially in the developing world.

Already it has been established by the international health organizations that water related diseases is the major health problem in many parts of the world. Children are more vulnerable to water brone diseases.

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Availability of clean drinking water is a major challenge at the global level and in many parts of Pakistan. Usually women and especially young girls are given the responsibility to fetch water from far flung areas for their families. This in turn affects their health and diminishes opportunities for continuing their educational activities.



Fig: 9.19 Women folk had to travel long distance to fetch water for their families.

Although water cycle renews itself at the global level, usable water is depleting with every passing moment. Sustainable development of water resources is a right step for saving this precious resource for the generations to come.

9.6 SUSTAINABLE DEVELOPMENT OF WATER RESOURCES OF PAKISTAN

Pakistan has sufficient water resources available for consumption. Surface water and ground water resources are present throughout the length and width of Pakistan. Monsoon rains bring huge amount of water but due to poor planning and mismanagement this valuable water takes a destructive form and cause floods.

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Pakistan needs a sound water conservation plan for avoiding water crisis, famine and any possible ecological disaster to happen. Following are some of the important measures for sustainable development of water resources of Pakistan.

- Improving planning, management and community participation in the utilization of local water systems.
- For effective utilization of water resource there must be a regular programme for cleaning canals and waterways.
- A huge amount of water is lost due to seepage from canals lining. Proper lining of the canal system could reduce these losses.
- Efficient irrigation techniques can reduce water loss. For example drip irrigation delivers water directly to the roots of crops and save precious water.
- Steps for the conservation of environment and to check and control those factors which are contributing to its degradation.
- Establishment and maintenance of proper sanitation system for ensuring less contamination of local water bodies.
- Maintaining a proper check on the extraction of ground water.
- Storage of flood water during monsoon season by construction of small dams especially in the barrani areas.
- Launching public campaign emphasizing conservation of water at all levels.
- Lastly construction of mega dams could store huge amount of flood water and could provide water for irrigation too.

9.7 POTABLE WATER SYSTEM

Potable water or drinking water can be defined as the water which is considered safe for consumption both for humans and animals. You have learnt that natural freshwater sources like springs, lakes, rivers, if not contaminated by human activities, provide safe water for human consumption.

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Contaminated drinking water coupled with poor sanitation are the major reasons for different types of diseases like diarrhea, dysentery etc. These conditions account for nearly two million deaths with children under the age of five being the major victims. It is highly desirable to treat water before it is pumped for distribution. In a treatment plant water comes from surface water like man made water reservoirs, rivers, lakes. This water has high levels of particulate matter, minerals, metals, compounds containing chlorides. As opposed to this, groundwater is low in oxygen and it contains hydrogen sulphides and sulphate.

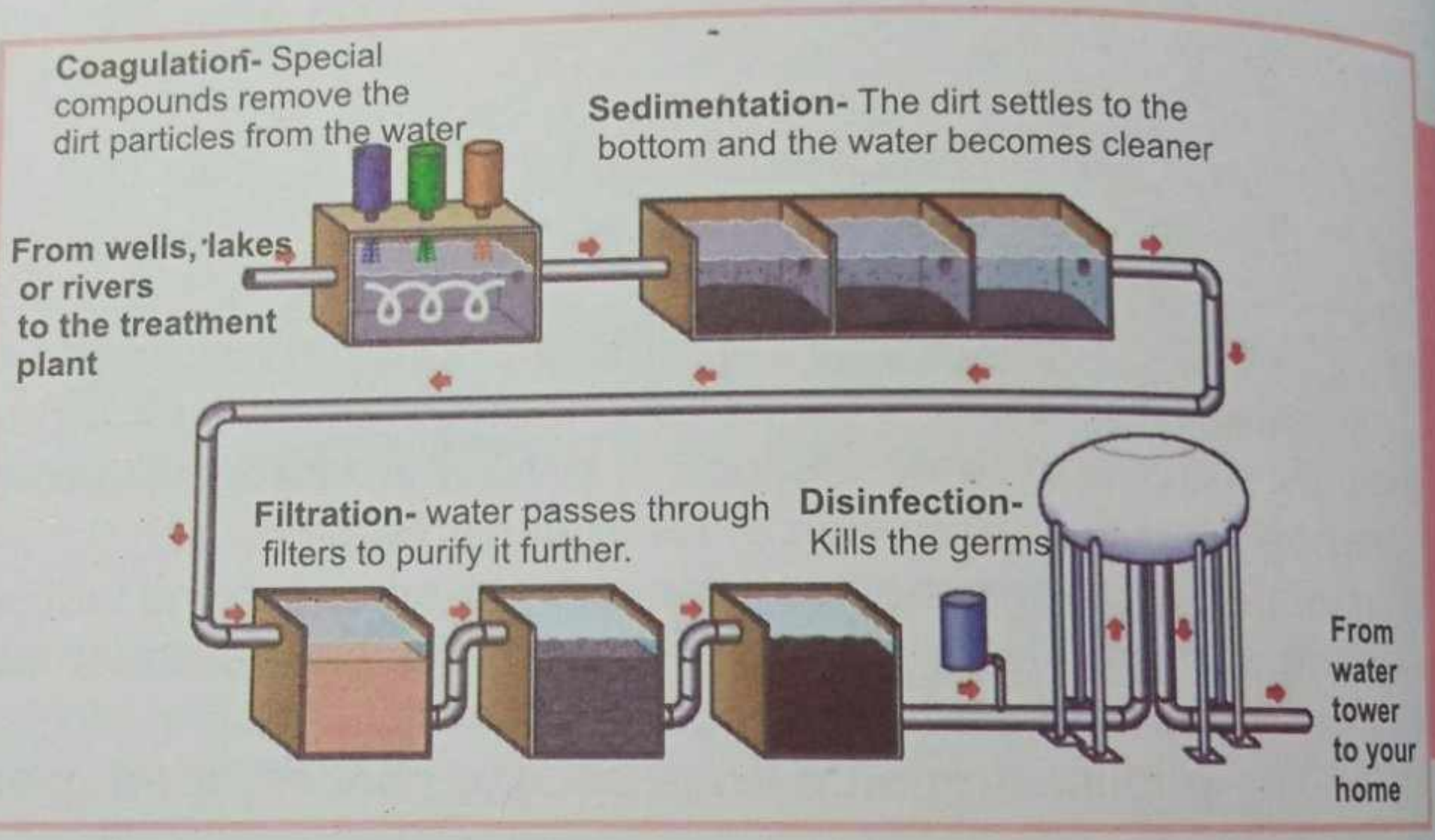


Fig: 9.20 Water treatment plant.

In a treatment plant, the first step is pre-chlorination for algae control and arresting biological growth. Second step is aeration along with pre-chlorination for removal of dissolved iron and manganese. Water is passed on for further chemical treatment using alum, caustic soda, ferrous sulphate. These chemicals help in neutralizing water and in the precipitation of metallic ions and particulate matter. Finally the treated waters proceeds for final filtration process. This filtration is done in stone/gravel filter beds or activated carbon. After this water is processed for final disinfection. This is done by an oxidant such as chlorine. After final disinfection, the treated water is pumped for distribution to different parts of the city.

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KEY POINTS

- Water is a vital resource used in various ways including direct consumption, agricultural irrigation, hydropower, industrial production, recreation, navigation, environmental protection, the disposal and treatment of sewage and industrial effluents etc.
- About 71 percent of the Earth's surface is covered by water and the oceans hold about 96.5 percent of all Earth's water.
- Approximately 30 percent of the world's fresh water is in liquid form held as ground water.
- Lake is a small standing water body which is generally filled with a stream (source) and has an outlet for draining water.
- Glaciers are made up of snow that falls over many years and compresses into large ice masses.
- Freshwater contains less than 1000 milligrams per liter of dissolved salts.
- The usage of water can be divided into three broad categories i.e. domestic consumption, commercial/ industrial use and usage for land irrigation.
- The total geographical area of Pakistan is 79.6 million hectares. About 27 percent of the area is currently under cultivation. Of this area, 80 percent is irrigated.
- Every glass of water consumed contains water molecules that have been used countless times before and in this way, all water on Earth can be reused again and again.
- Pressures on water resources are increasing mainly as a result of human activity – namely urbanization,

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- population growth, increased living standards, growing competition for water, and pollution.
- Freshwater pollution is caused by industrial wastes, sewage, runoff from farmland, cities, and factory effluents and the build-up of sediment.
- Mountain glaciers are shrinking, and this trend has accelerated considerably in recent years due to climate change.
- Urbanization is the process by which cities and towns develop and grow into larger areas.
- Deforestation is a process by which forest areas are removed and the land is utilized for other uses including agriculture, industrialization, resources or settlements.
- Poor water quality and unsustainable use of water resources can limit the economic development of a country, harm health and affect livelihoods.
- Potable water is water which is fit for consumption by human and animals.
- Population growth is a major contributor to water scarcity. Growth in populations means mounting demand and competition for water for domestic, industrial and municipal uses.
- Agriculture accounts for approximately 70 percent of global water use and for as much as 95 percent of water use in predominantly agriculture-based countries.
- Industrial production depends on water for processing, cooling and disposal of waste products.

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EXERCISE

A. Select the correct answers in the following questions.

1. **The largest bodies of water on Earth are:**
   a. Sea
   b. Rivers
   c. Oceans
   d. Underground water

2. **About 30% world fresh water is in the form of**
   a. Solid
   b. Liquid
   c. Gas
   d. Water vapours

3. **Glaciers are predominantly present in which one of the following regions?**
   a. Europe
   b. Antarctica
   c. Africa
   d. Asia

4. **Sea water is basically _____ in nature.**
   a. Acidic
   b. saline
   c. neutral
   d. fresh

5. **The concept of sustainable development encourages:**
   a. Form of growth that meets current basic needs
   b. Preservation of the resources for the need of future generation
   c. A change in all respects of life
   d. Growth to meet current needs, preservation for the needs of future and change in all respects of life

6. **How many percent of the world water is suitable for human use?**
   a. 25%
   b. 10%
   c. Less than 1%
   d. 40%

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7. **Water that is safe to drink is called**
   a. Tap Water
   b. Potable water
   c. Distilled water
   d. Non Potable water

8. **Which human activities need the most water?**
   a. Personal hygiene
   b. Cooking
   c. Irrigation
   d. Drinking

9. **How much of the global water supply is found in oceans?**
   a. Less than 28%
   b. About 75%
   c. About 87%
   d. About 97%

10. **What is the process by which water enters the small pore spaces between particles in soil or rocks?**
   a. Transpiration
   b. Infiltration
   c. Precipitation
   d. Sublimation

11. **Which of the following statements about the water table is false:**
   a. The water table changes when discharge is not balanced by recharge.
   b. The water table is generally flat.
   c. The water table is above the land surface in lakes.
   d. The water table is depressed near high volume pumping wells.

12. **The boundary between the saturated zone and the unsaturated zone is called:**
   a. Water table
   b. Aquifer
   c. Aquilude
   d. Sedimentation zone

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13. **Which one of the following is used in disinfecting water?**

a. Bromine
b. Chlorine
c. Iodine
d. Fluorine

14. **Which of the following can contaminate an aquifer?**

a. Land pollution
b. Air pollution
c. Extraction machines
d. All of these

B. Write short answers of the following questions.

1. Enlist various forms of water available on the Earth.
2. What do you mean by underground water?
3. What do you mean by freshwater. Why it is important to us?
4. What do you mean by potable water?
5. Enlist major pressures on water resources.
6. Give three main measures for sustainable development of water resources of Pakistan.
7. Give a brief account of climate change on water resources.

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C. Write in detail answers of the following questions.

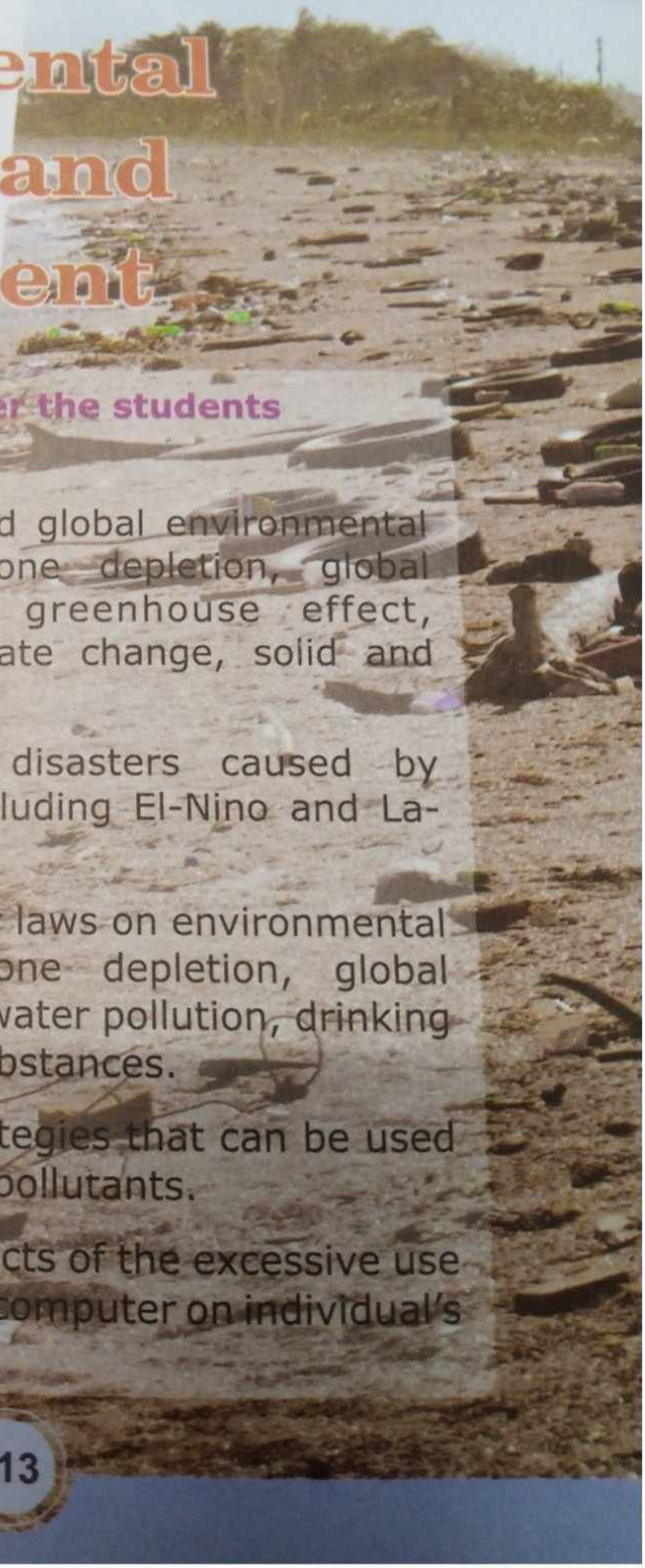
1. Identify the amount of fresh water available on Earth with an emphasis on Pakistan.
2. The level of agricultural production is directly related to the availability and effective use of water as a major input. Justify the statement.
3. Describe the existing ways of utilization of water resources in Pakistan.
4. Explain the issues and problems Pakistan is facing in utilizing the water resources effectively for its people.
5. Explain the methods of reclamation of water.
6. Write an essay on conservation of water.
7. Explain how water resources are being threatened by urbanization and deforestation.
8. Describe the implications of growing demand of water in the world.

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Unit 10

Environmental Problems and Management



After studying this chapter the students will be able to:

- Identify the regional and global environmental problems such as ozone depletion, global warming, acid rain, greenhouse effect, desertification and climate change, solid and hazardous wastes.
- Describe the natural disasters caused by earthquakes, storms including El-Nino and La-Nina.
- Identify the legislation or laws on environmental problems such as ozone depletion, global warming, air pollution, water pollution, drinking water quality and toxic substances.
- Describe the control strategies that can be used for treating air and water pollutants.
- Describe the harmful effects of the excessive use of Television, mobile and computer on individual's health.

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INTRODUCTION

Development and prosperity of the modern age has resulted in improving the quality of life and the living standard of people throughout the world. But this development and prosperity has been accomplished by paying heavy price in the shape of environmental degradation and climatic change which have global impacts. No matter how developed or otherwise a nation is, we all inhabit the same planet Earth and we have to tackle the issues and challenges of environmental degradation as member of the international community. In this chapter you will study some of the serious global environmental issues, the legislation addressing these problems and possible measures to control them.

10.1 REGIONAL AND GLOBAL ENVIRONMENTAL PROBLEMS

In a region sustainable development depends on environment. Local and global environmental issues are closely linked with each other. For example, in order to meet the demand of growing population, people in different parts of the world are transforming forests and natural grasslands into farmlands. There has been an increase in the use of nitrogenous fertilizers and irrigation practices. These have a direct impact on the environment. Land erosion, water logging and salinity of precious agricultural lands have resulted in land degradation. Natural ecological systems have been damaged, affecting the biodiversity of an area.

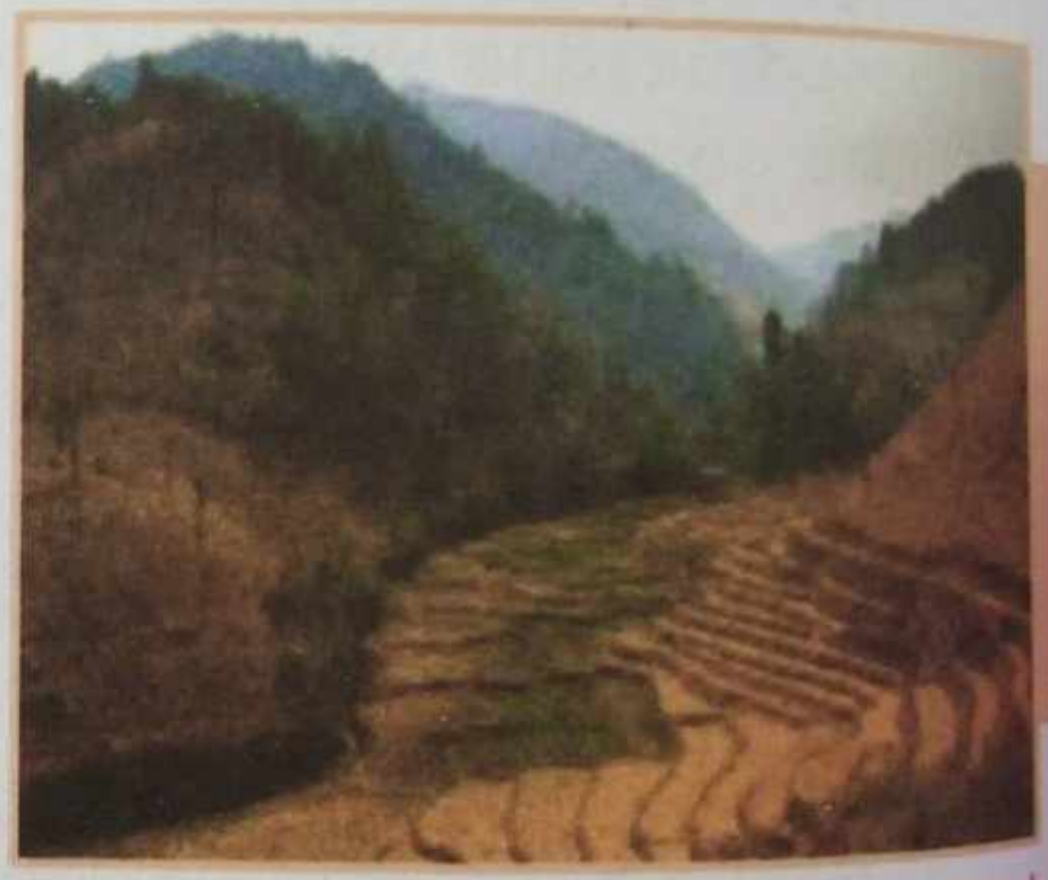


Fig: 10.1 Forests are being cleared for agricultural purposes.

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10.1.1 Ozone Layer Depletion

About 10-45 kilometres above the Earth's surface, there occurs a layer of ozone encircling our planet. This layer is present in the stratosphere part of the atmosphere. It shields the Earth from most of ultraviolet radiations coming from sun. Ozone layer is capable of absorbing 97-99% of the harmful ultraviolet radiations that are emitted by sun.

The depletion of ozone became known to us in 1985, with the discovery of a big hole in the ozone layer over Antarctica continent. The loss of ozone is caused by commercially important compounds called chloroflurocarbons (CFCs) of which the most important is Freon. When a CFC drifts up into the stratosphere it releases active chlorine which reacts with the ozone molecules of ozone shield. A single atom of chlorine destroys about 100,000 molecules of ozone. CFCs are used as coolants in air conditioners and refrigerators, as foam for insulation and packaging and as medical sterilizers.

With the depletion of ozone layer, higher levels of ultraviolet radiations reach the surface of the Earth. This causes skin cancer, eye cataracts, weak immunity and damage to crops.

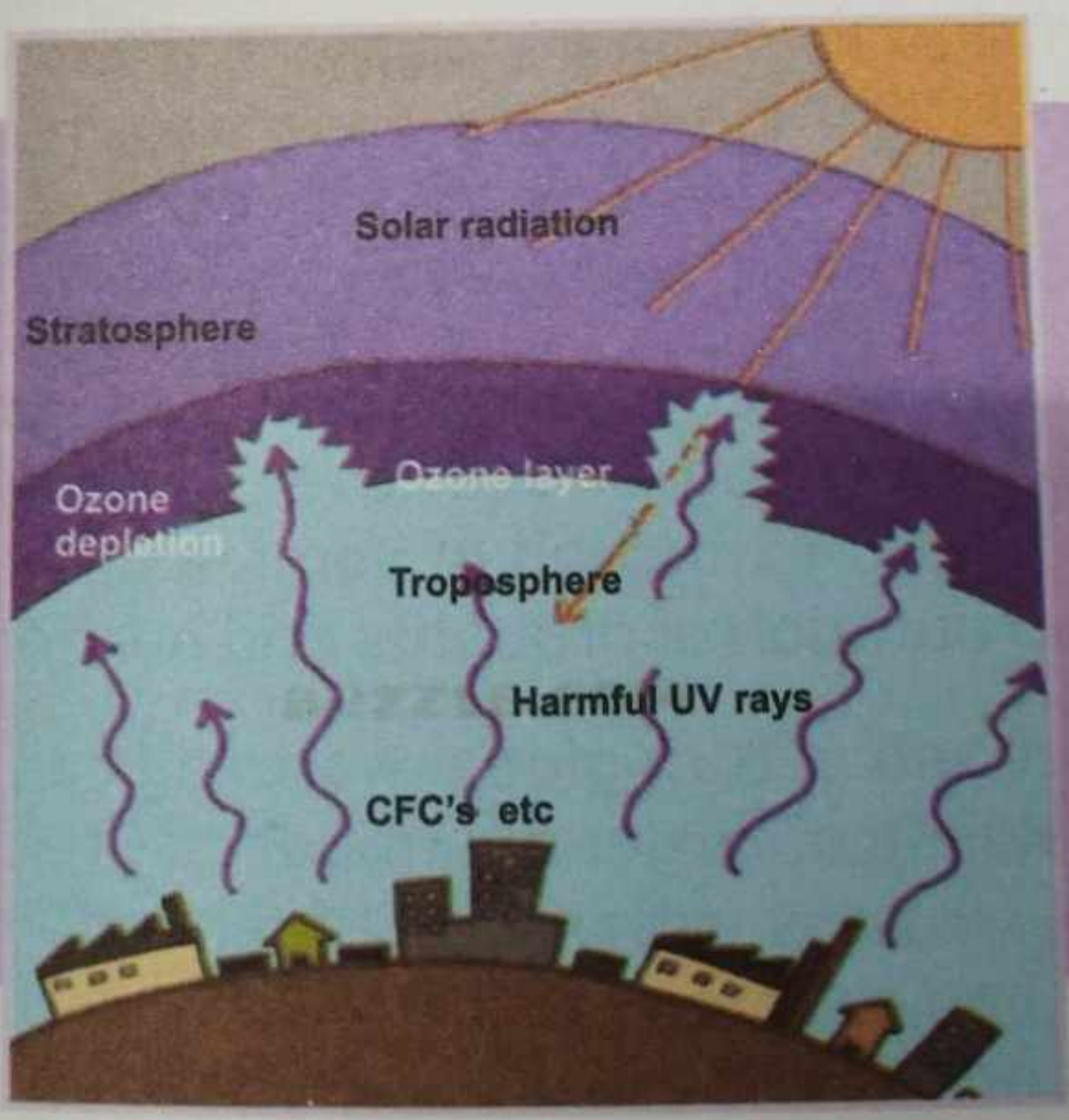


Fig: 10.2 Ozone layer depletion.

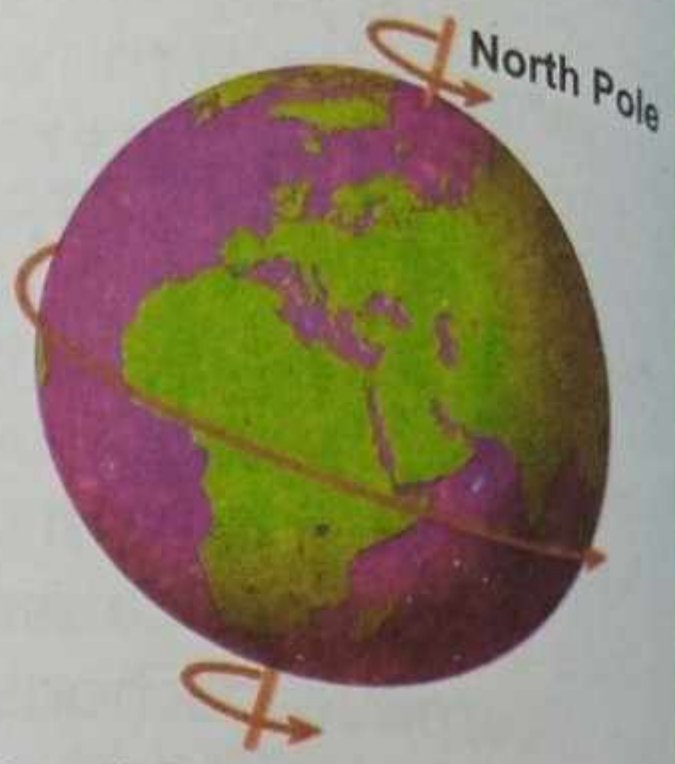
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FOR YOUR INFORMATION

Ozone loss occurs mainly at the poles

The ozone-destroying reactions take place most rapidly under certain conditions in the stratosphere. Scientists often refer to the part of the atmosphere where ozone is most depleted as the 'ozone hole', but it is not really a hole – it is a vast region of the upper atmosphere where there is less ozone than elsewhere.



10.1.2 Global Warming and Green House Effect

The greenhouse effect in the atmosphere cause global warming. The carbon dioxide in the atmosphere allows solar radiations to pass through, but does not permit heat to radiate back into the space. Instead, the heat is reflected back to the Earth's surface which heats up the atmosphere of the Earth. During the past several decades greenhouse gases have accumulated to such an extent that the earth's temperature has increased by 0.8°C as a result of this phenomenon.

The global warming produces harmful effects such as melting of polar ice resulting in rising of sea level, changes in the rainfall pattern, migration and extinction of some animals and increasing the frequency and duration of droughts and hurricanes.

Greenhouse effect and in turn global warming can be controlled by preventing the release of larger quantities of greenhouse gases by reducing the tremendous use of fossil fuel and wood for burning. Use of fossil fuels can also be reduced by using alternate means like electricity, solar energy etc.

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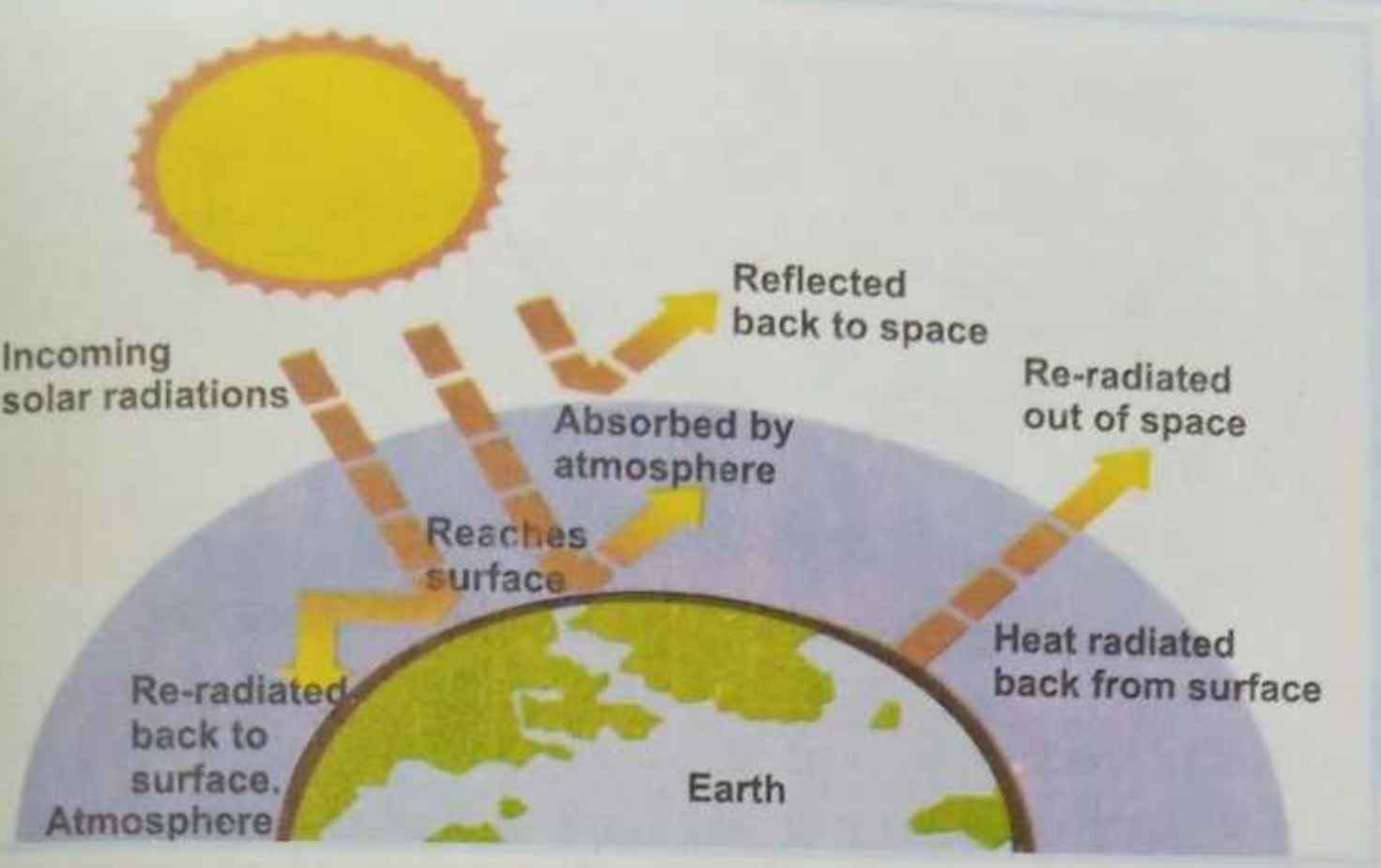


Fig: 10.3 Global Warming and the greenhouse effect.

Increase in the forest area is also a good remedy to reduce carbon dioxide in the atmosphere. Manufacture and use of CFCs should be eliminated completely.

Most greenhouses look like a small glass house. Greenhouses are used to grow plants especially in winter. Greenhouses work by trapping heat from the sun. The glass panels of the greenhouse let in light but keep heat from escaping.



10.1.3 Acid Rain

Acid rain is one of the most dangerous forms of air pollution. It is a widespread phenomenon which affects the living and non living things equally. For years it can remain in an area undetected and for this reason it is called as unseen plague. Technically, acid rain is rain that has a larger amount of acid in it than normal rain.

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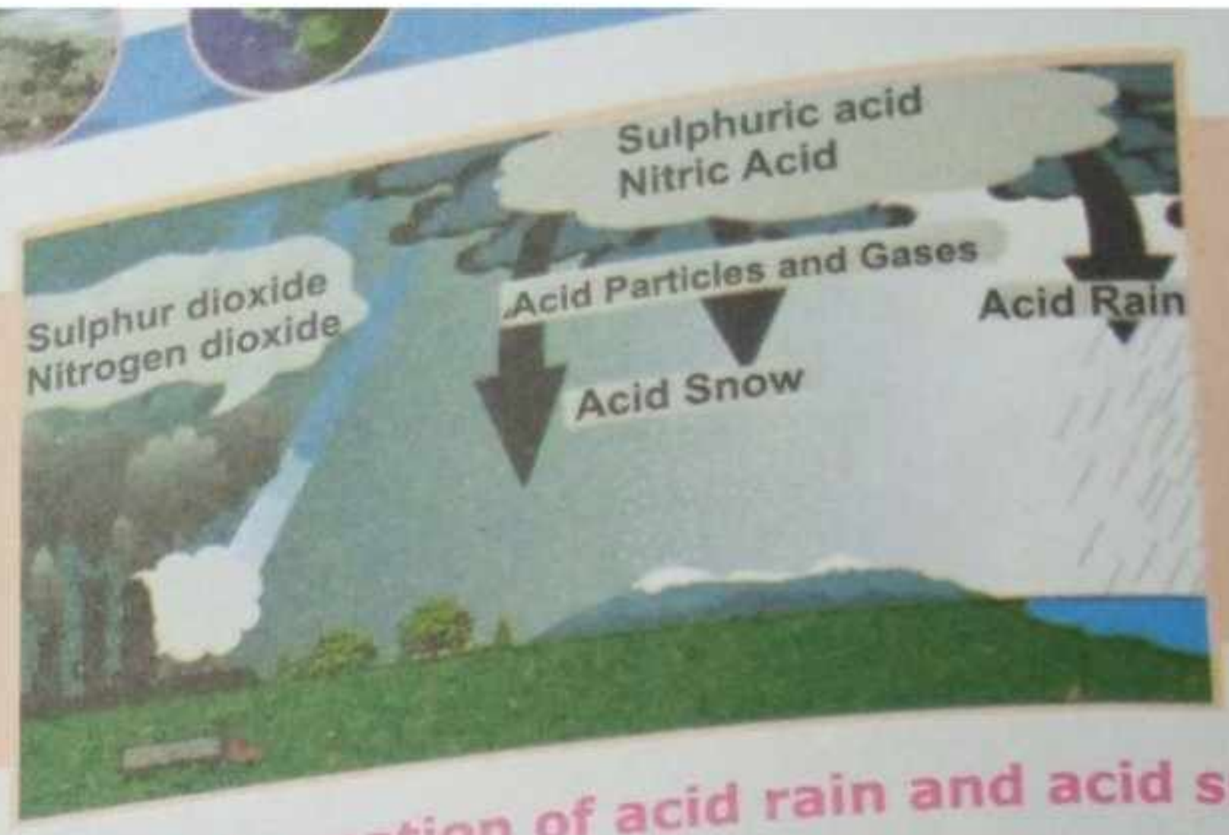


Fig: 10.4 Formation of acid rain and acid snow.

Acid rain is caused by smoke and gases that are given off by factories and automobiles that run on fossil fuels especially coal. When these fuels are burnt to produce energy, the sulphur that is present in the fuel combines with oxygen and becomes sulphur dioxide; at the same time some of the nitrogen in the air converts into nitrogen oxide. Sulphur dioxide and nitrogen oxides in the atmophere dissolve in rainwater to form sulphuric acid and nitric acid respectively. Rain containing these acids is known as acid rain.

DO YOU KNOW?



Before acid rain After acid rain

Acid rain can also damage buildings and historic monuments, especially those made of rocks such as limestone and marble containing large amounts of calcium carbonate. Acids in the rain react with calcium compounds in stones to create gypsum, which then flakes off. This phenomenon related to acid rain is termed as stone cancer.

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When this acid rain falls on buildings, it slowly dissolves the limestones and mortar. When it falls on plants, it damages their leaves and retards their growth. Falling on the earth, acid rain dissolves aluminum salts in the soil and washes them into rivers and lakes. These salts in higher concentration are poisonous to fish and other marine life.

10.1.4 Desertification

Desertification is a process whereby a productive land either through climatic variations or through unwise utilization by humans gets degraded and changes into desert. Sometimes a particular area experiences high and sustained temperatures lasting for months with infrequent and irregular rainfall which leads to dry conditions and drought. The overall impact of such sustained harsh conditions result in failure of vegetation to grow and sustain itself. If such conditions in such an area are being aggravated by overgrazing and deforestation, the situation becomes worst and desertification occurs.

Yet another major reason for desertification is the excessive use of land for agricultural activities. In order to feed the growing population, farmers use land excessively for better yields.



Fig: 10.5 Removal of vegetation exposes soil to the process of desertification.

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However, this unwise utilization of land leads to its degradation and loss of soil fertility. As the land is not given proper time to refresh itself, as a result it becomes unfit for further crops growing. Gradually the upper fertile layer of soil becomes vulnerable to the forces of erosion. If such hostile conditions are sustained for certain period of time the process of land degradation continues and once fertile and productive land changes into desert

10.1.5 Climate Change

Different regions of the world are characterized by different set of climatic conditions. These conditions sustain themselves over a period of many years. On the basis of these average weather conditions we can say that a certain area has a particular type of climate. Climate of an area depends upon the amount of sunlight it receives, some geographic factors like altitude, distance from the sea, vegetation cover available, wind, rainfall pattern, topography of the area etc. In recent past there has been a constant accumulation of greenhouse gases in the atmosphere which has resulted in global warming. At the same time greenhouse effect keeps the temperature of the Earth suitable for many life forms.



Fig: 10.6 Global climatic change has resulted in melting of Greenland's ice sheet.

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In the absence of greenhouse effect the temperature of Earth would have gone low enough to make life difficult. Global temperatures in the past one hundred years have been increasing more rapidly than the historic record shows and this increase has been attributed to increasing amounts of the greenhouse gases which are trapping heat. At the global level climatic change has made significant effects on the environment.

In addition to a rise in average global temperature, there have been other changes that indicate that climate indeed is changing. These include, shortening of winter, fast shrinking of Earth's ice cover, killing of coral reefs due to warming sea water, increase in mosquito-borne diseases, rising sea levels, increased precipitation (rainfall etc.) in most areas and extreme weather becoming more common.



Fig: 10.7 Corals, sponges and seaweeds cover most of the surface of many coral reefs are affected by warm temperatures.

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10.1.6 Solid and Hazardous Wastes

Different types of industries and household activities use chemicals for various purposes. Among these some chemicals are harmless and are disposed safely in the environment. However, there are some chemicals which when released in the environment have the potential to be harmful and dangerous for living organisms and the environment as a whole. Such types of chemicals are known as hazardous wastes. These wastes can occur in liquid, solid, or gaseous forms.

Industrial sector releases certain solid wastes which are non-biodegradable i.e these do not break down by biological processes and remain on land as such for a longer period of time. Such material include polythene bags, plastics etc. If these items are burnt in open they pose more serious threats.

Hazardous wastes include used chemicals like pesticides, cleaning fluids or the by-products of certain manufacturing processes. Some of the more serious wastes are nuclear wastes from nuclear reactors which have long term harmful effects on the health of living organisms. Dichloro-diphyenyl- trichloroethane (DDT) is yet another hazardous waste which has serious implications on human health.



Fig: 10.8 Solid and hazardous wastes.

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10.2 NATURAL DISASTERS

Planet Earth at times encounters tremendous changes which occur deep inside it or on its surface. Such changes are called natural disasters. These have the capacity to bring significant changes in the ecological systems. Natural disaster produce such a huge force that it can cause damage to the shape of the land or to the lives of people and other living things living in it. Natural disasters may be in the form of:

- Floods
- Droughts
- Volcanic eruptions
- Earthquakes
- Cyclones or Hurricanes
- Avalanches
- Forest fires etc.



Volcanic eruptions



Earthquake



Hurricans



Floods

Fig: 10.9 Natural disasters.

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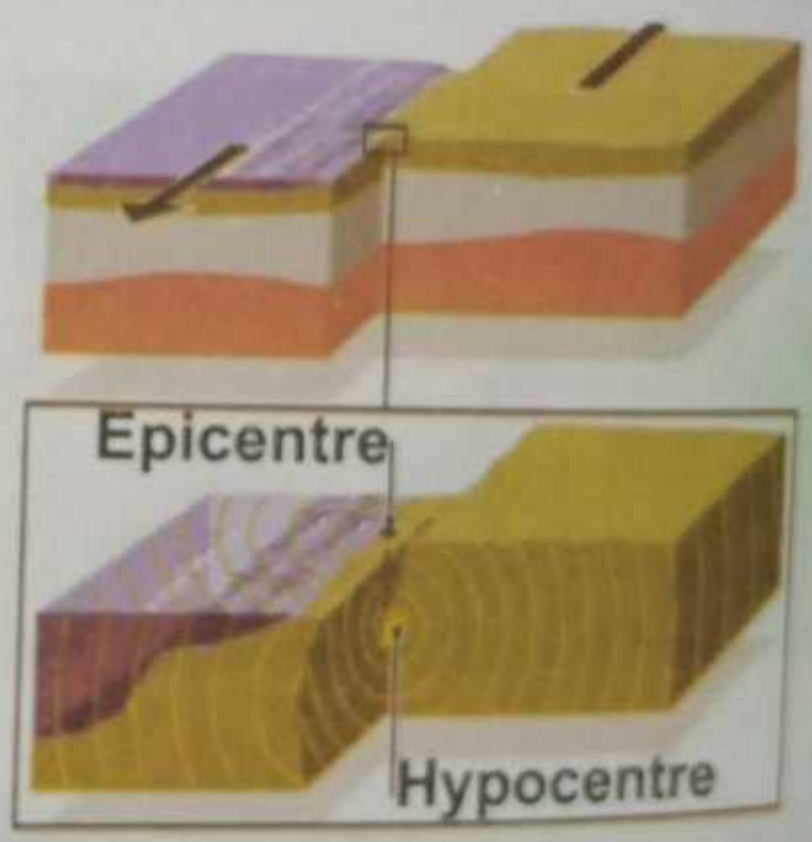
8.1 Earthquakes

An earthquake is an intense or forceful shaking of the ground. It is regarded as the most destructive phenomenon of nature. When earthquake strikes an area it brings fear, destruction and suffering. Often huge earthquakes are followed by aftershocks. During a severe earthquake the ground splits apart.

Earth is divided into plates. When these plates move against each other friction produces giant shock waves which move upwards towards the surface causing the earthquake.

DO YOU KNOW?

Earthquake is manifested when two tectonic plates moves suddenly against each other. The rocks usually break underground at the hypocentre and the earth shakes. Waves spread from the epicenter, the point on the surface above the hypocentre. If quake occurs under the sea it can cause tsunami.



TIDBIT

Japan is the region in the world where earthquakes occur frequently and are of severe nature.

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FOR YOUR INFORMATION

- **Earthquake of Oct 8, 2005**
  Magnitude on Richter scale: 7.6
- 87,000 Dead
- 100,000 injured
- 171,884 houses completely demolished.

(According to World Bank Report)







DO YOU KNOW?

Richter scale is used to measure the strength of earthquakes.



10.2.2 Storms

A storm can be defined as a violent disturbance of the atmosphere with strong winds and usually rain, thunder, lightning, or snow. It affects environment and results in severe destructive weather. Lives and property of the people are at risk in storms because it brings along with it strong wind, hail, thunder and lightning. Some of the negative impacts of storms are flooding, fallen trees and billboards resulting in road blockades, fire accidents, break down of communication system etc.

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DO YOU KNOW?

In a cyclone which is storm winds spin around in a giant circle with strong force good enough to uproot trees and destroy buildings.



10.2.3 El Nino and La Nina

A phenomenon in which a change in temperature between the ocean and atmosphere takes place in the east-central Equatorial Pacific region is called as El Niño-Southern Oscillation (ENSO) cycle.

El Niño and La Niña are two phases of this cycle. La Niña is the cold phase and El Niño is the warm phase of ENSO cycle. ENSO cycles make profound impacts on ocean and all those processes associated with oceans. Apart from this ENSO cycle also affects global weather conditions.

ENSO cycle lasts for 9 to 12 months and is repeated after every three to five years. The warm phase occurs more frequently than cold phase. El Nino or the warm phase effect climatic conditions around the world.

TIDBIT

El Niño means The Little Boy, or Christ Child in Spanish. La Niña means The Little Girl in Spanish.

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Impacts of El Niño and La Niña

El Niño results in an increase in the average ocean surface water temperature in the region and causes climatic change around the world. It also causes torrential rains across the west coast of North America and South America and warm water reduces the fish population.

Strong rains and damages caused by flooding were noticed from 1965-1966, 1982-1983, and 1997-1998. California to Mexico to Chile were the worst affected regions. La Nina is responsible for the opposite effects on climate as El Nino. For example, a major La Nina event in 1988 caused significant drought across North America.

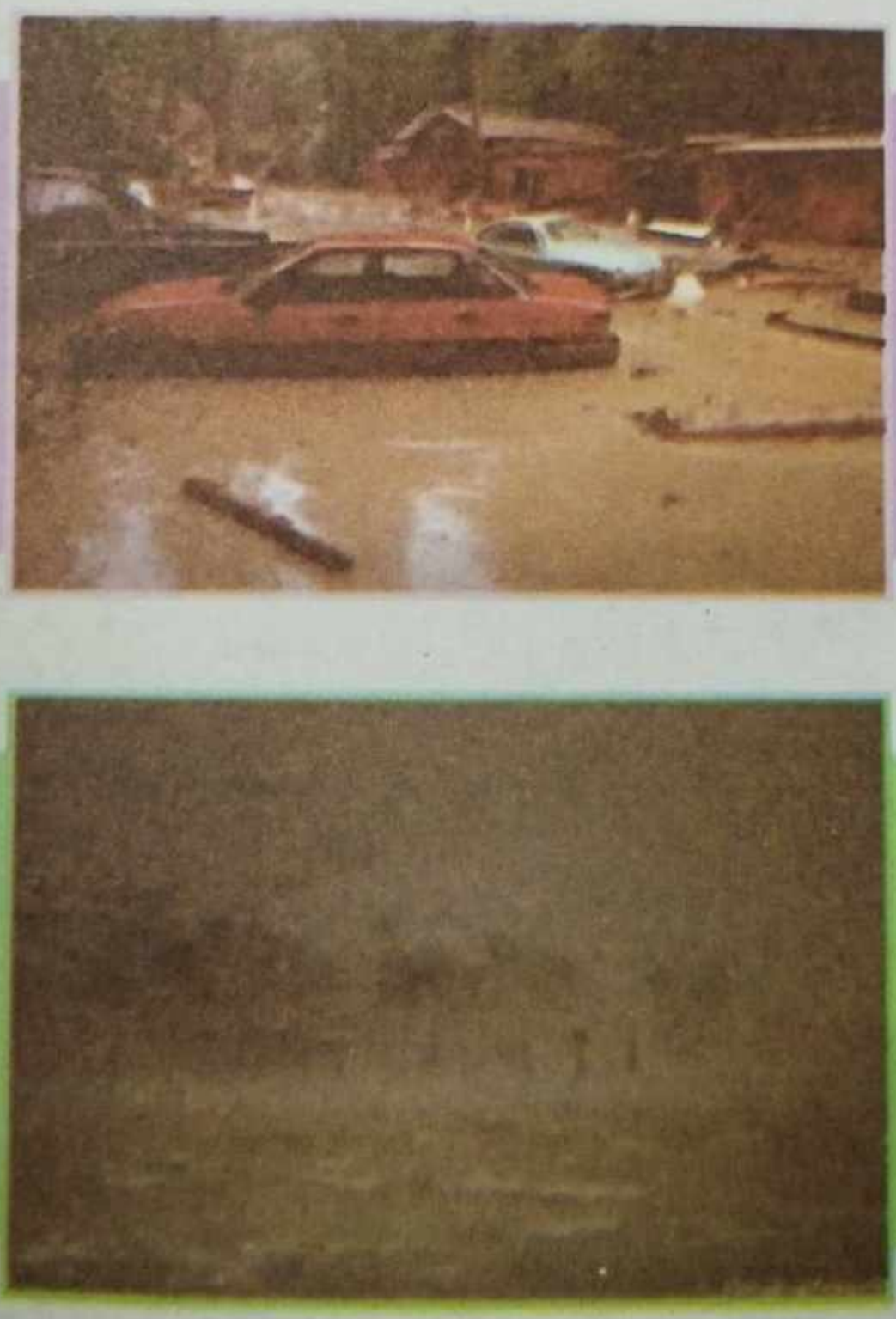


Fig: 10.11 Effects of El Nino and La Nina.

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10.2.4 International Laws and Environmental Issues

We as citizens of the world live in an environment where we share with each other different natural resources. With growing trends of industrialization and development, economic prosperity has brought with itself certain environmental concerns. Environmental problems and issues whether these are local, regional, or global in nature, need to be addressed with the cooperation of people and governments.

At the international level there has been an increasing demand for addressing the environmental issues backed by strong legislation because these are closely linked and affect sustainable development.

It was in these circumstances that international environmental law as a separate area of public international law was introduced in Stockholm Conference on Environment in 1972. Since Stockholm Conference the need for legislation in the field of environment has increased gradually.



Fig: 10.12 World leaders at Rio de Janeiro Brazil.

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At present the environmental issues in focus are destruction of tropical rain forests, ozone layer depletion and global warming, international trade in endangered species, protection of wetlands, transboundary nuclear air pollution, dumping of hazardous wastes, groundwater depletion, oil spills etc.

At international level cooperation has fostered by treaties, resolutions and agreements finalized by intergovernmental organizations. At home countries are having national laws and regulations to protect the environment.

Generally, the scope of environmental laws can be summarized into two categories. Firstly pollution control and remediation and secondly conservation of natural resources.

Following is the list of some of the important international laws pertaining to environmental issues.

- Convention on Biological Diversity
- Convention on International Trade in Endangered Species
- Framework Convention on Climate Change
- Law of the Sea (LOS)
- Stockholm Convention on Persistent Organic Pollutants

10.3 CONTROL STRATEGIES FOR TREATING AIR AND WATER POLLUTANTS

Pollution can be defined as the process by which harmful substances are added to the environment. It is any undesirable change in the environment that adversely affects the living organisms. Pollutants may be solid, liquid or gaseous chemicals produced as byproducts or wastes. These chemicals pollute air, water, soil and food. In the age of industrialization fossil fuels are being used as energy which in turn have resulted in various environmental problems.

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In the previous classes you have already learnt about various types of pollution. In this section you will study in detail air and water pollution. Both have significant effects on our life.

10.3.1 Air Pollution

Air pollution is dangerous to human health, harms plants and animals, damages materials from fabric to stone work. There are large number of pollutants which are the cause of air pollution (Table 10.1). Air pollution may result from the incomplete burning of fuels such as coal, oil, petrol and wood. Air pollution due to human activities includes exhausted fumes from automobiles, chimney fuels emitted from the factories, burning of garbage and other wastes and the use of chloroflurocarbons (CFCs) etc. The harmful gaseous pollutants are sulphure dioxides, nitrogen oxides, carbon monooxides, carbon dioxides and lead. At high concentration these gases has a damaging effect on both plants and animals. Generally these pollutants cause photochemical smog, acid deposition, green house effect and ozone shield destruction. You have already studied in detail about acid rain, green house effect and ozone layer depletion.



Fig: 10.13 Air Pollution in city.

One of the more common effect of air pollution is photochemical smog, a mixture of smoke and fog. It is produced when sunlight and ozone in the atmosphere act on oxides of nitrogen and unburnt hydrocarbons released from automobile exhausts. Smog is irritating to eyes and lungs and also damages plants.

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Table 10.1 Air pollutants and their effects

S.No	Air Pollutants	Source	Environmental effect
1.	Nitrogen oxide	automobiles and fossil fuels	Ozone shield destruction, Green house effect, Acid deposition and Smog.
2.	Hydrocarbons	Automobile, paint solvent and pesticides	Photochemical Smog
3.	Sulphur dioxide	Fossil fuel	Acid rain
4.	Carbon monoxide	vehicle exhaust	Green house effect
5.	Carbon dioxide	vehicle exhaust, fossil fuel, deforestation	Green house effect
6.	Methane	vehicle exhaust, farms	Green house effect and ozone shield destruction.
7.	Chlorofluorocarbons	Refrigerants and plastic foam	Ozone shield destruction and green house effect.
8.	Halogens	Fire extinguishers	Ozone shield destruction

FOR YOUR INFORMATION

One of the most destructive type of air pollution is radioactive pollution released from malfunctioning nuclear power stations. One such accident occurred in Chernobyl in 1986 where Radioactive isotopes emitted from the burning reactor spread over areas presently parts of Belarus, Ukraine and Russian Federation. Radioactive emissions has resulted in spreading different types of cancers in these areas even in later decades.



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DO YOU KNOW?

In the year 1952 when 4,000 people died prematurely in a single week in London, England because of severe air pollution. This was followed by another 8,000 deaths during the next few months.

METHODS TO REDUCE AIR POLLUTION

Air pollution can be minimized by adopting the following measures.

i. We can cut down the burning of fossil fuel by the using alternative means like biomass energy, solar energy etc.
ii. In the field of agriculture use of pesticides can be reduced by using new varieties of plants which are pest resistant.
iii. Lead free petrol can be used in vehicles.
iv. Deforestation should be checked and more plants should be grown.
v. Emission from industries should be controlled and treated before releasing them into the atmosphere and by following strict laws.
vi. Use of refrigerators, air conditioners, air fresheners etc. may be reduced to reduce the amount of CFCs emissions.



Fig: 10.14 Alternate forms of energy.

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10.3.2 Water Pollution

There are three basic environmental concerns of water pollution i.e surface water, ground water and oceanic water pollution.

Table 10.2 Different kinds of water pollution and their sources.

S.No	Kind of water pollution	Source of pollution
1.	Surface water pollution	Acid rain, pesticides, industrial waste, acid water from mines, fertilizers, organic waste, nuclear reactor wastes etc.
2.	Ground water pollution	Leakage from sewage pipes, septic tanks, irrigation, industrial and domestic wastes, that percolates down.
3.	Oceanic pollution	Waste dumping, pollutants carried by rivers, offshore mining, shipping and large oil spills, dumping of nuclear waste.

A. Sources of Chemical Water Pollution

Water pollution is brought about by industrial wastes, municipal wastes, agricultural wastes, fertilizers, pesticides etc. The movement of rain or irrigation water over land picks up pollutants such as fertilizers, herbicides, and insecticides and carries them into rivers, lakes, reservoirs, coastal waters, or groundwater.

The chemical wastes degrade the water quality and are harmful to other aquatic organism. D.D.T and other pesticides may pollute water thus decreasing population of fish and fish eating birds.

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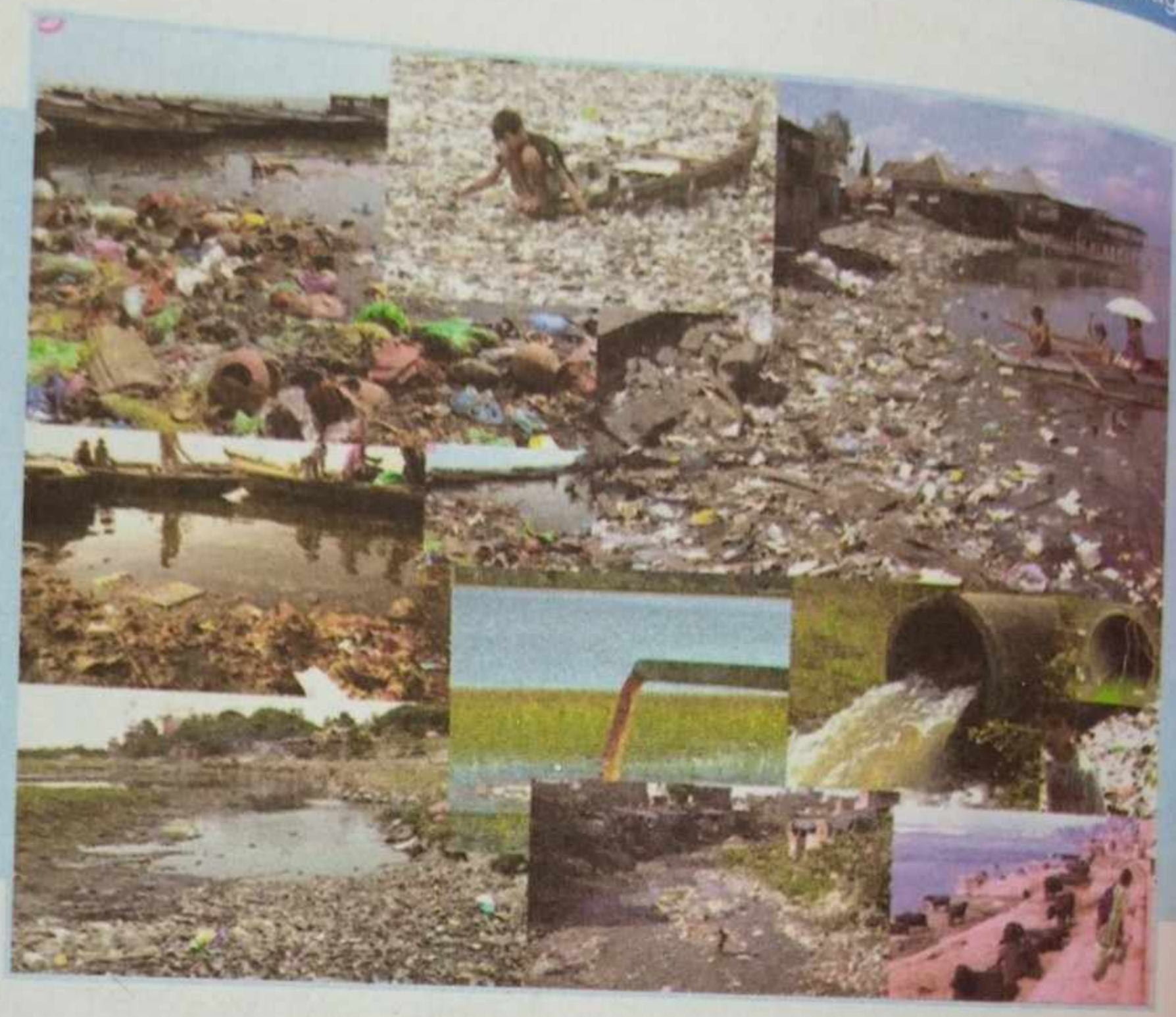


Fig: 10.15 Water Pollution.

Industries pollute water by adding chemicals like acids, alkalis, salts, pesticides, detergents, phenols and other compounds into it. This polluted water is highly toxic that may either kill the microorganisms that purify water or inhibit their growth.

Chlorinated organic compounds such as dioxins are released from paper and pulp mills. Leather tanneries are important source for earning precious foreign exchange. However, these produce a significant amount of solid waste in the form of sludge, hair and hide. The waste water discharged from these factories contains chromium, acids, sulfides and chlorides.

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Fig: 10.16 Paper and pulp mills release dioxins.

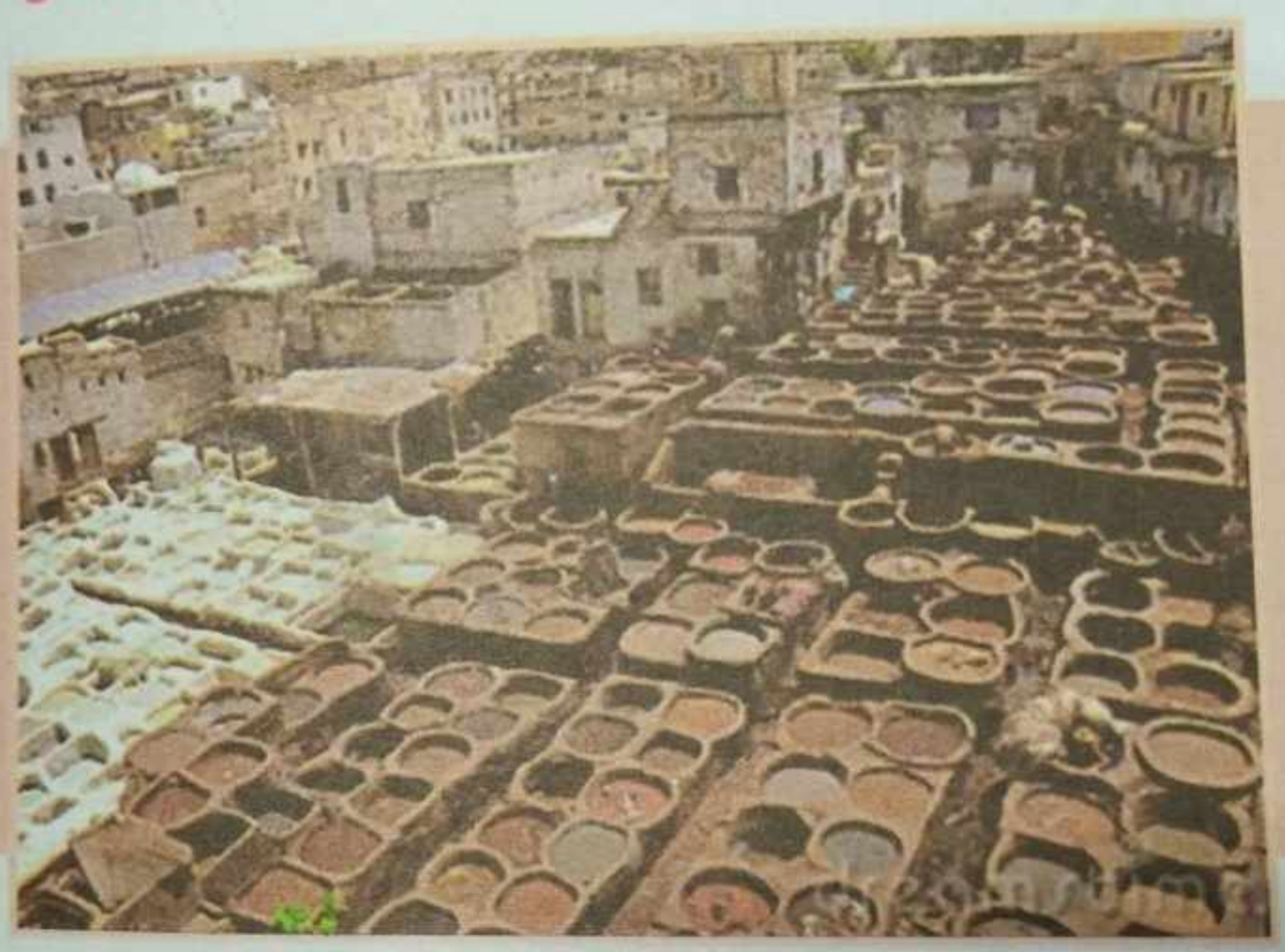


Fig: 10.17 Leather tanneries.

Petrochemical industries discharge wastes that contain phenols, and benzene, suspended solids, oils and grease. Water discharged from mines and stainless steel production release metals, such as copper, nickel, and chromium. High concentrations of these metals can be harmful to human health.

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B. Health Effects

Water makes approximately 70% of the body tissues and is essential component of cell protoplasm. Its deficiency in the body causes dehydration which can be fatal. Two to three liters of water is lost daily in urine, sweat and faeces. This loss of water is compensated by drinking water.

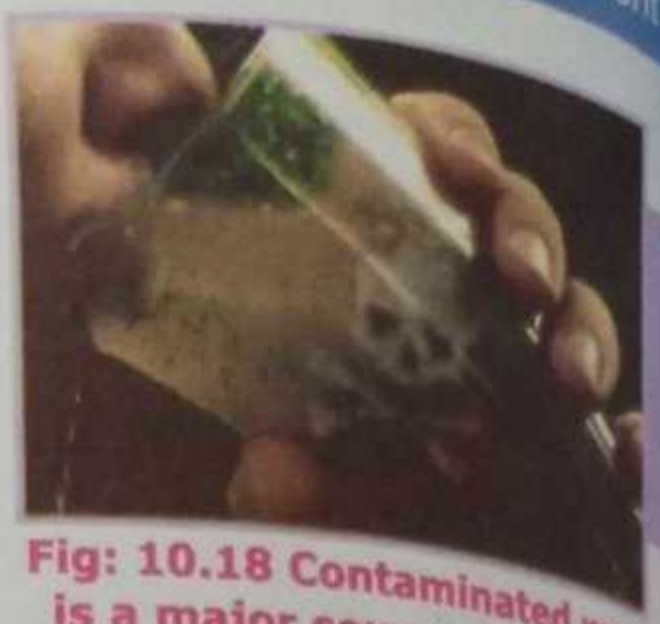


Fig: 10.18 Contaminated water is a major source of diseases in Pakistan.

So the direct route of exposure to pollutants in water is by drinking contaminated water or by eating food cooked with water having toxins in it.

Frequent use of contaminated water for drinking purpose can cause irritation or inflammation of eyes and nose, skin, and gastrointestinal system.

Contamination of copper, arsenic, or chromium in drinking water can cause liver toxicity. Excretion of certain chemicals such as cadmium, copper, mercury, and chlorobenzene through kidneys can damage these organs.

C. Methods to reduce water pollution

Water pollution can be reduced by adopting the following measures.

i. Sewage treatment plants can be built to help degrade organic wastes.

ii. Human and animal wastes need to be disposed off properly.

iii. Use of pesticides can be reduced by alternative means e.g introducing friendly insects to protect crops from pathogens. This is called biological control.



Fig: 10.19 Biological control in action.

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iv. Industrial and domestic wastes should be treated properly before releasing them in water bodies. For this purpose waste treatment plants are used.

v. Unnecessary use of fertilizers and pesticides must be avoided.

10.4 PROTECTION AT INDIVIDUAL LEVEL

Progress and development in the field of technology has made possible for us to get maximum benefit from the tools and gadgets of modern age. These devices have become very much part and parcel of our daily life. On one hand these devices are useful and productive. On the other hand they are one of the biggest source of entertainment for us.

Apart from the positive aspects of these modern gadgets and tools, these are putting certain negative impacts on their users, especially in case if these are used indiscriminately. In the following section you will study some of devices and machines which have transformed the life of the present day human being but their excessive use can be harmful for individual health.

10.4.1 Harmful Effects of Excessive Use of Television

Television is an excellent entertainer on one hand and useful educator at the other hand. It is one of great invention of all time. Television is watched by people of all ages. For some it provides information and education and for other it provides non stop entertainment.

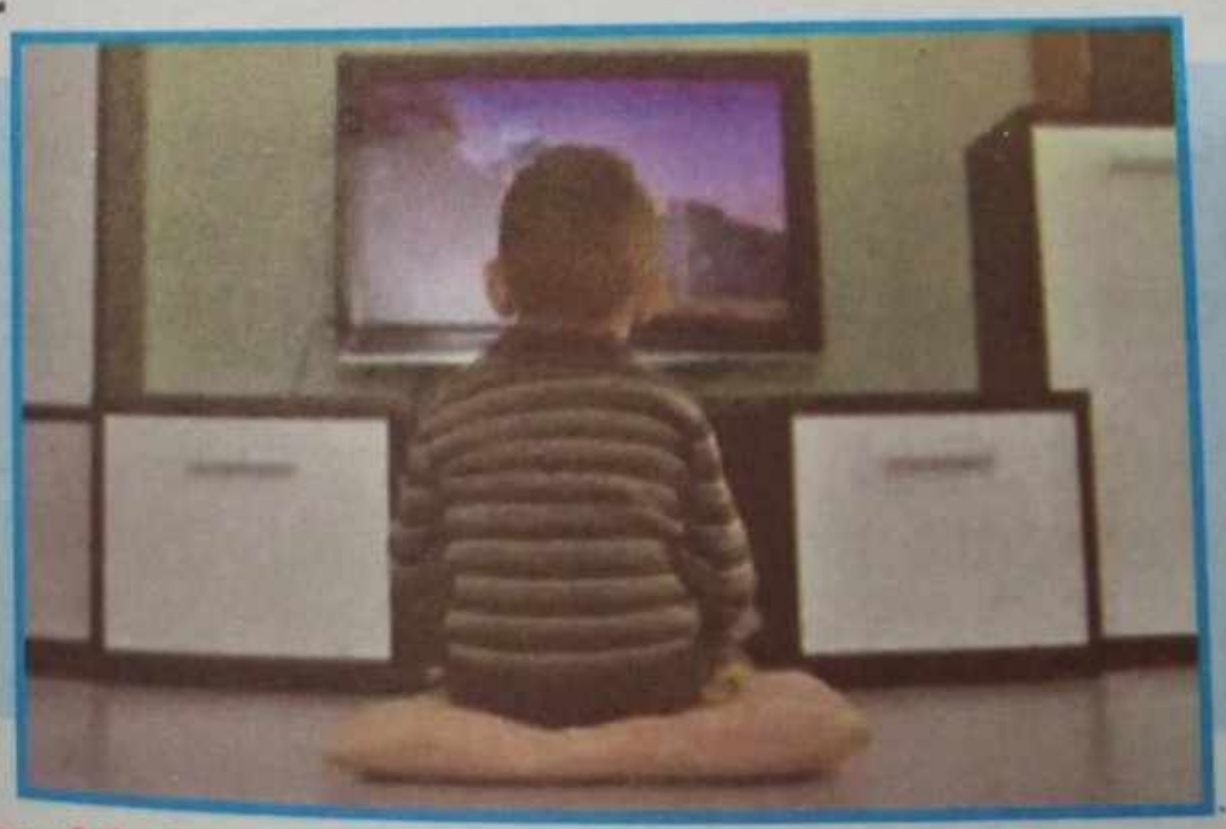


Fig: 10.20 Watching too much TV is harmful.

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Watching Television in moderation is a good activity. However, watching too much television is harmful. It is common that children are glued to television and they spend maximum time watching their favorite programs. Recent research suggests that children who spend more than 4 hours continuously per day watching TV are more likely to be overweight. In much older people it can lead to obesity and heart diseases.

When you watch television your thinking mechanism stops and your focus is to listen and watch the programs being aired. In this situation you watch news, analysis, reports, documentaries being prepared by different persons with diverse view points. This situation often creates an environment where you can be easily misinformed and manipulated leading you to make an opinion that is not yours but is based on the analysis and research of those who produced such programs.

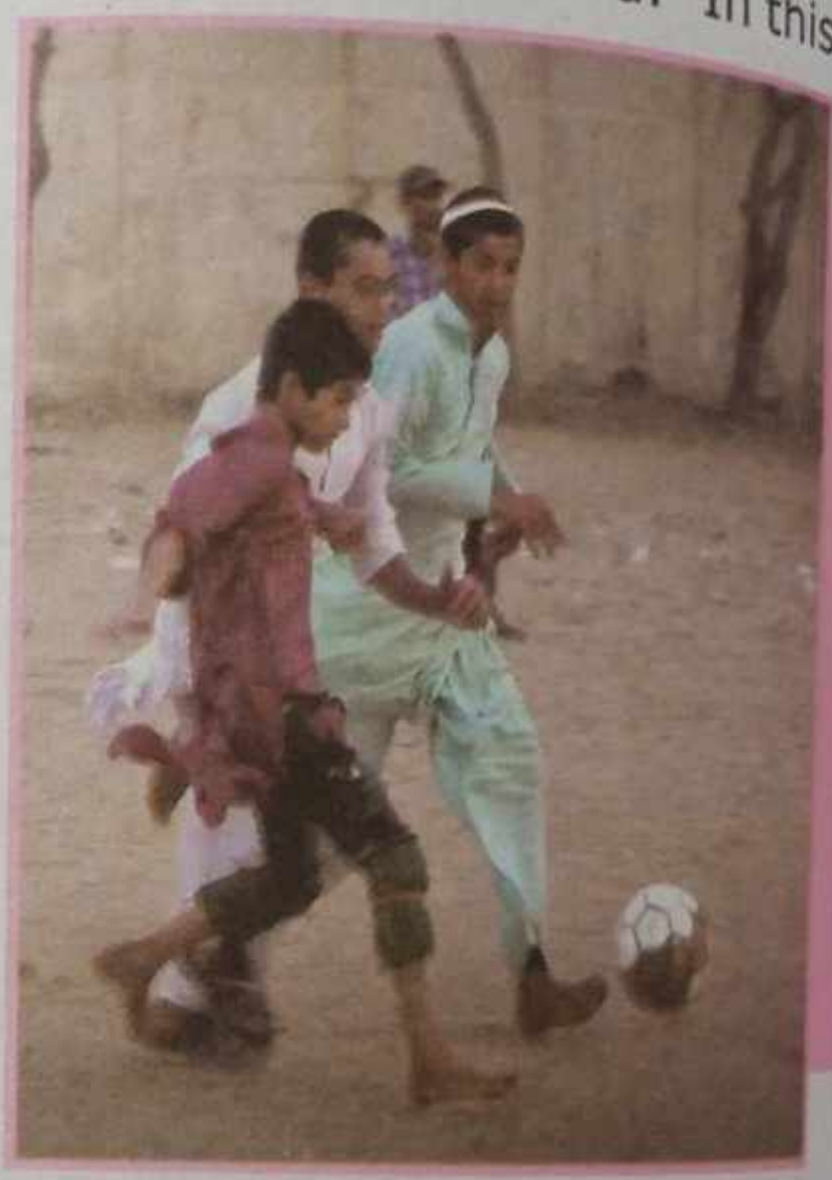


Fig: 10.21 Physical activities help in healthy development of the body.

Watching too much television often leads to behaviourial changes as seen in young children who watch aggressive cartoons, movies etc become violent and develop a destructive nature.

Our social development is also affected due to the time we decide to spend watching too much television. It is better to play different sports in the playground instead of watching them on television.

Television even influences your spending habits. Often different types of advertisements project wrong information and viewers often believe whatever is expressed in glamourous way. So it is desirable to watch television in moderation and use your thinking and analytical abilities before making opinions and choices.

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10.4.2 Harmful Effects of Excessive Use of Mobiles

In today's world one could not think of life without a cellular or mobile phone. It has become one of the fundamental means of communication in the world. It provides an easy and efficient way to get in touch with our family and friends. Every one of us spends a considerable amount of time using mobile phone. Despite its usefulness using too much mobile phones can put negative effects on our health.

TADBIT

There are an estimated six billions subscriptions of mobiles worldwide and the number is increasing every day.

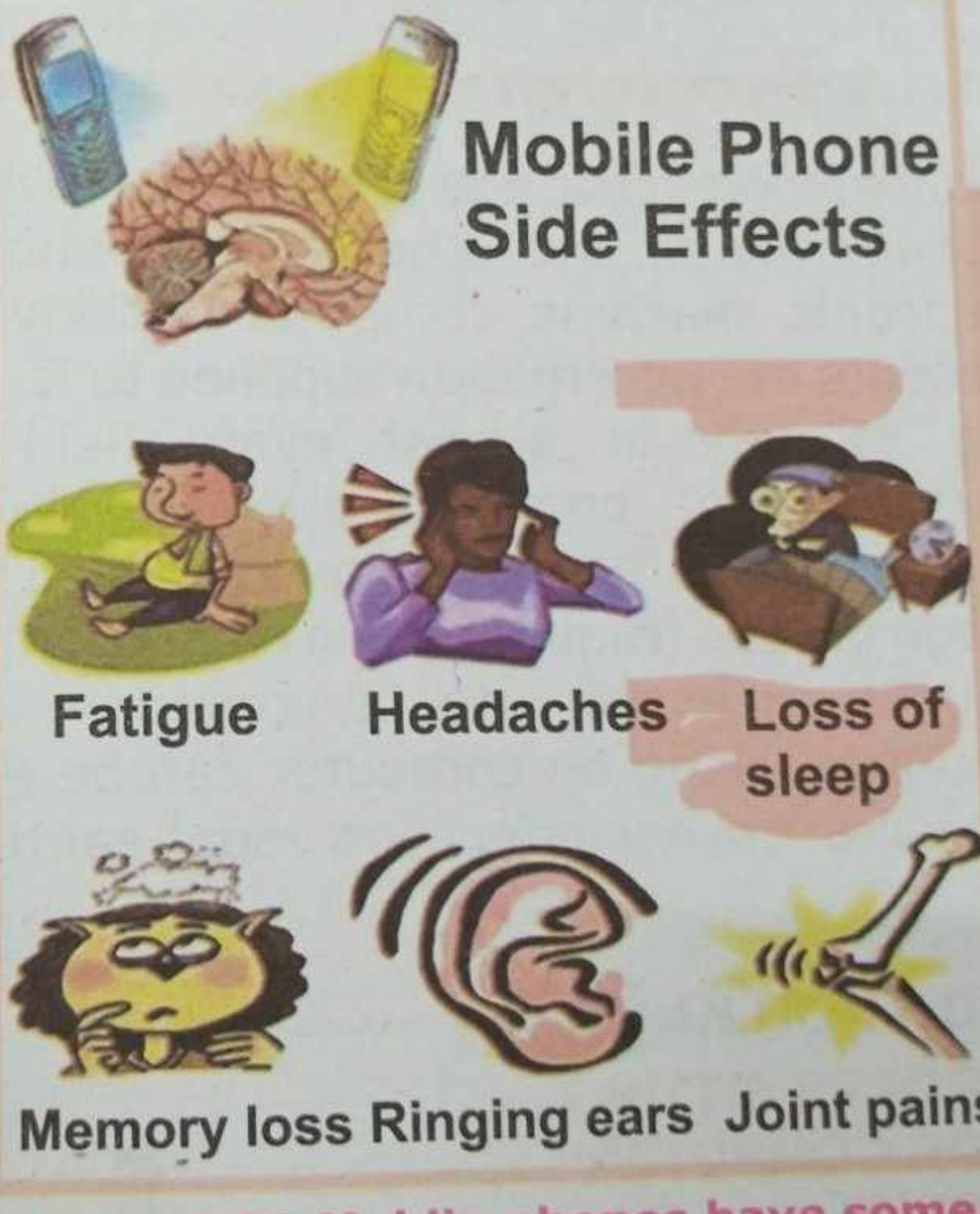


Fig: 10.22 Mobile phones have some serous effects on the body.

In a mobile phone there is a small transmitter and a receiver system. This system sends and receives calls in the form of radio waves. Adults and especially children can suffer the long-term effects of radiation waves on the brain. Mobile phone used in excess can have serious implications on our health especially in youth. The high frequency radio waves emitting from the mobile put negative effects on our stress levels and cause sleep disorders.

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You might have noticed a greasy oil residue on mobile phone especially on its screen. This is a breeding surface for many germs. While managing text messages and e-mails frequently at rapid speed can cause pain and inflammation in the joints of hand bones. If you hold the phone between your neck and shoulders while talking during work it can cause back pain. Focusing more closely on the mobile screen for text messaging and other tasks can harm your vision.

Though in the field of communication technology cell phone has revolutionized communication in the 21st century but its excessive use is harmful for our health. So care should be taken while using mobile phone technology.

10.4.3 Harmful effects of excessive use of computer

We are living in the age of computers where most of our daily tasks in one way or the other are dependent on computers. As an electronic machine computer quickly organizes, analyzes and presents the information supplied to it. Computer has a significant role to play in almost every field of life, e.g., education, entertainment, communication etc. With the advent of internet facility computer usage has increased many fold and people from all age groups frequently use computers for using internet. This has brought excessive use of computer at home or at workplace. Though working on computer can be enjoyable sometimes it can also have unseen effects on your health.

DO YOU KNOW?

PROPER SITTING FOR COMPUTER WORK

Lean back , raise chin and look straight



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Excessive use of computer can cause some serious health problems, for example, headache and backache, pain in hand and fingers joints, vision abnormalities and eye strains. The implications for growing children are even more serious. For example, sitting for longer periods can delay physical as well as mental development of the child. Sitting in room with no social interaction with the society can hinder the interpersonal skills of the child. Many children get addicted to this habit and it becomes difficult for them to get away from the computer which inturn affects their education.

So it must be in our mind that technology has a useful role to play in our lives. But at the same time excessive use of even useful tools and machines can bring undesirable effects on our health and physical well being.

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KEY POINTS

- Development and prosperity of the modern age has been accomplished by paying heavy price in the shape of environmental degradation and climatic changes which have global impacts.
- Local, regional, and global environmental issues are closely linked and their impacts affect the process of sustainable development in an area.
- Ozone layer is present in the stratosphere and it prevents harmful UV (ultra violet) radiations from entering the earth surface.
- Global warming is an increase in earth's temperature due to the effect of the greenhouse gases mainly carbon dioxide, methane, and some other gases.
- Global warming can result in melting of glaciers, flooding, climate change, droughts, diseases and increase in hurricanes frequency.
- Acid rain is rain that has a larger amount of acid in it than what is normal.
- Greenhouse effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere trap energy from the sun. Without these gases, heat would escape back into space and Earth's average temperature would be lower.
- Desertification is defined as 'land degradation resulting from various factors including climatic variations and human activities'.
- Climatic change on a global scale is either due to the amount of heat that is let into the system, or the amount of heat that is let out of the system.

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- Hazardous waste in the form of liquids, solids,or gases is dangerous or potentially harmful to our health and environment.
- Natural disasters are changes which are so great that they may cause damage to the shape of the land or to the lives of people and other living things.
- Natural disasters may be in the form of volcanic eruptions, earthquakes, cyclones, floods etc.
- An earthquake is a violent shaking of the ground. When tectonic plates move against each other, giant shock waves move upwards towards the surface causing earthquake.
- A storm is any disturbed state of an environment specially affecting its surface and resulting in severe weather.
- International cooperation in the form of treaties, agreements and resolutions created by intergovernmental organizations as well as national laws and regulations are being used to protect the environment.
- Pollution is the addition of unwanted and harmful materials into the environment of living things that bring undesirable changes in standard quality of an environment.
- Dependency on modern day devices is increasing and it is also increasing our chances of being affected by their negative aspects.
- Watching Television in moderation can be a good activity as television can be an excellent educator and entertainer but despite its advantages, watching too much television can be harmful too.
- Cell phone has revolutionized communication in the 21st century.
- Overuse of computers causes some physical effects in the form of eye strain, vision abnormalities, pain in hand and fingers joints, headache and backache.

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EXERCISE

A. Select the correct answers in the following questions.

1. **All of the following are layers of earth's atmosphere EXCEPT:**
   a. Troposphere
   b. Lithosphere
   c. Stratosphere
   d. Thermosphere

2. **Which one of the following causes acid rain?**
   a. Hydrocarbons
   b. Methane
   c. Halogens
   d. Sulphur dioxide

3. **Ultraviolet radiations from sun that reach the earth cause:**
   a. Respiratory disorder
   b. Typhoid fever
   c. Skin cancer
   d. Bronchitis

4. **The source of all of the following pollutants is vehicle exhaust EXCEPT:**
   a. Carbon mono-oxide
   b. Carbon dioxide
   c. CFCs
   d. Nitrogen oxide

5. **Which of the following is not a greenhouse gas?**
   a. Oxygen
   b. Carbon dioxide
   c. Chlorofluorocarbons
   d. Methane

6. **Which one of the following can cause stone cancer?**
   a. Carbon dioxide
   b. Sulphur dioxide
   c. Carbon monoxide
   d. Ozone

7. **Ozone layer is present in:**
   a. Troposphere
   b. Mesosphere
   c. Stratosphere
   d. Thermosphere

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8. **The ultraviolet radiations in stratosphere are absorbed by:**
   a. Oxygen
   b. Ozone
   c. Sulphur dioxide
   d. Argon

9. **Most hazardous metal pollutant in the automobile exhaust is:**
   a. Lead
   b. Mercury
   c. Cadmium
   d. Argon

10. **Which of the following gases contribute to the greenhouse effect on earth?**
   a. Carbon dioxide
   b. Methane
   c. Chlorofluorocarbons
   d. All of these

11. **Which of these is NOT an expected effect of climate change?**
   a. Sea levels rising
   b. Flooding in coastal cities
   c. Expanding glaciers
   d. Extreme weather

12. **Based on general knowledge which natural hazard has caused the greatest number of deaths in a single event?**
   a. Earthquakes
   b. Floods
   c. Volcanic eruptions
   d. Hurricanes

13. **Which of the following measures an earthquake's intensity ?**
   a. Richter scale
   b. Modified Mercalli scale
   c. Centigrade scale
   d. Moment magnitude scale

14. **Which of the following is an air pollutant?**
   a. Nitrogen
   b. Carbon dioxide
   c. Carbon monoxide
   d. Oxygen

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15. **Which of the following is a non-point source of water pollution?**

a. Factories
b. Sewage treatment plants
c. Urban and suburban lands
d. None of these

16. **Taj Mahal is said to be suffering from "Marble Cancer" What is Marble Cancer?**

a. Acidic Rain which corrodes marble.
b. Large number of Fungus in Taj Mahal marbles
c. Yellowing of the marble on account of Soot particles
d. Smokes entering Taj Mahal from adjoining industries

17. **Water pollution is primarily caused by:**

a. Forest fires
b. Volcanic eruptions
c. Biological decay
d. Human activities

B. Write short answers of the following questions.

1. Give a brief overview of the nature of ozone layer found in the atmosphere.
2. Define the term desertification.
3. List some measures to control the green house effect.
4. What are natural disasters and in which forms these are exhibited?
5. Enlist the names of different layers of atmosphere.
6. Define climate.
7. Write five major effects on environment by human activities.

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C. Write in detail answers of the following questions.

1. What are the main causes of ozone depletion? List some of the major effects of ozone depletion on the living organisms.
2. Describe global warming and its consequences.
3. How acid rain is caused? What impacts this rain can have on the life of living organisms of a particular region?
4. What do you mean by Climate change? Describe some of its effects.
5. Describe natural disasters caused by El-Nino and La-Nina.
6. Identify the legislation or laws on environmental problems.
7. Describe the control strategies that can be used for treating air pollutants.
8. Describe the harmful effects of the excessive use of Television on individual's health.

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Unit 11

Science, Technology and Development

After studying this chapter the students will be **able to:**

- Describe the principle of Lasers and optical fiber system, and describe their functions and uses in different fields with examples.
- Describe the functions and uses of X-rays, ultrasound, ECG, EEG, MRI, CT-scan and angiographies.
- Describe the technologies such as computer, telephone, fax, TV, radio, mobiles used in the modern information age.
- Explain the contribution SUPARCO has made in the development of our country and list its future plans.



NOT FOR SALE

INTRODUCTION

Economic growth and well being of a country is directly related to its scientific and industrial advancement. The most advanced countries of the world spend huge amount of money on scientific research. On the other hand, developing countries spend relatively less money on scientific research. As a result, the developing countries heavily depend on the developed countries for the transfer of scientific and technological knowledge. In the present days, science and technology has tremendous influence on our life. From education and health to economic and social development of the society, science and technology plays a key role. In this chapter you will study some of the major technological developments which have significant impacts on our daily life.

11.1 IMPORTANT TECHNOLOGICAL DEVELOPMENTS

Advancement in the field of technology has a direct impact on our daily life. Most of these technological developments have benefitted mankind in the shape of instant communication system, better diagnosis and treatment in the field of medicine, efficient use of information technology in various fields and many more.

Following are some of the important technological developments.

11.1.1 Lasers

Laser stands for "light amplification by stimulated emission of radiation." Laser is a device / source that produce an intense monochromatic and unidirectional coherent beam of visible light. It operates by the principle of stimulated emission of a photon by an atom in excited state.



Fig: 11.1 Laser

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The light beam produced by most lasers is pencil-sized, and maintains its size and direction over very large distances.

A laser consists of two fundamental parts:

1. An amplifying medium which can be solid, liquid or a gas. It is composed of atoms, molecules, ions or electrons whose energy levels are used to increase the power of a light wave during its propagation.
2. A pumping system: Its function is to excite the amplifying medium which in turn creates a condition for light amplification. For this purpose it supplies critical energy. Pumping systems can be optical, (the sun, flash lamps, tungsten-filament lamps, diode or other lasers), electrical (electric current in semi-conductors, gas discharge tubes) or even chemical.

The different components that make up a basic laser are illustrated in the diagram below.

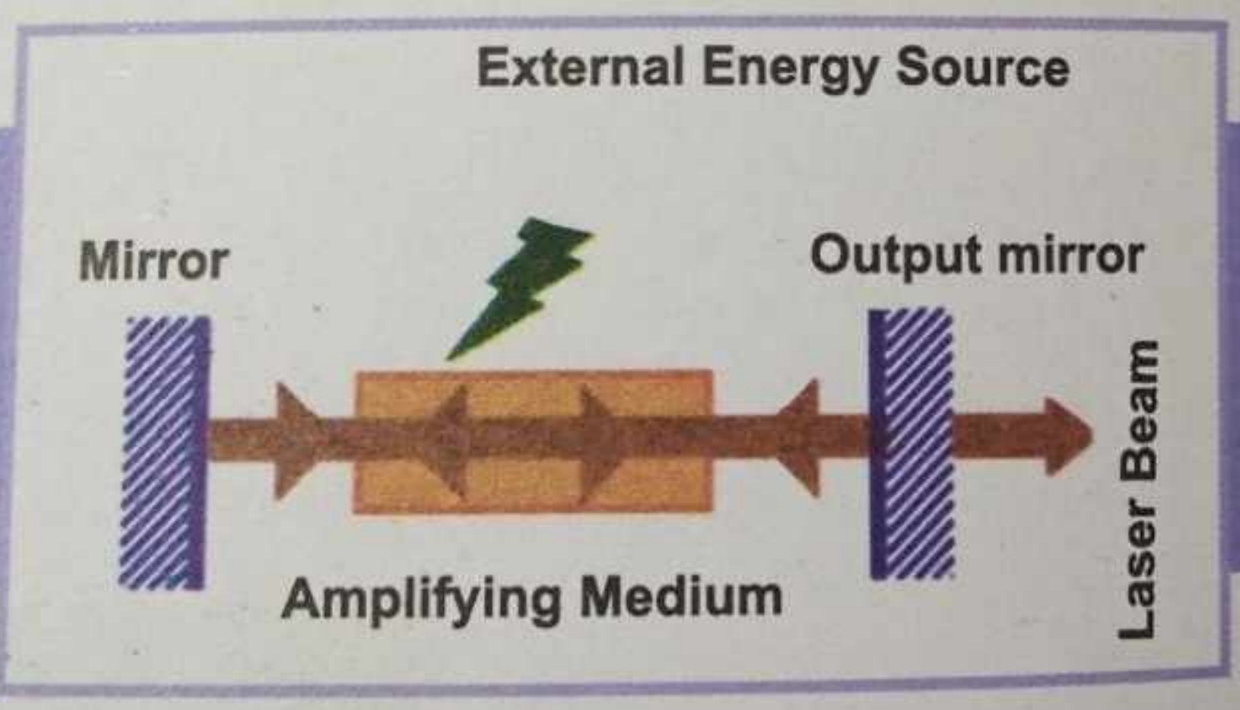


Fig: 11.2 Components of Laser.

ACTIVITY

Take an ordinary torch and a simple laser light device. Use both these devices to throw light on a wall of a dark room from the same distance. Record your observation in your note book.

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The fundamental parts of laser amplify light. This is known as a laser amplification. Most of the lasers use a cavity or an optical resonator. Technically, the whole device is known as a laser oscillator which uses reflecting mirrors to amplify the light source considerably by bouncing it back and forth within the cavity.

DO YOU KNOW?

Many useful inventions use lasers. For example, DVD and CD players, bar code readers etc. Metal workers use lasers to cut and weld metal. Likewise workers in clothing factories use lasers to cut through hundreds of layers of fabric at once.



Bar code reader



DVD players use lasers



Metal Cut by lasers

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Applications of Lasers

Lasers have been used in a number of areas of scientific research, and have opened a new field of scientific research,. Lasers are widely used in many ways. Some of these are described below:

1. Lasers are being used in telecommunications in space and in open-air communications.
2. Lasers are used for microsurgery of different body organs.
3. Lasers are used for bar-code scanners and also in printers for getting superior quality computer print outs.
4. Lasers are used in various industries for different activities like boring and cutting metals and for cutting several layers of fabrics in the textile industry.
5. Laser beam can be used to generate three dimensional image of an object in a process called holography.
6. Lasers are used in different types of weapons like tanks, missiles and bombers to locate the exact position of the enemy.



Fig: 11.3 Application of Laser.

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11.1.2 Optical Fibers / Fiber optics

An optical fibre is a very thin, flexible transparent glass or plastic rod. Its surface is coated with another type of transparent material whose refractive index is less than it. This coating not only protects the light but also optically insulates adjacent fibres. The thickness of an optical fibre is nearly equal to that of human hair i.e about one hundredth of a milimetre. A cable of optical fibre consists of 30 optical fibres.

Optical fibres operate on the principle of total internal reflection. When a ray of light enters at one end of an optical fibre, it undergoes total internal reflection off the sides of the fibre until it comes out at the other end as shown in the figure 11.4.

Optical fibres carry digital signals in the form of pulses of light. At the transmitted end, the electrical signals are encoded into light signals by a light emitting diode (LED).

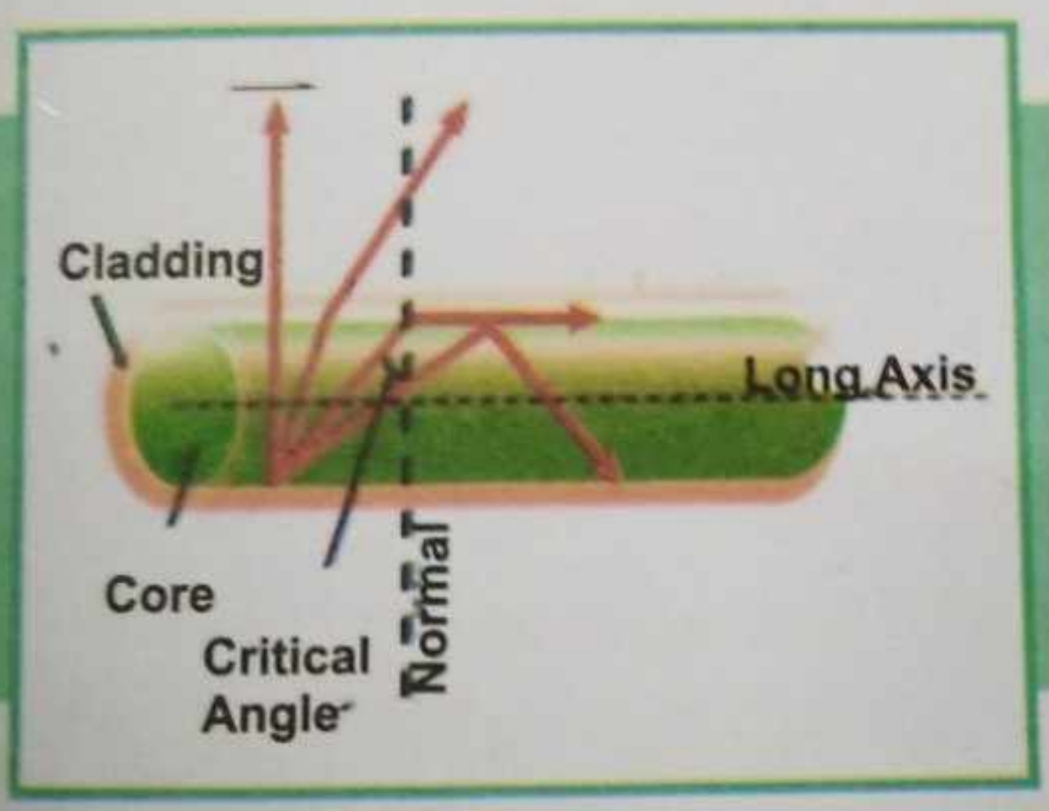


Fig: 11.4 Fiber Optic Internal Reflection.

TADBIT

The amount of energy required to send a flash of light across a distance in fiber optic cables is far less than that required to send electrical signals. Less power means less carbon output, lower emissions and lower prices.

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At the receiving end the light signals are decoded by a photodiode which turns them back into electrical signals.

Optical fibres are thinner and lighter than electric cables. They carry more signals than electric cables. They are not affected by electrical interference.

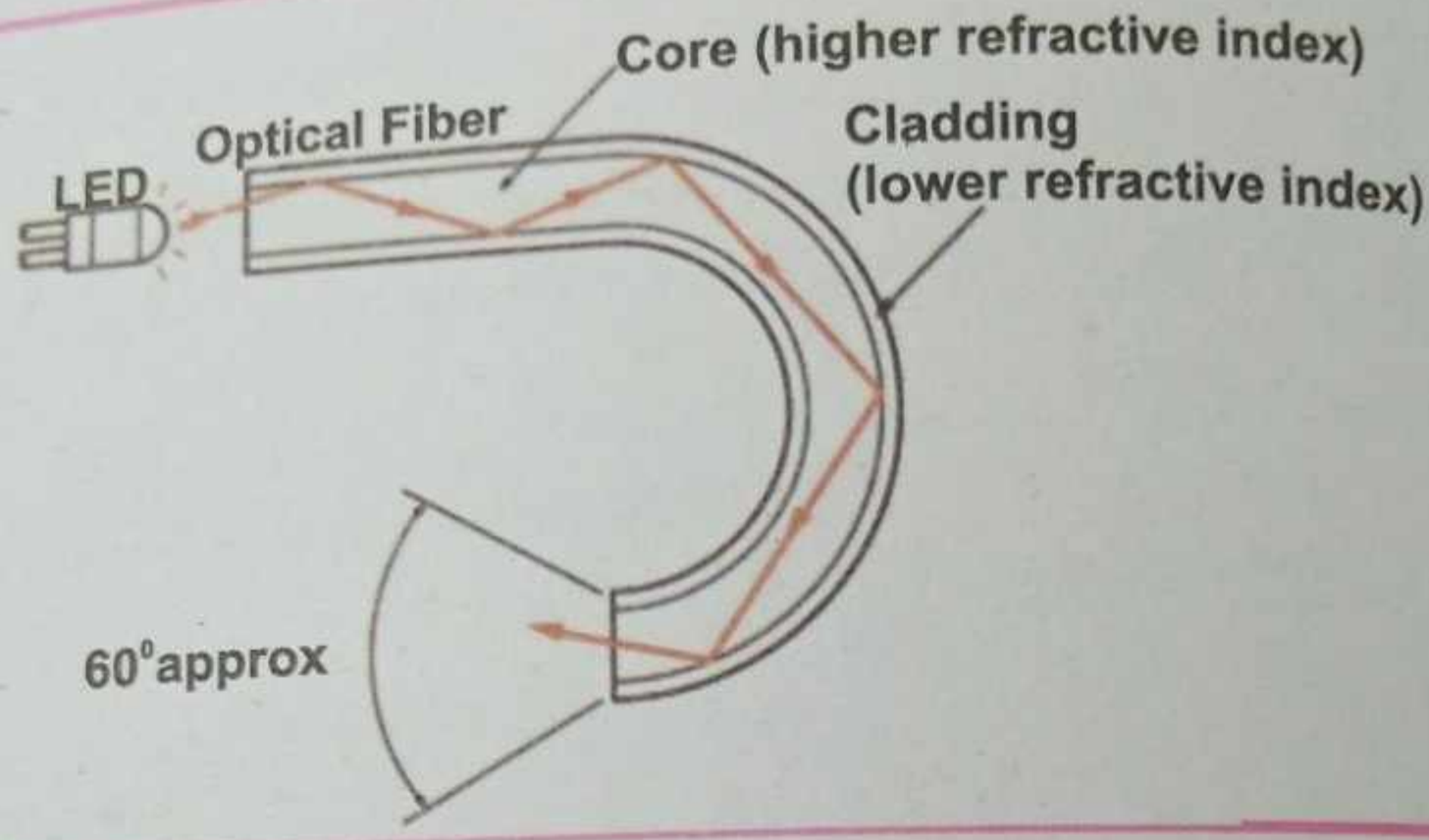


Fig: 11.5 Principle of optical fiber system.

FOR YOUR INFORMATION

Advantages of fiber optics

As compared to copper wire optical cable are less expensive and these can be drawn to smaller diameter. Optical fibers provide a high data transmission rates and higher carrying capacity. Data travels with maximum protection and offers very less losses. Optic fibers are small in size and light in weight. Optic fibers are non flammable and as electric current does not pass through it there is no danger of fire accidents.

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Uses

1. Surgeons and physicians often examine the internal organs of the body by obtaining their images on a screen with the help of optical fibres.
2. Optical fibres are used in telephone and other telecommunication systems.
3. These are used in the night vision devices, photo-electronics and automobile panel lighting.

FOR YOUR INFORMATION

Speed: Fiber can carry information so fast that you can transmit three television episodes in one second.

Bandwidth: Taken in bulk, it would take 33 tons of copper to transmit the same amount of information handled by 1/4 pound of optical fiber.

Resistance: Fiber optic cables offer greater resistance to electromagnetic noise such as radios, motors or other nearby cables. Because optical fibers carry beams of light, they are free of electrical noise and interference.

Capacity: Fiber optics have a greater capacity for information which means smaller cables can be used.

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FOR YOUR INFORMATION

Optical fibers are used for the transmission of internet data, especially graphical data. They are also used for the transmission of broadband signals, such as high-definition television (HDTV) telecasts. For this reason cable television companies also use fiber for delivery of digital video and data services. Telemedicine devices are used for the transmission of digital diagnostic images used by the doctors to diagnose and treat the patients effectively.

. Fiber-optic-based telemetry systems are being designed to handle the traffic on busy highways by using intelligent traffic lights, automated tollbooths, changeable message signs etc.



Fig: 11.6 Intelligent traffic lights.

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11.2 Modern Methods of Medical Diagnostics and Treatment

Following are some of the modern methods in medical diagnostics and treatment.

11.2.1 X-Rays

X-rays are electromagnetic radiations, lying between ultraviolet radiations and gamma rays in the spectrum. Their wavelength range is 10^{-11}m to 10^{-8}m. These were discovered by Wilhelm Konrad Rontgen in 1895. X-rays are produced in an apparatus called X-ray tube as shown in the figure: 11.7. An X-ray tube consists of a vacuum tube fitted with cathode and anode which are connected with a high voltage battery. A heavy metal (usually tungsten) is embedded at the anode. When cathode is heated by supplying the current, it emits high energy electrons. These energetic electrons when strike the target at anode, an intense beam of X-rays is produced.

Functions of X-rays

Some of the important functions of X-rays are below:

1. X-rays penetrate several centimeters into solid materials on which they are incident.
2. They cast shadows of the obstacles placed in their path of propagation.

ACTIVITY

Observe under the light an x-ray sheet showing a fractured bone.

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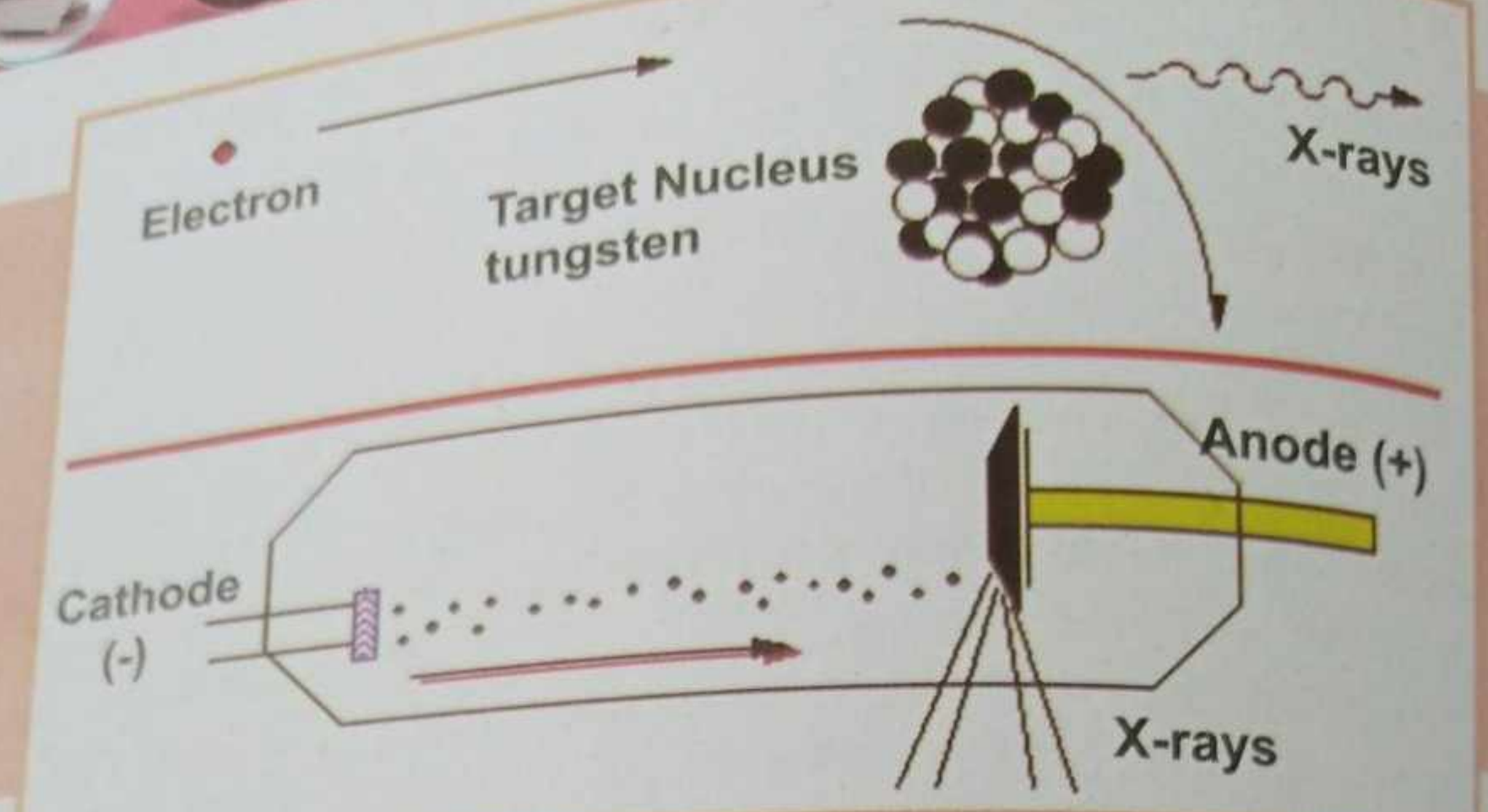


Fig: 11.7 Formation of image through x-rays.

3. They cause florescence in many substances.
4. By passing through solid, liquid or gas, they ionize the atoms.
5. They affect the photographic plates.

Uses of X-rays

Some of the important uses of X-rays are as under:

1. Medical Use: X-rays are used for the diagnostic radiography of bones, chest, kidneys, teeth, etc. to reveal the fractures or bones or abnormality of an organ. X-rays are also used for therapeutic purposes in the treatment of tumors.
2. Industrial Use: X-rays are used to test cracks in structural materials. They are also used to analyze the composition of alloys, structures of rubber and plastics.

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3. Safety Use: X-rays are used to look for weapons and bombs in sealed cases at airports.
4. Scientific Use: X-rays are used to study the crystalline structures of solids.

11.2.2 Ultra Sound

Human ear can respond to a sound having frequencies between 20Hz and 20KHz. The sound frequency less than 20Hz is called infrasonic and higher than 20KHz as ultrasonic. Infrasonic and ultrasonic sound frequencies cannot be heard by human ear but are not less beneficial to mankind. Ultrasonics are widely used waves which are harmless and produce no after effects like x-rays or nuclear radiations. They are longitudinal mechanical waves with frequency above the audible range so these waves have greater penetrating power.

FOR YOUR INFORMATION

Ultrasound technology is a field of increasing application in the areas of food, drug, and device industries. Ultrasonic techniques are presently utilized for applications ranging from bonding and sealing of thermoplastic packaging to medical diagnosis. Other industrial applications of ultrasound include cleaning equipment which utilizes ultrasound to form bubbles in the cleaning or sterilizing liquids. Ultrasonics are also used to form foam in beverage bottles and cans to expel air before closing them.



Ultrasonic leak detector.

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Production of Ultrasound Waves

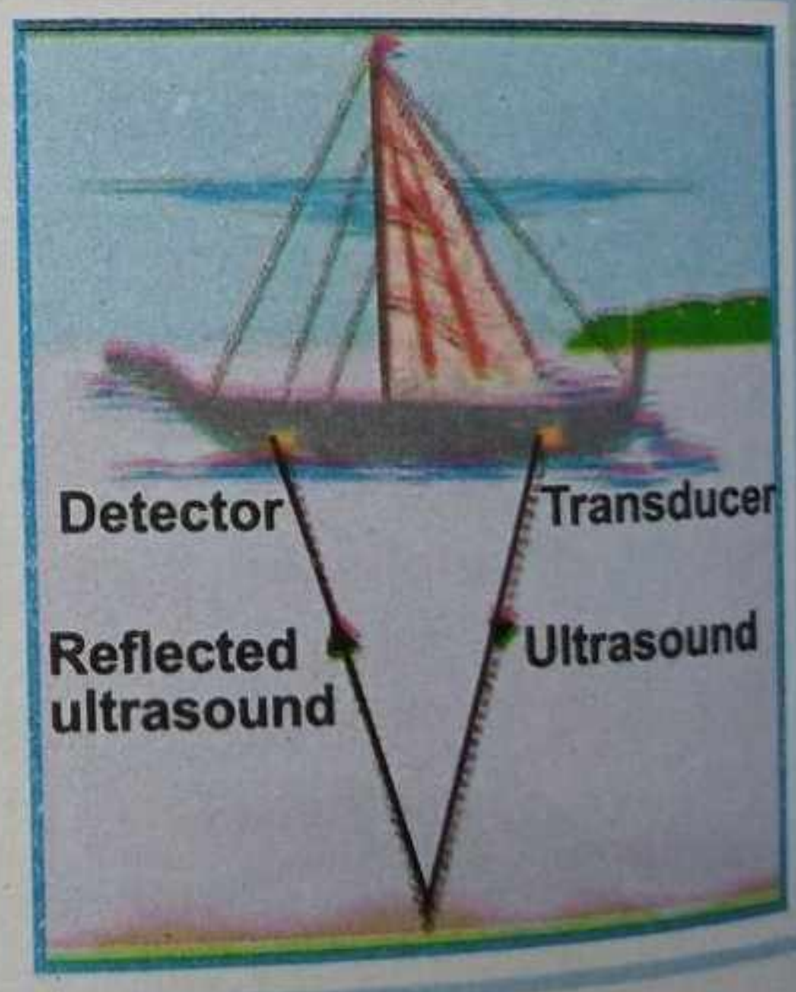
Ultrasound is one of the widely used tools for disease diagnosis and examination of several body parts. The main part of the ultrasound imaging equipment is the transducer. During diagnosis the transducer remain in contact with the surface of the body of the patient. When electrical pulses are supplied to ultrasound machine, the ultrasonic sound is focused by the transducer into small beams which can strike the internal organs. After striking the echo pulse is returned and signals are picked by the transducer and are converted back into electric pulses that are then processed by the system and images are formed.



Fig: 11.8 Ultrasound in diagnosis of diseases.

FOR YOUR INFORMATION

SONAR stands for Sound Navigation and Ranging. This technique is helpful in exploring and mapping the ocean because sound waves travel farther in the water than do radar and light waves. It is primarily used to develop nautical charts, locate underwater hazards to navigation, search for and mapping objects on the sea floor such as shipwrecks, and to map the sea floor itself.



Application of ultrasonic waves

i) Ultrasonic waves are widely used as diagnostic, therapeutic, and surgical tools in medicine and industries.

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iii) Ultrasonic waves are also used to obtain cross-sectional pictures of patient's organs in hospital.
iii) Ultrasonic guidance devices are used for the blind.
iv) These waves are used to kill bacteria and microorganisms in liquids.
v) Ultrasonic scans are preferred to x-rays as ultrasound is much safer than x-rays. Ultrasounds are considered best to examine the soft fleshy parts of the body.

11.2.3 EEG (Electroencephalogram)

The electroencephalogram (EEG) is a diagnostic procedure in which electrical activity of the brain is recorded by placing small metal discs called electrodes on the scalp. The recorded waves form pattern show the electrical activity reflected from the cortex of the brain. Cortex is the largest part of the brain which is concerned with the higher functions of the brain such as thought and action.

Brain is composed of nerve cells or neuron which produces electrical signals known as action potentials. From one nerve cell to other, action potential moves through a gap called as synapse with the help of special chemicals known as neurotransmitters.

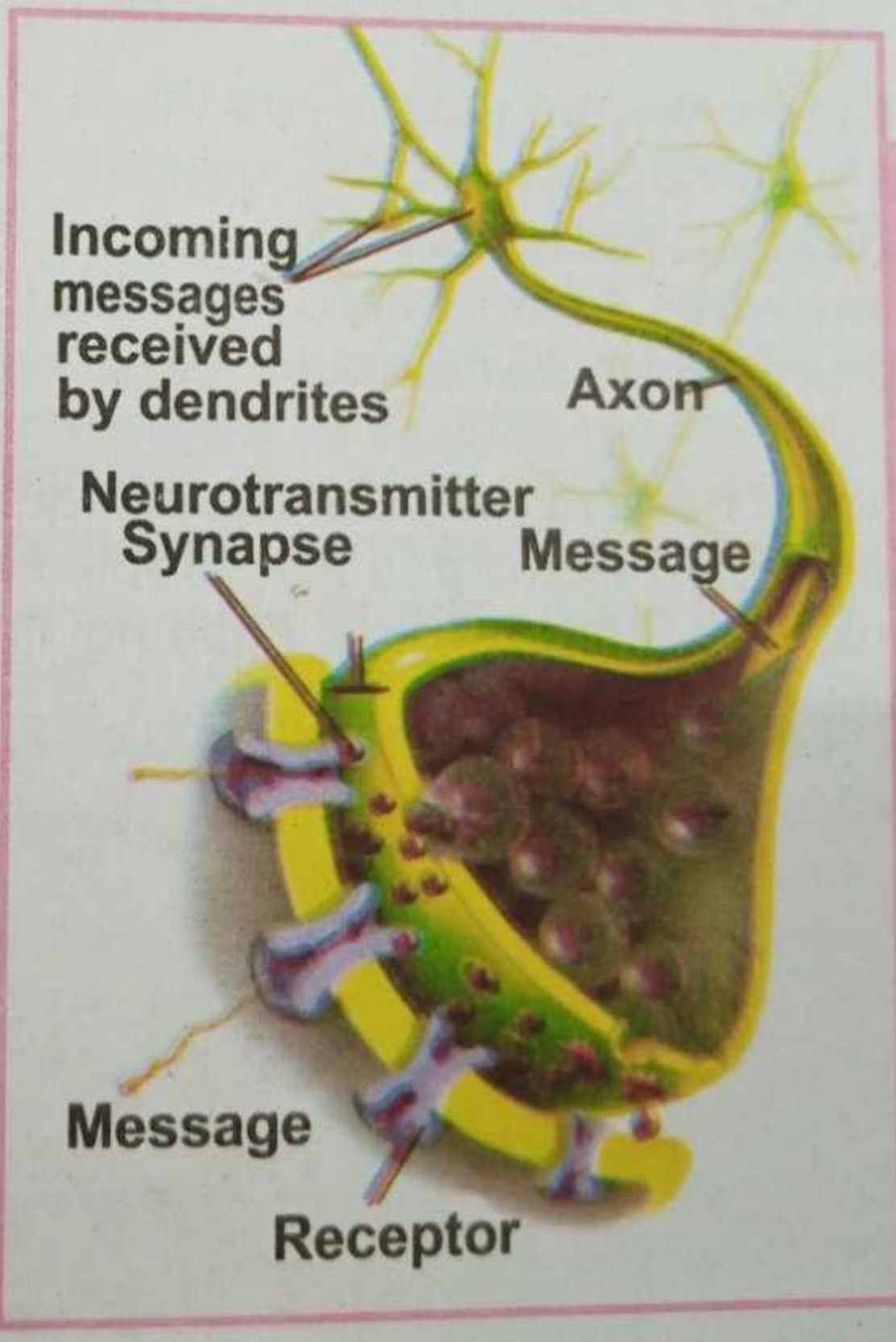


Fig: 11.9 Structure of nerve cell.

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For taking reading of the electrical activity of the brain electrodes are placed on the scalp at specific positions. Each electrode site is labeled with a letter referring to the area of brain underlying the electrode .e.g. T-Temporal lobe and F-Frontal lobe and a number. Even numbers denote the right side of the head and odd numbers the left side of the head.

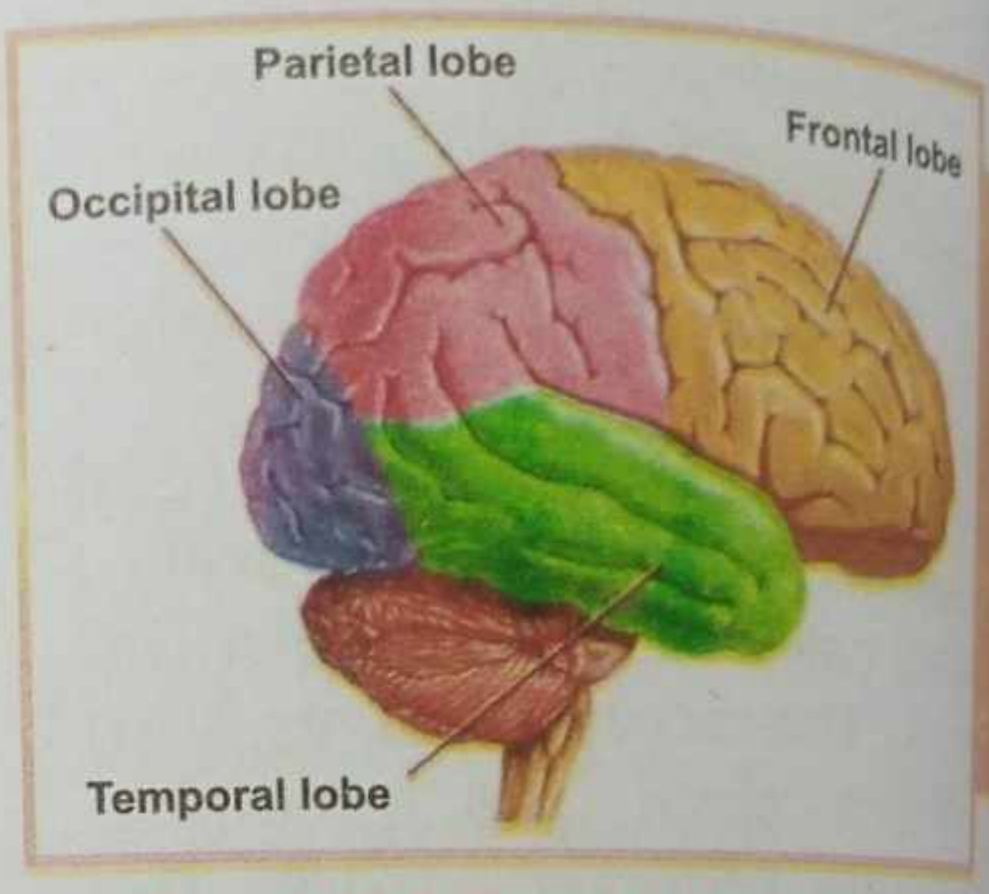


Fig: 11.10 Different lobes of brain.

There is a great variety of electrodes that can be used. Majority are small discs of stainless steel, tin, gold or silver covered with a silver chloride coating. These normally have a lead attached.

Sometimes, an elastic cap fitted with electrodes is used instead. The electrodes are connected with wires to an instrument that amplifies the brain waves and records them on computer equipment.

The technician may ask the patient from time to time to open and close eyes, perform a few simple calculations, read a paragraph, to look at a picture or a flashing light, breathe deeply for a few minutes.



Fig: 11.11 Electrodes are being attached for test.

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Video is frequently recorded during the EEG. Body motions are captured by a video camera while the EEG simultaneously records brain waves. This combined recording may help doctor diagnose and treat a medical problem.

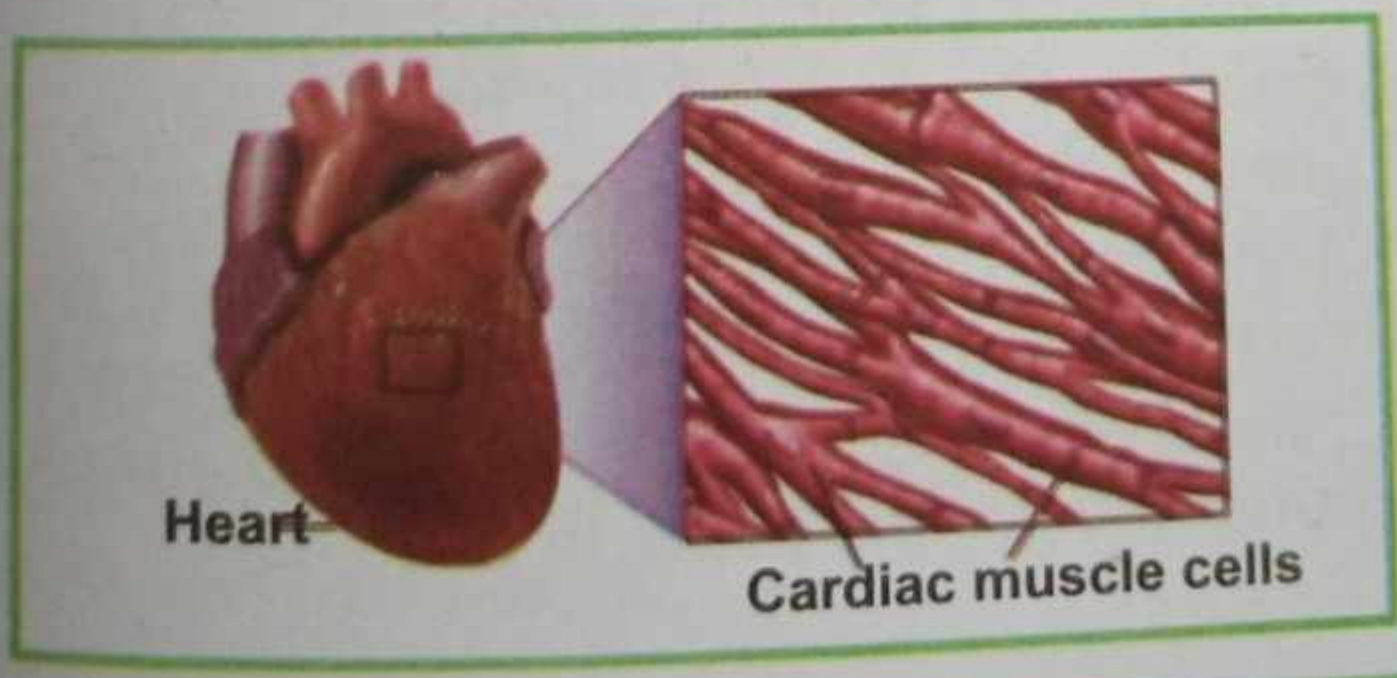
11.2.4 ECG (Electrocardiogram)

An electrocardiogram (ECG) is an electrical recording of the heart and is used in the investigation of heart disease. An electrocardiographic lead is a recording electrode or a pair of recording electrodes at a specified location on the body. In clinical practices, twelve leads are usually used in the diagnostic ECG, although there is no limitation to the number of leads. The leads are usually placed on the elbows and stifles.

The electrocardiography is a technique of recording the bio-electric currents generated by the heart.

FOR YOUR INFORMATION

Cardiac cells at rest are considered as polarized, having no electrical activity. The cell membrane of cardiac muscle cell separates different concentrations of ions such as sodium, potassium, and calcium. This is called the resting potential. Electrical impulses are generated automatically by specialized cardiac cells. Once an electrical cell generates an electrical impulse and ions cross the cell membrane, the resting potential turns into action potential also known as depolarization.



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The graphical display of this recording is called electrocardiogram. The ECG, refers in general to both electrocardiogram and electrocardiography. For more than one hundred years, the ECG has been used to reveal the condition of the heart and to diagnose cardiac illnesses. This has been possible because the cardiac muscle cells generate bio-currents which can be detected inside the body or on its surface using some special electrodes. Unlike the bio-currents generated by some other muscles, the currents generated by the heart muscles are periodic, that is, they consist of a repeated sequence of characteristic waveforms which correspond to a heart beat.

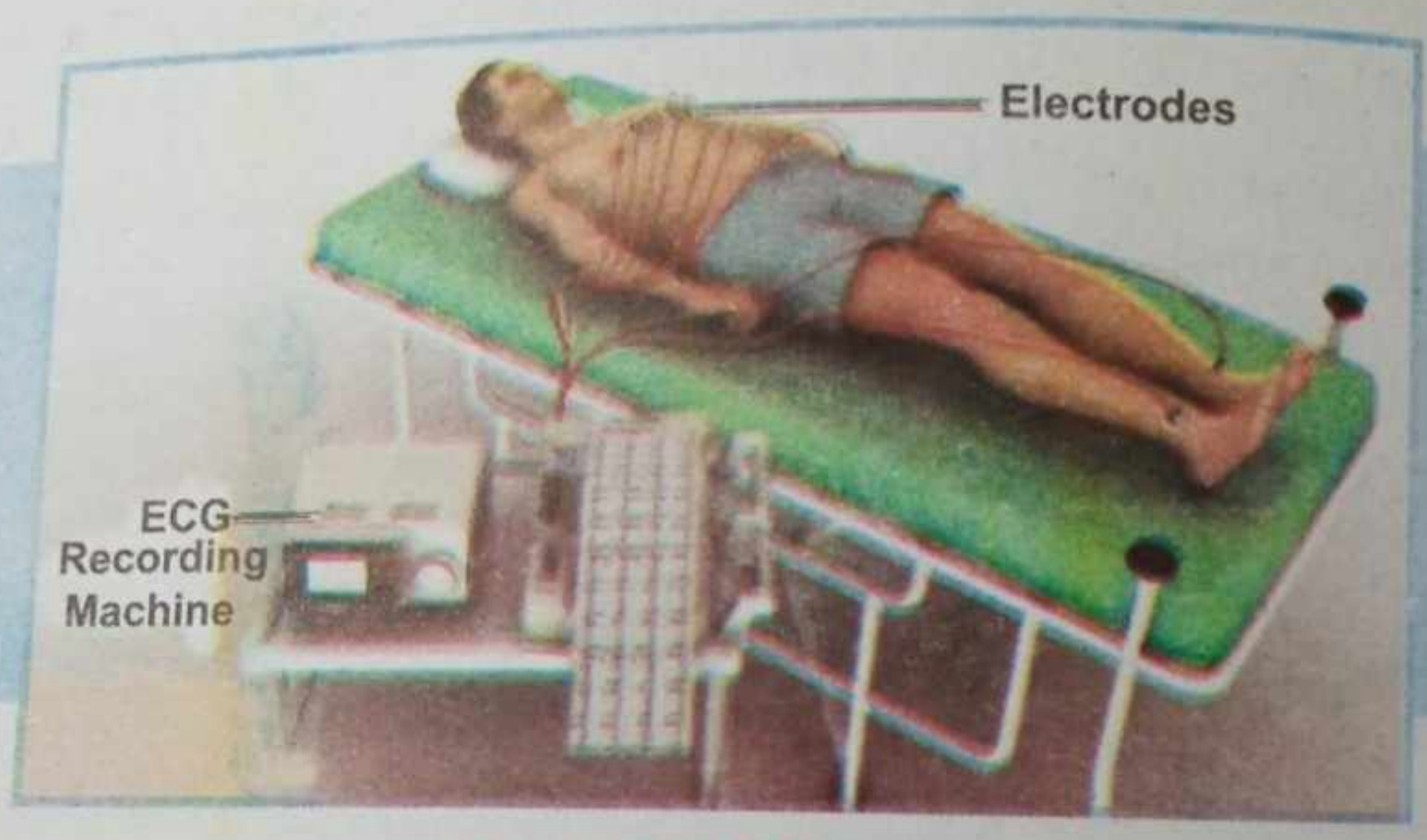


Fig: 11.12 ECG test.

11.2.5 CT SCAN (Computerised tomography)

Computerized tomography scans are special type of x-ray tests that produce cross-sectional images of the body using x-rays and the images are generated in the computer. With the help of computerized tomography scans, small nodules or tumors get detected which are not visible, unnoticed and undetected by x-rays. Such images generally helps doctors to diagnose a certain abnormal condition developing in the body.

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Computerised tomography scans are generally used to collect graphical information which can be used to assess the general health of the brain, neck, spine, chest, abdomen, pelvis and sinuses.

Computerised tomography (CT Scan) of the brain

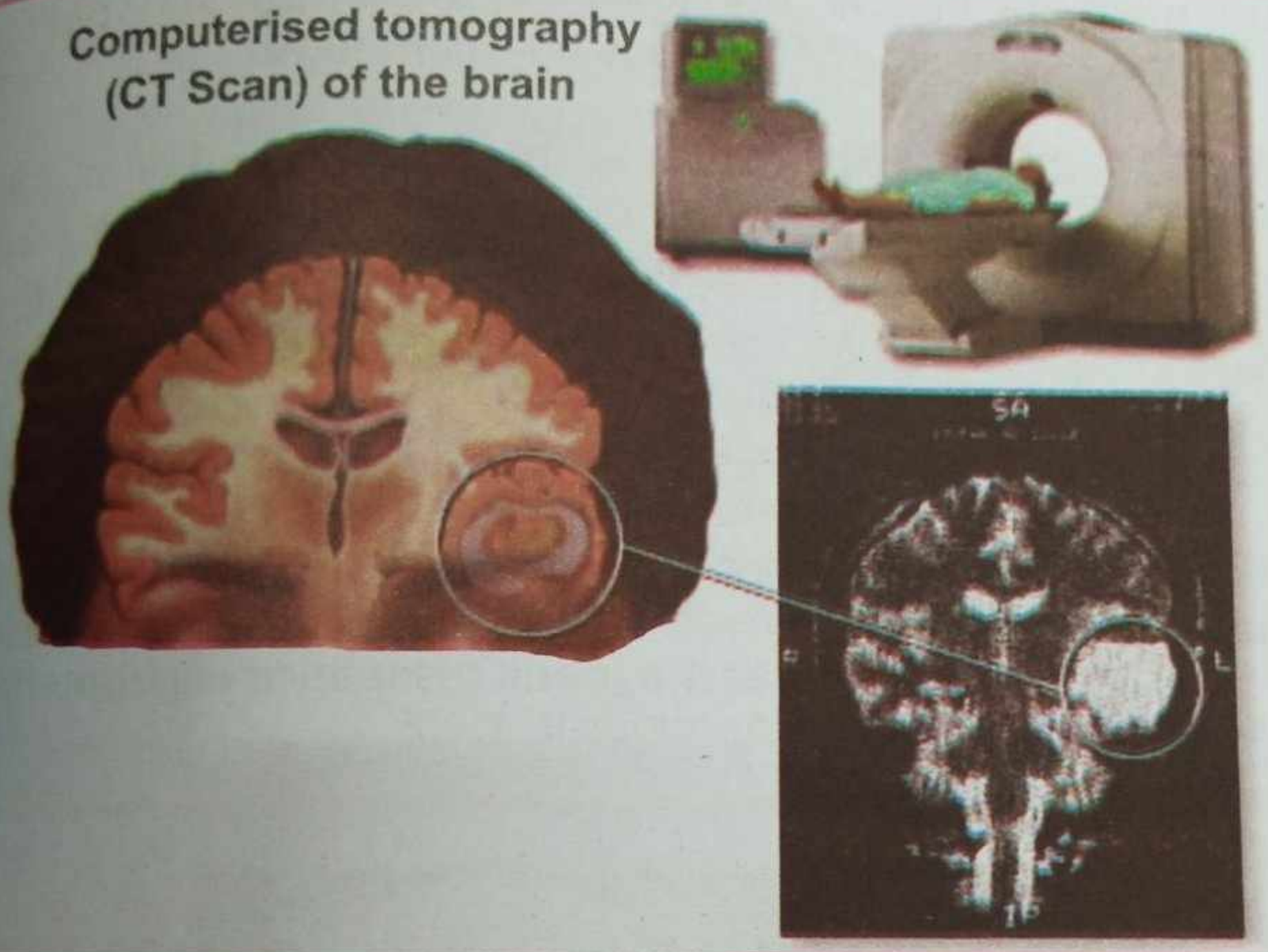


Fig: 11.13 CT scan

One of the advantage of CT scan over other diagnostic procedures is that it is useful in the examination of the soft body tissues like liver, stomach, and some other abdominal organs. It is also being used for the examination of brain to look for a mass, stroke, area of bleeding, or blood vessel abnormality. CT scans are also used as a confirmatory procedure for checking the already known results using X-rays and ultrasound test. CT scan can also be used to see the spread of a cancer in the body.

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11.2.6 MRI (Magnetic Resonance Imaging)

Magnetic resonance imaging (MRI) scanners are used to produce two- dimensional and three- dimensional internal images of the body. These scanners work in a similar way like that of CT scan. However, MRI scan does not use X-rays as in CT scan, rather it uses a strong magnetic field and radio waves to produce very clear and detailed images of inside of the body on a computer.

Commonly MRI is used to examine the brain, spinal cord, joints, abdomen, and pelvis. Apart form this, a special kind of MRI called magnetic resonance angiography (MRA) is used to examine the blood vessels.

FOR YOUR INFORMATION

Felix Bloch from Stanford University and Edward Purcell from Harvard University, working independently, performed the first successful nuclear magnetic resonance experiment to study the chemical compounds in 1946.

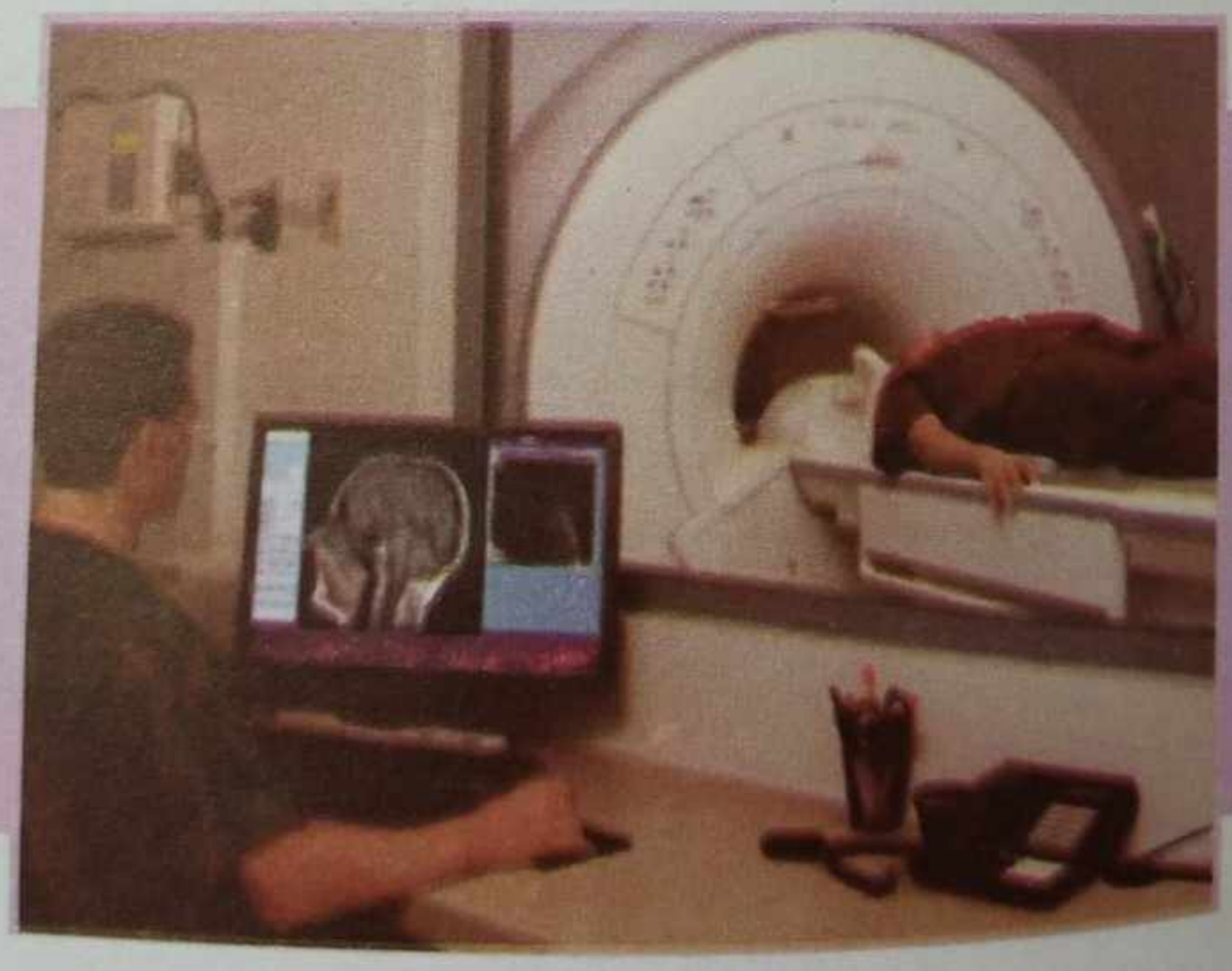


Fig: 11.14 MRI scan

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A head coil is placed around the patient's head while examining the MRI of brain. With the help of this head coil diverse images of brain are captured for diagnostic purposes. MRI scans are also used for the diagnosis of medical problems related to hearing, general weakness, blurred vision, seizures etc.

FOR YOUR INFORMATION

During an MRI test, patient is asked to remove all accessories such as jewelry, credit cards, and any metallic objects. The reason for this is that MRIs involve magnets, which may interact with objects. This in turn may lead to bad results and/or poor image quality.





11.2.7 Angiography

Angiography is a diagnostic procedure which detects the general conditions of the blood vessels. It gives an information showing whether blood vessels are narrow, irregular or blocked. It also gives an overview of the blood flow condition in the blood vessels and also detect the development of clumps of new vessels and other abnormal patterns like tumours and injuries. Angiography is also a useful procedure for investigating the narrowing or blockage of the coronary arteries supplying blood to the heart, so that necessary treatment like balloon angioplasty or coronary artery bypass operation can be done.

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It detects the presence of abnormal arteries in and around the brain. A general look into the procedure shows that it is a special form of x-ray examination which shows the problem of the blood flow in arteries and veins. A special dye is injected into the blood stream which detects any disease like atherosclerosis which causes fatty plaques to be deposited in the lining and narrows the vessel. It is also useful in the detection of blood clots.

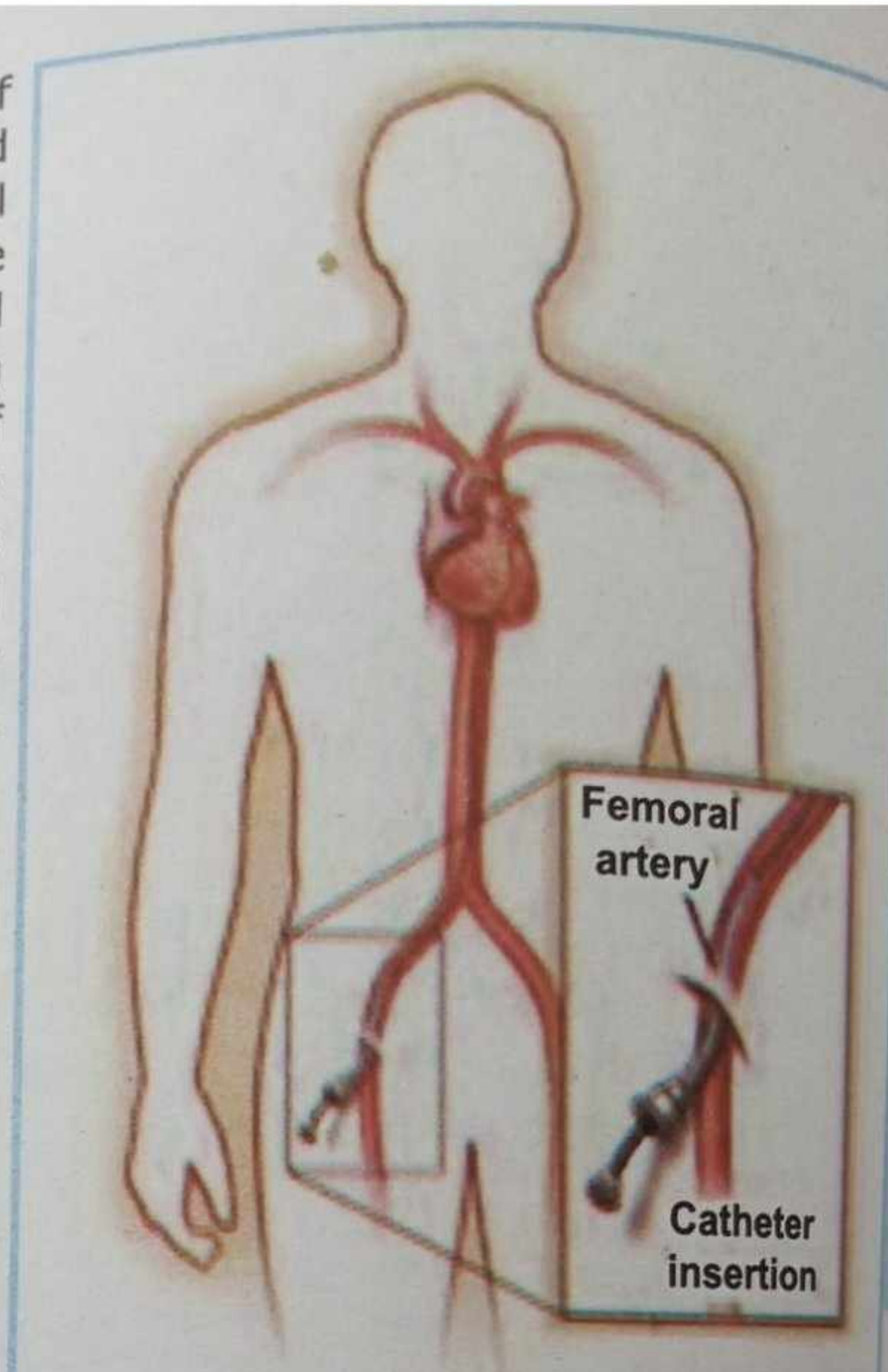


Fig: 11.15 Angiography.

11.3 INFORMATION TECHNOLOGY (IT)

The rapid advancements in electronics have provided new tools such as television, computer, internet, telephone, satellites etc. Our society is changing due to developments in information technology. While watching TV or reading a newspaper or magazine, it is impossible to miss coverage on seemingly diverse topic related to information technology, internet, World Wide Web (WWW), digital TV, online learning, corporate restructuring, wireless communication, medicine and so on. IT is based on the hardware and software of a computer and the telecommunication infrastructure. Computers have been used for information processing for many years.

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Computers are becoming more and more powerful both in terms of their computational speeds and also for their capacities for storing data. Computer technology is the most useful technology ever developed. IT is the combination of computer Technology and communications.

Rapid changes are taking place in information technology all over the world. The methods used in sending information instantly over long distances are called telecommunications. The devices are television, computer, radio, telephones, fax machines etc. Let's study some devices in detail.

11.3.1 Computer

A computer is an electronic device which can solve complicated problems. It processes data, entered into it and gives out the result rapidly. There are three basic kinds of computers i.e digital computers, analog computers and hybrid computers.



Analog computer.



Digital computer

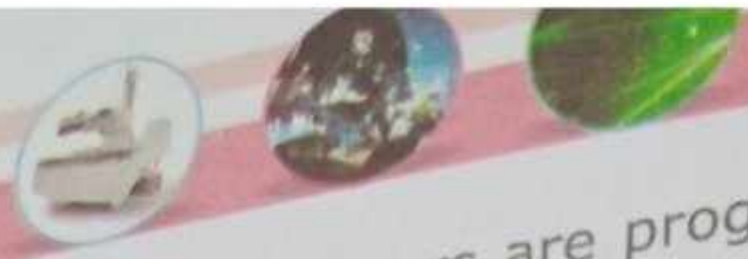


Hybrid computer

Fig: 11.16 Different types of computers.

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Digital computers are programmable so these can run variety of applications using software. Analog computers work with the physical characteristics like pressure, temperature, weight etc. Sometimes the properties of digital and analog computers are combined in a computer and such computer is called hybrid computer.

The use and importance of computer is rapidly increasing day by day. It is because of high speed processing, the reliability of handling the supplied information with accuracy, large memory and the capability of arriving at an end result. These properties have made computer to be an important tool for getting easy solutions to variety of problems we face on our daily life.

A set of computers connected through a network is called a computer network. For example, internet is a computer network. Computers connected by a network can mutually exchange information. The interconnected computers can serve as a common database.

Basic elements of a computer system

A computer system is composed of different components which work in a coordinated fashion for the accomplishment of a certain task. Overall, a computer has a hardware and a software component. The hardware components of the computer are the parts which can be touched and are visible to eyes. The software components consist progrmmes and applications that directs the hardware components for effective functioning. A computer has the following major parts.

i. Central processing Units (CPU)
ii. Memory or storage
iii. Input Units
iv. Output Units

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The set of instructions given to a computer is called program. We enter data through input devices. An input device is any hardware component that allows a user to enter data and instructions into a computer. Input devices are mouse, keyboard, microphone, digital camera, scanners etc.

An output device is any piece of computer hardware equipment used to communicate the results of data processing carried out by a computer to the user. Output devices are monitor, printers, computer speakers etc.

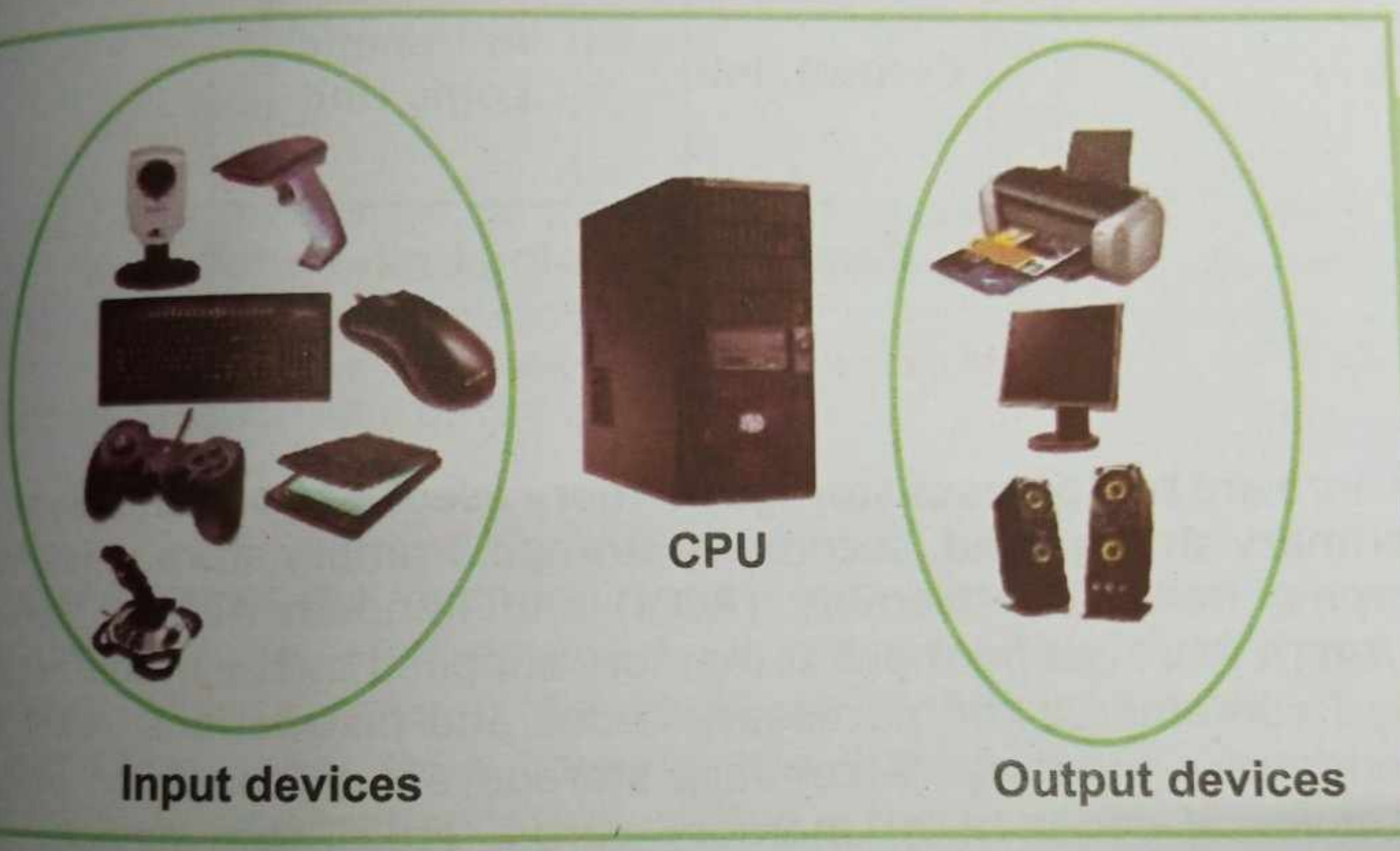


Fig: 11.17 Different devices of computers.

Electronic data is stored into the memory, from where it is processed as and where instructed. Central processing unit (CPU) executes the instructions sequentially. The instructions modify data stored in memory or obtained from an input device. Processed data may be stored back in memory or sent to an output device, such as monitor. The results can be viewed on the TV screen or can be printed by the printer for permanent record.

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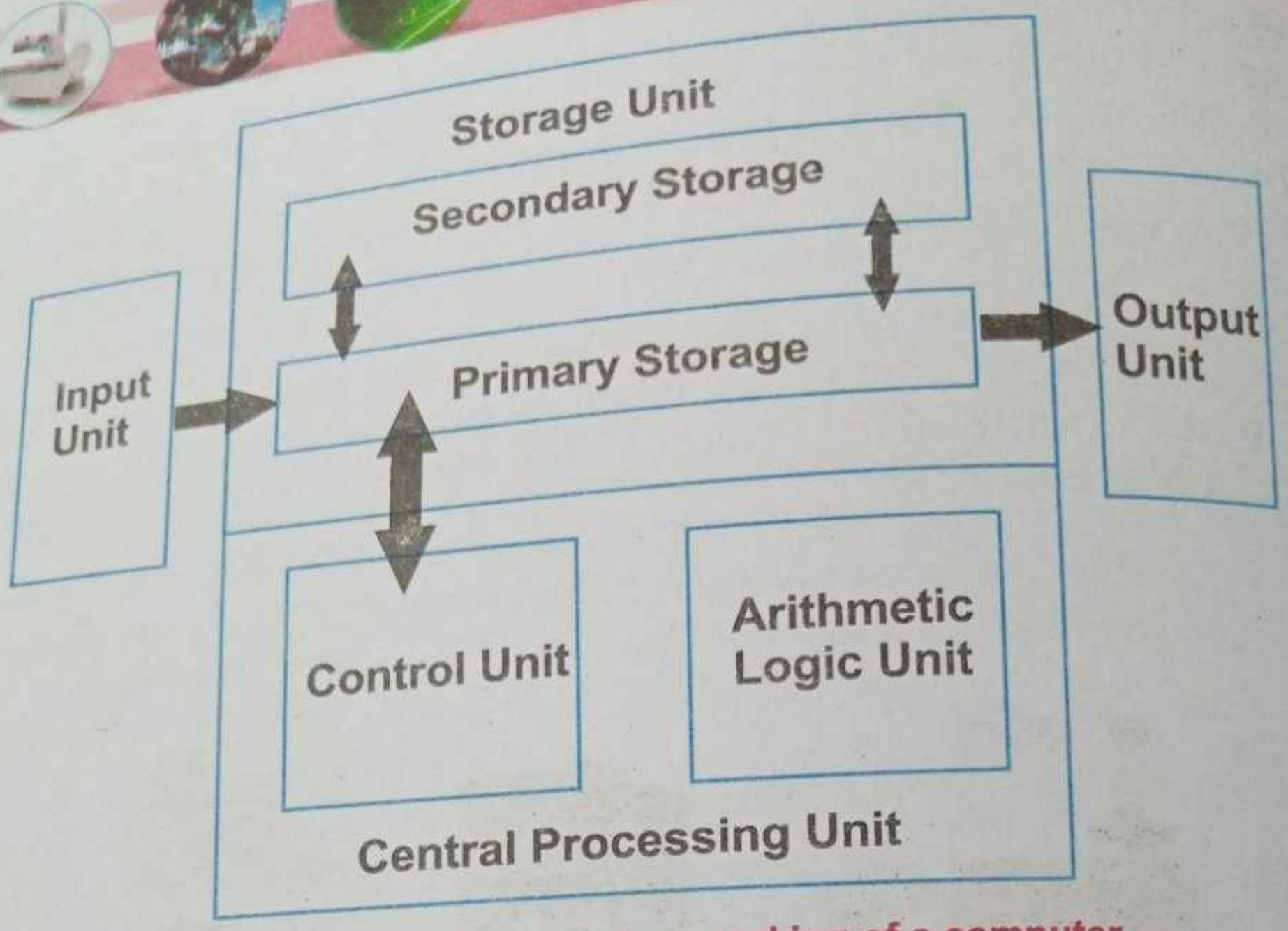


Fig: 11.18 Flow chart showing working of a computer.

There are two types of storage memory used in a computer system, primary storage and secondary storage. Primary storage is of two types; Read only Memory (ROM) and Random Access Memory (RAM). ROM is a permanent memory supplied by the manufacturer and contains all the necessary codes and instructions. RAM is a temporary memory. Secondary storage are in the form of USB (Universal serial bus), memory cards, etc. These devices give backup storage and also increases the data storage capacity.

Computer has a vital role to play in almost every field of life. In the field of education, computer provides an efficient mechanism for storage and access to information. It also preserves data for future use. Online education has made the dream of distance learning a reality. Computers help in audio-visual representation of information, thus making the process of learning interactive and interesting.

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Computers are extremely important in today's business. Ordering products, shipping information, price checks in retail stores etc. is done using computers. Many businesses use accounting software and ledgering systems to ensure the accuracy of their financial status.

Computers provide a wide range of communication methods like email, social networks, chat, web and teleconferencing etc.

With the advent of Internet, we are now enjoying the benefits of high technology media which is not only faster but also wide spread in range. In manufacturing industry computers are widely used to design and manufacture products.

11.3.2 Telephone

The word tele means far or distance and phone means sound. Putting them both together it means something that lets you hear sound from a distance.

Telephone has two main parts.

1. Receiver

The receiver turns the incoming signals into sound. As the signals pass through the electromagnet, it attracts the thin metal membrane. The changes in the amplitude of the signals will vary the attraction, and thus causing the membrane to vibrate accordingly. Such vibration is transmitted in the air as sound waves. Therefore we can hear the sound.

TADBIT

In 1946 world's first commercial mobile phone service started its operation. It could link moving vehicles to a telephone network via radio waves.



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2. Speaker

Most telephones use carbon powder speaker transmitter, a device to turn the sound wave into electric signals. The carbon powder is present in a case. When you speak, the sound vibrates the plastic membrane and presses the carbon powder.

The resistance of the powder drop when it is under pressure. Therefore, the sound vibration changes the electric current correspondingly.

When we speak on telephone, the sound energy changes into electrical signals. These signals travel along telephone cable and telephone receiver on other end of the lines changes the electrical signals again into sound. In the latest technology, sound signals are first converted into electrical signals which are then converted into light signals with the help of electronic circuits. These light signals travel along optical fibers. Advantage of this technology is that several thousand calls can be transmitted through a single optical fiber at the same time and there will be no interference effect of electric or magnetic fields on the light signal.

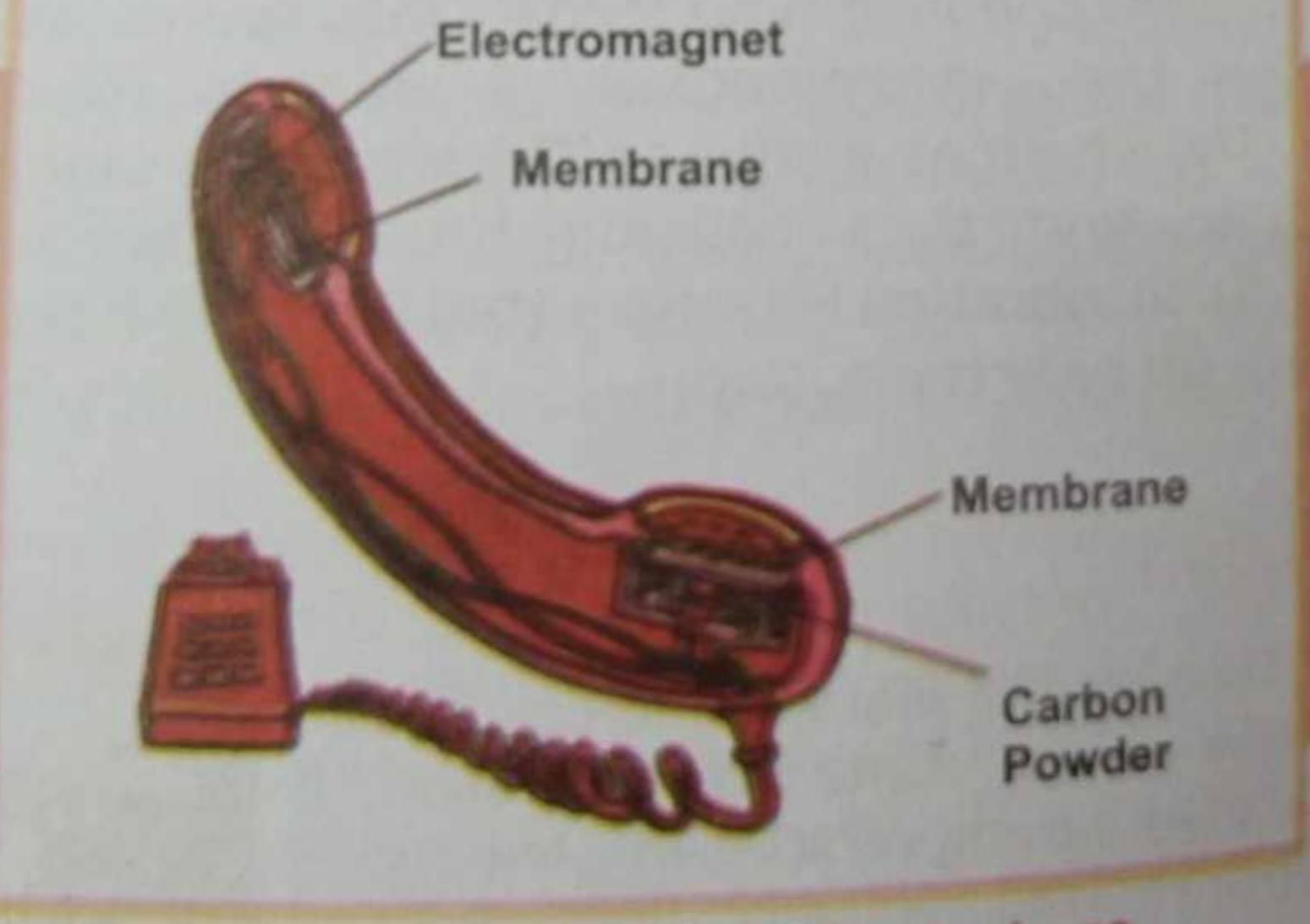


Fig: 11.19 Main parts of a telephone.

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11.3.3 Fax Machine

Fax machine is used to send contents of the documents to other destinations without changing the physical version of the document. Fax is a short of facsimile, which means exact reproduction of a document print or picture. A fax machine scans a document and changes the dark and light parts into electrical signals. These signals travel along telephone cable to the receiving fax machine, which reproduces the original document. The original document is scanned with a fax machine (or a telecopier), which processes the contents (text or images) as a single fixed graphic image, converting it into a bitmap, and then transmitting it through the telephone system in the form of audio-frequency tones. The receiving fax machine interprets the tones and reconstructs the image, printing a paper copy.



Fig: 11.20 Fax Machine.

11.3.4 Radio

Radio is a source of information and entertainment even in the presence of other useful present day gadgets. A radio works with the help of radio transmitter and a radio receiver. Radio transmitter transmits sound in the form of radio waves which are received by the radio receiver.

A radio wave is an electromagnetic wave which is transmitted by an antenna. Radio waves launched from a transmitting antenna move outward and without being influenced by the surrounding atmospheric conditions like rain, snow etc. Radio waves can easily penetrate non-metallic objects. They travel best in free spaces and require no material medium for their transmission.

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- Radio waves have different frequencies. For example, all FM radio stations transmit in a band of frequencies between 88 megahertz to 108 megahertz and you can tune your radio receiver to a frequency between this range for a particular FM radio station. Common radio frequency bands include:

- AM – 535 KHz to 1.7 MHz
- Citizen Band (CB) Radio – 26.96 MHz to 27.41 MHz
- Short Wave Radio – 5.9 MHz to 26.1 MHZ.
- FM – 88 MHz to 108 MHZ

In the radio station, a person talks in a microphone. The microphone converts the sound into electrical signals. the radio transmitter transmit the signals in the space in all directions in the form of radio waves. The radio receiver set picks up the radio waves in space by an aerial. The aerial converts the radio waves into electrical signals and send them to the tuner in the receiver set. The radio tuner can select the transmission of a particular radio station. The tuner sends the selected signals to an amplifier. Finally, the signals reach the speaker of the radio set and are converted to sound signals.

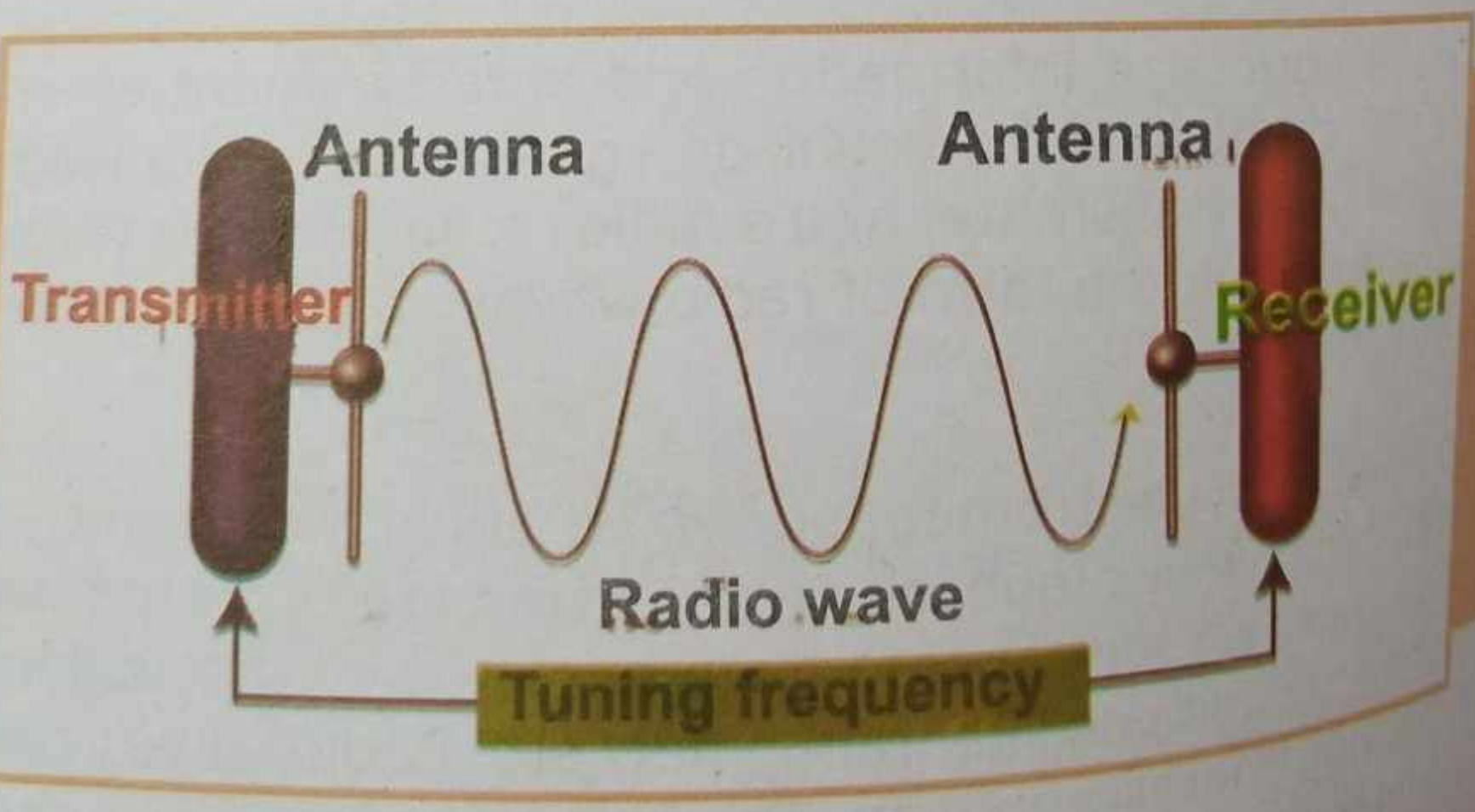


Fig: 11.21 Transmission of radio waves.

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11.3.5 Television (TV)

The word television is a combination of two words, tele and vision which means seeing at a distance. Television has been influencing our lives since its invention. On one hand, it provides us entertainment and on the other hand it is a source of valuable information.



Fig: 11.22 Television.

Working of a television is based on three basic things i.e. the **TV camera** that turns a picture and sound into a signal; the **TV transmitter** that sends the signal through the air; and the **TV receiver** (the TV set in your home) that captures the signal and turns it back into picture and sound. TV creates moving pictures by repeatedly capturing still pictures and presenting these to your eyes so quickly that they seem to be moving.

A television program is produced by focusing a television camera on a scene. The camera changes light from the scene into an electric signal, called the video signal. The video signals from the cameras are processed in a control room. Audio signals from microphones placed in or near the scene also flow to the control room, where they are amplified and combined. The signals are then sent to the transmitter.

The transmitter amplifies the video and audio signals and uses the electronic signals to modulate, or vary, carrier waves. The carrier waves are combined, and then sent to the transmitting antenna. In the antenna; the oscillations of the carrier waves generate electromagnetic waves of energy that radiate horizontally throughout the atmosphere. These waves excite weak electric currents in all television-receiving antennas within range. These currents have the characteristics of the original picture and sound currents. The currents flow from the antenna attached to the television into the television receiver, where they are electronically

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separated into audio and video signals. These signals are amplified and sent to the picture tube and the speakers, where they produce the picture and sound portions of the program.

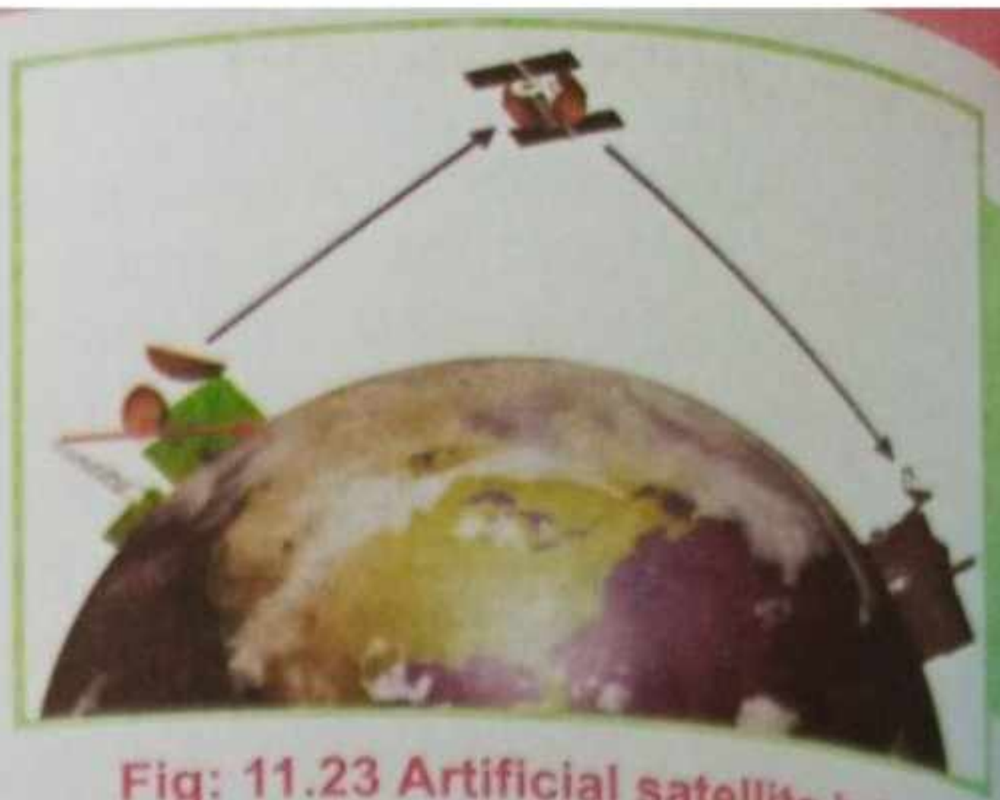


Fig: 11.23 Artificial satellite bring live events to our television screen.

Artificial satellites

Artificial satellites move around the earth. These satellites are used to relay messages e.g. speech, conversation, pictures etc, transmitted over electromagnetic waves from one place to far off places on the earth surface which enable us to view live events, matches etc.

11.3.6 Mobile or Cell phone

Cellular or mobile phone has revolutionized the communication technology worldwide. It is one of the booming industries in the world. In Pakistan mobile phone users are increasing with every passing day. Mobile phone is a type of short-wave analog or digital telecommunication in which a user has a wireless connectivity from a mobile phone to a nearby transmitter. Each of the transmitter has its own specific area of coverage which is technically called as a cell.

When the mobile phone user moves from an area to another area of coverage, the signals are passed on to the local cell transmitter operating in that specific area. When you speak into a mobile phone, the sound waves strikes the microphone in the handset which converts sound waves into electrical signals. In a mobile phone there is a microchip which converts these electric signals into radio waves which are beamed out from the antenna of the mobile. These radio waves travel through the air at the speed of light until it is received by cell phone mast which pass them to its base station. From the base station, the calls are transferred to their destination. This is how a call is made from one mobile to another mobile.

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When call is from one mobile phone network to another mobile phone network or to a landline number, the radio waves travel to and are received by the main telephone network before they are routed onward to the desired destination.

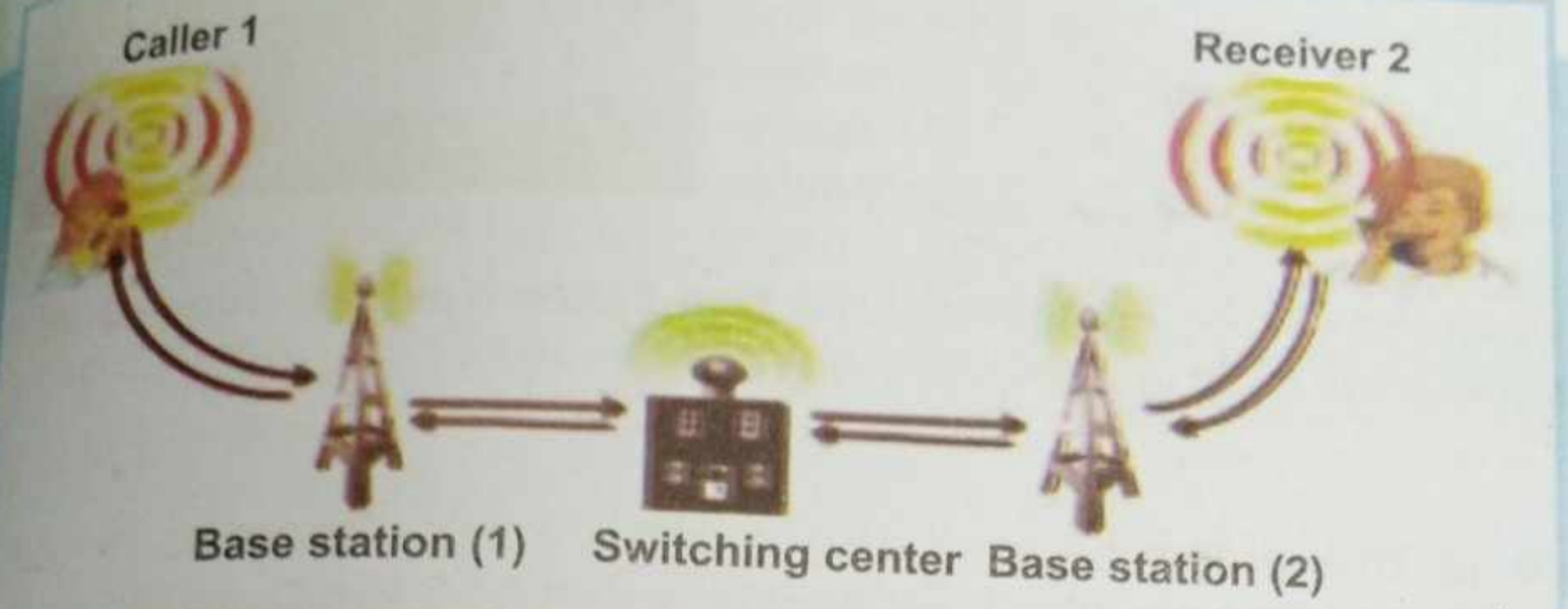


Fig: 11.24 Mechanism of cellphone calling.

11.4 Space Exploration

Human being is very conscious by nature and always tries to solve the mysteries of the events, which take place with or without his own contribution. This curiosity leads the man to enter space and to know the surroundings of the earth.

DO YOU KNOW?



On 20th July, 1969, the first man to step on the surface of moon, was Neil Armstrong,. When Neil Armstrong put his step on the surface of moon, he spoke the following historical words.
"One small step of man, one giant leap for mankind". He stayed there for about 21 hours and 37 minutes.

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FOR YOUR INFORMATION

Satellite is the man-made scientific instrument (object) which is sent from the earth and restricts it to orbit around the earth. The satellites are sent into the orbit with the help of rocket. On 3rd November, 1957 the Soviet launched Sputnik-2 which weighed 508 Kg and carried the first space traveler, a dog named Laika, which survived for several days.



Space is the place beyond the earth where there is no air or atmosphere. The air which we feel is about 112 km from the surface of the earth. Beyond the boundaries of this, approximately 160 km, all the place in the universe is called space.

It was believed that the stars and the upper space play a very important role in the changes taking place on the earth. Man always tries to know about the upper atmosphere or space.



Fig: 11.25 Layers of atmosphere on earth.

TIDBIT

The first T.V. relay station called Telstar was released in space in 1962.

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FOR YOUR INFORMATION

The word space station means the permanent station, which can be used as an experimental laboratory, where those experiments can be performed which are not possible on earth. The first idea of space station was presented by Russians. Russians sent salyat and Mir space station, while America sent Sky Lab and space shuttle into space.



11.4.1 Pakistan Space Programme

Due to the revolution in space exploration and importance of the role of satellite in various fields, Pakistan, although a developing country also realized the importance of space and space exploration, therefore established an organization named " SUPARCO" in 1962.

TIDBIT

In future the space station having solar cells will be installed and their cells will generate electricity which will be sufficient for earth with microwave beam.

SUPARCO means "Pakistan Space and Upper Atmosphere Research Commission". It is responsible for the execution of the space science and technology programmes in the country.

FUNCTIONS OF SUPARCO

Functions of the SUPARCO are:

i) Keeping in view the objectives of the commission it prepares and submit proposals, schemes or projects to the Government of Pakistan for getting necessary approvals.

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ii) The commission is entrusted with the responsibility of carrying out research and application programs approved by the Government of Pakistan.

iii) On the directives of the Government the commission conducts investigations and surveys mainly related to space and upper atmosphere.

iv) The commission prepares and submits quarterly progress reports and its annual budget to to the Government Of Pakistan for approval.

The commission consists of the following divisions

i. **Remote sensing and application Division (RSA)**
This center is for dissemination of satellite remote sensing data products. It also works on geographic information system technology for exploring earth resources, surveying, mapping and environmental monitoring.

ii. **Environmental and space science Division (E &SS)**
It carries out research in environmental pollution studies astronomy etc. and atmospheric science.

iii. **Ionosphere Research Division (IR)**
It is also Concerned with research studies about ionosphere and its effects.

iv. **Satellite communications Division (SC)**
Receive the data from the satellite.

DO YOU KNOW?

On 16th July 1990, Pakistan launched its first experimental satellite BADR-1.



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Contribution of SUPARCO

This research center sent several satellites for weather research. First satellite Badar-I was sent into space in 1990 after which Badar-II was sent. Pakistan has its own communication satellite, responsible for communication all over the country. Pakistan has its own surveillance satellite, which can check each and every movement in the region. It also has monsoon watch program. Weather satellite successfully predicts the information about rain, storms, hurricanes etc.

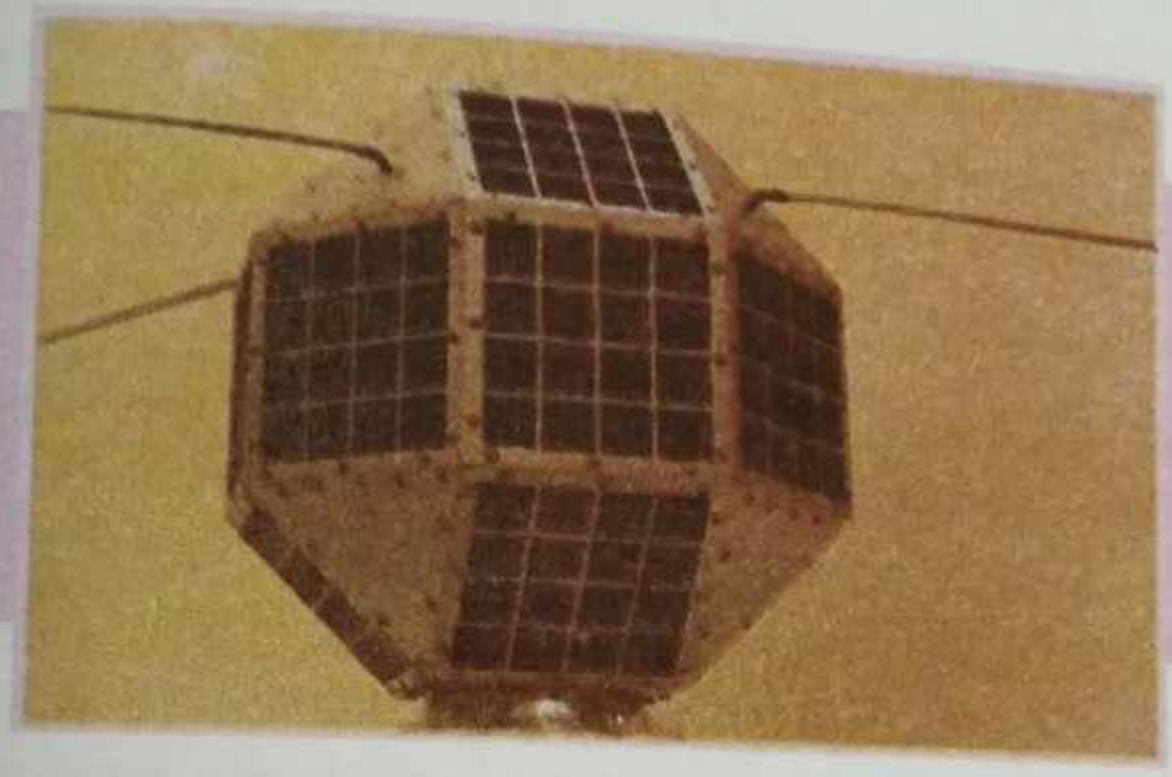


Fig: 11.26 Bader -1 satellite of Pakistan.

Future Plans of SUPARCO

Pakistan's National Satellite Development Programme (NSDP) is one of the major tasks entrusted to SUPARCO. It includes the development of the following.

- Development of effective communication Satellite
- Pakistan Remote Sensing Satellite (PRSS-1)
- Human Resource Development in the area of space exploration

In the field of Applications Programmes following fields have been focused for further studies.

- Remote Sensing Applications
- Space and Atmospheric Sciences
- Tele-Medicine

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KEY POINTS

- Economic growth and well being of a country is directly related to its scientific and industrial advancement.
- Lasers are devices that produce or amplify a beam of narrow, low-divergent light with a well-defined wavelength.
- A laser consists of two fundamental elements: an amplifying medium and a pumping system.
- Fiber Optics is a data communication technology. Fiber optics move information from one place to another. However, the transmission medium is light, and that light is carried within a hair-thin optical fiber via the process of total internal reflection.
- X-rays are electromagnetic radiations which have wavelength much shorter than ultraviolet light. The major use of x-rays is in medical diagnostics and treatment. The absorption of x-rays by dense material is used for x-rays imaging of the human body.
- The sound having frequency less than 20Hz is called infrasonic and higher than 20KHz as ultrasonic.
- Electroencephalogram (EEG) is recording of the electrical activity of brain from the scalp.
- An electrocardiogram (ECG) is an electrical recording of heart which is used in the investigation of heart diseases.
- Computerised tomography scan are special x-ray tests that produce cross-sectional images of the body using x-rays and a computer.
- MRI scanners produce highly detailed two- dimensional and three- dimensional images of the human anatomy.
- Angiography is a special form of x-ray examination that shows the pattern of the blood flow in arteries and veins.

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- Computer technology is the most useful technology ever developed. IT is the combination of computer Technology and the communications.
- On the basis of nature of input, computers can be classified into three types: digital computers, analog computers and hybrid computers.
- There are two types of storage memory used in a computer system, primary storage and the secondary storage.
- Computers provide a wide range of communication methods like email, social networks, chat, web and teleconferencing, etc.
- When we speak on telephone, the sound energy changes into electrical signals. These signals travel along the telephone cable and the telephone receiver on other end of the lines changes the signals again into sound.
- A fax machine scans a document and changes the dark and light parts into electrical signals.
- A radio wave is an electromagnetic wave propagated by an antenna. Radio waves have different frequencies.
- Television has been influencing our lives since its development. It is an important way of spending free time and shapes people's opinions about various issues.
- Artificial satellites move around the earth. These satellites are used to relay messages e.g. speech, conversation, pictures etc, transmitted over electromagnetic waves from one place to far off places on the earth surface which enable us to view live events, matches etc.
- SUPARCO means "Pakistan Space and Upper Atmosphere Research Commission". It is responsible for the execution of the space science and technology program in the country.

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EXERCISE

A. Select the correct answers in the following questions.

1. **The Laser light is:**
   a. Monochromatic
   b. Coloured
   c. Chromatic
   d. None of these

2. **The device that uses strong magnetic field and radio waves is:**
   a. X-ray
   b. C.T scan
   c. MRI
   d. Laser

3. **Artificial satellites are the objects which revolve round the:**
   a. Sun
   b. Earth
   c. Star
   d. Moon

4. **C.T. scan can take cross sectional images of the body by using:**
   a. X-rays
   b. Laser beam
   c. Ultrasonic waves
   d. Radioactivity

5. **Laser used for communication is in the form of:**
   a. heat
   b. light
   c. electricity
   d. sound

6. **Ultrasonic sound has the frequency:**
   a. 5k Hz to 10 kHz
   b. 10 Hzk to 15k Hz
   c. 15k Hz to 20k Hz
   d. above 20k Hz

7. **The light that travels along the fiber is made up of:**
   a. Binary code
   b. Single code
   c. Tertiary code
   d. All of these

NOT FOR SALE

9. **Identify an input device in the following:**
   a. Monitor
   b. Speaker
   c. Printer
   d. Mouse

9. **Electrocardiography is a technique of recording bio-electric currents generated by:**
   a. Brain
   b. Heart
   c. Spinal cord
   d. kidneys

10. **A magnetic resonance imaging scan produces cross-sectional images of the body using:**
   a. Ultrasound waves
   b. Strong magnetic field and radio waves
   c. X-rays
   d. Infrared rays

11. **Atherosclerosis causes fatty plaques to be deposited in:**
   a. Bones
   b. Muscles fibers
   c. Blood vessels
   d. Skin

12. **Identify the out put device in the following:**
   a. Mouse
   b. Keyboard
   c. Microphone
   d. Printer

13. **A fax machine scans a document and changes the dark and light parts into:**
   a. Ultrasoud waves
   b. Radio wave
   c. Electrical signals
   d. Infra red rays

14. **In radio the transmitter receives the message, encodes it into a:**
   a. Ultrasoud waves
   b. Radio waves
   c. Electrical signals
   d. sine wave

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B. Write short answers of the following questions.

1. What are the similarities and differences between MRI and CT scan.
2. How laser is used in different scientific processes.
3. Why optical fiber is better than copper cable for telecommunication?
4. What is the importance of artificial satellite in telecommunication?
5. How has mobile phone changed the life style of the people of Pakistan?
6. Differentiate between EEG and ECG.
7. Why MRI is safer than CT scan?
8. According to your opinion which technology has effected the human life a lot. Introduce this technology in few lines.

C. Write in detail answers of the following questions.

1. What are ultrasound waves? Why these waves are less harmful than X-rays.
2. How CT scan has helped in providing better way of diagnosis and treatment of diseases?

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3. Describe the principle of Lasers and its uses in different fields with examples.
4. Describe the functions and uses of ECG.
5. Describe the functions and uses of EEG.
6. Describe the main components of a computer.
7. Explain the contribution SUPARCO has made in the development of our country and list their future plans.
8. Write a note on the working of a telephone.
9. What is the role of information technology in our society? How it has revolutionized the human life?

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GLOSSARY

Acid: A compound that yields hydrogen ions (H+) when in aqueous solution. Acids have a sour taste and turn blue litmus red.

Acid deposition: Precipitation with a pH less than 5.6 formed in the atmosphere when certain pollutants mix with water vapor.

Acid rain: Rain with a pH less than 5.

Alcohol: Organic compound used in gums, resins, dyes and perfumes.

Alkali: A base that is soluble in water.

Aquifer: A porous and permeable body of rock or sediment through which groundwater flows.

Base: Generally, a substance that reacts with acids to form a salt, several different definitions of bases have been proposed by different scientists (listed in parentheses).

1) (Arrhenius) a compound that releases hydroxide ions (OH) in solution; 2) (Bronsted-Lowry) a molecule or ion that accepts hydrogen ions from solution; 3) (Lewis) a molecule or ion that donates an electron pair to an acid.

Biodiversity: The variety and abundance of life and its ecological context, including different kinds of organisms. The numbers of species, variations in their genes, and complexity of their ecological conditions.

Biomass: The combined mass of living or once-living organisms in a given area.

Biotechnology: It is the exploitation of biological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.

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Bond: The force that holds together units such as atoms or molecules.

Chemical reaction: The transformation of substances by the rearrangement of their atoms.

Chromosome: The organized genetic structure of DNA with associated proteins that contains the hereditary information necessary for reproduction, protein manufacture, and other functions.

Chlorofluorocarbons: Compounds consisting of carbon, chlorine, fluorine, and sometimes hydrogen once used widely as aerosol propellants and refrigerants.

Cramp: A sustained and involuntary contraction of the muscle.

Combustion: Commonly referred to as burning, a chemical reaction between a fuel (for example wood) and an oxidizing agent (for example oxygen) that produces heat (and usually, light).

Deoxyribonucleic acid: A double-stranded, helical polymer of the sugar deoxyribose, phosphate, and one of four nucleotide bases (Adenine, Cytosine, Guanine, and Thymine). The molecule is the primary carrier of genetic information in all cells.

Desalinization: To remove salts and other chemicals from sea or saline water.

Earthquake: It is a sudden violent shaking of the ground, typically causing great destruction, as a result of movements within the earth's crust or volcanic action.

Ecosystem: A community of living organisms and their interrelated physical and chemical environment.

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Electric current: A flow of electrons through a conductor, the amount of the current is proportional to the rate of electron flow.

Electrons: Negatively charged atomic particles.

Electronic communication: System for the transmission of information using electronic technology (e.g., digital cameras, cellular telephones, Internet, television, fiber optics).

Endothermic reaction: A reaction in which heat is absorbed i.e melting or boiling.

Energy: The capacity to do work. Work is done by transferring energy from one form to another. For example the chemical energy in a fuel is converted to thermal energy as it burns.

Environment: The total of the surroundings (air, water, soil, vegetation, people, wildlife) influencing each living being's existence, including physical, biological and all other factors.

Enzyme: A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.

Electrical charge: A fundamental property used to explain attraction and repulsion between certain particles. Two types of charge exist: negative charge, which is generally conveyed as an excess of electrons, and positive charge, which is generally conveyed as a lack of electrons and excess of protons.

Erosion: The action or process of eroding: wearing away by the action of water, wind, glacial ice, etc.

Exothermic reaction: A process or reaction that releases heat. Wood burning in the presence of oxygen is an example of an exothermic reaction.

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Equilibrium: The ability of an ecosystem to maintain stability among its biological resources (e.g., forest, fisheries, crops) so that there is a steady optimum yield.

Evaporation: The change of state of a substance from a liquid to a gas below its boiling point.

Extinction: The complete elimination of a species from the earth.

Gene: Material (usually DNA) that is inherited from a parent and which encodes instructions for some cellular function.

Greenhouse gas: A greenhouse gas is a component of the atmosphere that absorbs heat radiated by the Earth and subsequently warms the atmosphere, creating what is commonly known as the greenhouse effect.

Groundwater: Water that fills pore space in rocks and sediments and forms a subsurface aquifer. Groundwater is distinct from soil moisture which does not completely fill pore spaces and is immediately beneath the surface.

Hazardous waste: A solid that because of its quantity or concentration or its physical, chemical or infectious characteristics, may cause or pose a substantial presence or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed.

Incinerating: Burning to ashes; reducing to ashes.

Information technology: The technical means that humans create to store and transmit information.

Natural resources: Materials produced through or contained within Earth's natural systems and used by humans and other

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species. They include minerals and soil, water, air, and various plant and animal species (such as trees cut for wood, fish eaten for protein, and bees that pollinate plants).

Nitrification: The oxidation (as by bacteria) of ammonium salts to nitrites and the further oxidation of nitrites to nitrates.

Nitrogen fixation: The assimilation of atmospheric nitrogen into ammonia, most commonly through metabolic processes of soil microorganisms. Other agents of nitrogen fixation include lightning, forest fires, and the industrial process used to manufacture synthetic fertilizers.

Nucleotide: The building blocks of DNA and RNA, consisting of a nitrogen base, a five-carbon sugar, and one or more phosphate groups.

Organic compounds: Substances that contain Carbon.

Ozone: An isotope of oxygen that blocks ultra-violet radiation.

Ozone layer: A layer of higher than average concentration of ozone within the stratosphere. Within the ozone layer, concentrations are still in the range of 8-12 parts per million (ppm); concentrations outside of the ozone layer are around 0.02 ppm.

pH Scale: The strength of acids and bases. Pure water has a pH value of 7, acids have a lower value and bases higher.

Reactants: The substances that take part in a chemical reaction.

Radioactivity: The spontaneous emission of radiation due to a nuclear reaction or direct emission from an unstable atomic nucleus. Radioactivity takes several different forms, including the emission of alpha particles, beta rays, or gamma rays.

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Reactant: The initial material that participates in a chemical reaction. Written on the left side of a chemical equation.

RNA: Ribonucleic acid. A single-stranded nucleic acid containing the sugar ribose. In most organisms, a molecule responsible for transfer of the genetic information encoded in DNA for manufacture of proteins. In some organisms such as viruses RNA is the primary carrier of genetic information.

Recycling: Collecting and reprocessing a resource or product to make new products.

Reduction: A chemical reaction in which electrons are gained, or the chemical addition of hydrogen takes place.

Renewable: A naturally occurring raw material or form of energy that will be renewed through natural ecological cycles or sound management practices (e.g., the sun, wind, water, trees).

Saponification: The process of converting a fat or an oil into soap through combination with an alkali.

Ultraviolet: Wavelengths between 1 and 380 nanometers (nm) on the electromagnetic spectrum falling between X-rays (10-2 nm to 1 nm) and visible light (380 nm to 780 nm) are known as Ultraviolet or UV radiations. These cause sunburn and certain skin cancers.

X-ray: Electromagnetic radiation with wavelengths between those of ultraviolet and gamma rays, approximately 0.01-10 nm.

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