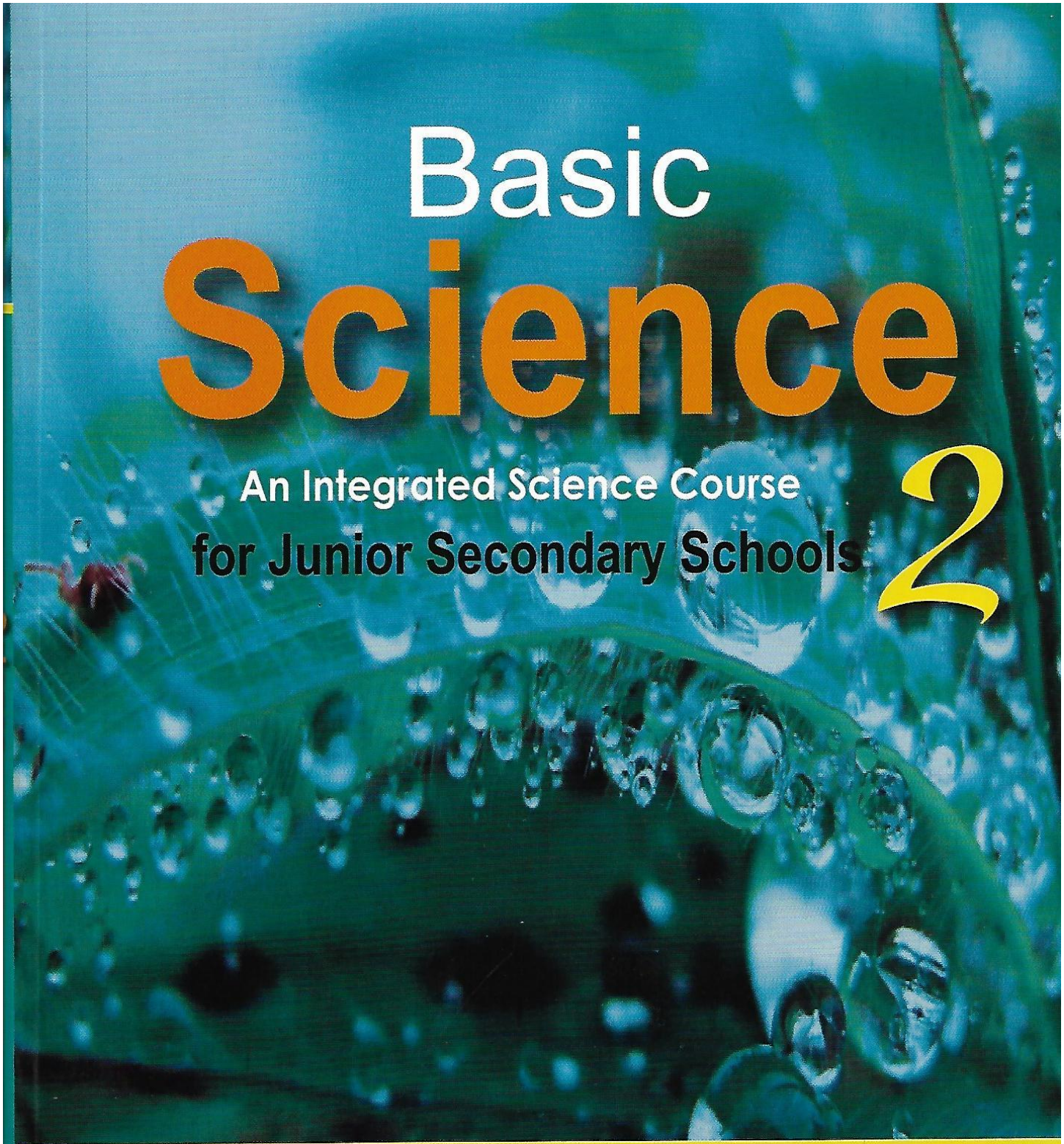

Basic Science 2

An Integrated Science Course for Junior Secondary Schools

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Basic Science

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Contents

Learning about our environment

Chapter 1 Living things

Introduction

The world contains a wide diversity of physical conditions which create a variety of environments where living things can be found. In all these environments, organisms interact and use available resources such as food, space, light, heat, water, air and shelter.

The interaction between living things and their non-living environment makes up the **ecosystem**.

Living things have various structures that enable them to survive, for example, digestive and respiratory structures in animals and reproductive structures in plants and animal. These structure assist the organisms in functioning within the ecosystem.

Each organism has particular forms of these structures that assist its survival.

From the characteristics of living things discussed in year one of this course, adaptation was identified as an important characteristic feature a living organism must possess in order to survive in its environment.

Every living thing, whether plant or animal has a special place in the environment where it normally lives. This place is called its **habitat**. In this chapter, you will learn more about living things, their habitats and adaptations, and relationships among living things in the same habitat. In chapters two and three, you will learn about the uniqueness of human beings and their special abilities, and the measurements of growth and development in living things.

Objectives

By the end of this chapter, you will be able to:

1 state the meaning of habitat;
2 list the different habitats of living things and identify the organisms found in them;
3 state the various features that living things use to adapt to their habitats; and
4 identify the characteristics of different organisms in the same habitat and what they have in common.

Habitat

The following are definitions of habitat given by scientists. The habitat:

1 is the natural environment for living things.
2 is a place where a particular type of living thing is usually found.
3 is an area or an environment where an organism normally lives or occurs.
4 is a natural locality, region or place where an animal or plant lives and survives i.e. the natural dwelling place of a living organism.

5 is the preferred home of a particular organism.
6 size can be as small as a piece of stale bread on which the fungus grows, or as big as a forest with trees.

From the above definitions, it can be said that habitat is the home of different species of living things. Different organisms choose different habitats for their safety and survival.

Components of a habitat

All habitats have four important components. They are: shelter, water, food and space. Whenever people think of habitat what often comes to their mind is shelter, but the other three components mentioned above are just as important as shelter. An organism cannot survive without all the four components. These are described below.

1 **Shelter** describes the structure which an organism lives near, around, on top of, or inside. A home of a living organism, such as a burrow, tree cavity, or space beneath an old log can be considered a shelter. A nest is also a shelter, bird's nest or beehive'. Another type of shelter is a *cover*. Cover may not be a home or nest, but simply an arrangement of plants, rocks, dead leaves, water or shade that an organism can hide in or move undetected by other organisms. Shelter is also a place that an organism uses to escape from unfavourable weather or other dangerous conditions.

2 **Water** is important to all forms of life, such that when an organism is not getting enough water in its habitat, that organism will die. Water is, therefore, an important part of any habitat.

3 **Food** is also essential. Food comes in many forms for many different organisms. Food may be a plant that a rabbit munches; or a hawk, that feeds on rabbit. Also, plants get their nutrients from the food in the soil.

4 **Space** is usually not counted as an important component of habitat, but all organisms must have it to be healthy. If too many species of one type of animal live in the same area, eating the same kinds of food, using the same shelter, and drinking the same water, all the components of that habitat will be used up and as a result, none of the animals will survive. The same thing will happen to plants; when a habitat is too crowded and in the bid to reach for light there is a struggle, the situation will become a survival of the fittest. It is only those whose branches are able to get to the light, and whose roots are able to get to the water and nutrients that will survive while others will die off. The type of habitat is determined by the kinds of plant that grow in the area, climatic condition of the area and the geography of the area.

Types of habitats

There are two major types of habitats.
1 Water environment called **aquatic** habitat.
2 Land environment called **terrestrial** habitat.

Aquatic habitat

Some organisms (plants and animals) feel most comfortable when they are wet, so they prefer to live in an environment that contains or is full of water. Organisms found in water environments are called **aquatic organisms** e.g. water lilies and fish. We all know fish

lives in water. However, water alone will not ensure that a fish is able to survive. Fish needs a habitat! The habitat is the water and all the other things that the fish needs to complete its life cycle: food and shelter, to breed. A fish's habitat is more than just the water. The water has to be the right type (freshwater, estuarine or marine), with the right temperature, quantity and quality.

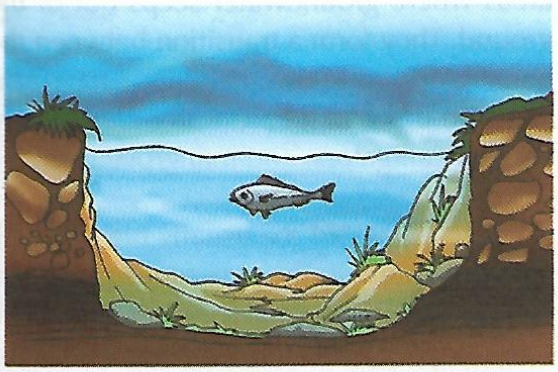


Fig. 1.1 A fish in a pond

Fig. 1.2 Water lilies

Aquatic habitats are not the same for different aquatic organisms. They can be grouped into three based on how much salt is in the water body.

1 **Freshwater habitat**
Freshwater habitat contains no salt. There are three basic types of fresh water habitats. They are as follows:
   a) Lentic: This is a slow moving water. It includes pools, ponds and lakes.
   b) Lotic: This is a faster moving water, e.g. streams and rivers.
   c) Wetlands: These are area where the soil is saturated or inundated for at least a part of the time.

   Freshwater habitats include streams, rivers, ponds and lakes. Examples of freshwater organisms are fish, crayfish and crabs.

2 **Marine (salty water) habitat**
This is characterised by the presence of dissolved salts. They include seas and oceans. Examples of marine organisms are big fishes, whales, octopuses, this is the dolphins and seaweeds.

3 **Estuarine (brackish) habitats**
An estuary is the point where freshwater and salt water meet. These includes lagoons, bays, and wetlands like mangroves, marshes and mud. Examples of estuarine organisms are periwinkles and lobsters.

Activity 1.1 Exploring an aquatic habitat

Materials required
Your science notebook, biro

Procedure
1 Your teacher would organise you into

groups of about five students each.
2 Visit an identified stream or pond in your community (freshwater habitat).
3 Observe the types of animals and plants found in and around the habitat.
4 Record your observations.
5 Submit your report to your teacher.

Terrestrial habitat

Some organisms are most comfortable in dry environment, free of wetness. They prefer land environment. Such organisms include lions and trees. Organisms that live on land are called **terrestrial organisms.** Terrestrial habitats include the air, top of the ground and under the ground. **Air organisms** live in or on trees. They are called **arboreal organisms**, for example monkeys, birds and ferns. **Top of ground organisms** live on the ground surface, for example human beings, dogs and trees. **Underground organisms** live inside the ground. Such organisms include the earthworms, termites and carrots. Terrestrial habitats are typically defined by factors such as plant structure (trees and grasses), plant spacing (forest, woodland and savannah), and climate.

Different kinds of terrestrial habitats exist in different regions of the world due to the weather conditions of **temperature** and **humidity** (how much water is available). Types of terrestrial habitats include deserts, forests, grasslands, tundras and marshes.

Kinds of terrestrial habitats

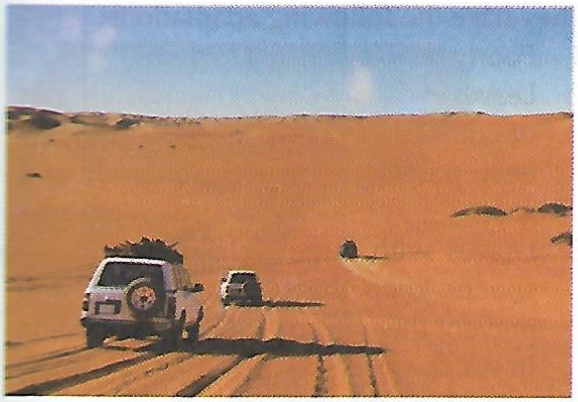
1 **Deserts**: They are found in regions with high daytime temperature and very low humidity as a result of limited rainfall. Deserts have scarce vegetation. They are also characterised by strong winds. Examples of living organisms that live in deserts are camels, owls, foxes, kangaroos, rats, snakes and bats.

2 **Marshes**: They are areas where water is present all through the year. The soil is usually very low in oxygen and marshy. Marshes support plants that are adapted to living in oxygen-poor soils. They are usually found along coastlines, far inland areas, and areas where groundwater seeps out of the ground. They form a transition between the aquatic and terrestrial habitats. Organisms found in this habitat are water lilies, crabs, shrimps, alligators, and mangrove trees.

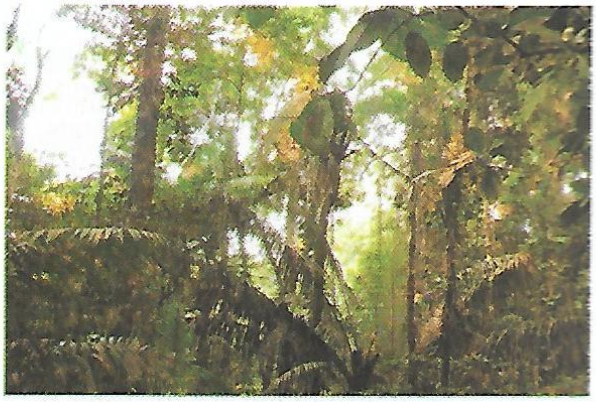
3 **Forests**: Forest are usually blessed with abundant rainfall. They are found in regions with good humidity that supports the growth of different plants. They are dominated by trees and cover over 30% of the world's land surface. Forests can exist in cold (temperate) and hot (tropical) regions. Forests are also called woodlands. Examples of living organisms that stay in the forest zones are chimpanzees and monkeys.

4 **Grasslands**: They are found in temperate and tropical regions and are dominated by grasses with few large trees and shrubs. Living organisms that stay in the grassland region include lions, scorpions and some snakes.

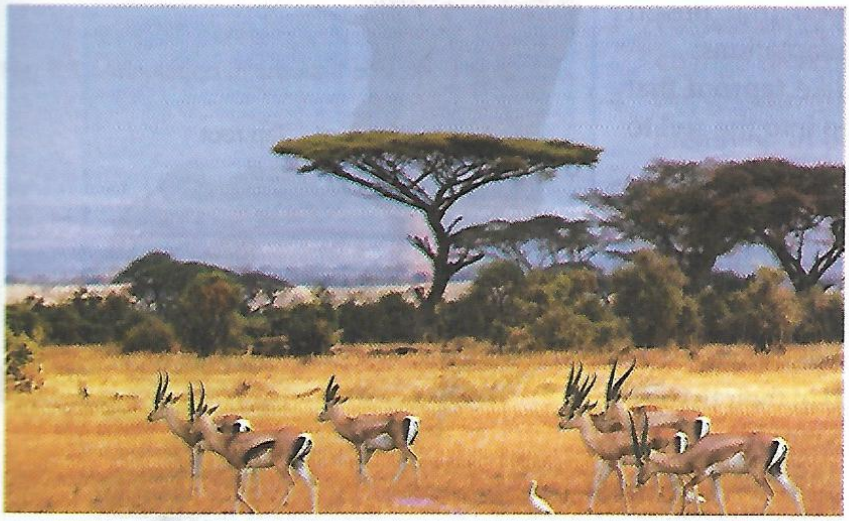
5 **Tundras:** They are found in cold regions. They are cold habitats with low temperature and short vegetation all year. Living organisms that stay in the tundra are polar bears, some cat species, and sheep.



a) *Desert*



b) *Forest*



c) *Grassland*

Fig. 1.3 Terrestrial habitats

All these habitats, whether aquatic or terrestrial, are homes to a large variety of plants and animals. The study of habitats helps us to understand the nature of the living things that inhabit them so that we can better protect both the habitats and the lives in them. Later in your study of science, you will learn more about these habitats.

Adaptations of living things

Some types of plants and animals are found in particular habitats and can only survive in such habitats. For example, there are certain types of plants and animals that can survive only in the rain forest habitat and never in the desert habitat. Again, organisms found in the desert hardly survive in the rain forest. When different plants and animals are carefully examined, certain features will be seen on them which enable them to live successfully in their particular habitats. Any special feature that enables an organism to live and survive in a particular habitat is called **adaptation**. Adaptations are physical features on organisms which can be observed.

Adaptations in plants

Plants need water for their survival. All plants show different adaptations that respond to the availability of water in their habitats. Plants that live in areas with limited rainfall such as deserts, have special physical features that make them stand out from other plants. Such physical features help them in special ways to increase their water intake when water is available and reduce water loss by transpiration when water is not available.

Scientists have observed that desert plants have the following adaptations:

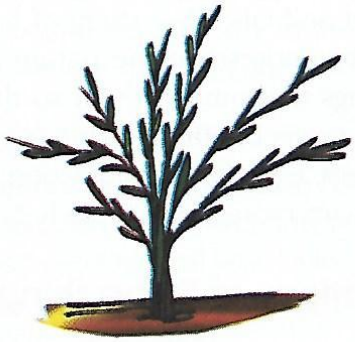
1 *Extensive root system*: like **taproot** that is able to penetrate deep into the soil to tap available water.
2 *Adventitious root* that spreads widely to draw water from large areas.
3 *Succulent leaves and stems* which serve as storage tissues that enable the plants to survive during long periods of dryness by using the water stored in their tissues. Plants in arid environments require protection from thirsty animals, as such most succulent plants are spiny, bitter, or toxic, thereby making them unattractive for thirsty animals to feed on.
4 *Reduced leaves* (green needle-like structures or tiny scales) which help to reduce the amount of water that can be lost from the plant to the atmosphere during transpiration. *Arboreal plants* (plants that live on other plants) have their roots attached to the host tree, and thick leaves with a smooth surface for water conservation.
Aquatic plants do not have to depend on their roots to absorb water.

They have the following adaptations:

1 Poorly developed root systems.
2 Leaves and stems covered with a thin layer of cuticles that are permeable to allow easy passage of water, minerals and gases.
3 Leaves with large air spaces. The air spaces keep the plants buoyant and prevent them from sinking or drowning in water.

a) Tap root

b) Adventitious succulent leaves



c) Reduced leaves, roots and stems

Fig. 1.4 Adaptations in desert plants

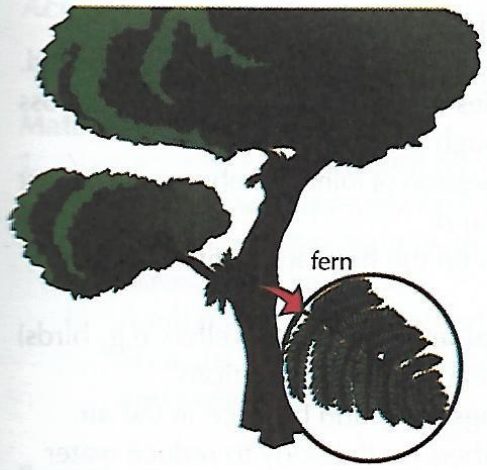


Fig. 1.5 Adaptation in arboreal plants

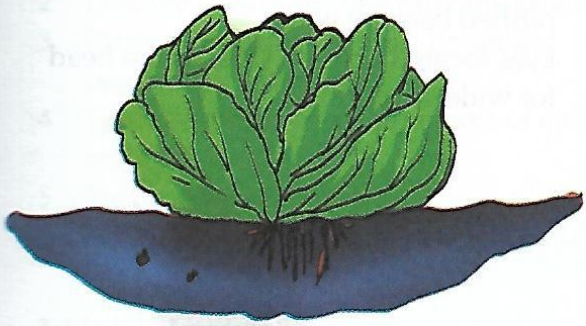


Fig. 1.6 Adaptation in aquatic plants

Adaptations in animals

Animals, like plants, have special physical features which enable them to survive in various habitats.

Fishes have the following adaptations for aquatic life.

1 Possession of tails and fins for swimming and balancing in water.
2 Streamlined body shape for smooth movement through water without being pushed back by water current.
3 Possession of tail which helps them to change directions when swimming.
4 Possession of gills that are used for breathing in dissolved oxygen in water.
5 Possession of swim bladder which enables them to adjust to changes in water pressure as they swim to different water depths.

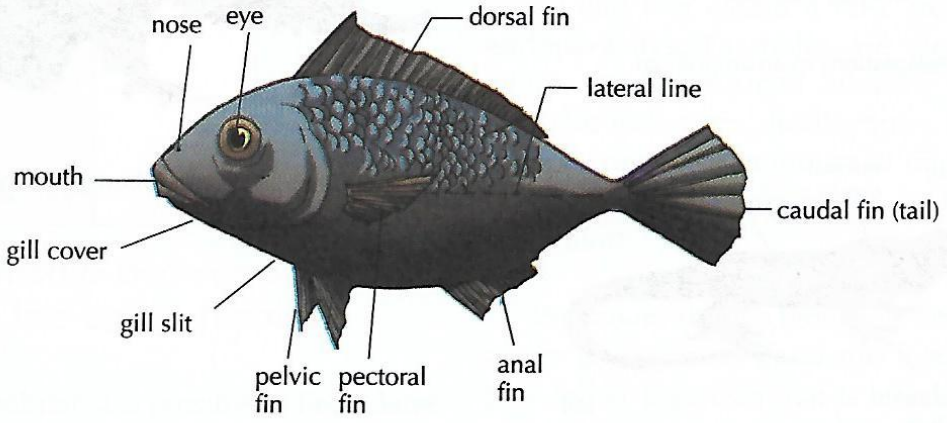


Fig. 1.7 Adaptation in fish

While fishes live only in water, some other animals can live both on land and in water. Such animals that live successfully both on land and in water are called **amphibians**. Examples are toads and frogs. They are adapted to live in both environments because they possess the following features:

1 streamlined body shape;
2 mouth that is very large and broad which enables them to catch and eat large prey;
3 webs between their toes for swimming while in water;
4 jointed limbs for walking while on land; and
5 large eyes, with bulging transparent lower eyelid, positioned on top of the head to give them a wide angled visual field, to detect movement and velocity of an object.

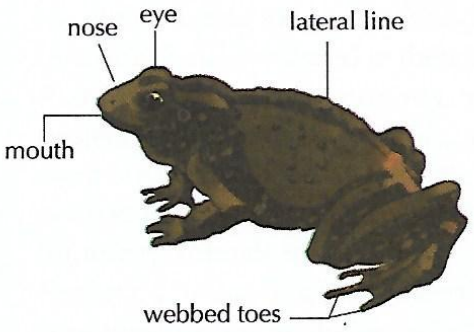


Fig. 1.8 Adaptations in an amphibian

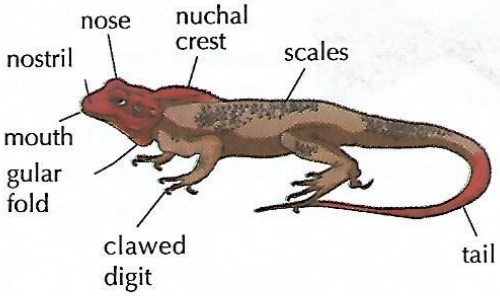


Fig. 1.9 Adaptations in a lizard

Terrestrial animals (e.g. a lizard) share the following adaptations

1 Possession of lungs for breathing on land.
2 Scales on the body to reduce water loss through the skin.
3 Possession of jointed limbs for movement on land.
4 Eyes on the head for frontal vision.

Arboreal animals (tree dwellers e.g. birds) have the following adaptations

1 Wings to fly and balance in the air.
2 Feathers on the body to reduce water loss.
3 Stream-lined body shape for smooth movement through the air without being pushed back by wind.
4 Eyes located on both sides of the head for wide vision.

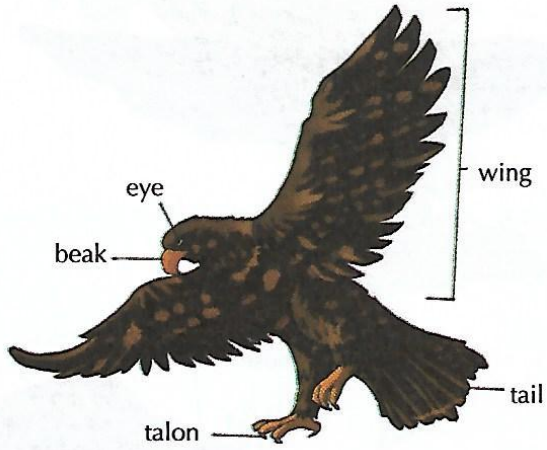


Fig. 1.10 Adaptations in arboreal animals

Activity 1.2 Identifying adaptations in organisms

Materials required

1 Your science notebook and biro
2 Your teacher would provide the following:
   a) A young mango plant (with its leaves, stem and root)
   b) A full plant of water lily, cut branch of cactus, preserved fish, toad, lizard and pigeon in a cage

Procedure

1 Your teacher would organise you into groups of 5 students each.
2 Pick the organisms one after the other.
3 Name the habitat of each organism (aquatic/terrestrial).
4 Observe the physical structures of each organism.
5 Identify the adaptations.
6 Record your observations as in Table 1.1.

Table 1.1 Organisms and their adaptations

	Organism	Habitat	Adaptations
1	Mango		
2	Water lily		
3	Cactus		
4	Fish		
5	Toad		
6	Frog		
7	Pigeon		

Relationship between organisms in the same habitat

In every habitat, it is possible to find a large variety of organisms co-habiting (living together). One activity that is common to all the organisms in a habitat is the struggle for survival. Whether big or small, every organism wants to stay alive. To increase the chances of survival, organisms in the same habitat engage in different types of relationships at different levels. These relationships may be harmful or beneficial.

Harmful relationships

These are relationships where either one or both types of organisms are harmed. Harmful relationships are called **antagonism**. Types of antagonism include:

1 **Parasitism**: This is a close association between two living organisms of different species which is beneficial to one and harmful to the other. The benefiting organism is called the **parasite**, while the harmed organism is the **host**. The parasite feeds and generally shelters on the host while the host suffers discomfort or deprivation. Parasites may attack outside or inside the body of the host.

Parasites which live on the outer surface of the host are termed **ectoparasites**. Examples are the hair louse which attacks the hair of the host (human beings) and tick which attacks the skin of dogs and cows. Those that live within a host are termed **endoparasites**. Examples are the worms which attack the small intestine of their host. Roundworms, hookworms, as well as tapeworms live in the small intestine of human beings sucking blood and causing discomfort.

2 **Predation:** This is a biological interaction where an organism (predator) feeds on its prey (other organism that is attacked). For example, lion waits for weaker animals like sheep and goat, catch them and kill them

for food; the hawk feeds on chickens; the eagle preys on toads and frogs while the cat preys on rats. In this relationship, one organism is harmed. The act of predation often results in the death of the prey and the eventual absorption of the prey's tissue through consumption.

a) A lion preying on a sheep

b) An eagle preying on a frog

c) A cat preying on a rat

Fig. 1.11 Predation in organisms

3 **Competition:** This is an association where organisms struggle with one another for limited resources in the habitat. It is a case of survival of the fittest. Examples are cows and goats competing for available grass in the same field. Competition may lead to insufficiency and harm for both organisms. Living organisms compete over water supplies, food, mates, sunlight, space and other biological resources.

Competition can be intraspecific or interspecific.

Intraspecific competition occurs when members of the same species compete for the same resources in an ecosystem. The organism that obtains less resources will usually perform worse than if it lives alone. However, in this situation, it may actually be more useful to think in terms of resource availability than competition.

Interspecific competition occurs when individuals of two separate species share limited resources in the same area. If the resources cannot support both populations, then lowered growth or survival may occur in at least one species. An example is the case of cheetahs and lions that feed on similar prey.

Beneficial relationships

These are relationships where organisms live together and help one another. The relationships do not cause any harm to any of the organisms relating together. Beneficial relationships are called **symbiosis**. Types of symbiosis include:

1 **Mutualism:** Both organisms benefit from the relationship and cannot live without each other, e.g. mycorrhizal association between plant roots and fungus, with the plant providing carbohydrates to the fungus in return for phosphates and nitrogenous compounds.
2 **Cooperation**: Both organisms benefit from the relationship but each can live without the other. It is a relationship of convenience.
3 **Neutralism**: Both organisms live together

without any benefit or harm. Many trees co-habit without affecting one another.

4 **Commensalism**: This is a symbiotic relationship in which one organism consumes the unused food of another, e.g. the remora fish and the shark. The dorsal fin of the remora fish is modified into a sucker with which it forms a temporary attachment to the shark. When the shark feeds, the remora picks up scraps. The shark makes no attempt to prey on the remora fish.

Levels of relationship in a habitat

Four levels of relationship may be observed in a habitat.

1 **Plants to plants:** Some plants provide support for others to climb, e.g. walnuts depend on other trees for support.
2 **Plants to animals**: Plants and animals depend on one another for healthy exchange of gases. Animals feed on plants while some plants feed on animals, e.g. the pitcher plant preys on insects that come around it.
3 **Animals to animals**: Animals engage in competition, predation, parasitism, mutualism, cooperation or neutralism relationships with other animals.
4 **Living organisms on dead organic materials**: Some living organism live and grow on dead and decaying organic bodies, taking their nutritive elements from the dead bodies. For example, *Mucor* lives on spoilt bread, maggots feed on dead animals, and flies feed on decaying materials. This level of relationship in the habitat is called **saprophytism**.

Fig. 1.12 Saprophytism

Humans and predation

Human as predators

Humans are omnivores. They hunt and trap animals using weapons and tools like clubs, spears, fishing gear, firearms, boats and motor vehicles. Humans also use other predatory species such as dogs in hunting and fishing. Some even enlist such non-predatory beasts like horses, camels and elephants in getting approaches to prey.

Humans and dogs make a predatory team rivalling any single predator in effectiveness.

Humans have reshaped huge expanses of the world as ranches and farms for the raising of livestock, poultry and fish to be eaten as meat.

However, it can be debated whether or not harvesting livestock fits strictly in the definition of predation.

Human raising and eating of livestock is part of agriculture and involves the feeding of and caring for animals, followed by their being slaughtered with an appropriate tool, cutting up and cooking. In many cultures,

animals are hunted or reared by specialists (such as ranchers or fishermen), brought to a marketplace, and sold in pieces to the people who actually consume the meat.

Human as preys

A lone, naked human is at a physical disadvantage to other comparable apex predators in areas such as speed, bone density, weight and physical strength. Humans also lack innate weaponry such as claws. Without crafted weapons, society, or cleverness, a lone human can easily be defeated by fit predatory animals such as wild dogs, big cats and bears. There are even recorded instances of lone humans being preyed upon by large carnivores. However, humans are not solitary creatures; they are social animals with highly developed social behaviours.

Activity 1.3 Exploring relationships among organisms in a habitat

Materials required

Your science notebook, biro, nearby habitat

Procedure

1 Your teacher will take you to a habitat.
2 Identify the organisms in the habitat.
3 Observe the interactions between the organisms.
4 Discuss the relationships among organisms observed with your mates.
5 Record your findings in your notebook as in Table 1.2.

Table 1.2 Relationships among organisms in a habitat

Organisms interacting	Description of interaction	Type of relationship	Harmful or benefiting

Activity 1.4 Identifying levels of relationship among organisms

Materials required

Your science notebook and biro

Procedure

1 Your teacher will organise you in groups of about five students each.
2 Discuss the statements of relationships among organisms listed on Table 1.3.
3 Identify the level of relationship for each statement.
4 Identify the type of relationship for each statement.
5 Record your findings in your science notebook as in Table 1.3.
6 Submit your record to your teacher.

Summary

1 Habitat is the home of living things. It could be aquatic (water) or terrestrial (land).
2 Types of aquatic habitats are marine, estuarine and freshwater, while types of terrestrial habitats are deserts, forests, marshes and tundra.
3 The special features which enable organisms to survive in their habitats are called adaptations. Organisms also engage in different kinds of relationships which could be harmful or beneficial to either or both of them.
4 Types of harmful relationship include parasitism, predation, and competition, while types of beneficial relationship include mutualism, cooperation, neutralism, and commensalism.

Table 1.3 Levels of relationship among organisms

Statement of relationships	Level of relationship	Type of relationship
1 Cat running after a rat		
2 Cattle egret on the back of a cow picking the ticks on the cow while the cow walks about		
3 Pitcher plant folding up an insect		
4 A climbing plant on another tree in the garden		
5 Maggots feeding on a dead animal		
6 Tree standing independently in the garden		

Revision questions 1

1 Which of these is not an adaptation of a desert plant? _____
   A Poorly developed root system.
   B Reduced leaves.
   C Adventitious roots.
   D Succulent tissues on leaves.
   E Succulent tissues on stem.

2 An organism that is eaten by another one is called _____.
   A predator
   B parasite
   C prey
   D lion
   E rat

3 Which of these is a harmful relationship among organisms in the same habitat? _____
   A Mutualism
   B Cooperation
   C Neutralism
   D Predation
   E Symbiosis

4 The ability of an organism to survive in a place where it lives is called _____.
   A habitat
   B population density
   C ecology
   D adaptation

5 Which of these adapts the duck to swimming in water?
   A Feathers
   B Fins
   C Beak
   D Webbed feet
   E None of the above

6 Which of these aquatic habitats contain salt? _____
   A Pond
   B River
   C Ocean
   D Stream
   E Puddle

7 _____ is the natural dwelling place of a living organism.

8 Name the two (2) major kinds of habitats for living things.

9 Write down four (4) kinds of living things that can be found in each of the two habitats named in Question 8.

10 What is the name of the habitat of animals that live on top of trees?

Chapter 2 Uniqueness of human beings

Introduction

Evolutionary biology proposes that humans evolved from ape-like ancestors. If this is true, then we are nothing more than glorified apes. However, compared to our closest *relatives*, scientific research indicates that humans are unique in many ways: creativity, personality, abstract thinking and moral judgement. Most of us, however, would argue that there is a distinct difference between human and animal intelligence and that human brains are arguably superior. In fact, many believe that humans are the most complex and intelligent animals on earth. For example, no other species matches our ability to use language. We are also believed to be more advanced in the areas of abstract thought, self-awareness and self-expression. We have the ability to reason and also solve various problems.

Human beings, male and female, are collectively called *man*, in science. Man belongs to the *animal kingdom*. Many people feel bad when they are called animals, but that is what they are, according to science. Man is an animal but a very special kind of animal. Man is a higher animal than other animals because of the presence of an "*S*" shape backbone. Man is said to be unique (special or different). But what makes man unique? Have you wondered what makes man different from all other animals? Man is different mostly because man has the ability to reason and solve problems.

In this chapter, you will learn about the intelligence skills of humans and their applications.

Objectives

By the end of this chapter, you will be able to:

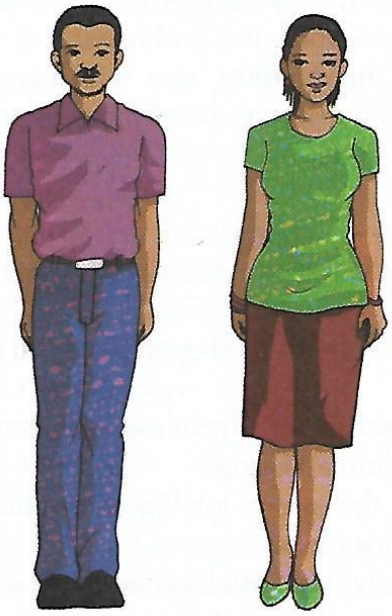
1 describe intelligence as a characteristic of human beings;
2 list the uses of intelligence to human beings; and
3 apply basic intelligence skills, e.g. observation and measurement of time and weight.

Man as an intelligent animal

Man belongs to a special group of animals called **primates**. Primates are higher animals. They have large brains, forward-facing eyes, nails and hands with thumbs that could face the other fingers. Primates also breast-feed their young ones and give birth to their young ones alive. Examples of other primates are monkey, gorilla and chimpanzee. Among the

primates, man shows greater advancement than the others. Man has the following special features that make him unique:

1 Man is able to stand upright and walk on two legs (rather than four) due to the presence of backbone. Man is the only primate with an "*S*" shape backbone. This is why man can stand upright and walk with his two legs, unlike other primates that move with their four limbs.



a) A man and a woman standing straight on two legs

b) A chimpanzee trying to stand

c) A kangaroo trying to stand upright

Fig. 2.1 Man is the only primate that stands well on two legs.

2 Man has a higher ability to handle tools due to the possession of the thumbs that could face the other fingers.

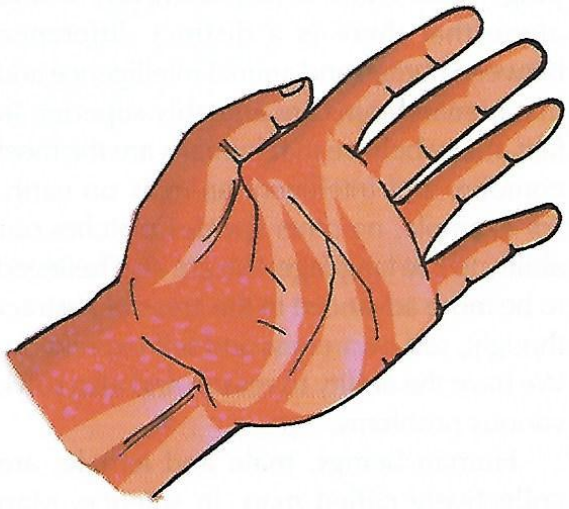
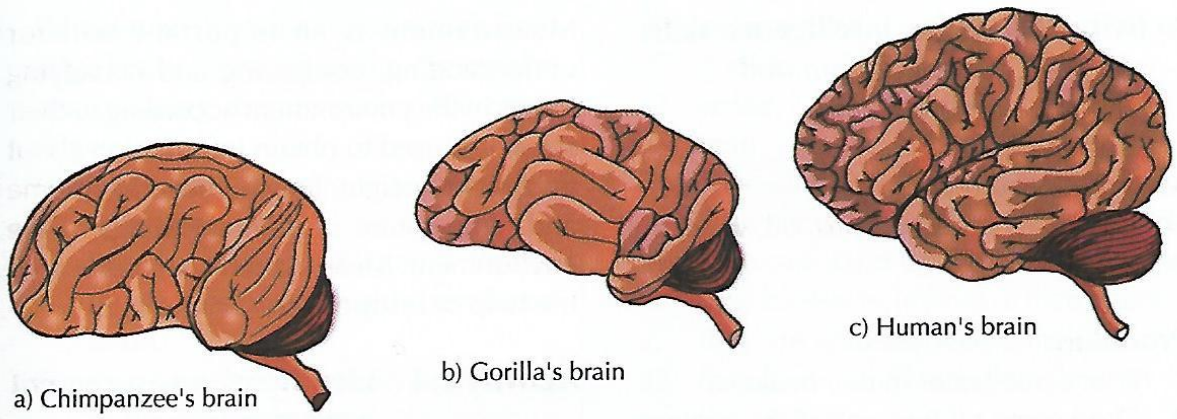


Fig. 2.2 Man has a unique hand

3 Man has higher intelligence due to the possession of a brain that is bigger and more developed than that of other primates.



a) Chimpanzee's brain

b) Gorilla's brain

c) Human's brain

Fig. 2.3 Man has a unique brain compared to other primates

The part of the human brain that is most developed is the **cerebrum**. The cerebrum controls the ability to think, calculate and speak. The intelligence of man is controlled by the level of development in the cerebrum. Due to the presence of the cerebrum, man is able to carry out the following functions:

1 think and understand issues;
2 reason logically;
3 speak different languages;
4 solve problems and explain situations;
5 socialise and sympathise with people;
6 love and protect self and others;
7 remember and distinguish good from bad;
8 control the environment and make peace; and
9 use basic intelligence skills.

The science process

Basic intelligence skills are called **science process** skills. They are used to explore and understand things and the environment and make them better. Science process skills include observation, classification, inference, measurement and conclusion.

Activity 2.1 Human intelligence and reasoning

Materials required

Puzzle, your science notebook, biro

Puzzle

There was an accident involving father and son.

The two were unconscious and rushed to two different hospitals. The son was taken to surgeon for surgery. The surgeon saw him and said:

'No, I cannot perform this surgery; this is my son.'

Question: Who was the surgeon?

Procedure

1 Work with a partner.
2 Read the puzzle.
3 Answer the question that follows it.
4 Give reasons for your answer.
5 Record your answer and explanations in your science notebook.
6 Submit your answer to your teacher.

Activity 2.2 Using intelligence skills (observation and inference)

Materials required
Your science notebook, biro, oil, water and beakers

Procedure
1 Pour some water in two beakers.
2 Drop some oil into one of the beakers.
3 What do you observe?
4 Record your observation.
5 What is your inference from this observation?
6 Record your inference.

Through observations, human beings are able to draw inferences and conclusions which enable them to solve problems. Human activities are directed by their intelligence.

Activity 2.3 Using intelligence skills (measurement)

Materials required
Your science notebook, pencil, calculator, measuring tapes, biro

Procedure
1 Measure the length and breadth of your school field.
2 Calculate the perimeter of the field. (2[length + breadth]) = perimeter.
3 Record the perimeter.
4 How many times will a student run round this field in order to cover a distance of one kilometre?
5 Calculate and submit your answer to your teacher.

Measurement is an important skill for understanding, comparing and classifying things in the environment according to their sizes. It is used to obtain information about the height, weight, length, breadth, volume and temperature of different things in the environment. Measurements are done with the help of instruments.

Activity 2.4 Identifying measurement instruments

Materials required
Your science notebook, biro, Table 2.1

Procedure
1 Work individually.
2 Study the list in Table 2.1.
3 Identify the instrument you will use to take each required measurement.
4 Record the instrument for each task in your science notebook.
5 Submit your notebook to your teacher.

Table 2.1

Measurement tasks	Instrument
The temperature of a baby	
The weight of an adult man	
The weight of a young girl	
The height of a classmate	
The length of the wall	
The time it takes to boil meat	

Summary

1 Human beings are terrestrial animals.
2 Human beings are higher animals because of the presence of an "S" shape backbones.
3 Human beings belong to a special group of animals called primates.

4 Primates are higher animals which have large brains, forward-facing eyes, nails, and grasping thumbs facing the other fingers.
5 Human beings are unique among other primates because:
   a) they have high intelligence due to the possession of a highly developed brain.
   b) they have high dexterity and ability to handle tools due to the position of their thumb that could face the other fingers.

Revision questions 2

1 Human beings are unique among other primates because _____.
   A they have higher intelligence due to a highly developed brain
   B they have forward-facing eyes
   C they have hands
   D they have nails
   E they can move about
2 Which animal among the primates has an "S" shape in its backbone? _____.
   A Man
   B Rat
   C Lizard
   D Monkey
   E Snail
3 Man belongs to a special group of animals called _____.
   A apes
   B pisces
   C primates
   D reptiles
   E herbivores
4 All the following animals are primates except the _____.
   A monkey
   B chimpanzee
   C gorilla
   D snake
   E man
5 The following are characteristics of primates except _____.
   A they can stand upright
   B they have eyes in front of their heads
   C they are cold-blooded animals
   D they have nails instead of claws in their hands
   E they have brains
6 The part of the human brain that is most developed is the _____.
   A cerebrum
   B skull
   C head
   D cerebellum
   E hair
7 Explain why you are unique among other primates.
8 Suggest three (3) ways of preserving organisms in a particular habitat.
9 How many teaspoonfuls of water will fill a 35 cm^3 bottle?
10 Give three (3) examples of primates.

Chapter 3 Growth and development

Introduction

You will have noticed that a baby does not remain the same size after birth. As the baby is fed with breast milk, there are noticeable changes such as increase in the size of the body.

When this is happening, we often say that the baby is growing. As growth is taking place, other changes occur, leading to overall physical development of the body. With time, the baby develops from infancy to childhood, to adolescence and then to adulthood.

In this chapter, you will learn about growth as related to increase in height and weight, types of growth as well as the different developmental stages.

Objectives

By the end of this chapter, you will be able to:

1 describe increase in height and weight as growth changes;
2 describe transition from infancy to adolescence and adulthood as developmental stages;
3 identify characteristic features of different developmental stages; and
4 group growth and developmental changes as temporary or permanent changes.

Growth and developmental changes

Growth

Growth occurs in plants and animals. Growth is the irreversible increase in the dry mass of living material, be it plants or animals. The process of development is so closely linked with growth that the words *growth* and *development* are commonly used to describe the processes which are normally thought as growth. However, development could be described as an increase in complexity.

Activity 3.1 Observing growth in plants

Materials required

Bean seeds, empty cans, water, farm soil, ruler and chalk, your science notebook, biro

Procedure

1 Fill two cans with soft farm soil.
2 Water the cans moderately.
3 Plant about three bean seeds in each can.
4 Place in a cool airy corner till the seeds germinate.
5 Bring the cans with their germinated seeds near a marked wall.
6 Observe the plants daily and take a record of the changes in heights.
7 Make a daily chart for about five days as in Table 3.1.

8 Discuss the chart in your group.
9 Submit your chart to your teacher.

Table 3.1 Growth chart

Days	Height of plants
1	
2	
3	
4	
5	

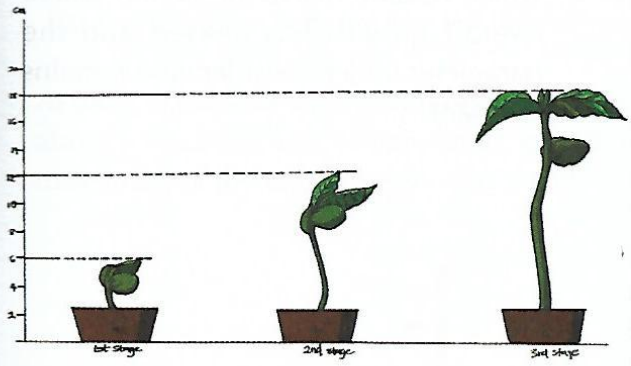
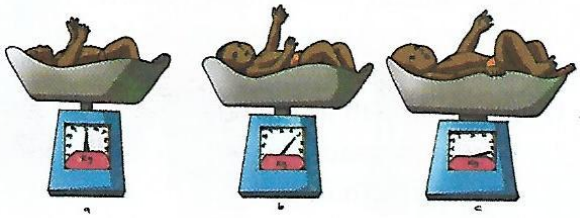


Fig. 3.1 Plants grow

In the above activity, you will have noticed a steady increase in the **height** of the plants. In your family or neighbourhood, you will have also noticed that healthy babies do not remain the same size after birth. A baby's **weight** may be measured at birth and measured periodically to find out if the weight of the baby is increasing.

As a baby is fed with milk, there are noticeable changes in height and weight. The increase in the size of an organism is referred to as **growth**. Growth brings about the addition of healthy flesh in the body of man. Growth may be observed as an increase in height and weight which can be measured with different instruments.



A progressive weight of baby

Fig. 3.2 Animals grow

Growth and developmental changes in man

Human development is a lifelong process of physical, behavioural, cognitive and emotional growth and change. In the early stages of life – from babyhood to childhood, childhood to adolescence, and adolescence to adulthood – enormous changes take place. Throughout the process, each person develops attitudes and values that guide choices, relationships and understanding.

An understanding of the rapid changes in a child's developmental status prepares parents and caregivers to give active and purposeful attention to these changes.

Development

As growth is taking place, other changes occur which lead to maturity. The series of orderly changes by which an organism comes into maturity is referred to as **development**. Development brings about changes from simple to complex (not easy to understand) forms in physical appearance and performance.

Growth changes

Human growth, from birth to maturity, involves great changes in body size and appearance. The growth process is not a steady one. Sometimes, growth occurs rapidly, and at other times, slowly. There are four major stages of growth from birth to adulthood:

1 Rapid growth in infancy.
2 Slow and steady growth in childhood.
3 Rapid growth in puberty.
4 Gradual and slow growth in adolescence till adulthood.

Measuring growth

In measuring growth, a growth curve is produced by plotting different parameters such as length, height, mass, surface area, volume and number against time. The shape of this curve is described as **sigmoid**, meaning *S*-shaped and is typical of such growth.

A sigmoid curve can be divided into four parts as shown below.

Features of a sigmoid curve

1 The first phase is the **lag** phase, during which little growth occurs.
2 This leads into the second phase which is the **log** phase, during which growth proceeds speedily. During this phase, the rate of growth is very rapid and at any point is proportional to the amount of material or number of cells already present.
3 The third phase is the **decelerating** phase, during which growth becomes limited as a result of the effect of some internal or external factors.
4 The final phase is the stationary phase which usually marks the period where overall growth has ceased and the parameter under consideration remains constant.

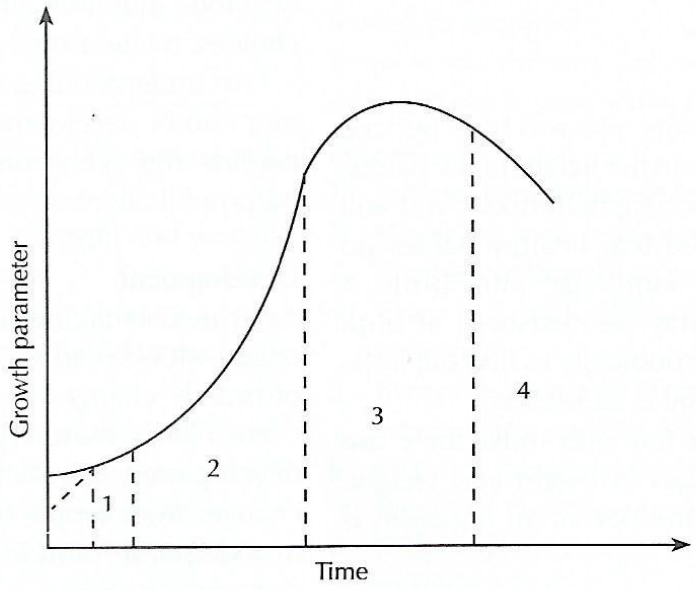


Fig 3.3 The sigmoid curve

Fig. 3.4 Changes in body size from birth to adulthood

At birth, babies are only about one quarter of their adult height. Adult height is reached at about 23 years of age. At babyhood, growth in size is very fast. This can be determined by measuring of the baby's height and weight at regular time intervals.

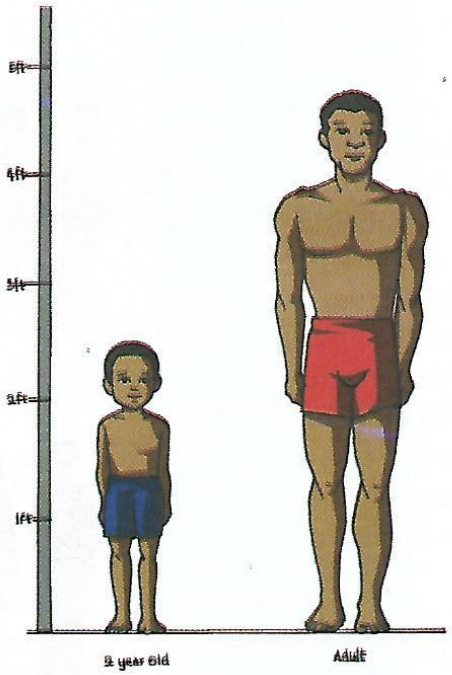


Fig. 3.5 Measurement of height

Growth patterns differ for different individuals. This is because growth depends on two major factors which are **heredity** and **environment**. Children tend to look like their parents in body structure, but the environment may modify this tendency. The living conditions of children including food (nutrition), hormones and hygiene may affect their body structure and growth.

Developmental changes

Children are not just smaller versions (types) of adults. They are full individuals with particular needs and capabilities. Increase in body size affects the capabilities of healthy children. There are very visible stages children pass through from birth to adulthood. These stages are the same for boys and girls, as shown in Fig. 3.6, although girls generally mature before boys.

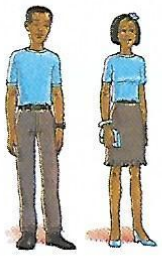
Age (Years)	Stages of development		Development
	Girls	Boys	
0 1 2 3	Infancy	Infancy	
4 5 6 7 8	Childhood	Childhood	
9 10 11 12 13	Puberty	Puberty	
14 15 16 17 18	Adolescence	Adolescence	
19 20 21	Adulthood	Adulthood	

Fig. 3.6 Stages in development for human males and females

Growth is a quantitative (quantity) parameter while development is a qualitative (quality) parameter. While growth is **physical** and measurable by increase in size, development is **behavioural** and measurable by performance or capabilities of the individual. An increase or change in the capabilities of the individual is described in science as **developmental change**. Normal developmental changes are **progressive transitions** (increasing from time to time) and move from the simple to the complex. Each stage is marked by characteristic features, e.g. a baby develops from infancy to childhood, then to adolescence and to adulthood.

Stages of development and general characteristics

Growth is a *quantitative* matter because it means that there is a positive increase in weight and in the amount of cell protoplasm such that it is measurable with a ruler or balance.

Development is a *qualitative,* observable change in structure and function of the organism, that goes on side by side with growth and by which an organism comes into maturity.

Activity 3.2 Identifying developmental changes

Materials required

Posters or pictures provided by your teacher, showing:

1 Male and female infants.
2 Male and female in childhood.
3 Male and female at puberty.
4 Male and female adolescents.
5 Male and female adults.
6 Your biro and science notebook.

Procedure

1 Study the posters or pictures provided.
2 Identify the features of development in each item.
3 Record the features in Table 3.2.
4 Submit your record to your teacher.

Table 3.2 Developmental stages

Stage	Characteristic features	
	Male	Female
Infancy Childhood Puberty Adolescence Adulthood		

You will have noticed that at each stage there are various features that indicate development.

1 **Infancy**
At this stage, the individual is marked by small body size, small organs, delicate structure and no teeth. Capabilities include lying down, sitting, smiling, kicking, crawling, babbling and playing with toys.

2 **Childhood**
This is the stage before puberty. It is characterised by light body weight, small size, small and organs and presence of teeth (but temporary teeth). Individuals can stand on two legs, walk and run. There is an increase in activities and playing with toys. The child speaks a few words, could make requests and obey commands.

3 **Puberty**
This is the transition stage from childhood to adolescence. The stage is marked by the development of secondary sexual features. In boys, you can observe growth of the penis, facial hair, underarm hair,

pubic hair, moustache and broken voice. In girls, you can observe breasts and rounded buttocks. In both boys and girls, you can observe pubic and armpit hair. There is also a rapid gain in height and weight, with stronger bones. The individual at this stage is very active and sweaty. Menstruation commences in girls.

4 **Adolescence**
This is the stage before adulthood. It is characterised by further increase in body size, well-formed body parts and organs. There are also increased skills and dexterity (mastery). The individuals at this stage are inquisitive and anxious to try anything. Such an individual needs to be assisted by adults.

5 **Adulthood**
This is the stage of full maturity. Individuals here can become mothers or fathers. Full body size is attained and there may be no increase in height. The wisdom teeth appears and individuals here are highly skilled.

Late adulthood may indicate signs of old age including grey hair and bending of the body. Capacity to reproduce may also reduce. Noticeable changes in adulthood are usually due to age and sometimes stress or poor feeding.

Handling pubertal changes in boys and girls

Most childcare experts argue that as children attain puberty, they not only become difficult to handle, but also begin to withdraw.

Here are some strategies parents, guardians and teachers can use to handle, correct and rebuke their children without offending them or making them feel unappreciated.

1 Always encourage them to maintain a high degree of personal cleanliness during this period.
2 One of the common traits in children growing towards puberty is anger and the feeling of not belonging to their family or friends' circle; this needs to be handled with care. Most of them will try to be rebellious. They need to be talked to nicely and one must try as much as possible not to offend them. It is that time in which they go through a major transformation in their lives. They are going through emotional, mental and biological changes, and one needs to be understanding and patient in order to manage their unpredictable behaviour.
3 Parents must always allow them to express all their feelings. Strong feelings cannot always be denied and angry outbursts should not always be viewed as a sign of serious problems. They should be recognised and treated with respect.
4 To respond effectively to overly aggressive behaviour in children, we need to have some ideas about what may have triggered an outburst, then have time to listen to their opinions and now try to come up with a solution.
5 Never forget to always lay down rules. Adolescent boundaries need to be clearly outlined to the individual. Continuously advise the child on what is permissible and what is not.

Emotional development

Here are some of the emotional changes that

occur during puberty.

1 **Feeling overly sensitive**: During puberty, since your body undergoes many changes, it is common to feel uncomfortable about them and become overly sensitive about your physical appearance. As a result, you may feel irritated quite easily, lose your temper or feel depressed. It will be useful to be aware of the changes in your behaviour and talk about them with an adult you are comfortable talking to.

2 **Looking for an identity**: Since you are in the process of becoming an adult, you may feel inclined to figure out what makes you unique as a person. There is also a general tendency that you associate more with your friends than your family members. You may try to figure out how you are different from others and how you fit into the world. This may eventually lead to some sort of struggle to become more independent of your parents and family.

3 **Fear of uncertainty/feeling uncertain:** Since you are not completely an adult and are not a child anymore, puberty can potentially lead to uncertain times. As a transition phase, you may begin to wonder and think about new and unfamiliar aspects of life such as career, livelihood and marriage. Since all of these are new and unfamiliar, when you start thinking along these directions, you may feel uncertain about the future.

4 **Conflicting thoughts**: Since you are somewhere in-between, as a teenager during puberty, you may feel stuck between how you were as a child and how you wish to be as an adult. For example, you might want to be more independent and at the same time, might also look for support from your parents. Another example could be along the lines of whether you wish to give up on the interests that you had as a child to be able to fit in with your friends. As a result, you may feel confused and look for clarity.

5 **Mood swings**: To add to the uncertainty and conflicting thoughts, you may also experience frequent and sometimes extreme changes in your mood. For example, sometimes your mood will change between feeling confident and happy to feeling irritated and depressed in a short span of time. These frequent changes in how you feel are called **mood swings**. They may occur due to shifting levels of hormones in your body and other changes taking place during puberty.

6 **Feeling conscious about self**: The onset of puberty can vary on an individual basis. Therefore, the way you grow may be different from the way your friends grow. This can make you conscious about the way you and your body are growing up. These experiences are more pronounced for girls because they develop faster and earlier than boys. Also, the changes in their bodies such as development of breasts and widening of hips are more noticeable. These make them feel more conscious about their bodies in the presence of peers, especially of the opposite sex.

7 **Peer pressure**: With the onset of puberty, your conversation with your friends will increase. Your peer group and you are likely to be influenced by what you see around you in popular media and the culture that is represented through them. You might often pick up on *what's in* and *what's out* in terms

of the way you dress, your language and even your behaviour, depending upon what you see.

Note that some temporary changes can be corrected medically or by change in behaviour. Some examples of temporary changes are bedwetting, sweating, rise in body temperature, growth of pimples, and diseases as a result of malnutrition.

Classification of growth and developmental changes

Human growth and developmental changes could be permanent or temporary. **Permanent changes** remain throughout lifetime and are not reversible, e.g. development of permanent teeth which are 32 in human beings.

Fig 3.7 Temporary and permanent teeth

Temporary changes are the developmental changes that may naturally disappear with time, e.g. temporary teeth called **milk teeth**. Milk teeth are twenty (20) in number. They develop one after the other between ages one and four. By the age of 6 years, these milk teeth fall off and give way for the permanent ones to come up.

Changes that are associated with each human stage of development (childhood, adolescence, adulthood) are permanent changes.

Factors affecting developmental stages and growth

1 Exercise and rest.
2 Nutrition (Balanced diet).
3 Diseases.
4 Heredity.
5 Temperature and light (plants).
6 Love and care.

Summary

1 Growth is increase in size due to addition of new body cells.
2 Development is the series of changes by which living things come into maturity.
3 The changes in body size, height and weight with time are called growth changes.
4 Developmental changes can be described as the transition from one stage of life to another, i.e. from infancy to childhood, adolescence and adulthood.
5 There are marked physical features that distinguish each of the human developmental changes. Some of these features differ in boys and girls.

Revision questions 3

1 Childhood is characterised by _____.
   A development of secondary sexual features
   B a small size
   C a well formed reproductive system
   D well formed bones
   E decrease in strength

2 A change that occurs and disappears with time is called _____.
   A physical change
   B chemical change
   C temporary change
   D traditional change
   E permanent change

3 Human development can be measured by _____ of the individual.
   A size
   B weight
   C performance
   D height
   E sight

4 List any three (3) growth changes in living things.

5 List three (3) examples of developmental changes in:
   a) infancy.
   b) adolescence.
   c) adulthood.

6 State the characteristics of growth and developmental changes.

7 List any four (4) changes in human growth and development and classify each as temporary or permanent change.

8 List three (3) factors that affect developmental stages and growth in humans.

9 State two (2) differences between boys and girls during adolescence.

10 List the developmental stages of man.

Chapter 4 Body image

Introduction

Body image is just one part of our self-image. People might think of others as carefree when it comes to their appearance. Hence, a lot of people spend time in front of the mirror because they are so much concerned about the way they look. For some people, body image may be a problem while for others, it is rather a blessing or gift. This chapter will help you to manage your feelings and formed opinions about yourself.

Objectives

By the end of this chapter, you will be able to:

1 define body image;
2 identify some features of body image such as size, height, race, and ethnicity;
3 explain how puberty affects body image; and
4 list some misconceptions about beauty on body image.

Meaning of body image

Body image can be defined as a person's opinions, thoughts and feelings about his or her body and physical appearance. In other words, it is the perception that a person has about his or her physical body as well as the thoughts and feelings that result from that perception.

Some people see themselves as handsome or beautiful, while some are worried because they feel they are ugly. It is all about your perception of what your body looks like. Body image is also considered as a comparison of the sense of one's physical appearance with that of others. Feelings about body image can be positive, negative or both, and they are influenced by individual and environmental factors.

Features of body image

The physical features that affects our body image include size, height, race, ethnicity, and eyes. They are discussed below.

1 **Size**: This has to do with how big something is. Size usually has either a positive or negative effect on body image. For instance, some people believe that only slim and tall women are usually selected for adverts or modelling, and that slim women are physically fit and healthier with good postures. Hence, the general perception that they look more attractive than fat women.

2. **Height**: Height can influence body image, because it has to do with how tall or short an individual is compare to another person. Some men that are short in height see a defect in their body image. This is because most women prefer to marry a tall and slim man than a short or fat man.

3 **Racism**: This is a situation where some set of people feel they are above or below another set of people due to physical traits like the colour of the skin. The white often believe that black skinned people or Africans are inferior to them. This affects the perception of body image and as a result, some black people see themselves as inferior to white people.

4. **Ethnicity:** The features of a particular ethnic group can influence the perception of their body image. For instance, some tribes in Yoruba land have tribal marks on their cheeks. This may affect their perception of their body image; some may see themselves as ugly or not attractive as a result of the marks on their face while some may see themselves as prettier.

5. **Eyes:** Some people have big eyeballs, some wear contact lenses, and some naturally have bad sight. All these affect the way body image is perceived.

Puberty and body image

At puberty stage, a lot of body changes are experienced by both boys and girls. These changes can influence how body image is. Body image is just one part of our self-image that is based on how our body looks. This is because our bodies change so much during puberty that they become the focus of our attention. Puberty affects body image in boys in the following areas: the chest is broader, the moustache grows, muscles get bigger, height increases and the body gains weight. In girls, breasts are enlarged, pimples appear on the face, hips are broader and body gains more weight and height increases. All these features change the body appearance of both boys and girls. As a result, they are perceived as adults by the opposite sex.

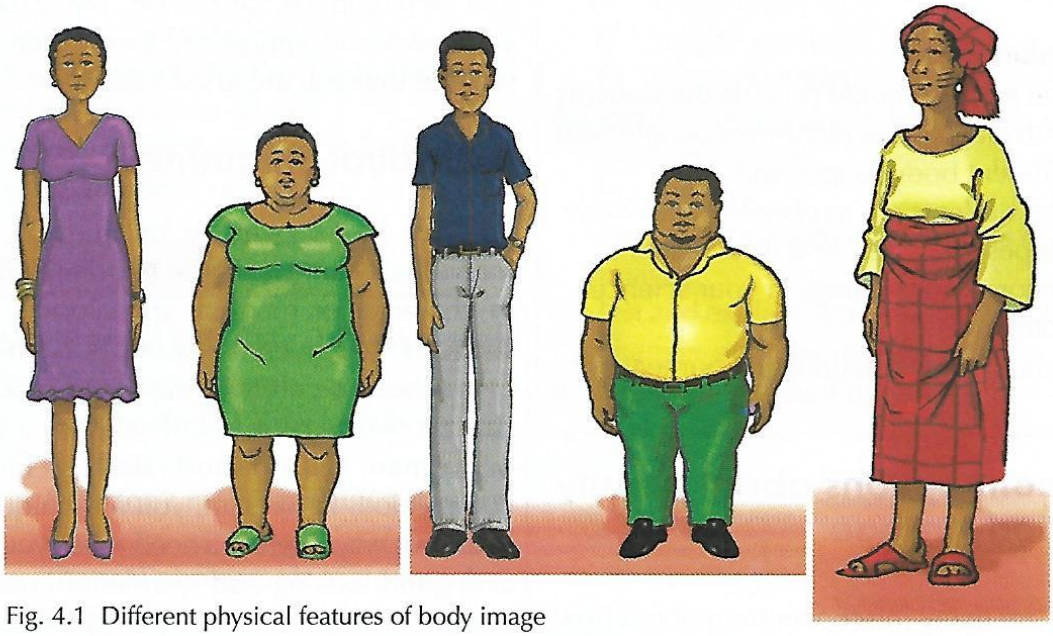


Fig. 4.1 Different physical features of body image

Effects of pubertal changes on body image

Pubertal changes are changes that occur in growing boys and girls in which their sex organs get mature or developed to function. This affects the body image of an individual because the physical appearance changes.

Some of the effects of pubertal changes on body image include:

1 Changes in body appearance in boys and girls.
2 Maturity of sex organs.
3 Increases in weight and height in both boys and girls.
4 Discovery of oneself.
5 Change in appearance that can bring about attraction between boys and girls.

Activity 4.1 Identifying different shapes and sizes of the body

Materials required

Charts, your science notebook, biro

Procedures

1 The teacher should provide the students with diagrams or pictures of people with different body shapes and sizes.
2 The students are to observe these body shapes and sizes, and discuss them.
3 Record your findings in your science notebook.
4 Submit your notebook to your teacher.

Misconceptions about beauty on body image

There are many misconceptions about how beauty affects the body image of some people. People do think that being thin or slender brings health, happiness, success and beauty. So far, this is not necessarily true. Also, the media as well helps to promote acceptance and happiness in being slim, tall, and even white. This can increase depression, inferiority complex, anger and dissatisfaction in both men and women who do not fit into this image.

When people have all these dissatisfactions within themselves, they begin to have negative feelings about their beauty and this affects their body image. So, do not be distracted about the people that are celebrated as a result of their body images. The truth of the matter is that every male or female (child, adolescent or adult) is handsome or beautiful. Everybody has one or more parts of the body that have an advantage over others. To some, people, it is their facial appearance: round, oval or oblong. To some it is their complexion, hairy body, earlobe, soft skin and palms, round body structure, pointed nose, flat nose, long, thin or plump leg, and so on. Try to locate your own and appreciate them; then you will see that you are good-looking.

Individual uniqueness

Science has proved to us that no two individuals can exactly be the same, either in character or physical appearance. This suggests that every creature is a unique being, because all over the world, nobody can be like him or her. If you are a man or woman, tall or short, dark or fair in complexion, fat or slim, you are unique in your own way. There is a need to see yourself as a good-looking and wonderful creature because it determines your perception about your body image.

In conclusion, as a unique being, you need to accept yourself, appreciate your body and beauty, adjust your posture (if need be) and maintain good personal hygiene.

Summary

1 Body image is the perceptions, opinions or feelings that an individual has about himself or herself, that is, the physical body.
2 The physical features of the body image include: size, height, race, ethnicity, eyes, hair and colour of skin.
3 Body image can be influenced in adolescents as a result of changes that normally take place at puberty. For instance, a boy with pimples, broader chest, cracked voice and bigger muscles will have a change in his body image compared to when he was a child.
4 A positive body image depends on how an individual sees himself or herself. This perception brings out the real beauty in an individual. Hence, beauty does not come by starving, eating poor diets, negative perception of body image or feeling inferior to others.
5 Nobody on earth can exactly be like you, hence you are a unique human being.

Revision questions 4

1 Which of the following statements best describes body image? _____.
   A The drawing of a person's body appearance.
   B A person's moral attributes of his or her body.
   C The real photograph of a person's body.
   D A person's emotional attitude and perception of his or her body.
2 One of the following is not a physical feature of body image. _____.
   A Size
   B Age
   C Height
   D Ethnicity
3 Developmental changes in girls include the following except _____.
   A large breasts
   B broader hips
   C facial pimples
   D broader chest
4 Only tall and slim women are beautiful. _____.
   A True
   B False
   C Not sure
   D All of the above
5 Boys and girls undergoing pubertal changes have the same change in _____.
   A bigger muscles
   B wider hips
   C weight gaining
   D broad shoulders
6 Explain the following terms:
   a) body image
   b) puberty
7 Mention some physical features of body image.
8 List and explain some effects of pubertal changes on body image.
9 Explain individual uniqueness.

Chapter 5 The human respiratory system

Introduction

Food performs different functions in the body. Food enables the body to produce the energy required for various human activities. Food substances are used by the body to build new body cells, which help us to grow and replace worn out cells. Certain food substances also help to protect the body from diseases. However, the body does not depend on food alone for the production of all the energy required. There is a need for oxygen, which is present in the air. In order to make this oxygen available, human beings breathe in air. The oxygen is then used to break down food substances in our body, releasing useful energy and some waste products. The process by which food substances are broken down in our body to release the energy we need is called **respiration**.

A system is a unit made up of different parts which work together to perform a given function or functions. The respiratory system is one of the systems of the body. It performs the function of respiration in our body. In this chapter, you will learn about breathing, respiration, the parts of the human respiratory system, and the functions and problems of the respiratory system.

Objectives

By the end of this chapter, you will be able to:

1 identify parts of the human respiratory system;
2 distinguish between breathing and respiration;
3 understand that pulse rate and breathing rate increase with exercises; and
4 identify the problems associated with breathing.

Breathing and respiration

Living things need energy which they get by burning up (oxidation) carbohydrates and fats. In this process, carbon(IV) oxide (CO_2) and water are usually produced.

Breathing is the process of gaseous exchange between the respiratory organs in the body and the outside environment. Breathing is divided into two parts called inspiration and expiration.

Respiration is the process whereby carbohydrate (glucose) is broken down to release energy.

Air, just like the blood, has routes through which it passes. It enters into the body through the respiratory organs. The respiratory organs are collectively called the **respiratory system**.

There is more carbon(IV) oxide in the

air that is breathed out (exhaled) than in air breathed in (inhaled).

The inspired (breathed in) air is called **inhaled air** while the expired (breathed out) air is called the **exhaled air.**

Inspiration simply refers to the breathing in of air or oxygen into the respiratory organs such as lungs.

Expiration is the breathing out of CO_2 and H_2O (water) vapour into the atmosphere.

Equation of respiration

Carbohydrate + Oxygen → Water + Carbon(IV) oxide

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2$$

When you breath in air, the ribs move up and out, the chest expands and then the air rushes in and fills the lungs. Also in expiration, the ribs go down, the chest contracts and the air rushes out of the lungs.

Composition of atmospheric air and expired air in a typical subject. (Note that only a fraction of the oxygen inhaled is taken up by the lungs.)

Table 5.1 Composition of atmospheric air and expired air

Component	Atmospheric air (%)	Expired air (%)
Nitrogen gas	79%	79%
Oxygen gas	20.96%	16.02%
Carbon dioxide gas	0.04%	4.38%
Water vapour	Trace	0.60%

Types of respiration

There are two major types of respiration: and

1 Aerobic respiration.
2 Anaerobic respiration.

1 Aerobic respiration

This is a type of respiration that occurs in the presence of oxygen. It is a process of energy transfer that the cells utilise to convert organic molecules into chemical energy. Most plant and animal cells respire aerobically, i.e. in the presence of oxygen.

2 Anaerobic respiration

This is a type of respiration that does not require oxygen to take place. It is also called **fermentation**. Among plants, it takes place in yeast and bacteria such as *E. coli*. Among animals, only certain cells are temporarily anaerobic (when they are short of oxygen), an example is the muscle cells.

Anaerobic respiration is of two types:

1 Alcoholic fermentation.
2 Lactic acid fermentation.

Table 5.2 Differences between breathing and respiration

	Breathing	Respiration
1	Breathing is a physical process.	Respiration is a chemical process.
2	Breathing is a process of taking in oxygen into the lungs and bringing out CO_2 from the lungs.	Respiration is the process of taking the oxygen from the lungs into the bloodstream and cells.
3	Breathing can be controlled.	Respiration cannot be controlled.
4	Breathing is an exchange of gases between cells and the external environment.	Respiration is a process that takes place in the cells.
5	Breathing involves two stages; ventilation and gas exchange. Ventilation is the movement of air in and out of lungs and gas exchange is the absorption of oxygen from the lungs with the release of CO_2.	Respiration involves only one process that produces energy and eliminates CO_2 and H_2O in the bloodstream or cells.

Pulse rate

The **pulse** is how many times in a minute that our arteries expand and contract in response to the heartbeat. This rate is exactly equal to the heartbeat and the rate of heart contractions. These heart contractions cause the increase or decrease in blood pressure.

Taking the pulse, therefore, is a direct measure of the heart rate. The pulse rate can be normal, rapid or slow.

The pulse rate varies among individuals of different ages, sizes of the body and state of health.

Rapid pulse rate may be caused by:

1 fear;
2 rigorous muscular activities;
3 fever; and
4 heart diseases.

Exercises such as walking, jogging, running and playing games have stimulating effect on the body. They are good because they increases the rate of heartbeat as shown by the pulse rate, and so bring about a great flow of blood through the body. They increase the breathing rate and, therefore, strengthen the lungs.

Location of pulse

Pulse can be located:

1 under the wrists;
2 behind the knees;
3 in the groin;
4 at the temple on each side of the head; and
5 on top or the inner side of the foots.

Parts of the human respiratory system

The human respiratory system consists of a number of organs which work together to ensure the supply of oxygen to the body cells and the removal of carbon(IV) oxide from the cells. These organs are nostrils, larynx, pharynx, trachea (windpipe), bronchi, lungs, bronchioles, alveoli and sometimes mouth.

Activity 5.1 Tracing the parts of the respiratory system

Materials required

Your science notebook, biro, and model of the respiratory system

Procedure (group work)

1. Observe the respiratory system from the model provided.
2. Identify the parts of the system.
3. Observe the branching out of the trachea into bronchi.
4. Observe the numerous tubes in the lungs.
5. List the parts of the system according to the order in which air passes through them.
6. Submit your science notebook to your teacher.

The **nostrils** are the openings of the nose through which air enters the body. The nostrils are lined with a membrane of cells that secretes mucus which moistens the air we breathe. There are hairs on the

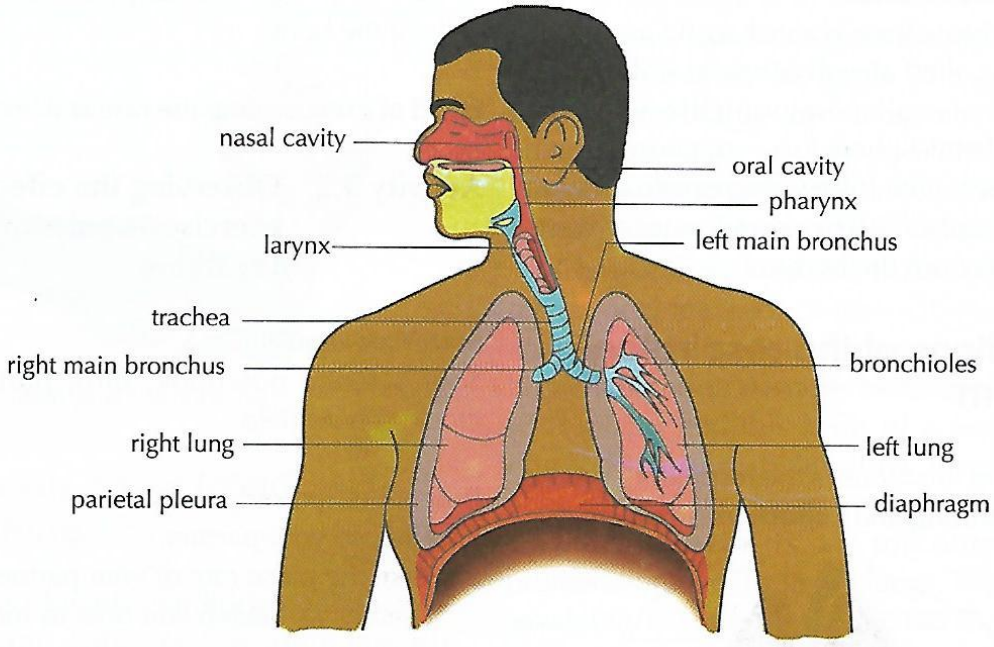


Fig. 5.1 The human respiratory system

lining of the nostrils which filter the air, allowing any dust particles to stick on the mucus membrane. The dust-carrying mucus is removed from time to time to ensure cleanliness of the nostrils. The nostrils lead into the **pharynx**, which is the lower end of the mouth cavity.

The pharynx leads into the **larynx**, which is also called the **voice box**. The larynx leads into the **trachea**, which is also called the **windpipe**. The trachea branches into two **bronchi** (singular - bronchus). The trachea and bronchi appear like rings of soft bones. This makes them strong for their functions. Each bronchus leads into a **lung**.

The lungs are two identical organs located in the chest cavity, placed on the two sides of the heart. The lungs are red and covered with a membrane called **pleural membrane**. They are spongy organs. Inside the lungs, the bronchi branch into tiny tubes called **bronchioles**.

The bronchioles branch again into many air sacs called **alveoli** (singular—alveolus).

The alveoli communicate with the external atmosphere in a continuous system of tubes, which follow the reverse order to remove carbon(IV) oxide and water as waste products from the body.

Functions of the respiratory system

The main functions of the respiratory system are **breathing** and **cellular respiration**.

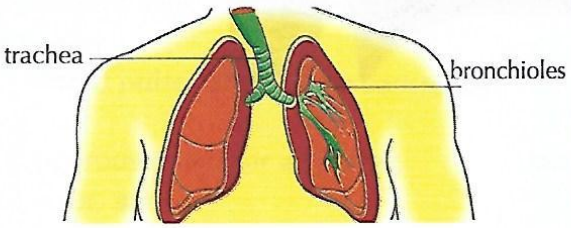


Fig. 5.2 The trachea and bronchi

Breathing and respiration are not exactly the same.

Breathing is described as exchange of gases in which oxygen is breathed in and carbon(IV) oxide is breathed out. Breathing is one of the stages in respiration. It supplies the essential material (oxygen) for respiration and takes away a poisonous end-product of respiration (carbon(IV) oxide). On the other hand, respiration is the process by which oxygen breathed in from the atmosphere, is used in breaking down food substances in our body cells to release needed energy with carbon(IV) oxide and water as the waste products.

Respiration is made up of two parts called **external** and **internal respirations**. External respiration (breathing) involves exchange of gases and this takes place in the lungs. Internal respiration involves the breaking down of food substances and release of energy. It takes place within the cells of the body.

Effect of exercise on pulse rate and breathing

Activity 5.2 Observing the effect of exercise on pulse rate and breathing

Materials required

Your science notebook, biro, partner, a clock, school field

Procedure (paired work)

1 Choose your partner.
2 Take the pulse rate of your partner. Your teacher will teach you how to measure the pulse rate. The pulse rate is calculated as the number of pulses per minute.
3 Observe the breathing of your partner.

4 Allow your partner to run round the school field as fast as he or she can.
5 Take the pulse rate again.
6 Observe the breathing of your partner again.
7 Record your observations.
8 Take your own turn.
9 Your partner takes your pulse rate and observes your breathing.
10 Run round the school field as fast as you can.
11 Let your partner take your pulse rate and observe your breathing again.
12 Check your records.

Results

You might have observed an increase in the pulse rate after the exercise. The breathing also becomes faster after the exercise. So we infer that exercise can increase both the pulse and the breathing rate of human beings.

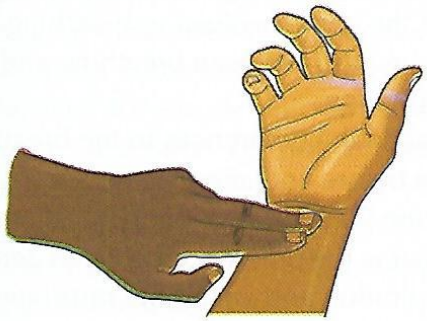


Fig. 5.3 Measuring the pulse rate

Problems associated with breathing

There are health conditions which make breathing difficult for some people. Such health conditions usually affect the performance of some important organs of respiration. The health conditions may have hereditary or environmental causes. Some of these conditions include pneumonia, tuberculosis, bronchitis and asthma.

Pneumonia is a disease of the lungs in which the air sacs of the lungs are clogged up with mucus, making gaseous exchange difficult. It is caused by bacteria present in an unhealthy, cold and wet environment. Sufferers experience pains in the chest and difficulty in breathing.

Tuberculosis is also a disease of the lungs in which the lungs lose their elasticity and are unable to allow gaseous exchange. It is caused by bacteria. Sufferers experience prolonged cough and pains.

Asthma is a disease of the bronchi in which the sufferers experience shortness of breath or temporary breathlessness. It is triggered off by a dusty environment.

Bronchitis is cough arising from difficulty in breathing. It is also a disease of the lungs.

Emphysema is when the delicate walls of the alveoli break down, reducing the gas exchange area of the lungs. The gradual loss of gas exchange area forces the heart to pump even larger volumes of blood to the lungs in order to satisfy the body's need. The added strain can lead to heart failure.

Chronic bronchitis: Any irritant reaching the bronchi and bronchioles will stimulate an increased secretion of mucus. In chronic bronchitis, the air passages become clogged with mucus and this leads to a persistent cough. Chronic bronchitis is usually associated with cigarette smoking.

Lung cancer is an uncontrolled proliferation of cells in the lungs. There are several forms of lung cancer, but the most common are those involving the epithelial cells lining the bronchi and bronchioles.

Summary

1 Parts of the respiratory system are nostrils, pharynx, larynx, trachea, bronchi, lungs, bronchioles, alveoli and sometimes the mouth.
2 Breathing is the taking in of oxygen and the release of carbon(IV) oxide.
3 Breathing is one of the stages of respiration.
4 Respiration is the process in which oxygen is used to break down food substances in the body cells to release useful energy, with carbon(IV) oxide and water as waste products.
5 The process of respiration is made up of two part called external and internal respirations.
6 Exercise and physical activities increase the pulse rate and the breathing rate of human beings.
7 The health problems associated with the respiratory system include pneumonia, tuberculosis and asthma.

Revision questions 5

1 Which of these diseases is not associated with the respiratory system? _____.
   A Pneumonia
   B Anaemia
   C Tuberculosis
   D Asthma
   E Lung cancer
2 The following are the parts of the respiratory system except _____.
   A nostrils
   B pharynx
   C trachea
   D oesophagus
   E mouth
3 A patient having difficulty in breathing can be helped by the doctor by using _____.
   A hydrogen
   B nitrogen
   C oxygen
   D carbon (IV) oxide
   E zinc
4 The percentage composition of oxygen gas in air is about _____.
   A 10%
   B 21%
   C 30%
   D 60%
   E 79%
5 The inhaled air passes through one of these routes:
   A Nose → trachea → bronchi → bronchioles → lungs
   B Nose → bronchi → trachea → lungs
   C Nose → bronchi → lungs
   D Lungs → nose → trachea → bronchi
   E Nose → lungs → bronchi
6 List the parts involved in breathing.
7 Distinguish between breathing and respiration.
8 Explain the differences in the breathing rate before and after exercise.
9 Name three (3) respiratory problems.
10 What is the difference between aerobic respiration and anaerobic respiration?

Chapter 6 The human digestive system

Introduction

Feeding is an important characteristic of all living things. Human beings move about in search of food because they depend on food for the energy they require. Food substances are circulated in the body in simple and soluble forms. The food we eat usually comes in solid form, which does not dissolve in water. Our body cells cannot utilise the food in this form. In order to help our body cells utilise the food we eat, our food must be broken down by a special process into simple and soluble forms. The process by which food substances are broken down into simple and soluble form is called **digestion**. All the parts of the body which work together to ensure digestion of food makeup the **digestive system**. In this chapter you will study the parts of the digestive system, the processes of digestion and absorption of food, and simple food tests.

Objectives

By the end of this chapter, you will be able to:

1 identify parts of the digestive system and the roles they play in digestion;
2 describe digestion and absorption processes;
3 describe the chemical nature of food; and
4 perform simple food tests.

Digestion

Digestion is the process which involves the breaking down of food into smaller and simpler components which can be absorbed and assimilated into the body.

The path or passage through which the food passes is called the **alimentary canal.**

The digestive system is responsible for converting the food we eat into energy for our bodies to use.

Parts of the digestive system

Activity 6.1 Identifying parts of the human digestive system

Materials required

Model of the human digestive system, chart of the human digestive system, your science notebook, biro

Procedure (group work)

1 Observe the model.
2 Observe the chart.
3 Identify the various parts of the digestive system and their proper names and spellings.
4 Make a list of the parts in the order they occur in the digestive system from the mouth to the anus.
5 Submit your notebook to your teacher.

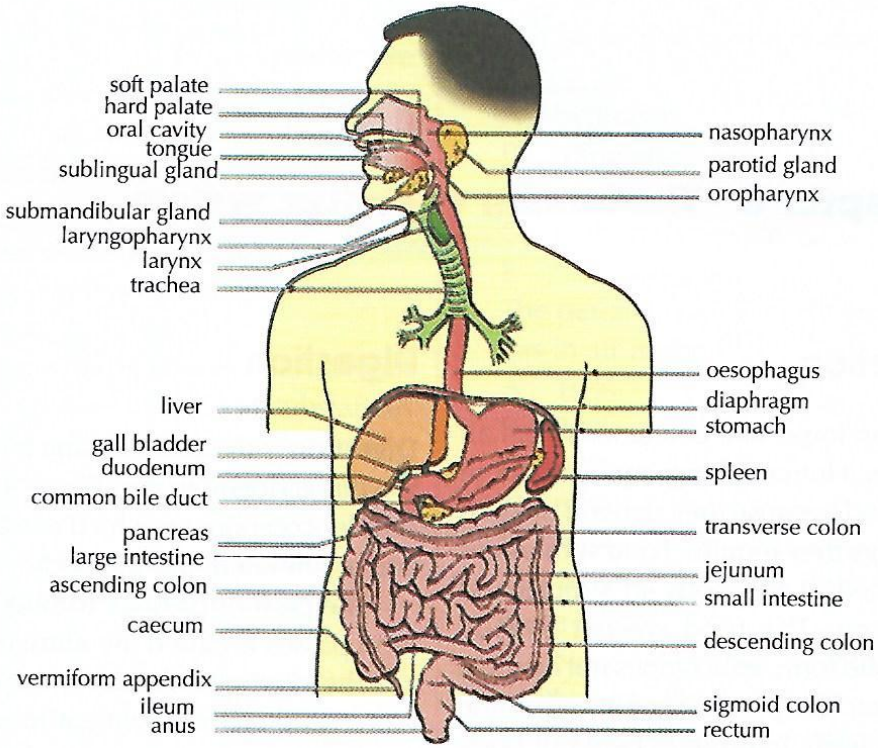


Fig. 6.1 Parts of the human digestive system

The human digestive system is made up of **five major parts**, and the food we eat must pass through these five parts before the undigested portion is finally removed from the body. These parts are mouth, gullet or oesophagus, stomach, small intestine and large intestine.

Parts of the digestive system

The major parts of the digestive system are:

1 salivary glands in the mouth;
2 pharynx;
3 oesophagus or gullet;
4 stomach;
5 small intestine; and
6 large intestine.
7 rectum

Accessory digestive organs are:

1 liver;
2 gall bladder; and
3 pancreas.

Functions of the parts of the digestive system

Mouth

The mouth is the first point of contact of food with the digestive system. It:

1 takes the food;
2 holds the tongue that tastes the food and rolls it up for swallowing;
3 holds the teeth that chew the food;
4 produces enzymes that initiate the digestion of certain classes of food; and
5 produces the saliva that mixes with the food to soften it before it is swallowed.

Gullet

The gullet is a long tube or passageway that:

1 connects the mouth to the stomach; and
2 provides passage for food into the stomach.

Note that no digestion of food takes place in the gullet.

Stomach

The stomach is a sac-like organ that:

1 provides temporary storage for the swallowed food;
2 gradually releases the food into the small intestine for further digestion;
3 churns the swallowed food into a semi-fluid that can pass into the small intestine (the semi-fluid food is called **chyme** at this stage);
4 produces gastric juices and enzymes which act on the food;
5 has muscles that relax and contract to allow the movement of food into the small intestine;
6 acidifies food; and
7 produces gastric juice, which contains pepsin that digests protein.

Small intestine

The small intestine is a long, narrow tube. In an adult human being, this tube is as long as 8 metres and only about 2.5 cm in diameter. The small intestine itself has three components. These are *duodenum, jejunum and ileum*. In the small intestine:

1 bile produced in the liver neutralises the acidic food from the stomach;
2 enzymes in digestive juices finalise the breakdown of food into an absorbable form;
3 there is absorption of food nutrients into the bloodstream. (The walls have numerous needle-like structures called villi for absorption.); and
4 there is final digestion of all foods.

Large intestine

This is a tube that is five times shorter than the small intestine and twice as big in diameter. It has three main components. These are ascending colon, transverse colon and descending colon. The large intestine:

1 absorbs water from undigested food materials;
2 leaves waste substances called **faeces** which are passed out from time to time through the anus; and
3 does not carry out any digestion.

Liver and gall bladder

The liver is connected to the gall bladder via the bile duct and then to the small intestine. The major functions of the liver are:

1 production and secretion of bile;
2 detoxification of blood;
3 secretion and storage of glucose; and
4 production of albumin.

The gall bladder stores bile. Bile helps in the emulsification of fats.

Pancreas

The pancreas secretes digestive enzymes into the duodenum, the first segment of the small intestine. These enzymes break down proteins, fats and carbohydrates. The pancreas also makes insulin, secreting it directly into the bloodstream. Insulin is the chief hormone for metabolising sugar. The pancreatic juice contains enzymes like *amylase* which converts starch to glucose; *protease* which works on protein to convert it to amino acids; *lipase* which converts emulsified fats into fatty acids, and *glycerol*.

Digestion of food

Digestion of food takes place in stages from the time it enters the mouth. Digestion starts in the mouth for certain classes of food while

for others, digestion starts much later as the food goes down the digestive system. In each part of the digestive system, certain things happen. Some chemicals present in specific parts of the system act on the food to bring about the breaking down of food. These chemicals which take part in the process of food digestion are called **enzymes**. Remember that classes of food include carbohydrates, proteins, vitamins, fats and oils, mineral salts and water. Carbohydrates, proteins, and fats and oils are acted upon in different parts of the digestive system. Table 6.1 summarises the stages of digestion for the different food classes.

For the digestion process to be effective, enzymes are needed. These enzymes are usually produced by different organs in the body. They are biochemical catalysts which, when added to a chemical substance e.g. food, reduces the amount of time and energy required to complete a chemical process such as breaking down of food molecules.

Characteristics of enzymes

1 All enzymes are protein.
2 Enzymes possess great catalytic power.
3 Enzymes are highly specific in nature.
4 Like the proteins, enzymes can be coagulated by alcohol, heat, concentrated acids and alkaline reagents.
5 Enzymes have an optimum pH range within which the enzymes function at their peak.
6 At higher temperatures, the rate of the reaction is faster.
7 Enzymes are inactiviated/denatured when exposed to excessive heat.

Table 6.1 Stages of digestion of food classes

Stage	Food classes		
	Carbohydrate	**Protein**	**Fats and oil**
Mouth	1 Food is masticated (chewed into small pieces). 2 It is mixed with saliva and swallowed. 3 Enzyme in saliva called *ptyalin* digests carbohydrates into simple sugar.	1 Food is masticated. 2 It is mixed with saliva and swallowed. 3 No digestion takes place.	1 Food is masticated. 2 It is mixed with saliva and swallowed. 3 No digestion takes place.
Gullet	1 Food passes down towards stomach. 2 No digestion takes place.	1 Food passes down towards stomach. 2 No digestion takes place.	1 Food passes down towards stomach. 2 No digestion takes place.
Stomach	1 Food is churned into chyme.	1 Food is churned into chyme.	1 Food is churned into chyme.

	2 Food is mixed with gastric juice. 3 Food is acidified. 4 Bacteria in food are killed.	2 Food is mixed with gastric juice. 3 Food is acidified. 4 Bacteria in food are killed. 5 Enzyme called *pepsin* digests proteins into peptones.	2 Food is acidified. 3 Bacteria in food are killed. 4 Enzyme called *rennin* changes fat in milk into semi-solid.
Small intestine	1 Food acidity is neutralised. 2 Final digestion into simple sugars takes place. 3 Simple sugar is absorbed into the bloodstream and circulated.	1 Food acidity is neutralised. 2 Final digestion into amino acids takes place. 3 Amino acids are absorbed into the blood stream and circulated.	1 Food acidity is neutralised. 2 Food is emulsified (changed into droplets). 3 Final digestion into glycerol and fatty acids takes place. 4 Glycerol and fatty acids are absorbed into the bloodstream and circulated.
Large intestine	1 Undigested particles are pushed on. 2 Water in undigested food is absorbed. 3 Semi-solid faeces remains.	1 Undigested particles are pushed on. 2 Water in undigested food is absorbed. 3 Semi-solid faeces remains.	1 Undigested particles are pushed on. 2 Water in undigested food is absorbed. 3 Semi-solid faeces remains.
Anus	1 Faeces is passed out from time to time.	1 Faeces is passed out from time to time.	1 Faeces is passed out from time to time.

Activity 6.2 Discussion on digestion of carbohydrates

Materials required

Model of the digestive system, your science notebook, biro

Procedure (group discussion)

1 Examine the model of the digestive system.
2 Identify the parts of the digestive system.
3 Discuss what happens to carbohydrate food in the:
   a) mouth;
   b) gullet;
   c) stomach;
   d) small intestine;
   e) large intestine; and
   f) anus.
4 Record the points made at each stage.
5 Submit your science notebook to your teacher.

Activity 6.3 Discussion on digestion of protein

Material required
Model of the digestive system, your science notebook, biro

Procedure
Follow the steps in Activity 6.2.

Absorption of food

As you can see from Table 6.1, the end products of digestion are simple sugars from carbohydrates, amino acids from proteins and fatty acids and glycerol from fats and oils. Vitamins, mineral salts and water do not need digestion. They exist in soluble and absorbable forms. At the end of digestion all the end products, vitamins, salts and water are absorbed in the small intestine. The small intestine has special structures for this role. These structures appear like small fingers on the walls of the intestine. They are called **villi** (singular: villus). Villi help to increase the surface area of the small intestine for absorption of food nutrients into the bloodstream. The undigested food materials are passed into the large intestine where excess water is pulled out and re-absorbed. What is finally left is semi-solid faeces.

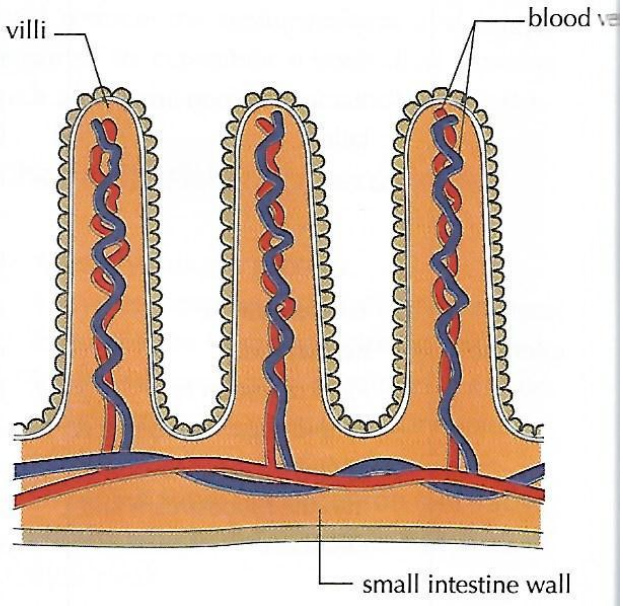


Fig. 6.2 Villi of the small intestine

Activity 6.3 Discussion of food absorption

Materials required
Digestion chart, your science notebook, biro

Procedure (group discussion)
1. Identify the end products of digestion.
2. Discuss what happens to the end products.
3. Discuss what happens to the food materials that are not digested.
4. Prepare your note on absorption of food in human beings.
5. Submit your science notebook to your teacher.

Table 6.2 **Simple food tests**

	Food	Test	Observation
1	Starch	Iodine solution + Yam/bread.	Blue–black colouration is formed.
2	Reducing sugar (glucose)	Benedict's solution + Glucose.	Brick-red precipitate is formed.
3	Reducing sugar (fructose)	Fehling's solution + Fructose.	Red/yellow precipitate is formed.
4	Protein	Millon's test: Millon's reagent +Egg albumen.	White precipitate is formed, which on heating turns brick-red.
5	Protein	Biuret test: Sodium hydroxide solution and drops of copper sulphate + Egg albumen.	A violet colour is formed.
6	Fats and oils	Smear groundnut oil on a piece of paper.	Paper becomes translucent.
		Sudan III solution + Butter.	Distinct red colouration is formed.

Simple food tests

Food is any substance we eat in order to:

1 provide the energy we need, (carbohydrates, fats and oils, proteins);
2 build up our body tissues for growth (proteins);
3 repair our worn out tissues (protein);
4 enable body functions to proceed smoothly (mineral salts, vitamins, water); and
5 defend our bodies against diseases (vitamins).

All the food we eat can be classified into six, these are carbohydrates, proteins, fats and oils, vitamins, mineral salt, and water. All the food we eat are chemical in nature. They can react with other chemicals to produce new substances. Different food classes react differently and produce different substances. Scientists use simple food tests to identify food classes or the contents of food materials.

Activity 6.5 Test for carbohydrates

Materials required

Pipette, dilute iodine solution, boiled rice, uncooked yam, boiled cassava leaves, your science notebook, biro

Procedure (group experiment)

1 Cut a piece of yam.
2 Using a pipette, place a drop of dilute iodine solution on the freshly cut surface of the yam.
3 Record your observation.
4 Place two drops of the iodine on the rice.
5 Record your observation.
6 Place two drops of the iodine on the surface of a freshly boiled cassava leaf.
7 Record your observation.

Result

In all the experiments, you might have observed a dark-blue colour on the surface of the food materials. This indicates the presence of starch in the food materials. We, therefore, infer that they contain carbohydrates.

Activity 6.6 Test for proteins

Materials required

Pipette, fresh egg white (albumen), sodium hydroxide solution, copper sulphate solution, test tubes, your science notebook, biro

Procedure (group experiment)

1 Place a small amount of egg white in a test tube.
2 Mix the egg white with a little sodium hydroxide solution.
3 Add one drop of copper sulphate solution.
4 Record your observation.

Result

The solution turns to violet. This indicates the presence of protein.

Activity 6.7 Test for fats and oil

Materials required

Paper, oil palm fruit, alcohol (methylated spirit), your science notebook, biro

Procedure (group experiment)

1 Rub a freshly opened oil palm fruit on a clean piece of paper.
2 Record your observation.
3 Dip the stained paper into methylated spirit.
4 Allow the paper to dry.
5 Record your observation.

Result

First, the oil in the palm fruit makes a semi-transparent mark on the paper. When dipped into methylated spirit and dried, the oil disappears. This is because fats and oils dissolve in alcohol. We infer that the food material belongs to the fats and oils class. Table 6.3 provides a summary of food tests using different chemical reagents.

Table 6.3 Food tests using different chemical reagents

Food class	Reagent	Observation
1 Carbohydrates	Dilute iodine solution	Turns blue–black.
2 Proteins	Copper sulphate solution	Turns violet.
3 Fats and oils	Alcohol	Dissolves.

Digestive disorders

A digestive disorder is any health problem that occurs in the digestive tract. Conditions may range from mild to serious. Examples of such disorders are:

1 Peptic ulcer.
2 Constipation.
3 Diarrhoea.
4 Gallstone.
5 Appendicitis.
6 Liver problems such as hepatitis *B* or *C*.
7 Cirrhosis.

Summary

1 The digestive system is described as all the parts of the body which work together to ensure the digestion of the food we eat.
2 The parts of the digestive system are the mouth, gullet, stomach, small intestine, large intestine and anus.
3 Digestion of food takes place in stages in the different parts of the digestive system.
4 The different classes food are digested in different parts of the digestive system.
5 Digestion of carbohydrates starts in the mouth while digestion of proteins starts in the stomach.
6 The end products of digestion are:
   a) simple sugar (glucose) from carbohydrates;
   b) amino acids from proteins; and
   c) fatty acids and glycerol from fats and oils.
7 Vitamins, mineral salts and water do not undergo digestion. They exist in soluble states and are absorbed directly into the body.
8 Digestion does not take place in the gullet and large intestine.
9 Absorption of food nutrients takes place in the small intestine while excess water is also absorbed in the large intestine.
10 Undigested food particles are stored temporarily in the large intestine as semi-solid substance called faeces.
11 Faeces is passed out of the body through the anus.
12 There are six classes of food: carbohydrates, proteins, fats and oils, vitamins, mineral salts, and water.
13 All foods are chemical in nature and react with other chemicals to produce new substances.
14 Simple food tests are used to identify food classes:
   a) Carbohydrates give blue–black colour in the presence of iodine solution.
   b) Proteins give violet colour in the presence of copper sulphate solution.
   c) Fats and oils dissolve in alcohol.

Revision questions 6

1 One of these statements is not correct about vitamins.
   A Vitamins do not undergo digestion.
   B Vitamins are passed out of the body.
   C Vitamins exist in a soluble state.
   D Vitamins are absorbed directly into the body.
   E Vitamins are essential for the body.
2 Carbohydrates are absorbed into the body in the form of _____.
   A acids
   B glucose
   C glycerol
   D complex sugar

E water

3 Carbohydrate digestion starts in the _____.

A duodenum
B ileum
C large intestine
D mouth
E stomach

4 The alimentary canal can be defined as _____.

A a tube in which food is broken down in the body into simple forms that can be absorbed
B the energy bank of the body
C a system made up of tiny cells held together by tendons
D a tube in which food passes through an animal's body
E a tube that gives the body shape

5 Draw and label parts of the human digestive system.

6 Describe the process of digestion in the mouth.

7 Describe what happens to the following food types in the stomach:

a) carbohydrates
b) proteins
c) fats and oils
d) vitamins

8 Mention the end products of carbohydrates, proteins, and fats and oils in digestion.

9 Mention three chemical reagents used in food tests.

10 Describe and give the results of simple food tests for:

a) carbohydrates.
b) proteins.
c) fats and oil.

Chapter 7 The human circulatory system

Introduction

The cells of our body require oxygen and digested food substances in order to produce the energy needed for our activities. These materials (oxygen and food substances) are not produced by all the cells. Remember that oxygen gets into the body through the respiratory system. Since other parts of the body do not have the ability to obtain oxygen directly from the air, oxygen must be taken from the lungs to these other parts. In the same way, digested food substances must be taken from the organs where they are digested to other parts of the body.

Remember also that during respiration, certain waste materials are produced in the cells of the body. These waste materials also need to be taken away from where they are produced to the parts of the body fashioned for their removal.

The parts of the body which work together to ensure the circulation of oxygen and digested food substances as well as transportation of waste products from one part of the body to another are collectively referred to as the **circulatory system**. In this chapter, you will learn about the human circulatory system: its parts, structure and functions of the parts, importance of the circulatory system, some diseases of the blood, and the importance of blood tests.

Objectives

By the end of this chapter, you will be able to:

1 identify the organs of the circulatory system;
2 recognise how the organs work and relate to other systems;
3 describe the main functions of the heart and blood vessels; and
4 mention blood diseases and the significance of blood tests.

Parts of the human circulatory system

The circulatory system is an organ system that permits blood to circulate and transport nutrients, oxygen, carbon (IV) oxide, hormones, and blood cells to and from cells in the body. These nourishes the body and helps it to fight diseases. It also stabilises the body temperature and pH, and maintains homeostasis.

The circulatory system is made up of the blood, the heart and the blood vessels.

The blood

In all living things, the circulation of materials takes place through a liquid medium. In human beings, blood is the liquid medium that carries the materials around the body.

These materials include the following:

1 Oxygen from the lungs.
2 Digested food substances such as glucose, mineral salts and amino acids.
3 Waste products such as carbon(IV) oxide, urea, and excess salt.

Blood does not flow through any route that pleases it, but rather through the blood vessels and the heart.

The circulatory organs are the organs that make the movement of the blood around the body possible.

Fig. 7.1 The white blood cells

Blood components and their functions

1 Plasma: The plasma is the most abundant component of the blood. It has a number of functions which include carrying glucose which is the most important nutrient required by each cell for generating energy.

2 White blood cells: The infections that threaten to damage the body are handled by the white blood cells found in the blood. White blood cells are also known as **leucocytes**. The whole immune system of a human body is dependent on the ability of white blood cells to identify the pathogens, cells with cancerous materials in them, and matters which are foreign to the body. They are given the duty of destroying and cleaning the body of these enemy cells.

The white blood cells are of different shapes and sizes. They are larger in size than the red blood cells but fewer in number. They have irregular shapes and are colourless. They also have nuclei.

3 Red blood cells: They are small and circular in shape. They are numerous and have no nuclei. They contain a proteinous material called **haemoglobin**. They are red in colour. The main job assigned to the red blood cells is to make sure that oxygen is delivered to all cells of the body when the pumping of blood has been carried out by the heart.

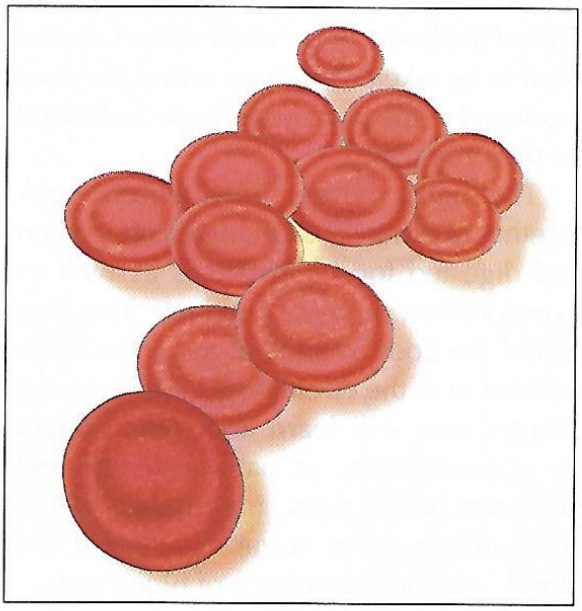


Fig 7.2 The red blood cells

4 **Platelets:** The platelets are the lightest and the smallest components of blood. Due to their small size, they usually travel near the walls of the vessels carrying blood. They are fewer and smaller than red blood cells and have no nuclei. The wall of the blood vessels is made up of special cells named *endothelium* which stops the platelets from sticking to the blood vessels.

However, in case of an injury, this layer of endothelium gets damaged and blood flows out of the blood vessels. When this happens, the platelets react immediately and get attracted by the tough fibre which surrounds the walls of the blood vessels. The platelets then stick to the fibres and begin to change their shape, thereby making a type of seal (clot) which stops the blood from flowing out of the body.

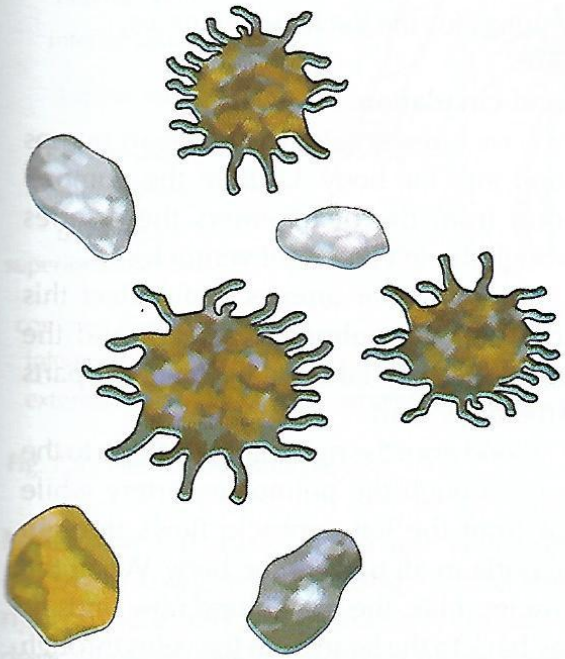


Fig 7.3 The platelets

Functions of the blood

1 Blood is the primary means of transport in the body that is responsible for transporting important nutrients and materials to and from the cells that make up our body.
2 The blood helps in taking oxygen processed by the lungs to all the cells of the body and then to collect the carbon(IV) oxide from the cells and deliver it to the lungs.
3 The blood helps with the job of collecting metabolic waste from different parts of the body to the kidneys for excretion.
4 The blood helps to carry out the transportation of hormones produced by the glands of the endocrine system.
5 The blood (white blood cells) performs the important task of protecting the body from the threat of infection and disease-causing bacteria that can cause serious damage to the body cells.
6 The platelets in the blood handle the task of limiting blood loss in the wake of an injury by helping the blood to clot quickly.
7 The blood oversees the temperature of the body and maintains it to a level that is tolerated (accepted) by the body with ease.

The human heart

The human heart is:
1 muscular;
2 shaped like a cone; and
3 made up of four chambers.

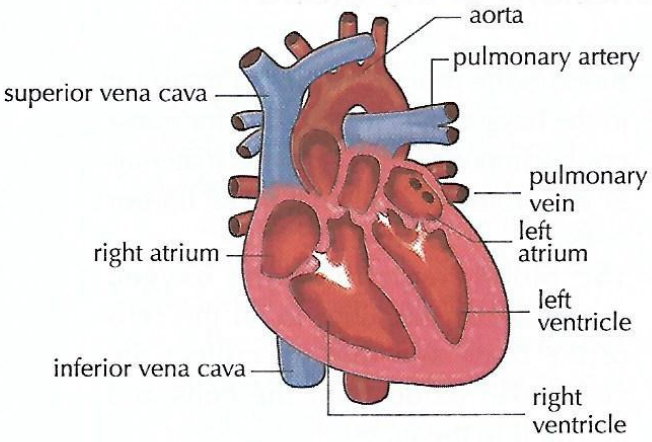


Fig. 7.4 The human heart

The four chambers of the heart consist of two upper chambers and two lower chambers. The upper chambers are called **auricles**. The lower chambers are the **ventricles**. Of all the chambers, the left ventricle is the most muscular. Between the auricles and ventricles are two small openings called valves. The opening between the left auricle and the left ventricle is called the **bicuspid valve** while the opening between the right auricle and the right ventricle is called the **tricuspid valve**.

The heart is located in the chest cavity of the body and is connected to all parts of the body by means of blood vessels.

Activity 7.1 Examining the model of a human heart

Materials required

Model of the human heart, chart on the structure of the human heart, your science notebook, pencil, biro

Procedure (group activity)

1 Examine the model of the human heart provided by your teacher.
2 Identify the chambers of the heart.
3 Identify the blood vessels that are around the heart.
4 Use the chart to label the different parts of the heart shown in the model.
5 Submit your work to your teacher.

Functions of the heart

The major function of the heart is to pump the blood that is circulated in the body. Blood leaves the heart through the left ventricle to all parts of the body and comes back to the heart through the right auricle. The valves between the auricles and ventricles control the direction of blood flow.

The heart pumps blood so that the blood takes food, oxygen and other materials to all parts of the body, and collects waste products from all cells. The heart communicates with the lungs for the exchange of gases.

Blood circulation

We have already said that the heart pumps blood into the body. Usually, the pumped blood from the heart enters the arteries through the left and right ventricles.

The particular arteries that collect this blood are the **pulmonary artery** and the **aorta**, and they take the blood to all parts of the body cells.

Blood from the right ventricle flows to the lungs through the pulmonary artery while that from the left ventricle flows through the aorta to all parts of the body. When the muscles relax, the used blood now finds its way back to the heart from the veins through the left and right auricles.

The left half of the heart deals with blood that is rich in oxygen. That is because the

blood first flows into every other part of the body. As the blood circulates round the body, it takes along with it the excess carbon(IV) oxide in the body together with other waste products, and gets rid of them as it is returning to the ventricle which branches into two, with one artery going into each lung.

Activity 7.2 Tracing the blood flow

Materials required

Chart on blood circulation, your science notebook, pencil and biro

Procedure (class activity)

1 Your teacher will assist you to trace the flow of blood using the chart.

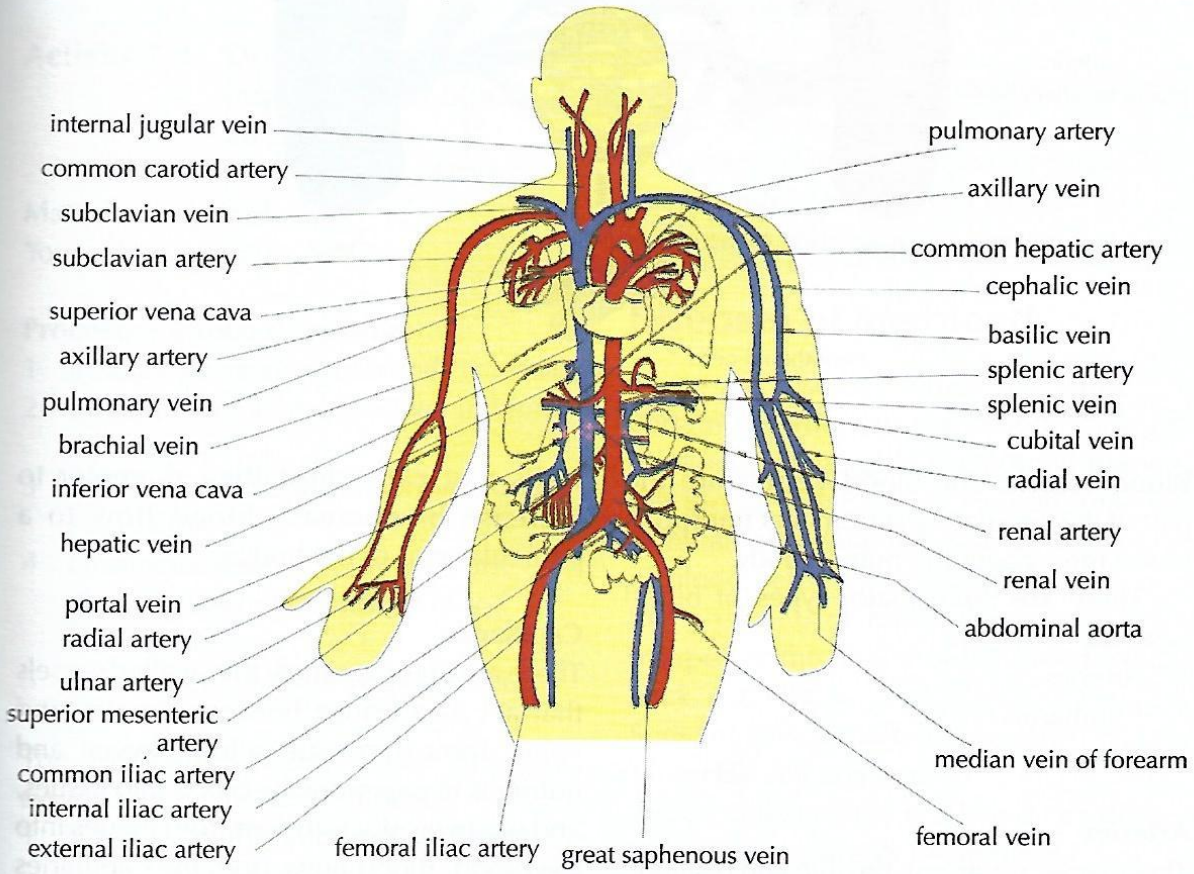


Fig. 7.5 Human circulatory system

Note: The left auricle and left ventricle circulate oxygenated blood, while the right auricle and right ventricle circulate deoxygenated blood, and they never meet because there is a wall separating them called **septum** which divides the heart longitudinally.

2 Trace the movement of blood from the heart to all parts of the body.
3 Trace the movement of blood from all parts of the body to the heart.
4 Make your own diagram of blood circulation.
5 Submit your work to the teacher.

Structure of the blood vessels

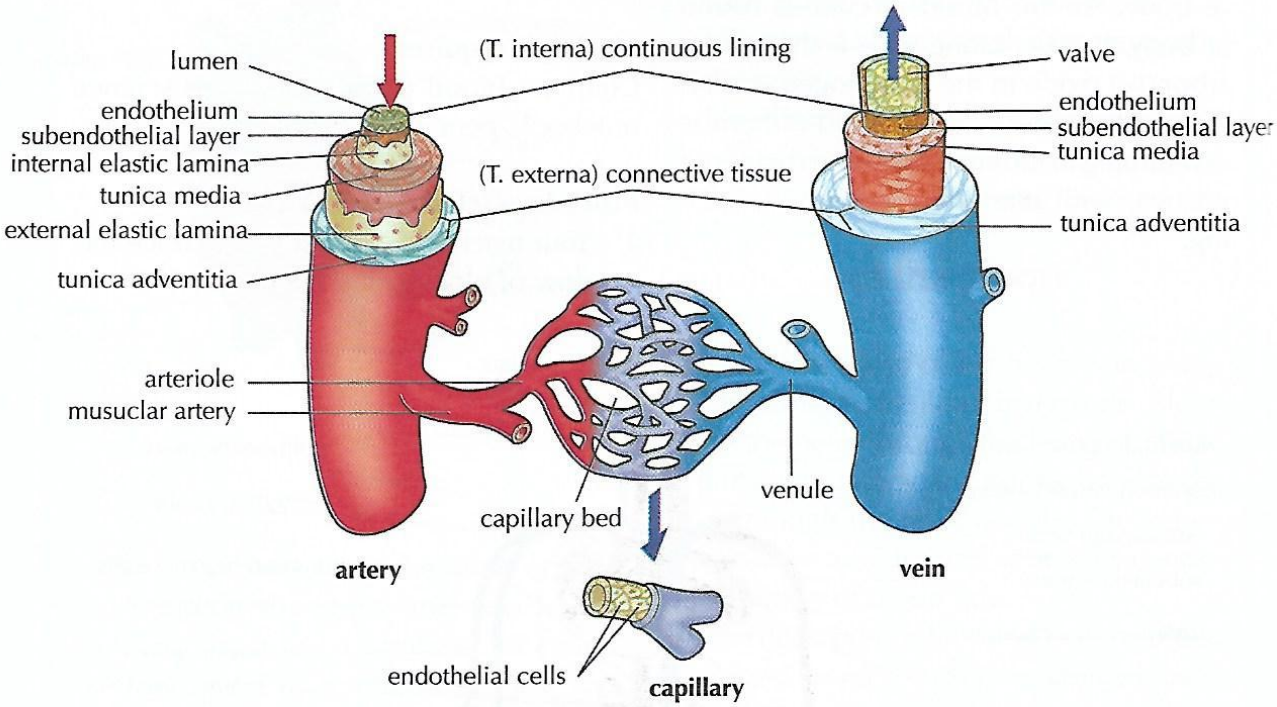


Fig. 7.6 Blood vessels

Blood vessels: The blood vessels are the part of the circulatory system that transports blood throughout the human body.

There are three major types of blood vessels:

1 Arteries.
2 Capillaries.
3 Veins.

Arteries

The arteries are strong, flexible and resilient; they carry blood away from the heart and bear the highest blood pressure. Because arteries are elastic, they narrow (recoil) passively when the heart is relaxing between beats and thus help maintain blood pressure. The arteries branch into smaller and smaller vessels, eventually becoming very small vessels called **arterioles**.

Arteries and arterioles have muscular walls that can adjust their diameter to increase or decrease blood flow to a particular part of the body.

Capillaries

These are tiny, extremely thin-walled vessels that act as a bridge between arteries and veins. Their thin walls allow oxygen and nutrients to pass from the blood into tissues, and waste products to pass from tissues into the blood. Blood flows from the capillaries into very small veins called **venules**, then into the veins that lead back to the heart.

Veins

The veins have much thinner walls than arteries, largely because the pressure in veins is so much lower. Veins can widen (dilate) as the amount of fluid in them increases. They carry blood from the body cells to the heart.

It is worthy of note that if a blood vessel breaks, tears, or is cut, blood leaks out causing bleeding. Blood may flow out of the body as *external bleeding*, or it may flow into the spaces around organs or directly into organs as *internal bleeding*.

Importance of the circulatory system

Activity 7.3 Discussion of the importance of blood circulation

Materials required
Your science notebook, biro

Procedure (group discussion)
1 Discuss the meaning of blood circulation.
2 Mention the organs involved in blood circulation.
3 Discuss what happens during blood circulation.
4 From your discussion, make a list showing the importance of blood circulation.
5 Submit your work to your teacher.

The importance of the human circulatory system can be listed as follows:
1 It serves as the transport system of the body, for carrying many substances from one part of the body to another.
2 It serves as the body's defence against diseases and harmful organisms.
3 It serves as the cleaning agent of the body, carrying poisonous waste products from where they are produced to the parts of the body where they are removed.

Activity 7.4 Discussion of the circulatory system as the defence system of the body

Materials required
Your science notebook, biro

Procedure (group discussion)
1 Discuss the role of white blood cells in blood circulation.
2 Discuss what could happen if the white blood cells are damaged.
3 Make your notes to show the importance of white blood cells in your body.
4 Submit your work to your teacher.

Diseases of the blood

There are diseases which are caused by certain disorders in the blood. They can be due to a change in the normal shape of the blood cells, e.g. sickle-cell anaemia, or by an abnormal increase in the number of blood cells, e.g. leukaemia, or even by the presence of harmful organisms that overpower the ability of the blood to fight back, e.g. HIV.
Some of these blood diseases are:

1 Sickle cell anaemia

Sickle cell anaemia is a hereditary disease (passed from parents to children).

The red blood cells of sufferers do not have the normal shape and do not contain normal haemoglobin. They are shaped like a sickle or an *S* and, therefore, unable to carry oxygen needed in the body. The cells die quickly, making the sufferers weak most of the time. There is no cure for it for now. It can only be managed with medical care.

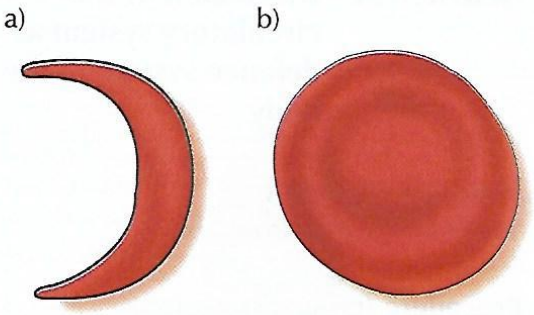


Fig. 7.7 a) Sickle celled red blood cell
b) Normal red blood cell

2 Leukaemia

Leukaemia is a cancer of the blood. Sufferers have excess white blood cells. The red blood cells are reduced abnormally and the patient usually dies of weakness.

3 Haemophilia

This is a blood disease in which the sufferers easily bleed to death from injuries because their blood cannot clot like normal blood. It is hereditary, though it is not common in Nigeria.

4 HIV/AIDS

HIV (Human Immunodeficiency Virus) attacks humans through the blood. On entering the human blood, the virus (HIV) begins to destroy the white blood cells, reducing the number of white blood cells in the blood, thus damaging the body's defence mechanism, and thereby exposing the body to all sorts of diseases. When the body's immunity (resistance) against diseases is completely destroyed, the patient is said to have a full-blown AIDS (acquired immune deficiency syndrome) and may die quickly from various diseases such as tuberculosis.

As you have learnt, AIDS is a terminal disease. Medical science is yet to find a cure for AIDS. We can only control HIV by a combination of drugs, or take measures to prevent the entry of HIV into our blood. HIV/AIDS is a common disease among the youths today.

Activity 7.5 Prevention of HIV/AIDS

Materials required

Chart on various ways to contract HIV/AIDS, your science notebook, biro

Procedure (group discussion)

1 Study the various ways to contract HIV/AIDS provided by your teacher.
2 Discuss the action that can be taken to prevent HIV/AIDS.
3 List the various ways to prevent HIV/AIDS.
4 Submit your work to your teacher.

Significance of blood tests

Blood tests are carried out for the following reasons:

1 To find out the health status of an individual i.e. to know how healthy an individual is and the possible health problems the individual could have.
2 To identify the disease(s) affecting the individual and the organism(s) causing such diseases, e.g. HIV/AIDS, sickle-cell anaemia, and malaria.
3 To determine the blood group of an individual.
4 To confirm pregnancy.
5 To monitor known health conditions, e.g. blood sugar level.
6 To screen blood before transfusion.
7 To choose marriage partners, e.g. marriage should not be encouraged if the two partners have sickle-cell anaemia, or test positive for HIV/AIDS.

Blood groups

Human blood is classified into four groups. The blood groups are *A*, *B*, *AB*, and *O*.

Each blood group has its own protein in the red blood cell and its type of antibody in the plasma which makes it different from any other group.

The antibody in one group may cause the blood of another group to clot and die. This is why before doctors give blood transfusion, they conduct tests to ensure that the blood group of the donor matches the blood group of the recipient. Otherwise the recipient may die from blood clotting.

After the test:

1 Record your blood group in your diary and on the class chart.
2 From the chart, note the number of students in each blood group and the blood group that is most common in the class.
3 Note how many students are in the same blood group as you.
4 Find out from your teacher the number of your classmates that you can donate blood to or receive blood from and why.

Table 7.1 Table of blood groups

Blood group	Antigen	Who can accept from it	To whom it can be donated to
A	*A*	*A, AB*	*A, AB, O*
B	*B*	*B, AB*	*B, AB, O*
AB (universal donor)	*A & B*	*A, B, AB*	*A, B, AB, O*
O (universal recipient)	Nil	*A, B, AB & O*	O only

Activity 7.6 Find out your blood group

Materials required
General hospital, chart, biro

Procedure
For this activity, your teacher will contact the general hospital or government health centre to arrange for blood group tests for all the members of your class. Your teacher will also provide a class chart to record the blood group of your class members.

Summary

1 All the parts of the body which work together to ensure the circulation of oxygen, digested food substances as well as transportation of waste products from one part of the body to another, are collectively referred to as the circulatory system.
2 The parts of the circulatory system are the blood which is circulated in the body, the heart which pumps the blood, and the blood vessels which carry the blood about.

3 The blood consists of the plasma, red blood cells, white blood cells and platelets.
4 The heart is made up of four chambers; the left and right auricles and the left and right ventricles.
5 There are three types of blood vessels; the arteries which carry blood from the heart to other parts of the body, the veins which carry blood from the body to the heart, and the capillaries which communicate between the arteries and veins.
6 The functions of the blood circulatory system include transportation of substances, defence of the body against diseases and removal of poisonous waste substances from the body.
7 Diseases of the blood include sickle-cell anaemia, leukaemia, haemophilia and HIV/AIDS.
8 The importance of blood tests includes the identification of diseases, and choice of marriage partners.
9 Blood groups in human beings are *A*, *B*, *AB*, and *O*.
10 It is important to know your blood group for many reasons, including blood transfusion.

Revision questions 7

1 One of these is not a use of blood tests _____
   A To screen blood before transfusion
   B To help in choosing a marriage partner
   C To determine blood group
   D To determine the sex of a child
   E To identify diseases
2 The blood cell that has a nucleus is the _____.
   A red blood cell
   B white blood cell
   C platelet
   D plasma
   E grey blood cell
3 All these are functions of the blood except _____.
   A distribution of digested food
   B making oxygen available for the body
   C protecting the body from disease
   D maintaining body temperature
   E helping to maintain fatness
4 Haemoglobin is a chemical that carries _____ round the body.
   A carbon (IV) oxide
   B nitrogen gas
   C oxygen
   D water vapour
   E pressure
5 List the main parts of the circulatory system.
6 Draw and label a simple structure of the:
   a) heart b) arteries
   c) veins d) red blood cell
   e) white blood cell
7 List the functions of the circulatory system.
8 Discuss the blood diseases that is common among youths today and why.
9 Name your blood group.
10 Briefly describe the red blood cells.

Chapter 8 The human excretory system

Introduction

During the process of respiration, oxygen from the atmosphere is used in breaking down food substances in our body to release useful energy and some waste products. The waste products that are released during respiration and other activities of the body are carbon(IV) oxide, excess water, salts and urea. These products are called **excretory waste**. It is poisonous and, therefore, must be removed from the body. The process by which excretory waste is removed from the body is called **excretion**.

It is important to note that faeces is not listed as excretory waste. Whereas excretory waste is released from the body cells, faeces do not come out of the cells. Faeces consist of undigested food materials from the digestive system, passed out in the form of semi-solids through the anus. The process by which faeces is removed from the body is called **Defecation**.

Different organs of the body are involved in excretion. All the organs involved in excretion constitute the **excretory system**. In this chapter, you will learn about the excretory organs and their functions, the need to excrete and the excretory products.

Objectives

By the end of this chapter, you will be able to:

1 define excretion;
2 name the excretory organs;
3 describe how the organs work;
4 discuss the need to excrete; and
5 name an excretory waste.

Excretion

Excretion is the process by which waste products of metabolism and other unused materials are eliminated from the body of an organism. It is an essential process in all forms of life. Excretion is necessary because if the metabolic waste is not removed, it may be toxic (poisonous) and harmful to the body.

The waste products that are released during respiration and other activities of the body are carbon(IV) oxide, excess water, salts and urea. These products are called excretory waste. The organs that pass out this excretory waste are shown on Table 8.1 below.

Table 8.1 The excretory organs and their product

Excretory organ	Excretory product
Lungs	Carbon(IV) oxide, water vapour.
Kidneys	Urea, water, mineral salts.
Skin	Urea, water, mineral salts.

Table 8.2 Differences between excretion and defecation

	Excretion	Defecation
1	Removal of waste products of metabolism from the body.	Removal of undigested food and unabsorbed food from the body.
2	Excretory products come in gaseous (CO_2) and liquid forms.	Egested products come in solid or semi-solid form.
3	Products are removed through the kidney, lung, and the skin.	Products are removed through the anus.

Organs of the human excretory system

The human excretory system consists of different organs of the body, which collectively ensure the removal of different waste products. These organs are:

1 Kidney.
2 Skin.
3 Lungs.
4 Liver.

1 The kidney

Every human being has two kidneys located at the back of the abdomen with one on the left and the other on the right. The kidneys are bean-shaped as shown in Fig. 8.1. They are made up of kidney tubules called **nephrons**, which are the units for excretion. A section through the kidney shows three regions: the outer region called the **cortex**, the inner region called the **medulla** and the funnel-shaped **pelvis** that leads to the urinary duct called **ureter**. Each nephron is made up of the **Bowman's capsule** containing the network of blood vessels called **glomerulus**. Attached to the Bowman's capsule is a coiled set of tubules made up of the **proximal convoluted tubule** that leads to a descending **loop of Henle**. This in turn is connected to the ascending tubule called **distal convoluted tubule** that passes through the medulla region to open into the pelvis.

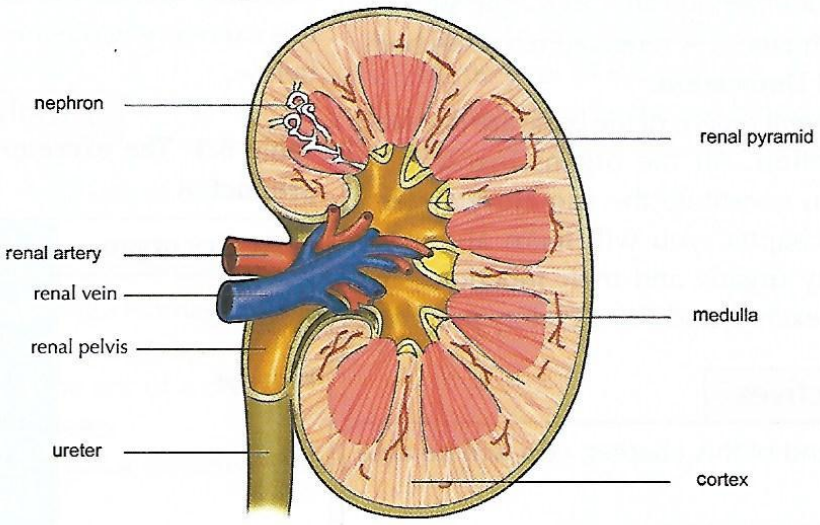


Fig. 8.1 The human kidney

How the kidney works

The kidney is connected to the body's circulatory system. Blood carrying excretory products from all parts of the body are purified in the kidney. There are many excretory units in the kidney known as **nephrons**. Each works in the same way. Blood reaching the kidney enters into the glomerulus at high pressure that sieves out protein and blood cells to be retained in the cup of the Bowman's capsule. Excess mineral salts, excess water as well as urea flow into the space in the tubule. Some water and mineral salts are reabsorbed in the tubule. The liquid containing excess salts, excess water and urea is passed into the bladder as urine. Urine is passed out of the body from the bladder through the urethra.

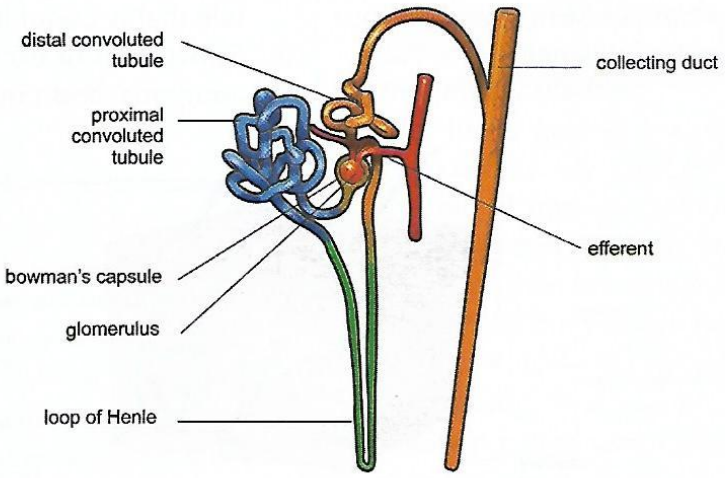


Fig. 8.2 Kidney tubules nephron

Activity 8.1 Drawing the structure of the human kidney

Materials required

Model of the human kidney, your science notebook, pencil

Procedure (individual activity)

1 Observe the model of the kidney provided by the teacher.
2 Draw the structure of the kidney showing the main parts.

2 The skin

The human skin is made up of two layers: the **epidermis** and the **dermis**. The epidermis is made up of the dead **horny layer**, **granular layer** and the sensitive **Malpighian layer**. These serve to protect the inner structures. In the dermis are many structures including the **sweat glands**, **the sweat ducts** and the **sweat pores** that are directly involved in excretion of sweat from the body.

How the skin works in excretion

The sweat gland collects excess water, excess

salt and urea from the blood capillaries in the dermis to form a salty liquid called **sweat**. The sweat flows into the sweat duct through the contraction of the muscles and passes out through the sweat pores. The passing out of sweat through the skin helps to control the temperature of the body. It causes cooling. However, if the sweat dries on your skin, it may block the sweat pores and if bacteria settles on it, you may have body odour. This is why you must wash your body regularly.

Activity 8.2 Drawing the structure of the human skin

Materials required

Model of the human skin, pencil, your science notebook and pencil.

Procedure (individual activity)

1. Observe the model of the human skin provided by your teacher.
2. Draw the structure of skin, showing the main parts.

The lungs and how they work in excretion

The lungs are used for the removal of carbon(IV) oxide that results from cell respiration in the body. Carbon(IV) oxide dissolves in the blood plasma and is carried to the lungs through the blood vessels. The gas diffuses through the capillaries into the alveoli. When contraction of the chest cavity takes place, carbon(IV) oxide flows from the alveolus to the bronchioles, then to the bronchi, and to the trachea and finally out through the nostrils.

4 The liver

The liver does not pass out any excretory waste directly but is involved in changing the chemical composition of some substances that are harmful to the body into less or non-harmful forms. The liver is thus involved in the following excretory functions:

1. Conversion of dead red blood cells into bile that is useful in digestion.
2. Conversion of excess amino acids into ammonia and consequently urea that can be easily removed from the body through the kidneys.
3. Conversion of poisonous alcohol, nicotine and pesticide to non-poisonous substances.

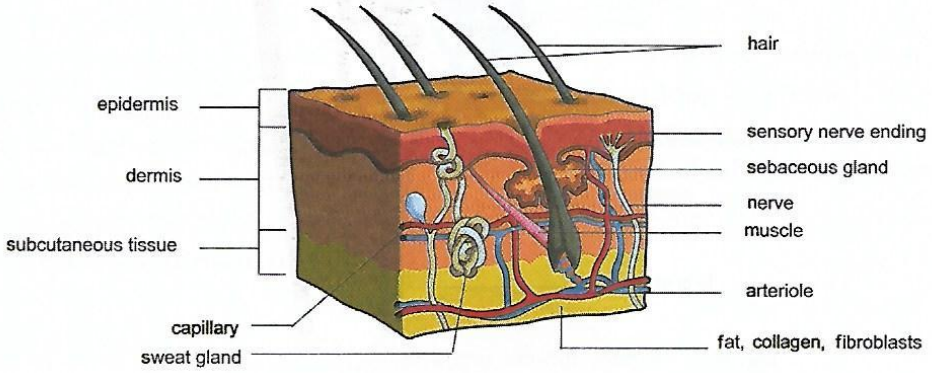


Fig. 8.3 The human skin

Activity 8.3 Identifying different excretory organs and their excretory products

Materials required

Models and charts of the kidney, the skin, the lungs and the liver, pencil, science notebook

Procedure (group work)

1 Identify the models.
2 Identify the parts of each modelled organ.
3 Indicate the waste products removed by the identified model.
4 Discuss how the excretory waste products are removed by each model.
5 Identify similarities in the structure of the excretory organs.

The need for excretion

Excretion is the removal of harmful waste products of metabolic activities from the human body. If this process of excretion does not take place, waste accumulates in the body and may poison or destroy the body. This will consequently result in sickness and eventually by death. A good example is when there is problem with the kidneys; if they fail to remove urine from the body, excess salt, water and urea become retained in the blood. This results in abnormal swelling of body parts that can lead to death if not properly managed through the advanced process of dialysis or kidney transplant. In either of the two treatment procedures, a lot of money is required and the victim suffers much pain.

Summary

1 The waste products from respiration and other body activities are called excretory waste.
2 The process of removing these waste products from the body is called excretion.
3 The main organs of excretion in human beings are the kidneys, the skin, the lungs and the liver.
4 The kidney is made up of three regions; the cortex, the medulla and the pelvis.
5 There are excretory units in the kidney called nephrons made up of the glomerulus in the Bowman's capsule extending to the conducting tubules that terminate in the pelvis.
6 Filtration takes place in the Bowman's capsule due to high blood pressure, and the resultant fluid made up of water, salt and urea called urine is passed into the urinary bladder.
7 The lungs give out waste product of carbon(IV) oxide through diffusion from the blood into the alveoli which later flow out through the alveoli to bronchioles, then to bronchi, and to trachea and finally out through the nostrils.
8 The skin collects the waste products containing urea, water and salt in a solution called sweat through diffusion into the sweat gland which pushes the same out through the sweat duct and sweat pores.
9 The liver does not remove any waste product of cellular activity directly from the body but converts harmful substances to less or non-harmful ones.

Revision questions 8

1 The following are excretory waste except _____.
A carbon (IV) oxide

B urea
C mineral salts
D faeces
E sweat

2 An organ responsible for the removal of urine from the bloodstream is the _____.
A lung
B liver
C kidney
D skin
E bile

3 Types of excreted materials are: _____.
A gases and solids
B faeces and sweat
C urine and carbon (IV) oxide
D gases and faeces
E liquid and gas

4 Excretion is _____.
A the removal of metabolic waste products from the body
B the removal of undigested food
C the removal of water only
D the flushing out of solids
E the washing of undigested products

5 An organ responsible for the removal of sweat from the bloodstream is the _____.
A lung
B kidney
C skin
D liver
E bile

6 List three excretory organs and the waste products each excretes.

7 Describe the role of excretory organs in the human body.

8 Discuss the need for excretion in the body.

9 Define excretory waste.

10 Explain briefly the difference between excretion and egestion.

Chapter 9 The human skeletal system and movement

Introduction

Most animals you know have very hard parts called bones. Touch your fingers and other parts of your body. You will find that bones support every part of the body; the head, the trunk and the limbs. Imagine that your body does not have bones, it would not have been possible for you to have a definite shape, move parts of your body or move from place to place. The bones in your body together form a framework of your body known as the **skeleton**. In this chapter, you will study the human skeletal system and how the bones of the skeleton are put together to bring about movement.

Objectives

By the end of this chapter, you will be able to:

1 identify the parts of the body responsible for movement;
2 describe how bones are put together to function;
3 discuss how muscles, together with bones, make movement possible;
4 name the components of the joints; and
5 describe the importance of movement to human beings.

The skeleton

The skeleton is the bony framework of the body. The skeletal system consists of different bones which work together to provide support and protection to the body.

Functions of the skeleton

1 It gives us shape.
2 It gives us support.
3 It makes our body firm.
4 It protects the delicate parts of our body, especially organs like the heart, brain, kidney and the liver.
5 It helps us in movement.
6 Red blood cells are formed in the long bones.
7 Bones provide adequate attachment for the muscles.

Types of skeleton

There are three main types of skeleton:

1 Hydrostatic skeleton
2 Exoskeleton
3 Endoskeleton

1 Hydrostatic skeleton: This is the type of skeleton possessed by soft bodied animals, e.g. the earthworm.

2 Exoskeleton: This is the type of skeleton found outside or on the external part of the body of some animals such as insects, ants and snails.

3 **Endoskeleton**: This is the type of skeleton found inside the body of some animals such as man and cattle.

The skeletal system in mammals

The skeletal system in mammals is grouped into two major parts. These are:

1 the axial skeleton; and
2 the appendicular skeleton.

Axial skeleton: The axial skeleton is made up of the skull, vertebral column, backbone, ribs and sternum or breastbone.
Appendicular skeleton: This is made up of the limb girdles (pectoral and pelvic girdles) and the limbs (fore limbs and hind limbs).

The human skeletal system

A **system** is a unit of living or non-living things that has different parts which work together to perform a given function. The human body is made up of different systems, and each system is made up of different organs. The skeleton is the hard part of the body. It consists of different bones which work together to provide support and protection for the body.

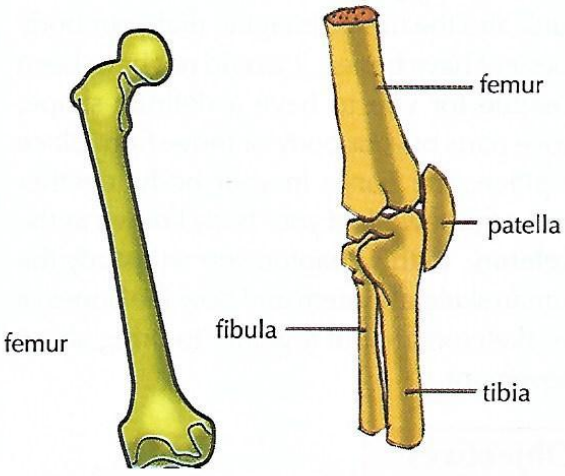


Fig. 9.2 Human bones e.g. lower limb

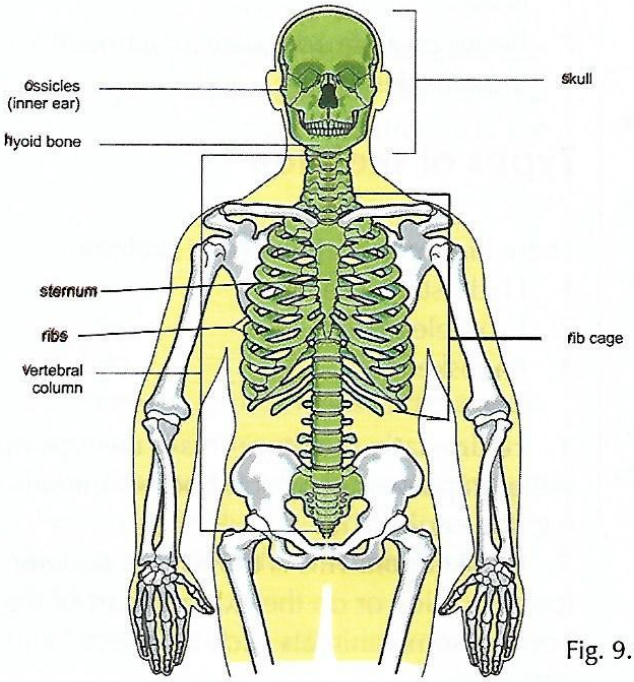


Fig. 9.1 The axial skeleton

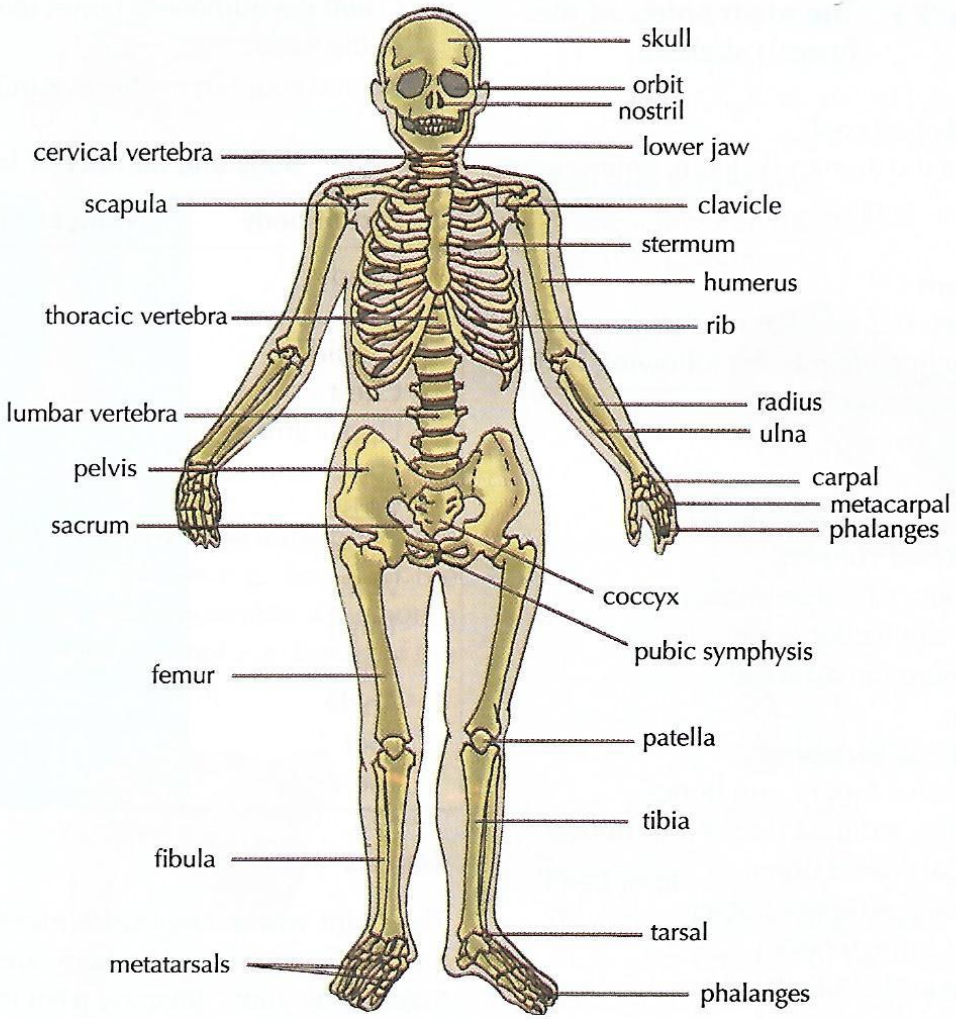


Fig. 9.3 The human skeletal system

The skeleton is also one of the parts of the body that make movement of the body possible and easy.

Parts of the body responsible for movement

As animals, human beings must move about in search of food, shelter and other basic needs of life. Movement in human beings is made possible by the possession of special structures such as bones, joints and muscles. Can you identify them?

There are three major parts responsible for movement. They are:

1 bones;
2 joints; and
3 muscles.

The bone

The bone is a major component of the skeleton. The bone consists of living bone cells, protein fibres (collagen) and minerals, mainly calcium phosphate and calcium carbonate. The bone consists of a hard outer layer (shaft) and a hollow cavity filled with the bone marrow.

Activity 9.1 The main bones of the human skeleton

Materials required
Model of the human skeleton, your science notebook, pencil

Procedure
Using Fig. 9.3 and the model provided by your teacher, identify the following bones:

1 Cranium (skull)
2 Orbit (eye)
3 Jaw bone
4 Cervical vertebra (neck bone)
5 Vertebral column
6 Scapula (shoulder blade)
7 Clavicle (collar bone)
8 Sternum (breastbone)
9 Ribs
10 Thoracic vertebra
11 Humerus (upper arm bone)
12 Radius and ulna (lower arm bones)
13 Carpals (wrist bone)
14 Phalanges (finger bones)
15 Femur (thigh bone)
16 Tibia and fibula (leg bones)
17 Patella (knee bone)
18 Tarsals (ankle bones)
19 Phalanges (toe bones)

Activity 9.2 Labelling the human skeleton diagram

Material required
Human skeleton chart, your science notebook, biro, pencil

Procedure (individual activity)
1 Examine the skeleton model.
2 Identify the different parts of the body e.g. head, neck, shoulders, and chest.
3 Count the number of bones in each part of the body.
4 Record your observations as in Table 9.1.

Table 9.1 Body and number of bones

Part of body	Number of bones
Head	
Neck	
Shoulder	
Chest	
Upper arm	
Lower arm	
Wrist	
Finger	
Waist	
Thigh	
Leg	
Ankle	
Foot	
Toe	

Joints

The point where two bones meet is called a **joint**. The bones of the body are attached together by joints. Imagine what the human skeleton would look like if there were no joints. It would look like a pole – which may not be able to move. The presence of joints makes the bones flexible for movement. The presence of joints between bones also helps to protect the ends of the bones from touching each other and from damage that could occur as they rub against each other. The joints allow a space between two bones. The space is filled with a fluid, which lubricates the bone-ends, making them flexible for movement. The bones are actually held together by rope-like materials called **ligaments.**

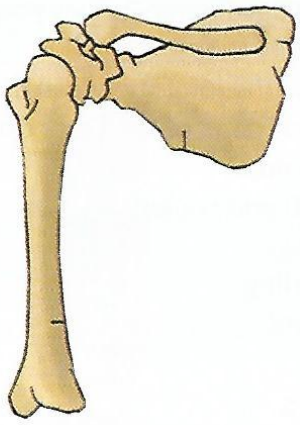


Fig. 9.4 A skeletal joint

Joints may be moveable if the bones are loosely joined together e.g. bones of the hands and legs, or immoveable if the bones are tightly joined together e.g. bones of the skull.

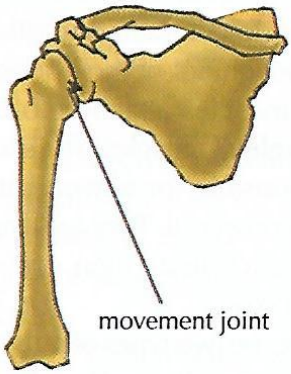


Fig. 9.5 moveable joint

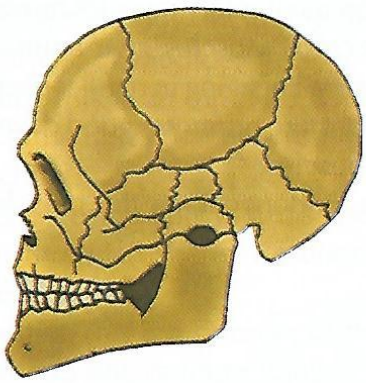


Fig. 9.6 immoveable joint

Types of joints

There are four main types of joints which make for different levels of movement.

1 **Ball and socket joint**
These allow free rotation of the bones e.g. the hip bones.

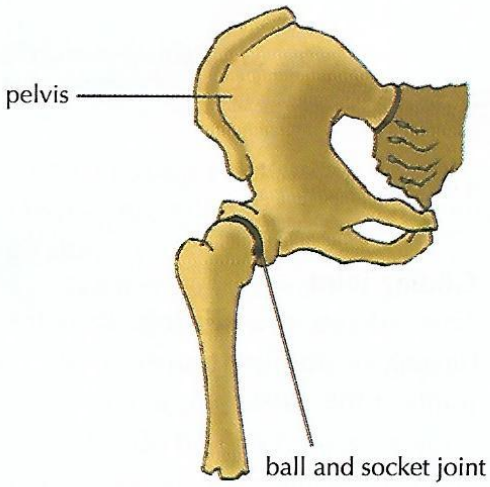


Fig. 9.7 Ball and socket joint

2 **Pivot joint**
This is found only in the neck bone. It allows the rotation of the head on the neck so you can move your head from one side to another. It also permits nodding and limited bending movements.

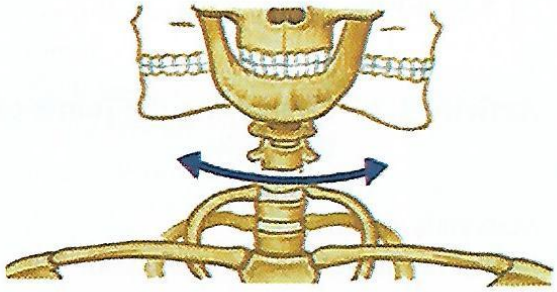


Fig. 9.8 Pivot joint

3 **Hinge joint**
This allows movement in one direction only e.g. elbow joint.

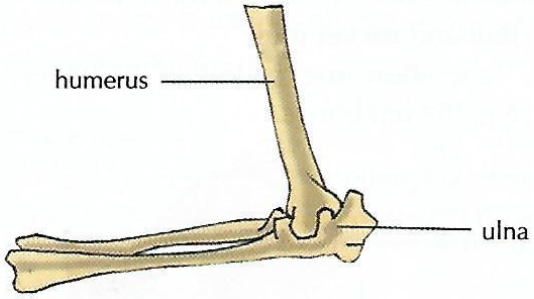


Fig. 9.9 Hinge joint

4 **Gliding joint**
This allows the sliding, twisting or turning of one bone over another, e.g. joints at the wrist.

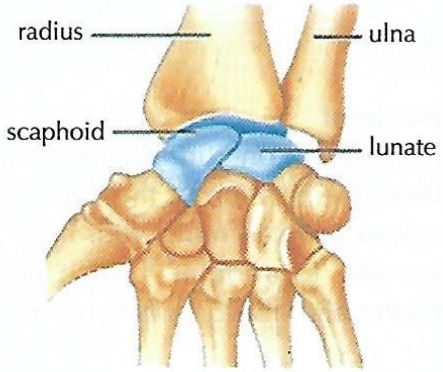


Fig. 9.10 Gliding joint

Activity 9.3 Identifying the joints of the body

Materials required
Model of the human skeleton, your science notebook, biro

Procedure (group activity)
1 Examine the skeletal system.
2 Look at the different bones you identified in Activity 9.1.
3 Observe the joints between these bones.
4 In which parts of the body do you find these joints?
   a) ball and socket
   b) hinge
   c) gliding
   d) pivot

Muscles

Muscles are attached to the skeleton to help the joints to move. A muscle is made up of long thread-like materials, which are arranged in bundles. The bundles are held together by thin tissues. The muscle is the flesh of the body. It has the special ability to contract (shorten) and relax when required. As a muscle contracts and relaxes, it brings about movement of the bones.

The muscles attached to the bones are called **skeletal muscles.** The skeletal muscles are responsible for movement of the body. They are powerful. They are usually arranged in pairs such that when one contracts the other relaxes.

There are two types of muscles, called the **voluntary muscles** and **involuntary muscles**. The voluntary muscles can be moved at will while the involuntary muscles move on their own accord. Muscles give animals shape and beauty. Engaging in regular exercise and proper posture promotes good development of the muscles.

The tendons attach the muscles to the bones.

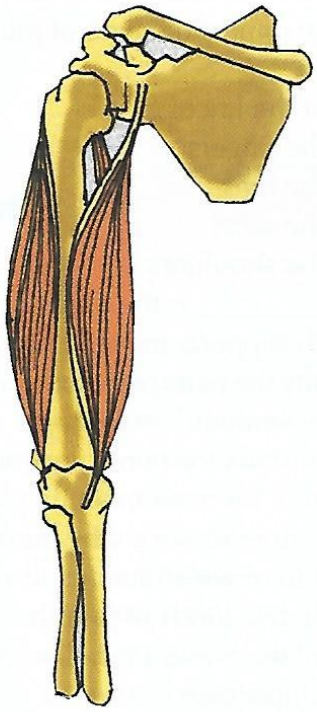


Fig 9.11 Skeletal muscle

Possible injuries to the bone and bone diseases

1 **Fracture**: This involves breaking of the bones, especially the long bones.
2 **Sprain**: This occurs as a result of bone twist at a joint where there are ligaments and tendons.
3 **Dislocation**: This occurs when the bones that are usually connected at a joint separate. It can occur at different joints in the body, including the knee, hip, ankle, or shoulder.
4 **Strain**: This is an injury to a muscle in which the fibres tear as a result of over-stretching.
5 **Osteoporosis**: This is a disease of the bone in which there is reduced bone mineral density.
6 **Arthritis**: This is a disorder of the joint. It involves one or more joints.
7 **Rickets**: This occurs as a result of insufficient amount of vitamin *D*, calcium and phosphorus. This can result in poor bone development in children.

Activity 9.4 Why do human beings move?

Materials required
Your science notebook, biro

Procedure (group discussion)
1 Discuss the following points in your group:
   a) What is movement?
   b) How does movement occur?
   c) What parts of the body are responsible for movement?
   d) Why do human beings move?
2 Record the answers agreed by your group.
3 Present your record to your teacher.

Importance of movement to human beings

Human beings move in order to:
1 obtain their food.
2 go to work and earn a living.
3 keep themselves and their surroundings clean.
4 exercise.
5 attend social functions.
6 find warmth and comfort.
7 find shelter and safety.
8 find sexual partners.

Summary

1 The skeleton is the bony framework of the body.
2 The skeletal system consists of different bones, which work together to provide support and protection for the body.
3 The parts of the body responsible for movement of the body are the bones, joints and muscles.
4 The bones are the hard parts of our body.
5 The joints are the meeting points of the bones.
6 The muscles are the fleshy parts of our body. They are made up of thread-like materials, which are arranged in bundles.
7 Movement is the change in position of the body.
8 Human beings move about in search of food, shelter, comfort, and other basic needs of life.
9 Movement is important to human beings because it is an indication that human beings are living things.

Revision questions 9

1 The ligament is the tough material that holds _____ bones together.
   A two
   B leg
   C head
   D hand
   E chest
2 The functions of the mammalian skeleton include all the following except _____.
   A protection
   B movement
   C excretion
   D support
   E attachment of muscles
3 Hinge joint is the type of joint found _____.
   A at the knees
   B the fingers
   C the toes
   D the wrist
   E the shoulders
4 _____ is the rigid body structure which supports movement in animals.
5 Identify the parts of the body responsible for movement.
6 Explain how the bones and muscles work together for movement.
7 State three reasons why human beings need to move about.
8 Name two kinds of joints.
9 Name the bones of the:
   a) Upper arm
   b) Leg
   c) Hand
   d) Head
10 What are the major functions of the skeleton?

Chapter 10 Family life education (I)

Introduction

Family life education involves training children on social issues such as child abuse, child trafficking, domestic violence, kidnapping, etc. This study is necessary because it educates children on how to avoid or guard against these social issues. Every family will be encouraged to train their children on ways of preventing such occurrences.

Family life education provides information on healthy living and preventive measures against societal ills such as rape, teenage pregnancy and abortion. The ways of passing this message to the youths and children through communication will be discussed in this chapter.

Objectives

By the end of this chapter, you will be able to:
1 define communication;
2 identify different ways people communicate;
3 state the components involved in communication; and
4 discuss steps of improving communication.

Meaning of communication

Communication is the process of using words, sounds or signs to exchange information.

Communication involves the passing of information between two or more people.

Ways of communication

There are different ways in which communication can be done. These are:

1 **Verbal communication**

This involves talk or speech. The person sending message uses verbal speech which could be through television, radio, telephone calls, face to face communication or announcers.

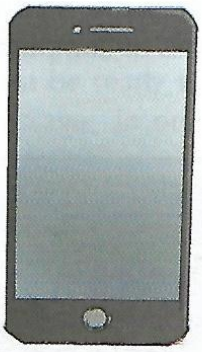


Fig. 10.1 A phone

Fig. 10.2 A television

2. **Non-verbal communication**
Messages are sent through eye contacts, facial expression, gesture, and reactions to situation. The sender and receiver are said to use body language to communicate. This type of communication was the one used in the olden days where mothers especially scold and correct their children using body language. Information can also be passed through body language.

3. **Written communication**
This involves writing letters, e-mails, signs, books or magazines. It is usually in the form of typed or written words. Examples are journals, newsletters, and newspaper.

4. **Visual communication**
In this case, messages are sent or received as pictures. The ideas are sent to receivers through visual aids which include signs, photography, drawing and electronic gadgets e.g. phones or computers.

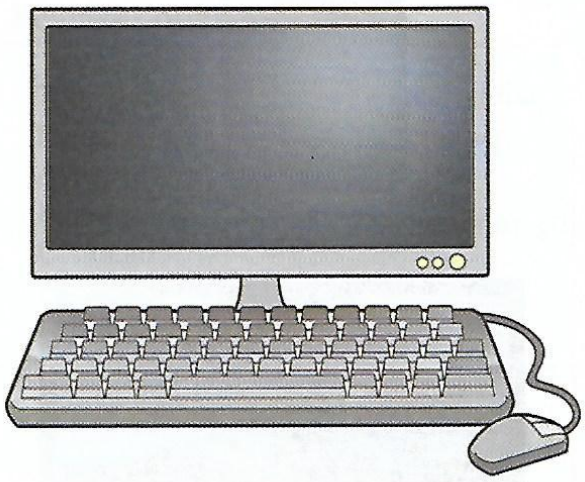


Fig. 10.3 The computer for Internet communication

Components of communication

1 **Context**
Context is the beginning of every message. There are different aspects of context. These include country, culture and organisation.

Every country, culture or organisation has its ways of sending information.

Another aspect of context is internal and external stimuli. Internal stimuli refers to likes, dislikes and attitude of the receiver and the sender of information, while external stimuli involves meetings, letters and the telephone. The way we communicate our idea is determined by the context.

2 **Sender/encoder**
The encoder is the person who sends the message. An encoder uses words, symbols or pictures which can easily be understood by the receiver. The encoder is also referred to as the sender; so the speaker or the writer is the encoder.

3 **Message**
This is the message sent to the receiver by the sender or encoder.

Before a message can be sent, the encoder must ensure that the message is clear and can easily be interpreted by the receiver.

A good or quality message does not need an interpreter but should be easily understood by the receiver .

4 **Medium**
This is the method through which an encoder communicates his message. The medium used to send a message could be through print, sound, electronic,

messenger or postman. Print media are newspapers and magazines; sound media include music, television, and radio. Electronic media are through emails, facebook, radio, Whatsapp, and Instagram. *Postman* is through parcels or letters.

5 **Receiver/decorder**
The receiver is the person who receives the message and also interprets it. He could be a listener or reader, depending on the choice of medium used in sending the message.

If it is a radio medium, he is a listener, and a reader in the case of letters or newspapers.

6 **Feedback**
Feedback is the response of the receiver to a message. It could either be a written or oral message. Silence could also be feedback to a message. Silence means consent. Feedback is the completion of communication.

How to improve communication

Communication skills can be improved when the following are taken into consideration:

1 **Establish trust**
Always avoid confusion when passing information. The truth must always be told in sending messages in order to avoid confusion.

2 **Clear speech**
The message must be clear and short to avoid misconception by the receiver.

3 **Learn to use body language**
In non-verbal communication, body language must be used for clarity of message. A mother can send a child out of a place with her eyes without uttering a word.

4 **Never assume anything**
The sender must ensure that every detail in the information is passed. Never assume that the receiver knows anything about such information.

5 **Send your message to the receiver**
Messages must be passed directly to the receiver and not to any other persons. This is because if it is delivered to a wrong person, it would not make any meaning to him.

6 The sender must note that the attitude and idea of the receiver determine the interpretation given to the message. Problems of wrong interpretation should therefore be avoided.

7 The sender must also take note of errors in typing with computers or phones. Care must be taken when sending written messages to ensure that correct words are written in order to avoid misinterpretation.

8 The receiver must have a listening ear. He must be ready to patiently listen to the message in order to avoid wrong interpretation.

Activity 10.1 Identifying various types of communication

Materials required
Chart, your science notebook, biro

Procedure (group work)

1 *Teacher should arrange the students in groups and choose a group leader.*
2 The teacher should provide various charts and pictures showing types of communication.
3 You should identify the various types of communication shown on each picture or chart.

4 Write out your answers and submit to your teacher.
5 Two of the groups should demonstrate verbal and non-verbal communication.

Summary

1 Family life education provides information on healthy living and preventive measures on social issues such as child abuse, domestic violence, kidnapping etc.
2 Communication is the process of using signs, sounds, etc. to exchange information between two or more people.
3 The different ways of communication include verbal communication, non-verbal communication, written communication and visual communication.
4 The components of communication are context, sender, message, medium, receiver and feedback.
5 Communication skills can be improved by establishing truth, summarising and speaking clearly, using body language, never assuming anything, passing your message to the receiver, and recognising problems in communication through technology.

Revision questions 10

1 Family life education involves _____.
A training children on social issues
B teaching children about science
C training children to become doctors
D helping children to read and write
E teaching children to be law abiding.

2 Communication is the process of exchanging _____ between two or more people.
A information
B books
C clothes
D shoes
E people

3 People communicate in the following ways except by _____ means.
A verbal
B non-verbal
C dancing
D visual
E written

4 The components of communication include the following except the _____.
A sender
B medium
C message
D context
E talking

5 A way of improving communication skills is by _____.
A using body language
B not listening to people
C speaking loudly
D insulting people
E not being honest

6 a) What is communication?
b) List five (5) different ways people communicate.

7 a) State the components involved in communication.
b) Explain any of the three (3) components mentioned above.

8 Discuss five (5) steps of improving communication.
9 What is family life education?
10 State two (2) social issues that constitute the study of family life education.

Chapter 11 Family life education (II)

Introduction

Life is in phases and life begins at birth and ends in death. Some developmental stages occur with birth and death. These stages are characterised by various emotional and developmental changes. In this chapter, lifespan continuum, emotional changes, developmental changes, and factors that influence individual sense of worth will be discussed.

Objectives

By the end of this chapter, you will be able to:

1 state the meaning of lifespan continuum;
2 list some emotional changes experienced;
3 state some developmental changes experienced; and
4 mention factors that influence individual sense of worth (body image).

Meaning of lifespan continuum

The process whereby a baby grows and develops into an adult, grows old and eventually dies is known as lifespan continuum.

This period is programmed to proceed automatically under normal conditions. The stages in the lifespan continuum are:

Birth (baby) → Childhood → Adolescence → Adulthood → Middle age → Old age → Death

Emotional changes

Emotions are strong feelings such as love, fear or anger. They are part of a person's character. Lifespan continuum involves some emotional changes in each of the stages throughout one's lifetime.

Birth – When a child is born, he cries to indicate that he/she is alive. Crying is also a sign of response to stimuli. Babies cry for everything such as hunger and pain.

The childhood stage is between the ages of 2 and10 years. Children here are afraid of every little thing, they try to cheat in order to have their way, they bully other children and are also affected by pressure from their peers.

The **adolescence stage** is between ages 10 and 17 years. Adolescents are usually unstable emotionally, and anxious most of the time, leading to stress. Some are usually shy and homesick (those in boarding schools). They experience mood swings and are attracted to the opposite sex.

Adulthood (18–35 years) is a stage where growth stops. Confusion and conflicts usually set in at this stage. Mood swings which can lead to depression can occur too. Also, love and caring for one another is noticed in some youths in this group.

Middle age (35 –50 years) comprises people who are emotionally stable. They are happy when their marriage work out and rejoice over their children making it in life. In some cases, disagreement and divorce are experienced where there is no joy.

Old age (50 years and above) is the last stage where the people have become old. People in this group may experience loneliness because their children will have gone out to start their own families. At this age also, they retire and enjoy the fruits of their labour as they patiently wait for the day they will die. They are fair in judgement because they usually understand situations around them.

Developmental changes

Developmental changes are the series of changes that occur during growth. They occur throughout the lifespan continuum. The developmental changes which occur in each stage are:

1 **Birth (infancy)**
There is the appearance of milk teeth, the child would be able to sit, crawl and walk/run. Ability to talk starts here.

2 **Childhood (2 – 10 years)**
They possess a very active body that makes them restless. They acquire manual skills like football, washing of plates and clothes, and writing.

3 **Adolescence (10 – 17 years)**
Here, there is rapid and continuous growth. Secondary sexual organs develop. Both boys and girls have pimples on their faces and pubic hair.

Fig 11.1 Different stages of the lifespan continuum

Girls develop breasts and broad hips. Menstruation also starts in this stage.

Boys, on the other hand, produce sperm, develop broad shoulders and their voice cracks and becomes deeper.

4 **Adulthood (18 – 35 years)**
The secondary sexual organs become more mature and are mainly useful at this stage.

5 **Middle age (35 – 50 years)**
Here, the organs gradually become weak. The secondary sexual organs also become weaker in men, and menopause sets in women.

Menopause is a stage in a woman's life when menstruation stops.

6 **Old age (50 years and above)**
The organs become weaker, eyes become dim, legs and arms become weaker. Grey hair covers the head. This is the stage when death comes and represents the end of the lifespan continuum.

Factors that influence individual sense of self worth (body image)

Body image (self worth) is your perception of how your body looks.

It is how you feel or think about your body. A healthy body image leads to body acceptance which results in feeling comfortable, confident and proud of one's body.

The factors that influence body image are:

1 **Size**
The emphasis here is on size, body weight, and appearance. The belief here is that one should have and maintain a slim figure. This slim stature is viewed as what makes ladies acceptable in the society.

2 **The media**
This sets unrealistic standards for what body weight and appearance should be. These standards affect young girls negatively when they see models on television and would want to look like them. An ideal stature of a man is held to be muscular. So anyone that is not up to that tends to feel inferior. This makes some boys and girls feel inadequate, ashamed and dissatisfied with their looks.

3 **Health professionals**
Health workers take the weight and height of individuals when they visit the hospital. They give advice to overweight patients to lose weight or face the risk of obesity, diabetes and heart disease. This information tends to make people feel bad about their stature.

4 **Family, friends and partners**
People are affected by what their family members, friends and partners say about them. When you are treated well, you will tend to have high self-esteem but when you are being criticised always, you will tend to have a low self-image/esteem.

5 **Society**
People are influenced by their culture, religion and race. The nature of your country helps to modify you.

6 **Home**
Children copy the attitude of family members as they grow up, and tend to exhibit this in their own behaviour.

Fig. 11.2 A fat girl and boy

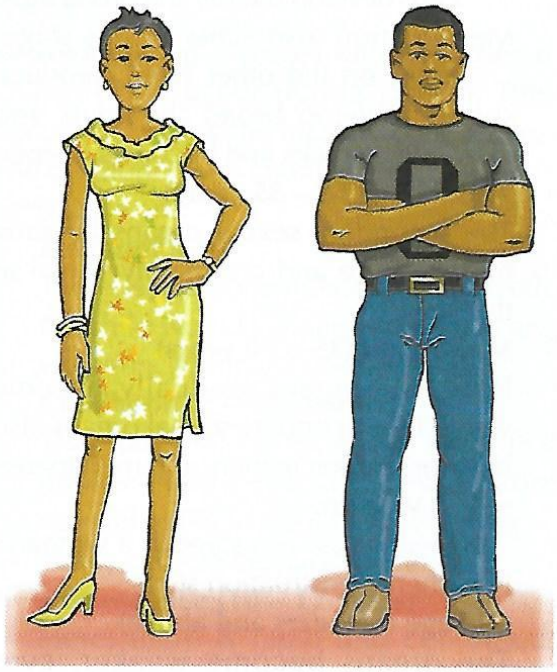


Fig. 11.3 A slim girl and a muscular boy

Activity 11.1 Identifying the perception of body image

Materials required

Your science notebook, biro

Procedure (group work)

1 Your teacher will arrange you into groups.
2 Select a group leader who will write the report.
3 Discuss these questions in your groups.
   a) How old are you?
   b) How do you feel about your body image?
   c) What are the factors that make you feel good about your body image?
   d) What are those things that make you feel bad about your body image?
4 Write out the responses in each group.
5 Present the responses to your teacher.

Summary

1 Lifespan continuum is a process leading from conception to death. The stages involved in lifespan continuum are: Birth → Childhood → Adolescence → Adulthood → Middle age → Old age → Death
2 Emotional changes are the feelings experienced at each stage of the lifespan continuum, e.g. crying at baby stage.
3 Developmental changes are those changes experienced in each stage as one grows. For example, babies have the ability to sit, crawl and walk.
4 Factors that influence individual sense of self worth (body image) include size, media, health, professionals, family and friends, society and home.

Revision question 11

1 The lifespan continuum involves stages between _____.
   A conception and adulthood
   B birth and babyhood
   C conception and death
   D death and life
   E conception and middle age
2 The stage where the emotional change is crying is _____.
   A adulthood
   B old age
   C baby
   D middle age
   E adolescence
3 In which stage do the sex organs mature? _____.
   A Adulthood
   B Adolescence
   C Old age
   D Baby
   E Middle age
4 The media makes girls want to be _____.
   A fat
   B slim
   C robust
   D short
   E obese
5 The following are factors that influence body image except _____.
   A the media
   B the size
   C the family
   D the society
   E the course of study
6 The developmental changes for adolescence include _____, _____ _____, and _____.
7 What is lifespan continuum?
8 List one emotional change experienced in each stage of the lifespan continuum.
9 List five factors that influence individual sense of self worth (body image).
10 List all the stages involved in the lifespan continuum.

Chapter 12 Reproductive health

Introduction

Reproductive health is the state of complete well-being of an individual's reproductive system.

There are different problems faced by individuals, depending on the available health service. This is determined by their educational level, age, ethnic group, religion and resources available. For intance, it has been observed that poor people experience health problems when it comes to their reproductive life because of lack of money for proper medical health services.

Reproductive health affects both males and females as you will understand in this chapter.

Objectives

By the end of this chapter, you will be able to:

1 state the meaning of genetic counselling;
2 list the importance of breast-feeding;
3 state the importance of genetic counselling before marriage; and
4 state the myths of breast-feeding.

Genetic counselling

Counselling means giving professional help and advice to someone. It is a type of talking therapy that allows people to talk about their problems and feelings in a confidential and conducive environment.

Genetic counselling is the the process by which a patient at risk of an inherited disease is advised of the consequences and nature of the disorder, and how it can be transmitted and managed.

Genetic counselling involves these processes:

1 Education about the inheritance of the disease, how to test for it, and management and prevention of the disease.
2 Considering the family and medical history to minimise the chance of disease occurrence or recurrence.
3 Counselling the patient to promote informed choices and adaptation to the risk of the disease.

Steps involved in this counselling are to identify family risk, investigate the problems present in the family, interpret information about the disease, analyse the inheritance pattern and risk of recurrence, and review available genetic testing options with the family.

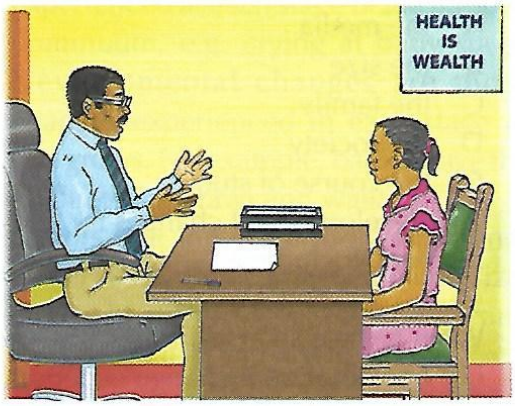


Fig. 12.1 A counsellor and a patient

Importance of breast-feeding

Breast-feeding is the process of giving a baby milk secreted from the breasts of the mother. Every nursing mother is expected to breast-feed her baby from the first day of delivery to about two years. Exclusive breast-feeding is recommended for six months after which semi-solid food is introduced to support the breast milk

Both the mother and child benefit from breast-feeding.

Fig. 12.2 A mother breast-feeding her baby

The importance of breast-feeding includes:

1 Provision of emotional bond between the baby and mother because during this process, the baby is tightly held close to the mother.
2 The breast milk is always available when the baby is hungry and reduces the time wasted to prepare formula food.
3 Breast milk protects the baby from disease or infection, thereby preventing the baby from frequent visits to the hospital.
4 Prevention of instant death of babies. Instant death syndrome is prevented in breast-fed babies because of the content of breast milk.
5 All the nutrients a baby needs is present in breast milk; so the child has adequate nourishment. This prevents malnutrition in babies.
6 Babies that are breast-fed are emotionally attached to their mothers.
7 Breast-feeding assists in proper growth of babies. These babies grow well and look healthier.
8 Breast milk contains colostrum which is rich in antibodies that protect against diseases.

Benefits of breast-feeding to nursing mothers

1 It prevents breast cancer in mothers.
2 It prevents ovarian cancer in mothers.
3 Breast-feeding mothers return to their size and shape faster because it prevents obesity.
4 Breast-feeding provides a mother to child bonding.
5 During the period of breast-feeding, most women don't menstruate, and this serves as a form of contraceptive (prevention of pregnancy).

Importance of genetic counselling before marriage

Genetic counselling can assist intending couples in discovering their genetic background in order to know whether they

are compatible or not and also helps to give advice on when to get pregnant and how to take care of the pregnant woman.

In cases where one of the couple has a history of birth defects, like Down's syndrome or sickle-cell anaemia, advice would be given to prevent a recurrence. If the couple have this history, they would be advised against the marriage.

The following are the benefits or importance of genetic counselling:

1 Genetic counsellors give advice to couples with history of genetic disorders so as to prevent further recurrence.
2 It helps to educate couples with HIV/AIDS on how to live with the disease and not transmit it to their children.
3 It assists individuals with sickle-cell anaemia in choosing life partners so as not to have children with the same disease.
4 It helps prevent cases of genetic disorder or mentally retarded children.
5 It assists in giving advice to women against pregnancy losses and miscarriages.
6 It helps people to learn about health care and the importance of seeking advice when required.
7 It educates those that have been exposed to radiation or drugs on what to do so as not to be affected by the effects of the radiation or drugs.
8 It provides information on people's family history, that is, it makes individuals know if there is any case of genetic disease in their lineage.

Myths of breast-feeding

Myths of breast-feeding are the widely held false beliefs of people which are traditional stories about breast-feeding. Let us discuss some of these beliefs.

1 Some women feel pain on their nipples and they feel discouraged to breast-feed their babies. Such pain can be avoided if the mother puts the breast properly in the baby's mouth from the first day. If this is done, the baby will get used to sucking milk from the breasts rather than holding on to the nipples.
2 Very few women don't produce enough milk to feed their babies. A good eating habit will facilitate the easy flow of milk from the breasts. If the mother eats well, milk will flow naturally.
3 Some enlightened women do not like breast-feeding their babies because they think their breasts will lose shape. This is not true because if the mother wears a good bra during pregnancy and after delivery, the breasts will still be firm.
4 Some believe that preparing formula food for babies is better than breast-feeding. It takes time to prepare formula food but breast-feeding does not need anytime for preparation. So it is faster.
5 Some believe that breast milk cannot be sufficient for babies without water. Medically, it has been proven that breast milk contains all the nutrients, including water that a baby needs for normal, healthy growth. This proves that breast milk is sufficient for a baby.
6 Some think that breast-feeding hurts. Breast-feeding does not hurt because it is a natural process or way of feeding a baby. But if it hurts, it shows that the baby is not properly positioned. So such mothers should seek advice on breast-feeding from experienced mothers or health centres.

7 Some people think that breast milk is the same as formula milk. This is not a fact because formula milk is made from cow milk while breast milk is from the baby's mother. There is a natural link between the mother and the baby.

8 Some young mothers see breast-feeding as an ancient thing to do. Breast-feeding does **not** make you less civilised. More benefits of breast-feeding are discovered every time.

9 Some people believe that breast milk does not provide some vitamins to the baby. This is not true. As long as the mother eats food rich in vitamins, the baby will get them from breast milk.

Activity 12.1 Discussion on importance of counselling

Materials required

Your science notebook, biro

Procedure

1 Teacher should divide the students into four groups.
2 Groups one and two should debate on the importance of genetic counselling (for and against).
3 Groups three and four should discuss the importance of breast-feeding for babies (for and against).
4 Each group should submit their points to the teacher.

Summary

1 Reproductive health is a state of complete well-being of individual's reproductive systems. This affects both males and females.

2 Genetic counselling is the process by which individuals with the risk of inherited disorder are advised on the consequences and nature of the disorder and management, and prevention of recurrence.

3 Breast-feeding is the process of feeding babies or children with milk from their mother's breasts.

4 Breast-feeding provides strong emotional bond between mothers and babies, prevents infection and diseases, is always available, prevents instant death syndrome in babies, and helps to prevent breast cancer, ovarian cancer and obesity.

5 The importance of genetic counselling involves giving advice to people with a history of disease, AIDS patients, and sickle-cell anaemia patients. It helps to prevent cases of mental retardation, give advice against miscarriage, and educate those that have been exposed to drugs or radiation.

6 Myths on breast-feeding include painful breast-feeding, breast sagging after breast-feeding, breast milk cannot be sufficient for a baby, and that breast milk is the same as formula milk. All these are not true about breast-feeding because it is the best and the milk provides every nutrient a baby requires for normal, healthy growth.

Revision question 12

1 Reproductive health affects _____.
A men only
B women only
C men and women
D girls only
E boys only

2 Which of the following is not a benefit or importance of genetic counselling? _____.
   A Educating AIDS patients
   B Educating sickle-cell anaemia patients
   C Helping in preventing mental retardation in children
   D Help to prevent miscarriages
   E Assist in child education.
3 Exclusive breast-feeding should be within which period?
   A 6 months
   B 8 months
   C 12 months
   D 9 months
   E 2 months
4 The importance of breast-feeding includes the following except _____.
   A mother to baby bonding
   B healthy growth in babies
   C improving baby's intelligence
   D contracting of disease
   E provision of nutrients for the baby.
5 One of the myths of breast-feeding is that _____.
   A breast-feeding is the best
   B mothers benefit from breast-feeding
   C babies benefit from breast-feeding
   D breast milk is the same as formula milk
   E babies visit hospital less frequently.
6 What is genetic counselling?
7 a) What is breast-feeding?
   b) List four (4) benefits or importance of breast-feeding.
8 State three (3) benefits or importance of genetic counselling before marriage.
9 Discuss two (2) myths of breast-feeding.
10 Explain why breast milk is better than formula milk.

Chapter 13 Abstinence

Introduction

The union of sperm and egg brings about fertilisation. However, an adolescent needs to abstain from premarital sex to avoid unwanted pregnancy. Someone addicted to alcohol is liable to die young. This can be avoided for a better tomorrow.

In this chapter, you will learn how to abstain from any habit that can lead to addiction, and the benefits of abstinence.

Objectives

By the end of this chapter, you will be able to:

1 define abstinence;
2 list types of abstinence;
3 explain myths and facts about abstinence;
4 state reasons why adolescents do not abstain;
5 state reasons young people must abstain from premarital sex;
6 identify reasons why young people engage in premarital sex; and
7 state skills and behaviour that promote abstinence.

Meaning of abstinence

The word abstinence means the practice of **not** having what you enjoy. Abstinence is a means of preventing pregnancy among adolescents by encouraging them to abstain from sexual intercourse. Education on sex also helps adolescents to make wise decisions.

Adolescence is a time of social and emotional development for adolescents. As such, they need to know what to expect and how to receive support through the changes. During adolescence, you will notice changes in the way the child interacts with family, friends and peers. This is sometimes as a result of myths and facts they have learnt from their environment. Some of these are discussed below.

Myths and facts about abstinence

1 Myth: Abstinence for a long time can lead to sickness.
Fact: If you do not abstain, you can contract diseases such as STI (Sexually Transmitted Infections). Abstinence is all about discipline.
2 Myth: Primary school pupils are too young to need information about sexuality.
Fact: Children also need to learn about all parts of their body so that no one can easily distract or molest them.
3 Myth: There must be premarital sex to know whether both of you love each other or are compatible.
Fact: Sex should be after marriage, for dignity and respect.
4 Myth: Sex education does not address abstinence.

Fact: Comprehensive sex education addresses abstinence.

Types of abstinence

1 **Lifelong abstinence**: This is a way of abstaining from a habit throughout one's life.
2 **Delayed abstinence**: This is when you delay a desired act till the appropriate time. For example, a man may decide to delay himself from pre-sexual activity till he gets married.
3 **Periodic abstinence**: This means abstaining from an act for a while. An example is someone that decides not to smoke cigarettes for a period of time.

Activity 13.1 Discussion on myths and facts of abstinence

Materials required
Your science notebook, biro

Procedure (group work)
1 The teacher should group the students into five.
2. Each group should discuss some myths and facts they know about abstinence.
3. In tabular form, write out the myths and facts that you have discussed in your group.
4. Submit your report to your teacher.

Reasons adolescents do not abstain from sex

1 Some believe everyone is doing it. When such people discuss about sex with their friends and feel odd, their probability of not joining is very slim.
2 Some believe that having sex will bring intimacy between them and their loved ones.
3 Some adolescents use sex as a weapon to maintain relationships. They believe they will be closer to their loved ones by having sex with them..
4 Some desire to do something they don't know out of curiosity like having sex.
5 Some believe that having sex before marriage is the best way to make their partners happy.
6 Some find it difficult to stop the act because they have experienced it and become addicted to it.
7 Some do have sex in order to feel mature like an adult.

Reasons young people must abstain from premarital sex

Any reason for not having sex before marriage is a good reason. The following are some reasons why youths should not have premarital sex.

1 Issues of STIs and pregnancy: To avoid unwanted pregnancy and STIs, adolescents should be far away from premarital sex. They should know that it is shameful when it results in STIs or pregnancy.
2 Religious or moral beliefs: It is wrong as a moralist or believer to engage in premarital sex. It should be within marriage with someone you love.
3 Focus on education: Adolescents should focus more on their education to avoid distractions.
4 In order not to get hurt: You need to protect yourself emotionally from being hurt after the act.
5 Dignity and self-respect: Adolescents must abstain from premarital sex and keep their virginity till after wedding.

Skills and behaviours that promote abstinence

1 **Parenting**: Parents should be able to monitor their adolescents to know what they are doing at any time. They should not leave everything to the school authority to do.
2 **Public enlightenment**: Frequent mass campaign and public lecture can assist adolescents to abstain from sex.
3 **Counselling**: Engaging the adolescents in educative discussion such as career talk, etiquette, sex education, and effects of being a victim of rape. All of these will help adolescents to abstain from immorality.
4 **Religious study**: Adolescents should be thought God's way, so as to live a moral and disciplined life that will help them abstain.
5 **Wise decision**: Teenagers should be helped to make wise decisions on how to say no to sexual advances.

Summary

1 Practice of not having what you enjoy.
2 Abstinence can be lifelong, delayed or periodic.
3 Adolescents must learn to say no to sex in order to avoid its dangers.
4 When an adolescent abstains from pre-marital sex, it accords dignity and self respect to him or her.
5 Abstinence is the best way for adolescents to go.

Revision questiond 13

1 Lifelong, delayed and periodic are types of _____.
A adolescence
B abstinence
C longevity
D intimacy
E sexuality
2 Adolescents should abstain from pre-marital sex to avoid _____.
A early marriage
B sexually transmitted infections
C good education
D sex
E none of the above.
3 All the following promote abstinence except _____.
A counselling
B parenting
C religious studies
D peer pressure
E public enlightenment
4 Abstaining from a habit for a while is _____.
A periodic abstinence
B delayed abstinence
C lifelong abstinence
D morning
E monitoring
5 Unwanted pregnancy can be caused by _____.
A premarital sex
B holding of hands
C reading
D telling stories
E all of the above.
6 Define abstinence.
7 State four (4) myths and facts about abstinence.
8 State reasons why adolescents do not abstain from sex.
9 State three (3) reasons why adolescents should abstain from sex.
10. Give four (4) skills and behaviours that promote abstinence.

Chapter 14 Drug abuse

Introduction

A drug is a chemical substance that is used to heal a disease or prevent the body from being attacked by a disease. Medical personnel are the ones that should prescribe drugs for people. There are different types of drugs depending on the types of diseases.

When drugs are used properly, it is said to be drug use, while using drugs without the doctor's advice or prescription is an abuse of drugs.

There are lots of social risk factors involved in drug abuse, such as inability of youths to resist peer pressure, desire to have a sense of belonging, taking drugs to gain confidence or boldness, and taking fake drugs.

In this chapter, you will understand what it means to abuse drugs, misuse drugs, and the social risks involved.

Objectives

By the end of this chapter, you will be able to:

1 define drugs and drug abuse;
2 state the method of drug abuse;
3 list common ways of misusing drugs; and
4 mention the social risk factors in drug abuse.

Meaning of drugs

Drugs are natural or synthetic substances which affect the body's functioning and structure.

Drugs can be used for medical or non-medical purposes.

Drugs used for medical purposes are prescribed by doctors and used to cure or prevent different diseases. The non-medical use of drugs is when it is taken for pleasure or illegally (without being prescribed by a doctor).

Drug abuse

Drug abuse is the illegal use of drugs without the doctor's prescription. Drug abuse could also be the use of drugs for a purpose other than that for which it is prescribed by the doctor. Taking a drug that was prescribed for a friend is drug abuse. This is very dangerous because taking drugs not prescribed for you affects the body and its organs thereby causing damage to the organs of the body.

Drug abuse is a serious health problem that affects a lot of families and communities. Examples of drugs that can be abused are cocaine, heroin, and marijuana.

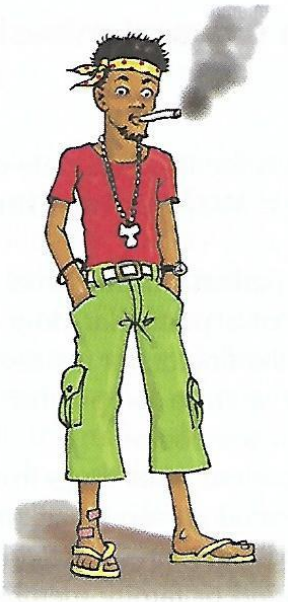


Fig. 14.1 A drug addict

Methods of drug use

There are different methods of using drugs, either prescribed or not prescribed. Drugs are taken into the body through the following ways:

1 **Swallowing**: Swallowing or ingesting drugs is the most common method of drug use. The individual takes the drug by mouth. This method is the safest method of taking drugs because it allows the body time to absorb the drugs. Drugs that are taken by swallowing are tablets, capsules, caplets or liquid.

2 **Smoking**: This method gets the drug into the body's system a bit faster than swallowing the drug because the drug goes into the lungs and then to the bloodstream. The most common drugs that are smoked are marijuana, heroin, and opium.

Individuals who smoke drugs are at risk of cancer of the mouth, throat or lungs, heart disease and cardiac arrest or other pulmonary disorders.

3 **Sniffing**: Sniffing or inhalation is the process of taking drugs through the respiratory tract. Drugs enter the body through the nasal mucus membrane and the stomach. Individuals who sniff drugs experience a sensation within few minutes after sniffing the drugs. There are some complications from inhaling drugs such as deterioration of the lining of the nasal cavity. Sharing of straws and other items for sniffing can lead to hepatitis or HIV.

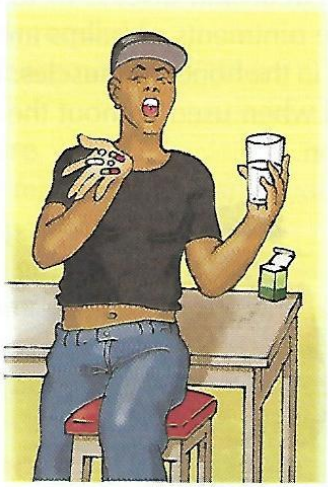


Fig. 14.2 Someone taking drugs

Fig. 14.3 A smoker and a hard drug addict

4 **Injecting**: This allows drugs to be introduced to the body directly into the bloodstream through the blood vessels. Drugs in liquid form can be introduced through injection, while drugs in powdered form can be mixed with water before injecting them into the body. This is the fastest method of using drugs.

5 **Absorption through the skin**: Some drugs in the form of creams are rubbed on the skin to treat skin disease or to tone the skin. Some ointments or balms are used to cure pains in the bones or muscles. They can be abused when used without the doctor's prescription.

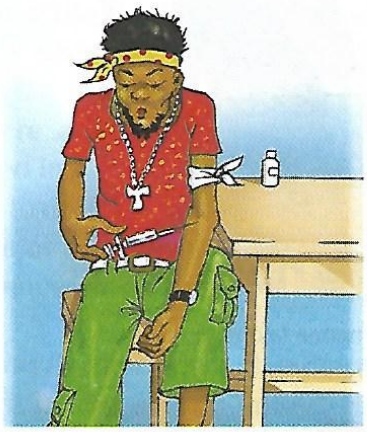


Fig. 14.4 A young man injecting himself with hard drugs

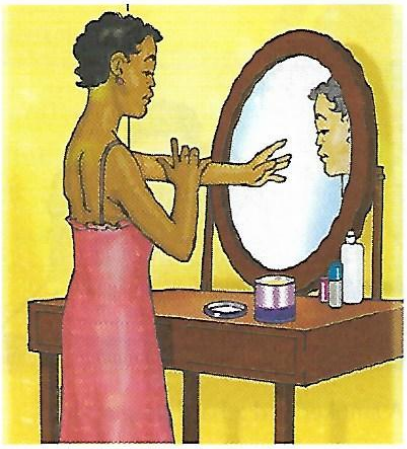


Fig 14.5 A woman rubbing cream on her arm

Common ways of misusing drugs

Drug misuse is the inappropriate or wrong use of drugs. Ways of misusing drugs include:

1 When a patient misinterprets the prescription of a particular drug or some drugs by the doctor, for instance, taking drugs at a time or period not stipulated by the doctor.
2 When a patient takes drugs from an inexperienced person (quack doctor).
3 When a patient shares a prescribed drug with a friend or family member whom the drug was not prescribed for.
4 When a patient takes a prescribed drug for another purpose, for example when a person takes a drug that is meant for headache to treat pains in the bones.
5 Taking drugs to induce sleep without seeking the doctor's advice.
6 Taking drugs to gain confidence or boldness to commit crime such as suicide, rape, assault, and hurting someone or oneself.
7 Taking drugs to attain sexual satisfaction.
8 Taking drugs such as cigarettes or alcohol for leisure or relaxation.
9 Taking drugs that are not registered by NAFDAC or taking fake or expired drugs.
10 Prescribing drugs by oneself, that is, when individuals prescribe drugs for themselves thinking that they have experienced such sickness before.

Social risk factors in drug abuse

Social risk factors in drug abuse are the many ways in which drug abuse is dangerous to an individual or society as a whole. Some of these risk factors include:

1 Exposure of children to much money. Children from rich homes are often exposed to a lot of money; so they get spoilt. This makes them want to associate with drug addicts because they have money to buy drugs at any price.
2 Youths with poor parental upbringing and moral value can easily be led to drug abuse.
3 Peer pressure or inability to resist pressure from friends. Some friends often use drugs as part of their social events; so every member of the group will have no choice but to take drugs.
4 Children from homes where the parents take drugs find nothing wrong in using drugs. They see this act as normal.
5 Some individuals involved in sports take drugs such as steroids to enhance their performance. This is why athletes or footballers are always tested before each event.
6 Some people take drugs in order to feel relief from pain, problems, fear, or disappointment.
7 Some children take drugs in order to have a sense of belonging, feel high, or on top.
8 Taking of drugs out of curiosity. Some individuals just want to know how taking drugs feels. This involves trying to experiment with what happens when someone takes drugs. This can later lead to addiction.
9 Broken home or poor background leads some children into taking drugs. Such children run away from home and get involved in drugs.
10 Since there is no law against taking alcohol or cigarette smoking, some youths take these as a form of entertainment in parties.

Activity 14.1 Identifying drugs usually abused

Materials required

Your science notebook, biro

Procedure

1 Your teacher will arrange you into two groups.
2 Each group should list drugs that are commonly abused in our society.
3 Each group should act a short drama on drug abuse.

Summary

1 A drug is a substance that affects the body's function, while drug abuse is the use of drugs without the prescription of medical practitioners.
2 Drugs are taken into the body by swallowing, smoking, sniffing, injecting and absorption through the skin.
3 Common ways of misusing drugs include misinterpretation of prescription by the doctor, taking of fake drugs, taking drugs for a purpose for which it was not prescribed, and taking drugs to induce sleep.
4 Social risk factors in drug abuse are the many ways in which drug abuse is dangerous to an individual and society at large.

Revision question 14

1 A drug is a chemical substance which affects body functions. It can be used medically or _____.
   A non-medically
   B physically
   C chemically
   D emotionally
   E privately

2 Drug abuse is the illegal use of drugs without _____.
   A buying it from a pharmacy/drugstore
   B the doctor's prescription
   C swallowing
   D all of the above
   E any of the above

3 Methods of using drugs include all of the following except _____.
   A swallowing
   B smoking
   C sniffing
   D injecting
   E handling

4 Common ways of misusing drugs are the following except _____.
   A taking drugs from fake doctors
   B misinterpretation of drugs
   C taking drugs to gain confidence
   D taking drugs for leisure
   E taking drugs that are prescribed by a medical doctor.

5 Which of the following is a social risk in drug abuse?
   A Peer pressure influence which makes one becomes a thug.
   B Being a responsible person in society.
   C Regular attendance at school.
   D Punctuality at work.
   E Being diligent and hard-working.

6 a) What is drug?
   b) Define drug abuse?

7 State five (5) ways of abusing drugs.

8 Mention five (5) common ways of misusing drugs.

9 List four (4) social risk factors in drug abuse.

10 List five (5) drugs that are commonly abused.

Chapter 15 Chemicals

Introduction

The number of chemicals in the world is so high that nobody can specifically tell it. In nature, chemicals exist in the soil, in rocks, in water, in the air, in plants and in animals. If you take a cup of seawater, pour the water into a beaker, and heat the water to dryness, you will see at the bottom of the beaker, a white residue, which is mainly common salt. When this material is purified, it becomes clean, white, edible common salt like the one you buy from the market. Common salt is also obtained from a kind of rock, which is rich in common salt. When the rock is crushed, water is added, and the solution of salt is filtered out and dried, common salt is obtained. Common salt is a chemical. Other chemicals such as chlorine (used for bleaching fabrics or in swimming pools) are manufactured.

There are many kinds of chemicals in nature and in man-made products. Chemicals are very useful to human beings. In this chapter, you will learn how chemicals are classified according to their intended uses and their hazardous (harmful or dangerous) nature. You will also learn safety measures that are applied when using chemicals. Chemicals are all around you, in the food you eat and the clothes you wear. You, in fact, are made up of a wide variety of chemicals.

Objectives

By the end of this chapter, you will be able to:

1 define chemicals;
2 classify chemicals based on their intended uses;
3 classify chemicals on the basis of their hazardous nature; and
4 state safety measures applied in using chemicals.

What chemicals are

A **chemical substance** is a form of matter that has a constant chemical composition, and characteristic properties. It cannot be separated into components by physical separation methods. A common example of a chemical substance is pure water; it has the same properties and the same ratio of hydrogen to oxygen, whether it is isolated from a river or made in a laboratory.

Chemical substance exists as solid, liquid, gas or plasma and may change between these phases of matter with changes in temperature or pressure.

A chemical can also be described as a substance produced by or used in a chemical process. In the next two activities, you will examine a physical process and a chemical process.

Activity 15.1 Changing water into steam

Materials required

250 cm^3 beakers, clean water, stoves, plates, your science notebook, biro

Procedure

1. Your teacher will divide the students in your class into groups, such that each group will have about five students.
2. Each group will put 150 cm^3 of clean water into a clean beaker.
3. Place the beaker of water on the stove and heat it until it begins to boil.
4. Hold a cold plate face up, about 25 cm above the beaker, so that the steam from the beaker touches the plate. (Take care to avoid the scalding of your hand by steam).
5. Observe carefully what happens to the steam and record your observations.

Result

You might have observed that when the water in the beaker was heated, it changed into water vapour. When the water vapour began to cool, it changed into steam. Steam contains visible droplets of water, hence the path of the steam is visible. Droplets of water in steam condense on the cold plate.

From this activity, you have learnt that when water is heated, the water (a liquid) changes into water vapour (a gas). When water vapour is cooled, it changes back into water (a liquid). No new substance is formed.

From experience, you know that when water is put into a beaker, and the beaker is placed in a freezer, the water (a liquid) changes into ice (a solid). When the beaker containing ice is brought out of the freezer and kept on a table in a room, the ice (solid) changes to water (a liquid). Again, there is no new substance formed.

As you learnt earlier, anything which occupies space and has weight is called matter. Matter exists in three states, namely, **solid**, **liquid** and **gas**. A change of state, such as liquid to gas and back to liquid, or liquid to solid and back to liquid is called a **physical change**. In a physical change, no new substance is formed.

Physical and chemical changes

A **chemical change** is a change which occurs when substances combine to form a new substance or decomposes to produce two or more different substances, while a **physical change** occurs when objects or substances undergo a change that does not affect their chemical composition.

One example of a physical change is when water freezes into ice. While ice may have different physical properties, it is still just water. Another example is when you dissolve salt in a cup of water. While the salt may appear to have disappear into the water, you still have water and salt – no substance changed into a completely new substance.

Here is one example of a chemical reaction.

Iron + oxygen → Iron oxide
(reactants) (product)

Iron oxide is also known as **rust**, and it cannot become iron or oxygen again. It is a completely new substance. In the equation, the substances on the left-hand side of the arrow are considered **reactants** (the substances that participate in a chemical reaction). The substance on the right-hand side of the arrow is considered a **product** (a substance that results from a chemical

reaction).

It is important to note from this example that no material is *lost* in the reaction. On one side of the equation, you have iron and oxygen; on the other, you still have iron and oxygen (now just combined into one chemical).

In that sense, this example illustrates what is known as the **law of conservation of mass**. The law states that the products of a chemical reaction have the same mass as the reactants. In other words, while things are re-arranged, nothing is created or destroyed.

Here are some ways to tell if a chemical change is occurring:

1 You might notice bubbling or a change in odour, indicating the production of a gas. Such is the case when baking soda is mixed with vinegar.
2 When two clear solutions are mixed together and the resulting mixture is cloudy (due to the presence of solid substance now in the solution).
3 A change of colour (like in our rust example).
4 A change in temperature or if light is produced such as with fire.

While any of the above may be evidence of a chemical change, physical change can have some of these effects. One way to determine the difference between the two is to think whether the new substance could be physically changed back into its original parts; in other words, if the evolved matter could go back to how it originally was.

Some examples of physical change

1 Melting of solid to liquid, e.g. ice cube to water.
2 Vapourisation of liquid to gas, e.g. water to steam.
3 Freezing of liquid to solid, e.g. water to ice cube.
4 Dissolution of table salt in water.
5 Melting of candle wax.
6 Breaking of a bottle.

Some examples of chemical change

1 Burning of a substance.
2 Rusting of iron.
3 Dissolving metal and limestone in acid.
4 The fermentation process.
5 Decay of substances.

Table 15.1 Differences between physical and chemical changes

	Physical change	Chemical change
1	A physical change is reversible, e.g. the freezing of water can be reversed.	A chemical change is irreversible; the burning of wood cannot be reversed.
2	A physical change is a change in which no new substance is formed e.g. freezing water into ice just results in water molecules which are 'stuck' together – it's still water.	A chemical change results in the formation of one or more new substances, e.g. burning of wood results in ash, carbon (IV) oxide etc. These are all new substances which were not there when you started.
3	No change in mass of substance.	Changes in mass of substance occurs.

In summary, there are really only two criteria for knowing whether change is chemical or physical:

1 After the change, does it look the same?
2 Can you change it back?

If the answers are yes, the change is physical every time, but if the answers are no, the change is chemical.

Causes of changes in matter

Changes in matter do not just occur. They are usually caused by changes in the conditions around the matter. The major causes of changes in the states of matter are temperature (heat) and environmental condition, such as light intensity, amount of air, moisture content and pressure. For example, water will remain in its liquid state if there is no change in the temperature of its environment.

Activity 15.2 Demonstration of the burning of magnesium ribbon

Materials required

A piece of magnesium ribbon, a crucible, a pair of tongs, a stove, your science notebook, biro

Procedure

1 Your teacher will cut out a piece of magnesium ribbon. Observe the colour of the magnesium ribbon.
2 Your teacher will use a pair of tongs to hold the magnesium ribbon, and then light the ribbon from the flame of the stove.
3 When the magnesium ribbon begins to burn, your teacher will place the burning ribbon in a clean crucible.
4 When the magnesium ribbon has finished burning, your teacher will arrange for the students to come round the laboratory table and observe the material left in the crucible.
5 Compare the colour and nature of the magnesium ribbon with the colour and nature of the product after burning.
6 Record your observations in your science notebook.

Result

You may have observed that the magnesium ribbon had a different colour from that of the product after burning. Burning changed magnesium metal into magnesium oxide. Magnesium oxide is different in colour, composition and properties from magnesium. A process in which a new substance is formed is called a chemical process. Both magnesium and magnesium oxide are chemicals.

Classification of chemicals

Classification means sorting things into groups based on certain characteristics, so that things with similar characteristics are placed in the same group. For instance, you can classify human beings into males and females, on the basis of sex. You can also classify human beings into babies, children, adolescents, and adults on the basis of age. Human beings may also be classified into White (Europeans and Americans), Black (Africans) or Yellow (Asians) on the basis of skin colour. The user of a classification chooses the basis that suits his or her purpose best.

Chemicals may be classified in different

ways. In this chapter, chemicals will be classified on the basis of:

a) intended use; and
b) hazardous nature.

Classification of chemicals on the basis of intended use (pharmaceutical/cosmetic chemicals)

Pharmaceutical chemicals are those used in the treatment of diseases and maintenance of good health. Cosmetic chemicals such as face powder or skin lotions are designed to improve the beauty of the body.

Manufacturers of consumer products are required by law to state on the package, the composition of the product. For this reason, on every package of a pharmaceutical product or a cosmetic product, you will see the components of the product. You will also see the directions for use and what you should do if you have an unhealthy reaction to the use of the product. It is good to adhere to the manufacturer's guidelines. Examples of pharmaceutical chemicals are shown in Table 15.2, while examples of cosmetic chemicals are shown in Table 15.3.

Table 15.2 Pharmaceutical chemicals

	Brand name	Scientific name	Use
1	Chloroquine	Chloroquine	Treatment of malaria.
2	Paracetamol	Paracetamol	Treatment of pain, ache and feverish conditions.
3	Milk of magnesia	Magnesium hydroxide	Treatment of constipation.
4	Epsom salts	Magnesium sulphate	Mild laxative.
5	Iodine	Iodine	For first aid in case of injury.
6	Ferrous sulphate	Ferrous sulphate	For treatment of anaemia.
7	Norvasc	Amlodipine besylate	Treatment of high blood pressure.
8	Penicillin	Penicillin	For treatment of pneumonia.
9	Ampiclox	Penicillin and ampicillin	For treatment of respiratory tract diseases.
10	Alcohol	Ethanol	An antiseptic.

Table 15.3 Cosmetic chemicals

	Brand name	Use
1	Talcum powder	Face powder.
2	Vaseline petroleum jelly	Beautifies and keeps skin healthy.

Nuclear chemicals

In our generation, you can hear of nuclear power and atomic energy. You hear fearful things about the consequences of a nuclear war. What do these things mean?

In science, what is known today may not be the product of an overnight study. There is a saying that *Rome was not built in a day*. This applies to many areas of human activity including science. Scientific knowledge grows gradually by the addition of new knowledge to old knowledge. In order to understand nuclear chemicals, the story of the atom will be briefly reviewed. It is an interesting example of the growth of scientific knowledge.

As you know, matter is anything that has weight and occupies space. You also learnt that matter may be classified into metals and non-metals and in some other ways, depending on the purpose of classification. Long ago, the question arose: What is matter made of? Or, what is the structure of matter?

The Greek philosophers were the earliest to record an opinion on this matter. About 400 BC, the ancient Greek philosopher, Democritus was the first to express the view that matter was made up of minute indivisible particles. He was followed in this line of thought 350 years later (about 50 BC) by a Roman thinker. Luretius. Then followed a succession of European and Arabian thinkers on the same matter. The idea was that if you took a piece of, say, gold, and cut it up into pieces, and cut the pieces into small pieces, and cut the small pieces into yet smaller pieces, and those pieces into smaller pieces and so on and on, a time would ultimately come when you would not be able to cut the pieces into smaller pieces again. The smallest pieces would be incapable of being divided any further. These smallest pieces would be the smallest particles which could ever be obtained. The Greeks gave these smallest possible particles the name *atoms*, which means *indivisible*.

In 1810, an English man, John Dalton stated what came to be known as Dalton's Atomic Theory, in which he made precise statements about atoms (atomic theory), which could be tested. His statements were:

1 Matter is made up of small, indivisible particles called atoms.
2 Atoms are indestructible and they cannot be created.
3 The atoms of a particular element are all exactly alike in every way and are different from the atoms of all other elements.
4 Chemical combination takes place between small whole numbers of atoms.

The above stated Dalton's atomic theory is very important. Although it has been amended in some respects, many regard it as the foundation of modern chemistry. Following the statement of this theory, scientists began to investigate the structure of the atom.

In 1911, Rutherford, after many studies, proposed the idea that the structure of the atom was somewhat like that of the solar system. In the solar system, the sun is in the middle, while the planets rotate round the sun, each in its own orbit. In the same way,

Rutherford proposed that in the centre of the atom is a small **nucleus**, which contain a number of positively charged particles (called **protons**). Very small negatively charged particles, called **electrons**, rotate round the nucleus, at a distance away from it, in different orbits.

Most of the mass of the atom is in the nucleus because the protons and neutrons are bigger and heavier than the electrons. The number of positively charged protons in an atom is equal to the number of negatively charged electrons in that atom. For this reason, an atom, as a whole, is electrically neutral.

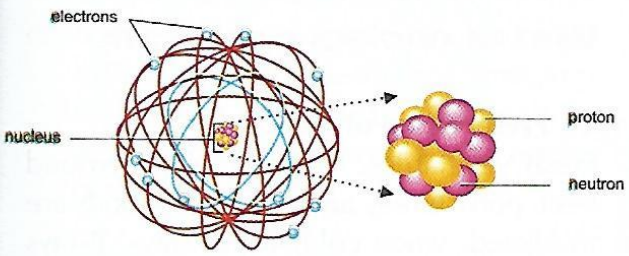


Fig. 15.1 Rutherford's model of an atom

As scientists learnt more and more about the atom, it was found that in a chemical reaction between two elements, the electrons are the parts of the atom involved. These reactions are of two kinds:

a) In one kind of reaction, one atom donates one or more electrons to the other atom.

b) In the other kind of reaction, one atom shares one or more electrons with the other atom. In these two kinds of reactions, the nuclei of the atoms are not involved.

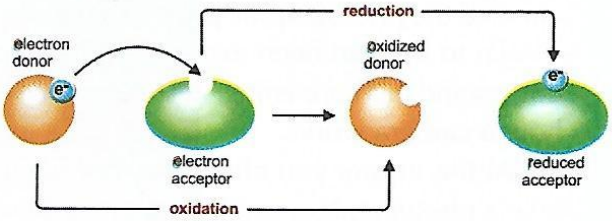


Fig. 15.2 Reaction involving transfer of electrons

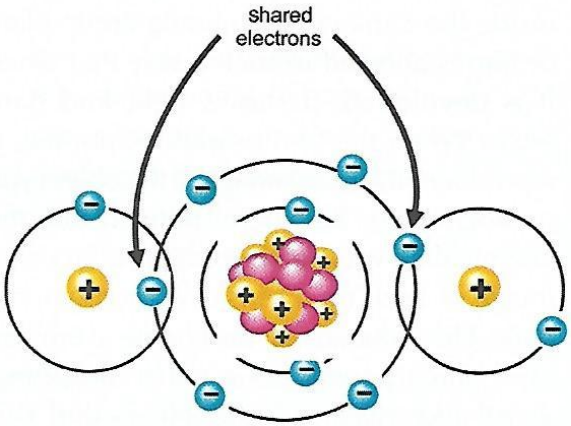


Fig. 15.3 Reaction involving sharing of electrons

Nature of nuclear reactions

In 1896, Henri Becquerel discovered that a certain chemical, when placed close to a photographic plate, which had been wrapped to prevent light from reaching it, affected the photographic plate in a manner similar to if it had been exposed to light. To understand this happening, we need to know how a camera works.

At the instant you click your camera to take a photograph, a small hole in the front part of your camera opens for a second and then closes. In the short time the hole is open, light rays travel from the object you are photographing, through the hole, to a sensitive photographic plate or film inside the camera. The photographic plate or film is affected in such a way that when it is developed, it shows light and dark areas. When the film or plate is printed, it reproduces the exact image of the object you photographed. Becquerel noticed that the chemical he was dealing with produced an image of itself on a sensitive photographic plate. He deduced that the chemical emitted rays which penetrated a paper wrapping, acted like rays of light. He called this happening radioactivity.

Subsequently, Rutherford found that the rays emitted by a radioactive substance were of three kinds and were named after the first three letters of the Greek alphabet: alpha (α), beta (β) and gamma (γ).

1 Alpha rays were positively charged helium particles.
2 Beta rays were negatively charged electrons.
3 Gamma rays were high energy electromagnetic waves, similar to light, and without charge.

Radioactivity is a natural, spontaneous (happening on its own without external cause) nuclear reaction, in which the nuclei of atoms of a chemical break up, giving out alpha, beta and gamma radiations and energy. A nuclear reaction in which nuclei break up is called a nuclear fission reaction. Another kind of nuclear reaction is called nuclear fusion (joining together). When some chemicals are bombarded with β particles (electrons), the nuclei absorb the electrons, forming larger unstable nuclei which then break up. X-rays are produced when a metal is bombarded with β rays (electrons). Nuclear reactions include spontaneous nuclear fission, called radioactivity, and artificially induced nuclear fusion.

Uses of nuclear chemicals

1 **Preservation of food**

Fresh vegetables, fruits, chicken, ground beef, pork, turkey and other fresh foods are irradiated, when cold, with X-rays, β-rays and γ rays. The irradiation helps to keep them fresh for a long time.

2 **Diagnosis of diseases**

A very important part of medical practice is to find out what is wrong. This search for what is causing a sickness or what amount of damage has occurred is *diagnosis*. It is normally done in a diagnostic laboratory.

a) X-ray photographs are used to determine if there are broken bones, if they have been set right, or how much healing has taken place.

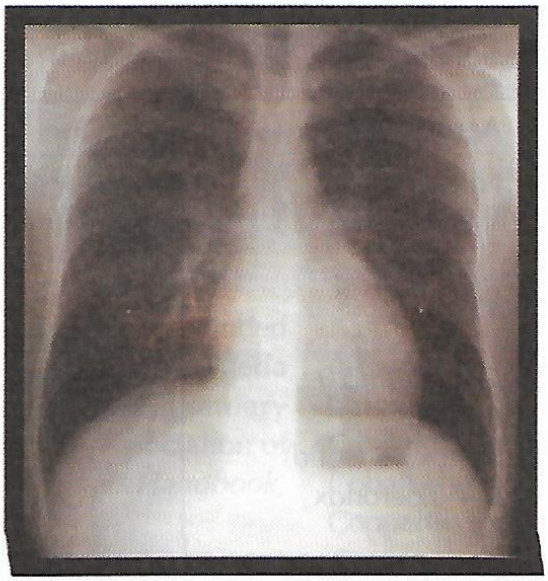


Fig 15.4 X-ray photograph

b) X-rays are used to find out if one has ulcer in the stomach or alimentary canal.
c) A diagnostic piece of equipment called MRI (Magnetic Resonance Imaging) makes use of nuclear chemicals to produce clear pictures of internal organs of the body.

3 **Treatment of some diseases**
   a) Radioactive iodine is used for treating cancer of the thyroid gland.
   b) Radiations are used to destroy unhealthy tissues such as cancerous cells, while preserving healthy tissues.
4 Radioactive rays are used in genetic engineering.
5 Nuclear energy is used to provide electricity.
6 Nuclear reactions are used for military purposes in the making of nuclear bombs.
7 Radiations (gamma rays from a cobalt-60 source) are used to sterilise many heat sensitive medical products e.g. cotton wool, syringes, burn dressings, surgical gloves, plastic and rubber sheets.
8 It can also be used in dating analysis e.g. determining the age of rocks and other materials that are of interest to geologists and anthropologists.

Agrochemicals

Agrochemicals are chemicals used in agriculture. They include the following:
1 Chemical fertilisers, which provide crops with essential nutrients for healthy growth and increased yield.
2 Insecticides which kill insects such as locusts, aphids, yam beetles, and caterpillars that eat leaves, stems or fruits, or suck the juice of crop plants.
3 Fungicides which kill fungi that attack and reduce the yield of crop plants.
4 Nematicides which kill nematodes that eat the roots of crop plants.
5 Herbicides which kill weeds.

Examples of the above are shown in Table 15.4.

Table 15.4 Agrochemicals and their uses

	Broad name	Agrochemical	Use
1	Mixed chemical fertiliser	NPK 20:10:10	For improving soil fertility and increasing crop yield.
2	Fertiliser	Urea	For promoting growth of vegetables.
3	Insecticide	Gammalin 20 (liquid)	For killing insects on crops.
4	Insecticide	Vertox 85 (solid)	For killing insects on crops.
5	Fungicide	0.4% peronox	For killing fungi such as the black pod disease of cocoa.
6	Fungicide	0.1% Bordeaux mixture	For killing fungi on crops such as rice or maize.
7	Herbicide	Round up	For killing weeds in farms.
8	Herbicide	Force up	For killing weeds in farms.
9	Herbicide	Cilysate	For killing weeds in farms.
10	Nematicide	Nemagon	For killing nematodes that attack crops.

Industrial chemicals

Industrial chemicals are those used in industries for the production of goods. They include a wide range of chemicals intended for many uses. Some industrial chemicals and their uses are shown in Table 15.5.

Table 15.5 Industrial chemicals and their uses

Industrial chemical	Use
1 Zinc sulphide	For the manufacture of paints.
2 Palm oil	For the manufacture of soap.
3 Lead	For the manufacture of motor vehicle batteries.
4 Sulphuric acid	For the manufacture of motor vehicle batteries.
5 Aluminium	For the making of roofing sheets, electric cables, pots, etc.
6 Hydrocarbons	For making plastics, polyester for textile fabrics, etc.
7 Steel	For making bodies of some vehicles.
8 Wax	For making candles.
9 Bitumen	For road surfacing.
10 Starch	For making alcohol, glue, etc.

Laboratory chemicals

Laboratory chemicals are those normally used in science laboratories for the teaching

and learning of science. The chemicals are used for many kinds of activities. A list of laboratory chemicals recommended by the Science Teachers Association of Nigeria (STAN) for teaching Senior Secondary Chemistry is shown in Table 15.6.

Table 15.6 List of chemicals recommended by Science Teachers Association of Nigeria (STAN) for teaching Senior Secondary Chemistry (Science Teachers Association of Nigeria, 1988, *Science Teachers Handbook,* Appendix Az, pp 99-100)

Chemicals

Section I

Alum of aluminium
Tetraoxosulphate(VI)
Benzene
Calcium chloride
Calcium oxide
Calcium trioxocarbonate(IV)
Candle
Copper tetraoxosulphate(VI)
Ethanol
Hydrochloric acid
Hydrogen peroxide (optional)
Iron dust
Kerosene
Lead (IV) oxide
Manganese(IV) oxide
Magnesium ribbons
Potassium tetraoxomanganate(VI)
Potassium trioxochlorate(V)
Potassium trioxonitrate(V)
Pyrogallol crystals
Red lead (lead(II) lead(IV) oxide)
Soap solution
Sodium hydrogen trioxonitrate
Sodium or potassium or both
Sodium peroxide
Sodium thiosulphate
Sodium trioxonitrate(V)
Starch
Sulphur
Tetraoxosulphate(VI) acid
Yellow and red phosphorus

Section II

Aluminium
Ammonium chloride
Calcium
Calcium trioxonitrate
Cobalt chloride
Copper(II) oxide
Copper(II) tetraoxosulphate(VI)
Copper turnings
Ethanedioic acid (oxalic)
Ethanoic acid
Iron(II) chloride
Iron (II) tetraoxosulphate(VI)
Iron(II) oxide
Lead trioxonitrate(V)
Litmus paper
Magnesium chloride
Methanoic acid
Potassium hydroxide
Sodium chloride
Sodium hydroxide
Sodium tetraoxosulphate(VI)
Zinc
Zinc chloride
Zinc tetraoxosulphate(VI)

Section III

Aluminium oxide
Ammonia solution
Barium trioxonitrate (V)
Calcium carbide
Copper(II) trioxocarbonate(V)
Diastase
Iron(II) tetraoxosulphate(VI)
Lead ethanoate
Lead(II) oxide

Animal charcoal
Barium chloride
Methylated spirit (optional)
Silver trioxonitrate(V)
Trioxonitrate(V) acid
Turpentine oil
Wood charcoal
Yeast

Section IV
Ammonium ethanedioate
Ammonium tetraoxosulphate(VI)
Ammonium trioxocarbonate(IV)
Ammonium trioxonitrate(V)
Bleaching powder
Copper(I) chloride
Copper(II) chloride
Copper(I) oxide
Dutch metal
Iodine crystals
Iodine solution
Lead chloride
Lead metal
Lead(II) oxide
Litmus solution
Mercury
Mercury(II) oxide
Methyl orange
Phenolphthalein
Platinised asbestos
Potassium bromide
Potassium heptaoxodichromate(VI)
Potassium hexacynoferrate(II)
Potassium hexacynoferrate(III)
Potassium iodide
Potassium tetraoxochromate(VI)
Soda lime
Sodium sulphate
Sodium trioxonitrate(V)
Trichloromethane
Zinc trioxocarbonate(V)

Section V
Calcium thiosulphate
Copper(I) trioxonitrate(V)
Potassium
Potassium iodide
Potassium perchlorate
Red lead
Sodium ethanedioate
Sodium citrate
Sodium dioxonitrate(III)
Sodium ethanedioate
Sodium ethanoate
Sodium hydrogen trioxocarbonate(IV)
Sodium hypochloride
Sodium methanoate
Sodium sulphide
Sodium trioxocarbonate(IV) decahydrate
Sodium trioxochlorate(V)
Sodium trioxosulphate(IV)

Classification of chemicals based on hazardous nature

Hazard means danger, risk or possibility of an accident. Hazardous chemicals are, therefore, those that are dangerous, risky or have a chance of causing harm to users. The hazard posed by a chemical may be physical hazards (as in the case of flammable chemicals), health hazards (as in the case of poisonous chemicals and carcinogenic chemicals which cause cancer), or environmental hazards (such as Gammalin 20 which kills fish in water). A toxic chemical is one that is harmful, poisonous or deadly. One way of classifying chemicals is whether they are very hazardous and toxic, or moderately hazardous and toxic or non-hazardous and non-toxic. Examples are given in Tables 15.7, and 15.8.

Table 15.7 Very hazardous or very toxic chemicals

S/N	Hazardous chemical	Hazardous concentration	Type of hazard or harm
1	Mercury vapour	Less than 0.1 ppm	Causes damage to skin, poisonous to all tissues.
2	Bromine, chlorine, iodine	0.1 to 2.0 ppm	Causes damage to skin, eyes, respiratory system.
3	Phenol	2.0 to 20 ppm	Caustic, absorbed through the skin; attacks the nervous system.
4	Hydrogen sulphide	2.0 to 20 ppm	Paralyses the sense of smell so that the chemical can no longer be detected by smell.
5	Ammonia	20 to 100 ppm	Attacks the mucous membrane such as in the eyes.
6	Asbestos particles		If inhaled, causes fibrosis of lungs and/or tumours.
7	Acids, e.g. Trioxonitrate(V)	Concentrated acid	Corrosive to the flesh, deadly if swallowed.
8	Sodium and potassium hydroxide, .880 ammonia		Caustic, corrosive to the skin.
9	Poisonous chemicals e.g. Arsenic		Some cause cancer.
10	Radioactive chemicals		Emit radiations which damage the flesh and organs.
11	Carbon (II) oxide gas		Poisonous, causes death if inhaled in large amounts.

Table 15.8 Moderately hazardous or toxic chemicals

	Chemical	Effects
1	Laughing gas (N_2O)	Makes one laugh, otherwise causes no serious harm in small amounts.
2	Soap solution	Not poisonous in small amounts left over on plates that are not well-rinsed.
3	Methylated spirit	Though inflammable, does not cause harm in small amounts; used to light spirit lamps.
4	Ethanol (alcohol)	Not harmful in small amounts, but harmful to the body in large amounts if taken habitually.

Table 15.9 Non-hazardous or toxic chemicals

	Chemical	Harmful effect
1	Sugar	None.
2	Water	None.
3	Common salt	None (if taken in moderation).
4	Vegetable oils	None.

Safety measures when using chemicals

Students all over the world have studied science for hundreds of years and a greater number of students will do so in the future. Therefore, no one need be afraid of studying science because some chemicals are hazardous or toxic. What is necessary is that every student should be aware of safety measures required in the storage and use of chemicals and take the safety measures. These safety measures, as summarised below, mean you should:

1 adhere to the manufacturer's safety instructions;
2 follow safety guidelines for chemical storage and handling;
3 observe and adhere to safety signs and instructions on chemical packages;
4 ensure proper labelling and storage of chemicals; and
5 obey laboratory rules which should be displayed at the entrance to every science laboratory.

Safety guidelines for storage of chemicals

1 Sodium or phosphorus should be stored in glass containers and the glass containers should then be stored in metal containers.
2 Reagent bottles should be shelved where the bottles cannot be easily knocked down.
3 Chemicals that can react with each other should not be stored close together.
4 Sodium should be stored in kerosene.
5 Phosphorus should be stored in water.
6 Poisonous chemicals should be locked up in cupboards.
7 Big bottles of acids and other hazardous chemicals should be stored standing on the floor.
8 Empty containers of sodium, potassium, calcium and phosphorus should be buried.
9 All bottles of chemicals must be properly labelled.

General safety rules in a laboratory

(Quoted from 'Education in Science' No 83, June 1979, by Abdullahi, Aliyu, 1982. *Science Teaching in Nigeria*.)

1 Do not go into the laboratory without permission.
2 Never run or rush about in the laboratory.
3 Never put anything into your mouth in the laboratory.
4 Never interfere with equipment or chemicals.
5 Never take anything from the laboratory without permission.
6 Never throw things in the laboratory.
7 Always wear eye protection (safety glasses or goggles) when told to do so by your teacher.
8 When heating things, use small amounts and watch very carefully what you are

doing all the time. Take care not to point test tubes at yourself or anybody else, and never look directly down a test tube.

9 All accidents and breakages, however minor, must be reported to your teacher at once.

10 If you get something in your mouth (by accident), spit it out at once, and wash your mouth with lots of water.

11 If you get burnt, or you have a splash on your skin, wash the affected part at once with lots of water.

12 Whilst waiting to get into a laboratory, line up quietly against the corridor wall, to allow equipment to be moved safely.

13 Do not eat sweets or chewing gum, pencils or fingers in the laboratory.

14 Never interfere with electrical fittings, with gas and water taps or with fire extinguishers.

15 Always have your teacher's permission for everything you do.

16 Make sure you know exactly what you are supposed to do; if in doubt, ask your teacher (again).

17 Wear your laboratory coat or overall when using chemicals, or handling living or non-living materials.

18 Always check that the label on the bottle is exactly the same as the material you want.

19 When not actually using a Bunsen burner, close the air hole so that the yellow flame can be seen.

20 Never hold or carry bottles by the neck, and do not put their stoppers down on the bench. Pour from the side away from the label.

21 Put rubbish into the correct waste bins provided and not into the sinks or on the floor.

22 Wash your hands after all practical work with chemicals, plants, animals or radioactive material.

23 Gloves made out of appropriate material must be worn. Prior to touching common items such as door knobs, the glove on the hand used to touch chemicals must be removed.

Summary

1 Chemicals are substances which take part in, or are produced in a chemical process.

2 Chemicals may be classified, on the basis of intended use, into pharmaceutical chemicals, nuclear chemicals, agro-chemicals, industrial chemicals and laboratory chemicals.

3 Chemicals may be classified on the basis of their hazardous nature into highly hazardous and toxic chemicals, moderately hazardous and toxic chemicals and non-hazardous and non-toxic chemicals.

4 When using chemicals, safety measures must be taken. These safety measures include:

a) adhering to the manufacturer's safety instructions;

b) following safety guidelines for chemical storage and handling;

c) observing and adhering to safety signs and instructions on chemical packages;

d) ensuring proper labelling and storage of chemicals; and

e) obeying laboratory safety rules.

Revision questions 15

1 A chemical process is one in which _____.
   A a gas is evolved.
   B a new substance is formed
   C a liquid changes to a solid
   D a solid changes to a liquid
   E none of the above happens
2 Which of the following is a class of chemicals?
   A Nuclear chemicals
   B Laboratory chemicals
   C Industrial chemicals
   D Non-hazardous and non-toxic chemicals
   E All of the above
3 A person who is spraying a farmland with a herbicide is advised to wear a _____.
   A watch
   B pair of slippers
   C nose mask
   D black belt
   E coloured shirt
4 A nuclear chemical is one in which _____.
   A nuclei of the atoms can take part in reactions
   B nuclei of atoms do not take part in reactions
   C alpha, beta and gamma rays are never produced
   D there are numerous nuclei
   E none of the above happens
5 The spontaneous splitting of the nuclei of atoms of a chemical, with the emission of alpha, beta and gamma rays is called _____.
6 When the label of a chemical is lost and there is no possible scientific process for identifying that chemical, the chemical in the bottle should be _____.
7 Define chemicals.
8 State four classes of chemicals.
9 List three (3) examples of each class of chemicals.
10 Mention four (4) safety measures in the use of chemicals.

You and energy

Chapter 16 Work, energy and power

Introduction

In Book 1, you learnt that energy is important in virtually all activities of man. You also learnt that energy cannot be created but can be transformed from one form to another. In this book, you will learn the different forms of energy in more detail.

Sometimes, the words power and energy are used interchangeably (to mean the same thing). Though they are not exactly the same, work, energy and power are related. In this chapter, their meanings will be given. The two forms of mechanical energy i.e. potential energy and kinetic energy, will be defined. Calculations involving work done and energy transfer when work is done will be explained.

Objectives

By the end of this chapter, you will be able to:

1 explain the meanings of work, energy and power;
2 explain the meanings of potential energy and kinetic energy;
3 apply the formula power = $\frac{\text{Work done}}{\text{time}}$; and
4 identify energy transfers that occur when work is done.

Meanings of work, energy and power

Work (W) is the product of force and the distance moved by the force. It is important to note that the force and the distance must be in the same direction. The unit of work is Joule (J). 1 Joule is the quantity of work done by a force of 1 Newton (N) moved through a distance of 1 metre (m). You already learnt in Book 1 that energy is the ability to do work. We can also say that when energy is expended (or used), work is done.

It is not surprising then that the unit of energy is also Joule. 1 Joule of energy is expended when 1 Newton of force moves through a distance of 1 metre. Thus, work and energy are like the two sides of the same coin.

Power (P) is the rate of change of doing work (W), or power is work done over time (T).

i.e. $P = \frac{W}{t} = \frac{F \times d}{t}$

where W = work done
t = time taken
F = force
d = distance covered

Power is also the rate of change of expending energy, or power is energy expended over time i.e. $P = \frac{E}{t}$

Since Force = mass × acceleration

$\therefore P = \frac{m \times a \times d}{t} = \frac{F \times d}{t} = \frac{W}{t}$

The unit of power is watt. 1 watt is the quantity of energy expended or work done in 1 second.

Example

What quantity of energy is expended (used) when a 60-watt electric bulb is turned on for 5 hours?

Solution

From the equation $P = \frac{E}{t}$

We can derive:

$E = Pt$

Converting time (t) of 5 hours to S.I. unit i.e. seconds gives:

t = 5 hours × 60 mins × 60 seconds

= 18 000 seconds

$\therefore$ E = 60 W × 18 000 seconds

= 1 080 000 J

= 1.08×10^6 J

= 1.08 Megawatt (MW)

Note: Mega = 10^6

Meanings of potential and kinetic energy

Mechanical energy is the energy used in moving something (a body) from one place to another. Mechanical energy is composed of potential energy and kinetic energy.

Potential energy means energy by virtue (because) of position. A coconut fruit on a coconut tree has a great potential energy by virtue of its location high above the ground.

Kinetic energy is the energy by virtue of the motion (movement) of a body. If the coconut fruit falls from its tree, its potential energy is converted (changed) to kinetic energy. Any body in motion (or anything moving) possesses kinetic energy. Examples of bodies in motion include a moving vehicle, a kicked ball, a stone that is thrown, a student walking or running to school, etc.

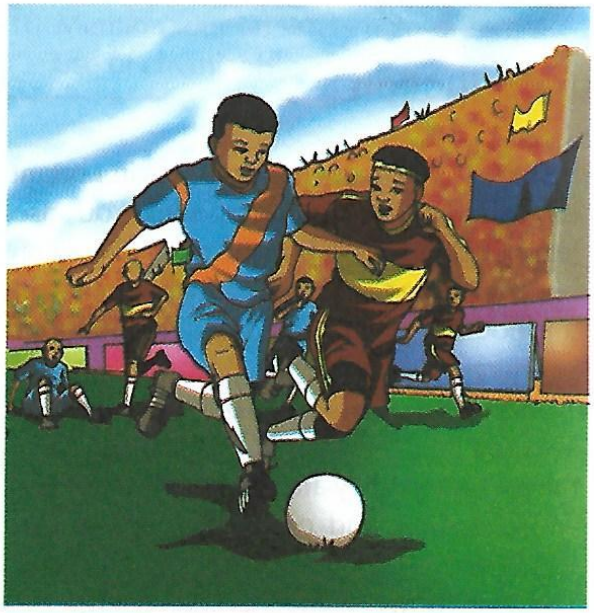


Fig. 16.1 Footballers playing ball

Calculations involving work done

The work (W) done by a force (F) is the product of force and distance (d) in the same direction of the force, i.e.

W = Fd

Example 1

A coconut fruit of mass 2 kg is 5 m high from the ground on a coconut tree. Calculate the work done as it falls down.

Solution

The force of the coconut is the gravitational force on it which is equal to its weight. (Remember weight is the product of mass and acceleration due to gravity (g).

$\therefore$ $F = mg$

The height is the distance

$\therefore$ $W = Fd = mgd$

Substituting $m = 2$ kg, $g = 10$ ms^{-2}

and $d = 5$ m

$W = (2 \text{ kg})(10 \text{ ms}^{-2})(5 \text{ m})$

$= 100$ J

Example 2

A force of 200 N is used to push a wheelbarrow whose handle makes angle 30° with the horizontal, over a distance of 50 m. Calculate the work done.

Solution

Fig. 16.2 A man pushing a wheelbarrow

Note that the force (F) and the distance (d) should be in the same direction. Since the direction of motion (movement) is the horizontal direction, the force which is applied, 30° to the horizontal, has to be converted. Work done is given by

$W = F \cos 30\, d$

Substituting $F = 200$ N and $d = 50$ m

$W = (200 \text{ N})(\cos 30)(50 \text{ m})$

$= (200 \text{ N})(0.866)(50 \text{ m})$

$= 8\,660$ J

Energy transfer when work is done

The energy expended when work is done in moving bodies is mechanical energy. There is a transfer of energy from potential energy to kinetic energy or from kinetic energy to potential energy, when work is done. For instance, the coconut fruit mentioned in Example 1 possesses potential energy. As it falls, the potential energy is changed to kinetic energy. If it is possible to fix the coconut fruit back on its tree after falling to the ground, the kinetic energy of the coconut fruit would be changed to potential energy. The simple pendulum shown in Fig. 16.3 also illustrates transfer of energy.

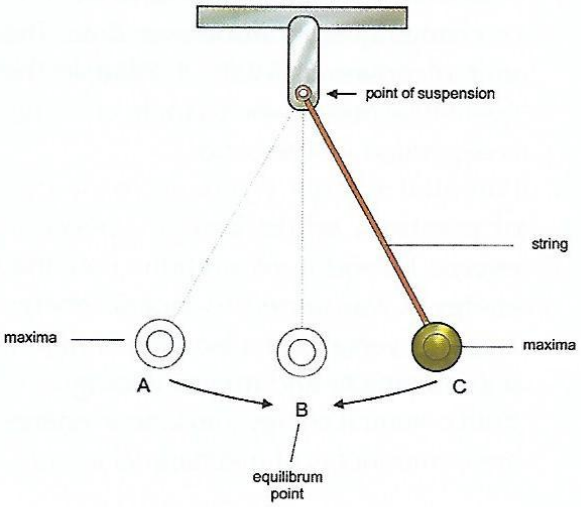


Fig. 16.3 An oscillating bob

The bob is at rest when it is at position B. The bob can be displaced to the left or right. When the bob is at maximum displacement to the left, i.e. at position A, it has its maximum potential energy. It also has a maximum potential energy when

displaced to position *C* towards the right. At the rest point *B*, the maximum kinetic energy is transferred to maximum potential energy. If it is displaced to *A* or *C* again, the maximum potential energy is transferred to maximum kinetic energy. Thus, there is a continuous transfer of mechanical energy from potential energy to kinetic energy as the bob oscillates.

Summary

1 Energy is the ability to do work, and work is done when energy is expended (used).
2 1 Joule is the quantity of energy expended or work done when 1 Newton (N) of force moves through a distance of 1 metre in the same direction.
3 Power is the rate of change of work done or change of work done over time. The unit of power is Watt. 1 Watt is the quantity of power when 1 Joule of energy is expended in 1 second.
4 Potential energy is energy by virtue of position, while kinetic energy is energy by virtue of motion. Potential energy is transferred to kinetic energy and vice versa as in a simple pendulum bob moving to and fro (oscillating).
5 Both potential energy and kinetic energy are components of mechanical energy.

Revision questions 16

1 The two main types of mechanical energy are kinetic and _____ energy.
A powerful
B electric
C potential
D carbohydrate
E general

2 The words _____ and energy are usually used interchangeably.
A strength
B power
C effort
D ability
E kinetic

3 The unit of measuring power is _____.
A Joule
B metre
C watt
D second
E kilogram

4 Mechanical energy is the energy used in _____ something.
A moving
B stopping
C directing
D carrying
E measuring

5 The formula for measuring power is _____.

6 Kinetic energy is energy by virtue of _____ while potential energy is energy by virtue of _____.

7 _____ energy could be transferred from kinetic to potential energy.

8 A student running is a form of _____ energy.

9 Calculate the quantity of electrical energy used by an electric bulb rated 60 watts used for 2 hours.

10 Calculate the power of a 100 kg man who jumps from a building 10 m high in 10 seconds, given that acceleration due to gravity is 10 ms^{-2}.

Chapter 17 Types of energy

Introduction

The molecules of a body are constantly in motion. Unfortunately we cannot see them with our naked eyes, except with the aid of a microscope. As a result of the molecules' movement, the whole body, though not moving, possesses kinetic energy. A cylinder of oxygen for instance may be kept in one place. It however possesses kinetic energy because its molecules are constantly in motion.

In this chapter, you will learn about the assumptions made in kinetic energy theory and how phenomena like boiling and evaporation can be explained using the theory. You will also learn about the factors that affect evaporation.

Objectives

By the end of this chapter, you will be able to:

1 state the different forms of energy;
2 state sources of energy;
3 explain the sun as a primary source of energy;
4 state the assumptions of the kinetic theory;
5 explain the molecular structure of solids, liquids and gases using the kinetic theory;
6 distinguish between boiling and evaporation using the kinetic theory; and
7 state the factors that affect evaporation.

The sun as a primary source of energy

Energy may be defined as the capacity to do work, and living organisms can be likened to machines in that they require energy to keep working and stay alive. The energy that powers most ecosystems is ultimately derived from the sun. Solar energy is captured by photoautotrophs (plants) in photosynthesis. These plants in turn form the food source or potential chemical energy supply for all other organisms in the ecosystem.

The energy from the sun drives the earth's weather systems and regulates earth surface climates. Temperature, wind speed and direction, evaporation and rainfall, all ultimately depend on the input of solar energy.

Forms of energy

1 *Mechanical energy*: This can be grouped into:
   a) Kinetic energy: Energy possessed by a body due to its motion.
   b) Potential energy: Energy possessed by a body due to its position.
2 *Chemical energy*: Energy that is contained in molecules.

3 *Electrical energy*: Energy from electric fields.
4 *Magnetic energy*: Energy from magnetic fields.
5 *Radiant energy*: Energy from electromagnetic radiation, including light.
6 *Nuclear energy*: Energy from binding nucleons to form the atomic nucleus.
7 *Gravitational energy*: Energy from gravitational fields.
8 *Ionisation energy*: Energy that is binding an electron to its atom or molecule.
9 *Thermal energy*: A microscopic disordered equivalent of mechanical energy.
10 *Heat energy*: An amount of thermal energy being transferred (in a given process) in the direction of decreasing temperature.
11 *Sound energy*: Energy transferred through sound waves.
12 *Solar energy*: Energy from the sun.

Energy sources

1 Sun: Light comes from the sun. Plants make use of sunlight in the preparation of their food.
2 Fuel, petrol, kerosene, etc.
3 Heat is a form of energy, but steam is obtained when water is heated. The energy in steam is used to do work in many industries. For example, the wheels of some locomotive engines are driven by steam.
4 Wind: In countries where there is a normal, steady wind blowing, windmills can be used to turn machines which can pump water from wells, or produce electricity.
5 Water: This is used to generate electricity, e.g. the Kainji dam.
6 Chemicals: Sodium hydroxide pellets generate some form of energy.
7 Magnet: By moving objects towards itself and away from itself, it does work.
8 Batteries.

Uses of energy in the home

1 For heating and cooling our homes.
2 To light our bulbs and power other electrical devices such as fans, refridgerators and ovens.
3 To power our vehicles (transportation).
4 For cooking.

Kinetic energy theory: Assumptions

The kinetic theory of matter is based on the following assumptions:

1 Matter is composed of molecules or tiny particles.
2 These molecules are always in motion and, therefore, each molecule possesses kinetic energy.
3 An increase in the temperature of the molecules results in an increase in their speeds and, therefore, an increase in their kinetic energy and that of the matter.
4 An increase in the average kinetic energy of matter leads to a change in the state of the matter.

Explanation of some phenomena using the kinetic theory

Molecules in solid state of matter are arranged in a very compact manner (sticking together) as shown in Fig. 17.1. When

heat energy is applied to the solid, the arrangement of the molecules becomes less compact. The heat energy increases the temperature of the molecules, resulting in an increase in their speeds and kinetic energy. This results in a change from the solid state where molecules are compact together, to the liquid state where molecules are less compact together (see Fig. 17.2). Further application of heat energy to the liquid state of matter leads to an increase in the temperature and, therefore, the speeds of the molecules. The molecules are thus moved further apart, resulting in a change of state from the liquid state to the gaseous state. Fig. 17.3 shows the arrangement of molecules in the gaseous state.

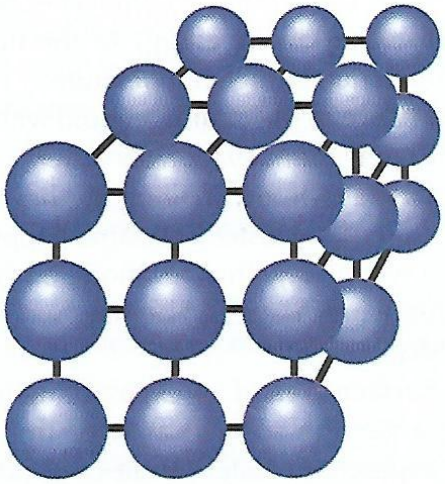


Fig 17.1 Arrangement of molecules in the solid state of matter

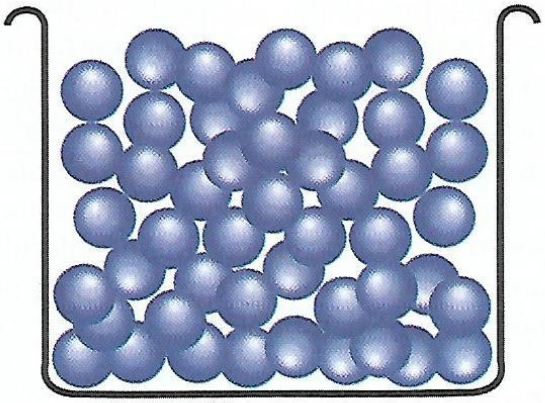


Fig 17.2 Arrangement of molecules in the liquid state of matter

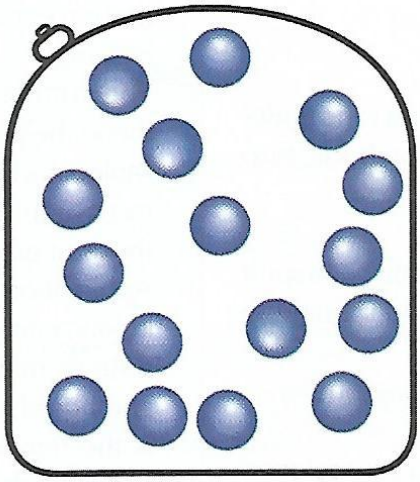


Fig. 17.3 Arrangement of molecules in the gaseous state of matter

Explanation of boiling and evaporation using the kinetic theory

As heat energy is applied to the liquid state of matter, the temperature and, therefore, the speeds of the molecules increase. Continuous application of heat raises the temperature to boiling point. At boiling point, molecules of the liquid that have acquired kinetic energy escape into vapour.

Evaporation which occurs at any temperature is the escape of molecules of a liquid from its surface. Molecules at the surface of a liquid are only bound by molecules below since there are no molecules above them. Any little application of heat energy increases their temperature, speed and kinetic energy. These molecules are, therefore, able to escape, being not bound (or held) by molecules above.

Factors that affect evaporation

Activity 17.1 Demonstrating the effect of surface area on evaporation

Materials required

Methylated spirit, two petri dishes (one wider than the other), your science notebook, biro

Procedure

1 Pour an equal quantity of methylated spirit into the two dishes, one wider than the other.
2 Check the quantity remaining on the following day.
3 Record your observations in your science notebook.

You must have observed that the liquid in the wider dish has reduced more than the liquid in the other dish. This is because the wider dish has a larger surface area which implies it has more molecules at its surface than those at the surface of the smaller dish. More molecules, having greater kinetic energy, will be able to escape from the wider dish than from the smaller dish.

Other factors that affect evaporation are:

1 **Temperature**: The hotter a liquid is, the faster its evaporation. This is because the average kinetic energy of the liquid is high due to high temperature.
2 **Nature of the liquid:** A liquid with a low boiling point evaporates faster.
3 **Dryness of air:** During the harmattan, clothes dry faster. The same happens on a windy day. Thus, evaporation is faster on windy days and on days when air is dry.
4 **Surface area of an exposed liquid:** The larger the surface area of the liquid exposed, the faster the rate of evaporation.

Summary

1 Molecules of a body are in constant motion even when the whole body is not moving.
2 The four assumptions of the kinetic theory help to explain some phenomena.
3 Molecules in the solid state of matter are the most compact in arrangement while those of gas are the least compact.
4 Application of heat increases the average kinetic energy and therefore changes the state of matter. Solid changes to liquid and liquid changes to gas. Boiling point is the temperature at which molecules of liquid change to vapour/gas.

5 Evaporation which occurs at any temperature is the escape of molecules of a liquid from its surface. Factors that affect evaporation are:
   a) temperature;
   b) nature of the liquid;
   c) area of liquid surface exposed; and
   d) windy atmosphere and dryness of the air.

Revision questions 17

1 Which of these is not an assumption of the kinetic theory?
   A Matter is composed of molecules.
   B Molecules are always in motion.
   C An increase in temperature results in a decrease in the speed of the molecules.
   D An increase in the average kinetic energy leads to a change in the state of matter.
   E Molecules make up matter.
2 Which of these conditions does not affect the evaporation of a liquid?
   A Temperature
   B . Surface area
   C Wind
   D Volume of liquid
   E Relative humidity
3 The molecules of the _____ state of matter are the farthest apart.
   A solid
   B liquid
   C gaseous
   D compact
   E organised
4 _____ takes place at a specific temperature.
   A Evaporation
   B Solidification
   C Boiling
   D Heating
   E Cooling
5 _____ takes place at any temperature.
   A Evaporation
   B Solidification
   C Boiling
   D Heating
   E None
6 Define boiling point.
7 Define evaporation.
8 Mention the four (4) factors that affect evaporation.
9 Mention any three (3) assumptions of the kinetic theory.
10 Define energy.

Chapter 18 Thermal energy

Introduction

Thermal energy is the same as heat energy. Sources of thermal energy include the sun, candlelight, a lit lamp and an electric cooker. Thermal energy is useful for cooking, frying, drying and ironing of washed clothes. Thermal energy can also be converted to other forms of energy such as electrical energy, mechanical energy and light energy. Heat can travel from one place to another in three ways: conduction, convection and radiation. Both conduction and convection require matter to transfer heat. If there is a temperature difference between two systems, heat will always find a way to transfer from the higher to the lower system.

In this chapter, you will learn about heat flow and different methods of heat transfer.

Objectives

By the end of this chapter, you will be able to:

1 illustrate that when two bodies are in contact, heat flows from the hot to the cold body;
2 name the methods of heat transfer;
3 describe heat conduction and its applications;
4 describe heat convection and state two of its applications; and
5 explain heat radiation and state two of its applications.

Heat flow

Activity 18.1 Demonstrating heat flow

Materials required

Water, two beakers, Bunsen burner, one conical flask, thermometer, your science notebook, biro

Procedure

1 Pour water into one beaker and place it on the Bunsen burner.
2 Use the thermometer to measure its temperature at boiling point.
3 Pour water into the second beaker and measure its temperature.
4 Pour both hot and ordinary water from the two beakers into the conical flask.
5 Measure the temperature of the mixture.
6 Record your observation in your science notebook.

You must have observed that the temperature of the mixture is between that of the hot water (having a higher temperature) and that of the ordinary water (having a lower temperature). This is because heat flowed from the hot water to the ordinary one so that while the ordinary water gained heat energy, the hot water lost heat energy.

Heat transfer

From Activity 18.1, we saw that heat flows from a hot body to a cold body. The method

of heat transfer, however, differs depending on the state of the body. For most bodies in solid state, heat energy is transferred by conduction. Heat transfer in fluids is mostly by convection. Liquids and gases are referred to as **fluids**. Radiation of heat energy does not require a medium. The three methods of heat energy transfer, namely **conduction**, **convection** and **radiation,** are discussed below.

Conduction of heat energy

Activity 18.2 Demonstrating heat transfer by conduction

Materials required

Bunsen burner, matchstick, iron rod, your science notebook, biro

Procedure

1 Light up the Bunsen burner.
2 Put one end of the iron rod in the flame of the Bunsen burner while holding the middle.
3 Record your observation.
4 After letting it cool down, put one end of the rod in the fire of the Bunsen burner while holding the other end briefly.
5 Record your observation.
6 After letting it cool down, put one end of the rod in the fire of the Bunsen burner while holding the other end longer than before.
7 Record your observation.

Result

You must have observed that when one end of the iron rod was put in fire and the middle was held, your hand was hot whereas when you held the other end briefly, your hand was not hot. When you however held the other end longer, your hand was hot. The reason is, heat energy is transferred to the molecule nearest to the source of heat which then transfers to the next till heat is transferred to the farthest molecule. It takes time for heat energy to get to the farthest molecule at the other end. Thus, you had to hold that end longer before your hand became hot. This is the method of heat transfer by **conduction**. Remember that the arrangement of molecules in solids is compact.

Conduction of heat is the process by which heat is transferred from the nearest molecule to the source of heat to the last molecule farthest from the source, without the molecules moving. Metals are good conductors of heat while water, wood, paper, and clothes are not. Of all metals, copper and silver conduct heat most. Handles of cutlery and pots are insulated because they become hot due to the conduction of heat. The better the conductor, the more rapidly heat will be transferred.

Convection of heat energy

Thermal energy is transferred from hot places to cold places by convection. **Convection** of heat energy is the method of transfer of heat energy in a fluid by the bodily movement of the fluid. This method is demonstrated in Activity 18.3 below.

Activity 18.3 Demonstrating transfer of heat energy by convection in water

Materials required

Conical flask, water, Bunsen burner, potassium permanganate, your science

notebook, biro

Procedure

1 Drop the potassium permanganate in the conical flask.
2 Pour water gently into the flask.
3 Put the flask on the Bunsen burner.
4 Observe the movement of the coloured water in the flask as the water is heated.
5 Record your observations in your science notebook.

Result

You must have observed that water coloured by the potassium permanganate rises up while the uncoloured water from the top comes down to replace the coloured water. The water initially at the bottom, coloured by the potassium permanganate, comes in contact with the heat energy first. It becomes hot and rises up while the cold water initially on top comes down. This process continues until the whole water is uniformly heated to boiling point. Thus, heat energy is transferred to the whole water by the bodily movement of the water i.e. by convection. Convection of heat energy is common in fluids. Fluids include liquids and gases.

Transfer of heat energy by convection also occur in gases e.g. air. In a house with good ventilation, hot air emanating from air breathed out rises and escapes from upper parts of the window while cold air from the lower part of the window replaces it.

Also, in the daytime, during dry season, the land is heated more than the sea. Hot air above the land rises up and is replaced by cooler air from the sea. At night, the land is cooler. Hot air from the sea rises up and is replaced by colder air from land.

Radiation of heat energy

The means by which heat energy reaches a body from the source without the need of a medium e.g. solid, liquid or gas, is called radiation. Examples of radiation are the heat from the sun, and heat released from the filament of a light bulb.

Activity 18.4 Demonstrating variation of intensity of radiated heat energy with distance

Materials required

100-watt electric bulb, power source, your science notebook, biro

Procedure

1 Connect the electric bulb to the power source.
2 Stand 50 centimetres away from the bulb.
3 Record your observation.
4 Stand 100 cm (1 metre) away from the bulb.
5 Record your observation.
6 Stand 150 cm (1.5 m) away from the bulb.
7 Record your observation.

Result

You must have observed that you felt the intensity or impact of the heat energy more when you were 50 cm away than when you were 100 cm away. The impact was least felt when you were 150 cm away. We can then say that the farther away a body is from the source of heat energy, the lesser the impact or intensity of the heat energy radiated.

The nature and colour of materials also affect the intensity of heat energy radiated through them. This is demonstrated in the Activity 18.5.

Activity 18.5 Demonstrating the effect of the nature of surfaces on radiation of heat energy

Materials required

Two cans (one painted black), Bunsen burner, 2 thermometers, your science notebook, biro

Procedure

1 Light the Bunsen burner and put it at an equal distance between the two cans.
2 Pour an equal quantity of water into the two cans.
3 Put a thermometer in each can.
4 Check the readings on the thermometers after a while.
5 Record your observations in your science notebook.

Result

You must have observed that the temperature read from the thermometer in the can painted black is higher than the temperature in the other can. This is because black surfaces are good absorbers of heat energy. The black surface of the painted can absorbed heat energy better than the surface of the unpainted can, that is, better than a shiny surface. Black surfaces are also good emitters of heat energy than shiny surfaces. Thus, if the roof of a house is shining, it would not absorb heat energy. It will rather reflect the heat away. Also, light colours reflect heat energy away instead of absorbing it. Therefore, in hot weather, it is not advisable to wear clothes of dark colour. The flask we use in our homes, called thermos flask, keeps the content hot if a hot content is kept inside. It also keeps the content cold if a cold content is kept inside. This is because the interior of the flask is coated with silver. Remember shining surfaces are not good absorbers or good emitters of heat energy.

Summary

1 When two bodies are in contact, like hot water and cold water, heat flows from the hot body to the cold body.
2 The three methods of heat transfer are:
a) conduction,
b) convection, and
c) radiation.
3 Conduction of heat is common in solids because of the compact arrangement of their molecules, convection of heat occurs in fluids i.e. liquids and gases, while radiation of heat does not require any medium.
4 Metals are good conductors of heat, with copper and silver being the best.
5 Good ventilation is necessary in homes so that the air we breathe out which is hot can escape by convection of heat, and cold or fresh air from outside can come in.

Revision questions 18

1 When two bodies, one hot and the other cold, are in contact, heat flows from _____.
A the hot to the cold
B the cold to the hot
C neither of them
D the hot to the hot
E the cold to the cold
2 Which of these is not a method of heat transfer?
A Conduction
B Emission

C Convection
D Radiation
E All of the above

3 Conduction of heat is common in _____.
A solids
B liquids
C no material
D gasses
E all materials

4 Convection of heat is common in _____.
A solids
B liquids
C no material
D gasses
E none of the above

5 Which of these media is needed for radiation of heat?
A Solids
B Liquids
C Gas
D Water
E None of the above

6 Mention two applications of conduction of heat.

7 Mention two applications of convection of heat.

8 Mention two applications of radiation of heat.

9 Describe with the aid of a diagram, the conduction of heat.

10 Describe with the aid of a diagram, the convection of heat.

Science and development

Chapter 19 Crude oil and petrochemicals

Introduction

Crude oil (also known as petroleum) is a dark brown, inflammable, liquid substance found deep down beneath the ground surface, or under the sea, (offshore). It is formed from living things (both plants and animals) that lived and died many, many years ago. The dead bodies of the dead plants and animals did not just decay, but were transformed into crude oil.

Crude oil, that is deep down beneath the earth's surface, cannot be seen from the earth's surface with the naked eyes, nor can it rise up to the surface of the earth on its own. The process of the search for oil is called **oil exploration**. The scientists that do oil exploration are called **geophysicists**. They have been trained in both geology (the study of the structure of rocks) and physics. When exploring for oil, geophysicists use a special instrument to send signals down into the earth to the rock layers, and receive signals back from the rock layers. The scientists study the signals which have been received back, and interpret them to show whether there are oil-bearing rock structures in that location or not.

The signals only help the scientists to suspect the presence of oil or not. To actually confirm the presence of oil, scientists carry out what is called **drilling** with an oil rig. Drilling involves forcing down into the earth, strong steel pipes, joined end to end, until the joined pipes reach down to the depth where oil is suspected to be.

Oil drilling is also done in the land beneath the ocean. This is called **offshore drilling**. (You may have observed drilling for a water borehole.) When the drilling pipes reach the oil layer, if oil is present, the first product that comes out through the pipes is petroleum gas, which normally forms a layer above the crude oil in the ground. The process of bringing the crude oil out of the ground is called **oil production**. Oil that comes out of the ground is made to flow through pipes into oil storage tanks, from where it may be sent to the refineries or to ships that transport them for export.

Petroleum or crude oil occurs in many countries of the world such as Russia, United Kingdom, Saudi Arabia, Iran, Iraq, Kuwait, USA, Venezuela, Egypt, Libya, Southern Sudan, Ghana and Nigeria. In Nigeria, oil occurs mostly in the Niger Delta area and offshore, under the Atlantic Ocean.

Petrochemicals are chemicals derived from petroleum or petroleum gas. In this chapter, you will learn the meaning of petroleum, the uses, and importance of petroleum and of petrochemicals.

Objectives

By the end of this chapter, you will be able to:

1 explain what crude oil and petrochemicals

are;
2 describe the process of refining crude oil;
3 state the uses of crude oil and petrochemicals;
4 state the importance of crude oil to Nigeria; and
5 name some materials made from petrochemicals.

Crude oil and petrochemicals

Crude oil or petroleum is a thick, brownish liquid mineral, formed deep down beneath the earth's surface, from the remains of dead plants and animals that lived long ago, under pressure. It consists of a complex mixture of gaseous, liquid and solid hydrocarbons. Hydrocarbons are chemicals which are made up of carbon and hydrogen atoms only. The colour of petroleum and its composition vary from one source to another. For instance, petroleum from Nigeria is dark brown in colour, while in another country, it may be darker in colour. Petroleum from Nigeria contains some sulphur while that from some other countries does not. The most sought after petroleum is that without sulphur because it has less pollution effect than one that contains sulphur. The density of petroleum also varies from one source to another, so do the percentages of the various components.

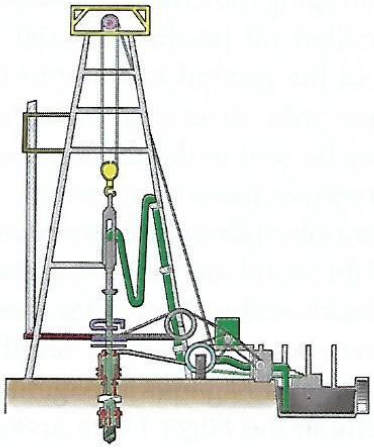


Fig. 19.1 An oil drilling rig

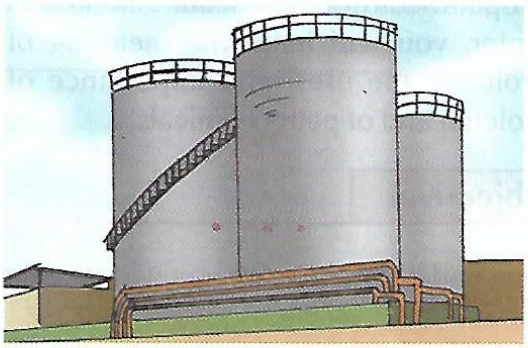


Fig 19.2 Oil storage tanks

Fig. 19.3 Equipment for oil exploration

Refining of petroleum

When crude oil (petroleum) is produced from an oil well, it flows through pipes to storage tanks. From there, it flows through other pipes to the factories where petroleum is refined. **Refining** is the process by which crude oil is separated into its components. The factory in which refining is done is called a **refinery**.

As stated earlier, petroleum is a complex mixture of hydrocarbons. These components of crude oil have different boiling points. When crude oil is heated, each component vaporises (turns to vapour) when its own boiling point is reached. For this reason, the method used in refining petroleum is called **fractional distillation.** This means that different components (fractions) of petroleum are distilled off (removed) at their respective boiling points.

In a refinery, crude oil is first heated to a temperature of 50°C – 60°C by passing it through pipes in a gas furnace. Then the heated petroleum is passed into the bottom of a distillation tower in which temperature varies from 400°C at the bottom to 40°C at the top.

As the vapours move up, each component condenses when the temperature in the tower falls below its particular boiling point. It separates out at its own level, while the other components with lower boiling points, move up to the upper parts of the tower. The thick liquids and solid components are found at the bottom of the tower.

Fig. 19.4 A distillation tower in a refinery

Products of petroleum refining

The products of petroleum refining, from the one that has the lowest boiling point (and therefore distills off at the top of the refinery) to the product that has the highest boiling point (and therefore distills off at the bottom of the tower) are shown below.

1 Petroleum gas (a gas at ordinary temperature)
2 Petrol (or gasoline)
3 Jet fuel (or aviation fuel)
4 Kerosene
5 Diesel fuel
6 Petrochemical feedstocks
7 Lubricating oils and waxes
8 Home heating oil
9 Fuel oil
10 Asphalt

Table 19.1 Uses of products of crude oil refining

S/No	Product	Use
1	Petroleum gas	Cooking gas.
2	Petrol	For driving petrol engines.
3	Jet fuel	For running aircraft.
4	Kerosene	For cooking stoves and bush lamps.
5	Diesel oil	For running diesel engines.
6	Petrochemical feedstocks	Petrochemicals are produced from this.
7	Lubricating oils and waxes	Engine oils, grease, candles.
8	Home heating oil	For running heaters in temperate countries.
9	Fuel oil	For powering generators, marine engines.
10	Asphalt	For surfacing roads.

Activity 19.1 Where oil is found in Nigeria

Materials required

Map of Nigeria, your science notebook, biro

Procedure

1 Draw the map of Nigeria in your science notebook.
2 Insert in the map, the places where petroleum is found.

Uses of petrochemicals

Petrochemicals are used for the industrial production of many essential goods. Some of these goods are listed below.

1 Plastics
2 Polyesters for manufacture of textiles
3 Paints
4 Synthetic rubber for shoe soles
5 Carpets
6 Fertilisers
7 Weed killers, and pesticides
8 Detergents
9 Pharmaceuticals

However, petrochemicals and their derivatives, as well as all chemicals and the facilities that handle them, are highly regulated throughout the world to ensure the health of consumers and the environment.

Activity 19.2 Visit to a petrol station

Material required

You science notebook, biro

Procedure

1 Your teacher will divide your class into groups, with five students in each group.
2 Your teacher will lead you to a petrol station, possibly near your school.
3 When you reach the petrol station, observe carefully, and record the different types of fuel sold in the station.
4 Observe and record the different types of lubricating oils and grease sold in the station.
5 Observe and record safety measures (and notices) put in place to prevent fires in the petrol station.
6 Present your report to your teacher for class discussion.

Importance of petroleum and petrochemicals to Nigeria

Petroleum and petrochemicals are very important to any nation that has oil. Some of the ways in which they are important are listed below.

1 In Nigeria, oil is the biggest national income earner. The export of petroleum and petrochemicals earns much income for the country.
2 The oil and gas industry provides employment for very many people.
3 Petrochemicals provide raw materials for many industries such as shoes, textiles, paint, pharmaceuticals, carpets, and other industries.
4 Aviation fuel, petrol, and diesel oil are indispensable for the transport industry. Petroleum and petrochemicals provide all these items and help a country to have an efficient transport system.

Summary

1 Petroleum is a natural, dark brown, thick, inflammable, liquid mineral. It is a complex mixture of hydrocarbons found beneath the land surface and under the sea (offshore).
2 Crude oil is formed from plants and animals that died long ago.
3 Petrochemicals are chemicals derived from petroleum and petroleum gas.
4 The process of searching for oil under the ground or sea is called oil exploration.
5 When the presence of oil is suspected, strong steel pipes are driven into the ground by a rig, to the expected depth. This process is called drilling.
6 If a drilling pipe hits an oil deposit, the first product that comes up to the ground surface through the drilling pipes is petroleum gas.
7 Petroleum is a mixture of many gaseous, liquid and solid hydrocarbons. Each component has a different boiling point. The components of petroleum are separated by heating so that each vaporises and separates out at its boiling point. This process is called fractional distillation.
8 The components of petroleum, from the most to the least volatile, are petroleum gas, petrol, naphthalene, kerosene, lubricating oils, paraffin wax and asphalt.
9 Petroleum and petrochemicals have many economic uses. They are Nigeria's largest source of income.

Revision questions 19

1 Which of the following is not a product of refining of crude oil?
   A Petrol
   B Kerosene
   C Diesel oil
   D Polythene
   E Lubricating oil
2 At room temperature, crude oil is _____.
   A a complex mixture of gases, liquids, solids
   B gas only
   C liquid only
   D mixture of gases and liquids only.
   E none of the above
3 Oil exploration means the process of _____.
   A drilling crude oil
   B refining crude oil

C collecting crude oil
D purifying crude oil
E searching for crude oil

4 The following are products of petrochemicals except _____.
A polythene
B rubber
C nylon
D petrol
E paint

5 Which of these methods will you use to separate crude oil which is a mixture of hydrocarbons?
A Filtration
B Chromatography
C Sublimation
D Fractional distillation
E Drilling

6 The heaviest product of the refining of crude oil is_____.

7 The process of searching for oil is called _____.

8 Name five (5) products of the refining of petroleum.

9 a) Define petrochemicals.
b) Name five (5) products made of petrochemicals.

10 State the importance of crude oil and petrochemicals to Nigeria.

Answers to objective revision questions

Chapter 1
1 A
2 C
3 D
4 D
5 D
6 C

Chapter 2
1 A
2 A
3 C
4 D
5 C
6 A

Chapter 3
1 B
2 C
3 C

Chapter 4
1 D
2 B
3 D
4 B
5 E

Chapter 5
1 C
2 D
3 C
4 B
5 A

Chapter 6
1 B
2 B
3 D
4 D

Chapter 7
1 D
2 B
3 E
4 C

Chapter 8
1 C
2 C
3 C
4 A
5 C

Chapter 9
1 A
2 C
3 E

Chapter 10
1 A
2 A
3 C
4 E
5 A

Chapter 11
1 C
2 C
3 A
4 B
5 E

Chapter 12
1 C
2 E
3 A
4 D
5 D

Chapter 13
1 B
2 B
3 D
4 A
5 A

Chapter 14
1 A
2 B
3 E
4 E
5 A

Chapter 15
1 E
2 E
3 C
4 A

Chapter 16
1 C
2 B
3 C
4 A

Chapter 17
1 C
2 D
3 C
4 C
5 A

Chapter 18
1 A
2 B
3 A
4 B
5 E

Chapter 19
1 D
2 A
3 E
4 A
5 D

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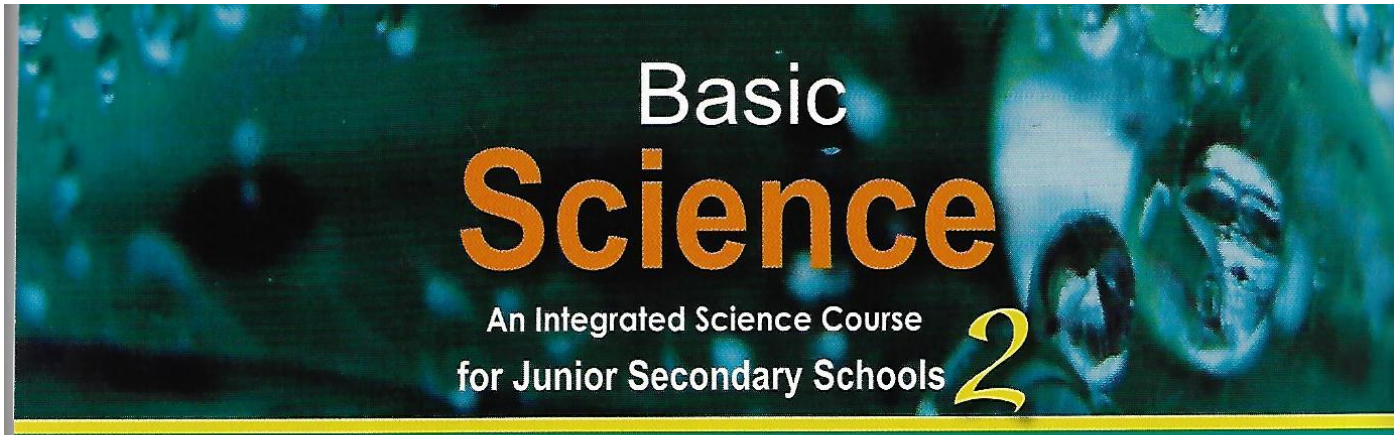

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