Module 4

Upper Primary Science

My Natural Environment

THE COMMONWEALTH of LEARNING

Science, Technology and Mathematics Modules

for Upper Primary and Junior Secondary School Teachers of Science, Technology and Mathematics by Distance in the Southern African Development Community (SADC)

Developed by
The Southern African Development Community (SADC)

Ministries of Education in:

- **Botswana**
- **Malawi**
- **Mozambique**
- **Namibia**
- **South Africa**
- **Tanzania**
- **Zambia**
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SCIENCE, TECHNOLOGY AND MATHEMATICS MODULES

This module is one of a series prepared under the auspices of the participating Southern African Development Community (SADC) and The Commonwealth of Learning as part of the Training of Upper Primary and Junior Secondary Science, Technology and Mathematics Teachers in Africa by Distance. These modules enable teachers to enhance their professional skills through distance and open learning. Many individuals and groups have been involved in writing and producing these modules. We trust that they will benefit not only the teachers who use them, but also, ultimately, their students and the communities and nations in which they live.

The twenty-eight Science, Technology and Mathematics modules are as follows:

Upper Primary Science
Module 1: *My Built Environment*
Module 2: *Materials in my Environment*
Module 3: *My Health*
Module 4: *My Natural Environment*

Junior Secondary Science
Module 1: *Energy and Energy Transfer*
Module 2: *Energy Use in Electronic Communication*
Module 3: *Living Organisms' Environment and Resources*
Module 4: *Scientific Processes*

Upper Primary Technology
Module 1: *Teaching Technology in the Primary School*
Module 2: *Making Things Move*
Module 3: *Structures*
Module 4: *Materials*
Module 5: *Processing*

Junior Secondary Technology
Module 1: *Introduction to Teaching Technology*
Module 2: *Systems and Controls*
Module 3: *Tools and Materials*
Module 4: *Structures*

Upper Primary Mathematics
Module 1: *Number and Numeration*
Module 2: *Fractions*
Module 3: *Measures*
Module 4: *Social Arithmetic*
Module 5: *Geometry*

Junior Secondary Mathematics
Module 1: *Number Systems*
Module 2: *Number Operations*
Module 3: *Shapes and Sizes*
Module 4: *Algebraic Processes*
Module 5: *Solving Equations*
Module 6: *Data Handling*

A MESSAGE FROM THE COMMONWEALTH OF LEARNING

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Introduction

Welcome to the programme in Teaching Upper Primary Science. This series of four modules is designed to help you to strengthen your knowledge of science topics and to acquire more instructional strategies for teaching science in the classroom.

Each of the four modules in the science series provides an opportunity to apply theory to practice. Learning about science entails the development of practical skills as well as theoretical knowledge. Each science topic includes an explanation of the theory behind the science, examples of how the science is used in practice, and suggestions for classroom activities that allow students to explore the science for themselves.

Each module also explores several instructional strategies that can be used in the science classroom and provides you with an opportunity to apply these strategies in practical classroom activities. Each module examines the reasons for using a particular strategy in the classroom and provides a guide for the best use of each strategy, given the topic, context, and goals.

The guiding principles of these modules are to help make the connection between theory and practice, apply instructional theory to practice in the classroom situation, and support you, as you in turn help your students to apply science theory to practical classroom work.

Programme Goals

This programme is designed to help you to:

- strengthen your understanding of science topics
- expand the range of instructional strategies that you can use in the science classroom

Programme Objectives

By the time you have completed this programme, you should be able to:

- develop and present lessons on environmental resources, needs and conservation, materials in the environment, health issues, and natural ecosystems
- guide students as they work in teams on practical projects in science, and help them to work effectively as a member of a group
- use questioning and explanation strategies to help students learn new concepts and to support students in their problem solving activities
- guide students in the use of investigative strategies to learn more about particular scientific concepts, and to find out how tools and materials are used in scientific inquiries
- prepare your own portfolio about your teaching activities
- guide students as they prepare their portfolios about their project activities

The relationship between this programme and the science curriculum

The science content presented in these modules includes some of the topics most commonly covered in the science curricula in southern African countries. However, it is not intended to cover all topics in any one country's science curriculum comprehensively. For this, you will need to consult your national or regional curriculum guide. The curriculum content that is presented in these modules is intended to:

- provide an overview of the content in order to support the development of appropriate teaching strategies
- use selected parts of the curriculum to develop specific teaching strategies
- explain those elements of the curriculum that provide essential background knowledge, or that address particularly complex or specialised concepts
- provide directions to additional resources on the curriculum content

How to Work on this Programme

As is indicated in the programme goals and objectives, this programme allows you to participate actively in each module by applying instructional strategies when exploring science with your students and by reflecting on that experience. There are several different ways to do this.

Working on your own

You may be the only teacher of science in your school, or you may choose to work on your own so you can accommodate this programme within your schedule. If this is the case, these are the recommended strategies for using this module:

1. Establish a schedule for working on the module: choose a date by which you plan to complete the first module, taking into account that each unit will require between six to eight hours of study time and about two hours of classroom time for implementing your lesson plan. For example, if you have two hours a week available for study, then each unit will take between three and four weeks to complete. If you have four hours a week for study, then each unit will take about two weeks to complete.
2. Choose a study space where you can work quietly without interruption, for example, a space in your school where you can work after hours.
3. If possible, identify someone who is interested in science or whose interests are relevant to science (for example, a math or science teacher in your school) with whom you can discuss the module and some of your ideas about teaching science. Even the most independent learner benefits from good dialogue with others. It helps us to formulate our ideas—or as one learner commented, "How do I know what I'm thinking until I hear what I have to say?"

Working with colleagues

If you are in a situation where there are other teachers of science in your school or in your immediate area, then it is possible for you to work together on this module. You may choose to do this informally, perhaps having a discussion group once a week or once every two weeks about a particular topic in one of the units. Or, you may choose to organise more formally, establishing a schedule so that everyone is working on the same units at the same time, and you can work in small groups or pairs on particular projects. If you and several colleagues plan to work together on these modules, these are the recommended steps:

1. Establish and agree on a schedule that allows sufficient time to work on each unit, but also maintains the momentum so that people don't lose interest. If all of you work together in the same location, meeting once a week and allocating two weeks for each unit, this plan should accommodate individual and group study time. If you work in different locations and have to travel some distance to meet, then you may decide to meet once every two weeks, and agree to complete a unit every two weeks.
2. Develop and agree on group goals, so that everyone is clear about the intended achievements for each unit and for each group session.
3. Develop a plan for each session, outlining what topics will be covered and what activities will be undertaken by the group as a whole, in pairs, or in small groups. It may be helpful for each member of the group to take a turn in planning a session.

Your group may also choose to call on the expertise of others, perhaps inviting someone with particular knowledge about teaching or about a specific science topic to speak with the group, as long as this is in keeping with the goals of the module and of the group.

Your group may also have the opportunity to consult with a mentor, or with other groups, by teleconference, audioconference, letter mail, or e-mail. Check with the local coordinator of your programme about these possibilities so that you can arrange your group schedule to be compatible with these provisions.

Colleagues as feedback/resource persons

Even if your colleagues are not participating directly in this programme, they may be interested in hearing about it and about some of your ideas as a result of taking part. Your head teacher or the local area specialist in science may also be willing to take part in discussions with you about the programme.

Working with a mentor

As mentioned above, you may have the opportunity to work with a mentor, someone with expertise in science education who can provide you with feedback about your work. If you are working on your own, your communication with your mentor may be by letter mail, telephone, or e-mail. If you are working as a group, you may have occasional group meetings, teleconferences, or audioconferences with your mentor.

Using a learning journal

Whether you are working on your own or with a group, it is strongly recommended that you use a learning journal. The learning journal serves a number of different purposes, and you can divide your journal into compartments to accommodate these purposes. You can think of your journal as a "place" where you can think out loud by writing down your ideas and thoughts, and this "place" has several "rooms".

Ideas/Reflections/Questions
In one part of your journal, you can keep notes and a running commentary about what you are reading in each unit, write down ideas that occur to you about something in the unit, and note questions about the content or anything with which you disagree. You can use this part to record general ideas about how to use some of the content and strategies in the classroom. If you consistently keep these notes as you work through each unit, then they will serve as a resource when you work on the unit activity, since you will have already put together some ideas about applying the material in the classroom. This is also the section of the journal for your notes from other resources, such as books of articles you read or conversations with colleagues.

Plans
This is the section where you work on your activity for each unit. At the start of each unit, you should start considering what activity you will choose to do, and then develop your ideas as you go along. Each activity will also have specific guidelines.

Observations/Reflections
This is the section where you record your observations about classroom experiences, how students seem to tackle various situations and how each instructional strategy works in practice. This is the place to record your notes after you implement the unit activity about what you feel worked well and what could be improved. If you are part of a group, you can keep your notes about good practice and effective group dynamics, based on the group experience, in this section.

Resources available to you

Although these modules can be completed without referring to additional resource materials, your experience and that of your students can be enriched if you use other resources as well. There is a list of resource materials for each module provided at the end of that module. You can also identify other resources that can enhance the teaching/learning experience, from among materials that may be locally available. These include:

- working examples of energy use in electronic communication or of materials or tools that are available in your environmnet for scientific inquiries related to these examples;
- magazines that have articles about science topics, with the emphasis on the subject of this module;
- books and other resources (including the internet) about science that may be available in your school or community library

Tips for selecting resources
Working with locally available resources may require selecting those that are most appropriate to help you explore further the module content to your context that may not be complete or relevant. When reviewing materials to see if they will help you with the module, consider:

- Which module topics does this material address?
- Is it possible the ideas in this material are transferable to the science classroom?
- Is it possible the ideas in this material are transferable to the technologies included in the module?

ICONS

Throughout each module, you will find some or all of the following icons or symbols that alert you to a change in activity within the module.

Read the following explanations to discover what each icon prompts you to do.

	**Introduction**	Rationale or overview for this part of the course.
	**Learning Objectives**	What you should be able to do after completing this module or unit.
	**Text or Reading Material**	Course content for you to study.
	**Important—Take Note!**	Something to study carefully.
	**Self-Marking Exercise**	An exercise to demonstrate your own grasp of the content.
	**Individual Activity**	An exercise or project for you to try by yourself and demonstrate your own grasp of the content.
	**Classroom Activity**	An exercise or project for you to do with or assign to your pupils.
	**Reflection**	A question or project for yourself— for deeper understanding of this concept, or of your use of it when teaching.
	**Summary**	Synthesis of the module or unit
	**Unit or Module Assignment**	Exercise to assess your understanding of all the unit or module topics.
	**Suggested Answers to Activities**	Answer keys
	**Time**	Suggested hours to allow for completing a unit or any learning task.
	**Glossary**	Definitions of terms used in this module.

CONTENTS

Module 4: My Natural Environment

Module 4
My Natural Environment

Module 4 Overview

The aim of this module “My Natural Environment” is to make you aware of the environment you are living in. Through questions you will ask yourself and your pupils you should be able to carry out some investigations. As you find answers to the questions you will be expected to interact with the environment through field trips.

The module has six units.

Unit 1: Air

This unit discusses air, that although you cannot see it, is real because it occupies space, has weight, and you can feel it. You will use questioning skills as your teaching strategy.

Unit 2: Water

In this unit we look at water, a liquid that can flow and take the shape of the container. We will also look at the importance of water and how we can conserve it.

Unit 3: Soil

The focus is on soil formation, types of soil, and its importance to agriculture. You will also look at soil erosion and conservation.

Unit 4: Light

This unit discusses sources, properties, and uses of light. You will practice the questioning skills to prepare yourself for classroom practices.

Unit 5: Plants

In this unit we deal with flowering plants and their general structure, their transport system, food production and how we depend on plants.

Unit 6: Animals

In this unit, you will look at groups of animals, where they live and what they eat. You will also learn about the interdependence of living things for survival. As you do the activities, you will use the questioning skills as your teaching strategy.

Learning Outcomes

After completing this module you should be able to demonstrate knowledge and understanding of:

- the existence of air
- conservation of water
- the importance of soil in agriculture
- construction of good questions during investigations
- human dependence on plants
- the relationships among living things

Unit 1: Air

Introduction

Air is all around us. It forms a layer around the earth we call the atmosphere. Some of the properties of air are that it is colourless, odourless, and tasteless. Although we cannot see it, we can feel it. Containers such as bottles and tins which to us seem empty, are not really empty but are actually full of air. Air occupies space and has weight.

In this unit you will look at many activities in order to understand and learn more about air. The teaching strategy you will use is questioning for teaching and learning. This skill is also reflected in the type of exercises you will be expected to do.

Objectives

By the end of this unit you should be able to:

- demonstrate that air occupies space and has weight
- state that air is necessary for living things
- describe air pollution and how it can be prevented
- demonstrate that air exerts pressure
- explain effects of strong winds on buildings, trees, and crops
- state one-fifth of the air is oxygen and that it is necessary for burning
- demonstrate the skill of questioning in a teaching/learning situation

Air in My Natural Environment

Composition

We call the space occupied by air around the earth the atmosphere. The composition of air is:

- Nitrogen 78%
- Oxygen 21%
- Carbon Dioxide 0.03%
- inactive or noble gases (Argon, Neon, Helium, Krypton, Xenon) constitute about 0.97% of air.

You know that air also contains varying amounts of water vapour and dust particles.

Our heavy industrial activities have contributed other substances to the air. These pollutants include sulphur compounds and hydro-carbons. Here is a list of examples of primary pollutants resulting from human activities:

- oxides of sulphur, nitrogen, and carbon or derivative compounds
- organic compounds of hydrocarbons (e.g., fuel vapours, organic solvents)
- acid gasses (e.g., sulphuric acid, hydrochloric acid)
- particles in air (e.g., smoke, dust)
- metal oxides and related compounds (e.g., lead cadmium, copper, iron)

- flourides and its organic compounds
- toxic and non-toxic odours
- radioactive compounds

Human activity that yields air pollutants include combustion of fossil fuels, power stations, oil refineries, solid waste incinerators, and industrial activity.

We need a good supply of fresh air, especially in enclosed places like homes and schools, and buildings need to be properly ventilated to ensure an adequate supply of fresh air. Stale air makes us sleepy because it contains less oxygen than fresh air. Airborne diseases, such as influenza, pneumonia, and tuberculosis, are more easily spread in enclosed spaces.

Good ventilation replaces stale with fresh air, and simply opening a window is a good way to ventilate a room.

Air Occupies Space

Carry out this investigation. For this you will need a bucket or dish, water, a dry cloth or paper, and a glass jam jar.

Pour water into a bucket or dish up to (about) its half mark. Place a dry piece of paper or cloth at the bottom (inside) of a glass jam jar. Press the paper/cloth firmly so it does not fall out when the jar is turned upside down. Slowly dip it into the water until it touches the bottom of the container. Do not tilt the glass. Slowly remove the glass from the water, keeping it vertical. Take out the piece of paper or cloth from the glass and examine it.

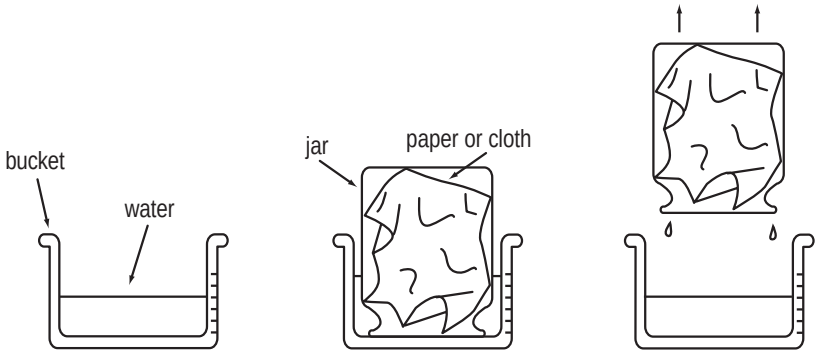


Figure 1: Air occupies space

Is it wet or dry? Explain your observations. In fact, if you followed the instructions correctly, the piece of crumpled paper or cloth will be dry. Air and water cannot occupy the same space at the same time, therefore the cloth or the paper remains dry.

Self-Marking Exercise

Now, try this exercise.

Use the following words to fill in the blank spaces in the passage below: **space, weight, less, occupies, air, lost air, same** (a word may be used more than once).

All vessels that appear empty contain (1)_____. This shows that air occupies (2)_____. Identical balloons, when blown to the same size have the (3)_____ weight. The balloon which loses air would weigh (4)_____ than the other. The extra weight of the heavier balloon is equal to the weight of the (5)_____. This tells us that air has (6)_____ and (7)_____ space.

Check your answers at the end of the Module.

Air Pressure

Try this investigation.

Blow air into a plastic bag or balloon until it is filled and seal it so that the air cannot escape.

What happens when you attempt to squash the bag/balloon? This is not easy. Can you give a reason why it is not easy to squash?

Make a small opening on the side of the plastic bag and squeeze it. What happens?

From your knowledge that air occupies space, you should have realised from the activity that air exerts a force on the surface it acts on. This is air pressure.

Try these experiments/demonstrations.

a) Place an empty glass jam jar or a drinking glass on the desk/table and fill it with water to the top. Carefully place a moistened thin card or any piece of heavy paper (e.g., index card) on the mouth of the jar. Make sure there are no air bubbles trapped in the jar. Turn the jar (or the glass) upside down while holding the thin card in position (see *Figure 1.2*). Then carefully remove your hand from the card. The water stays in the glass!

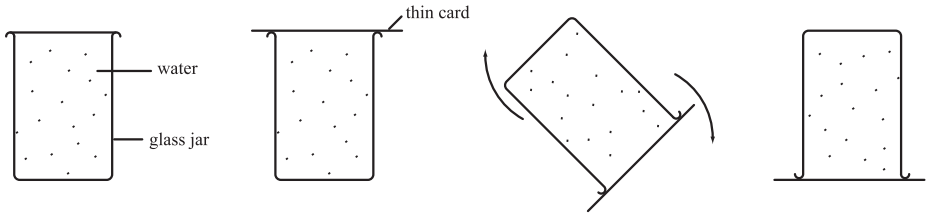


Figure 1.2: Upside down water experiment

i) What keeps the card attached to the mouth of the jar?

ii) What does this tell you about air pressure?

iii) Move the jar sideways and upward. What happens and why?

The previous experiment shows that, although invisible, air exerts pressure in all directions and the observable effect in this experiment is that it holds water in an inverted glass by "pressing on" and keeping the covering card in place.

b) Take a tin with a tight-fitting lid and pour a little water into it. Heat the water until it boils and steam starts to come out. Replace the lid tightly. Pour cold water over the tin to cool it. What happens to the tin and in what way can you make the tin come back to its shape? Why does the tin not normally collapse on its own? Give reasons.

The demonstrations you have just done show that air presses against things. We say air exerts pressure. This pressure on all objects is due to the "weight" of air in the atmosphere we call the atmospheric pressure.

When you closed and cooled the tin, the steam inside condensed making the pressure inside lower than that outside. This forced the tin to buckle or become crushed.

c) Arrange the apparatus as shown below. Place a candle firmly at the bottom of the dish/bucket and pour some water until it covers half the candle.

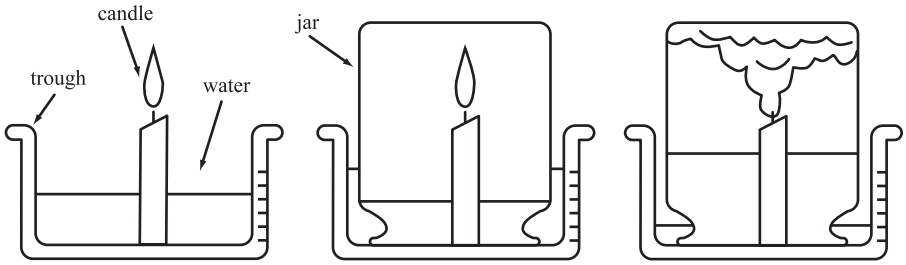


Figure 1.3: Burning Candle

Cover the candle with a big jam jar or any available glass container and observe what happens to the level of the water. (See *Figure 1.3*) Remove the jar, light the candle and cover the burning candle. What happens to the level of the water while the candle burns? What happens to the level of water when the candle goes out? Mark the new water level. What reasons can you give for the candle going out and the level of the water rising in the jar. Can you work out the fraction by which the water has risen? How does your result compare with what is presented in the percentage composition of air?

From the results of this activity you should realise that air has two components. One is the active component that supports burning and the other is the inactive component that does not support burning. Thus air is a mixture of gases. From this mixture of gases can you identify the active and inactive components?

List the other uses of the active component of air. This active component of air is also known as oxygen.

Use of Questioning

You have come across many teaching skills in the earlier modules. Some of these are:

- work cards/worksheets
- field work
- project work
- using local environment
- problem solving
- improvisation
- communication for learning/teaching
- assessment for learning

In this unit and the rest of the module, you will look at questioning as a teaching skill.

There are a wide range of questions and questioning techniques without which dialogue would be impossible. If you want your classroom to be a place of active learning, it is important for you to exploit the questioning techniques to their fullest.

- Who should ask questions in a classroom?
- How can you get pupils to ask questions in the lesson?
- How should you respond to incorrect answers?
- How should you distribute questions among your pupils?
- Why is it necessary to pause after a question before selecting a pupil to answer?
- Good questioning needs preparation—is this true? Why?
- How do you deal with silly or trivial questions?

In short, good questioning should include: Who? What? When? Did you? What do you think?

It is important to encourage your pupils to ask questions and to answer questions.

You have to recognise the type of questions children are raising and how to encourage “productive questions” which stimulate activity.

To be an effective teacher you need to recognise the importance of children’s questions as the means by which exploration can become an investigation and as another vital source of evidence of children’s existing ideas and ways of behaving scientifically.

Here are examples of some questions that are often asked in a lesson on breathing.

1. Is there something that all living people do until they die?
2. Why do we need to breathe?
3. Can you see what you breathe?
4. Which part of air is used for breathing and why?

5. What would happen if there was no oxygen left in the air that you breathe?
6. Does oxygen have weight?

We will now look at each question and see whether it is a good question or not.

The first question is not a very good question because it is ambiguous. There are many possible answers such as people eat, breathe, and excrete. To make this question free of ambiguity, you could rephrase it as follows. Is there something that all living people do all the time, without stopping, until they die? The answer then would be breathing.

Questions three and six are good questions, but they are lower level questions. They do not require much thinking. Making judgments are said to be high level questions.

Question four tests the pupil's recall of information and this is followed by their need to display understanding. It is a good question, although teachers should not be in the habit of asking too many questions at once. The pupils should be given an opportunity to think and answer before the next question is asked. The teacher should allow for a pause, if the questions are asked orally.

Question five is a good high level question that allows pupils to think.

Having looked at these questions we can then say that a good question should:

- be stimulating
- focus pupils' attention
- promote activity and/or reasoning
- lead pupils where the answers can be found
- not be ambiguous
- not ask pupils to do too many things at a time
- not be too long

Remember that your questions should be low level, high level, open ended, and closed. Such questions will not just require pupils to recall information, but will require them to think, reason, and make judgements.

Some of the reasons why we ask questions are to:

- encourage pupils to think
- encourage pupils to display their understanding
- check the knowledge, skill and understanding of pupils
- gain pupils' attention/manage the class or settle them down
- draw out shy pupils
- review or reinforce what has been learned
- follow up

Individual Activities

Activity 1

The approach of questioning is important for teaching and learning, and this is the approach we will use throughout the unit.

At this stage, we want you to reflect on this teaching strategy and ask yourself how you can effectively use it in the classroom.

Activity 2

Visit a hospital and find out how oxygen is used there. You need to write down the questions that you will ask. You could include questions such as:

- Why are some patients connected to an oxygen machine?
- How is oxygen used in the body?
- What would happen if too much oxygen was given to a patient?

Activity 3

Design a lesson on air that will be appropriate for the grade level you are teaching, using questioning as a teaching/learning strategy. Give particular attention to the way the questions are phrased so as to bring about the desirable learning outcomes. At the end of the lesson, reflect on how well the questions were used. It may be advisable that, apart from presenting a lesson plan to a fellow teacher, you actually invite this person to observe your questioning skills in the classroom.

Activity 4

Refer to your syllabus and identify those topics that you think will be dominated by questioning as a teaching approach. You will have to determine whether the questions will dominate the entire lesson, or come at the beginning, middle or end.

Activity 5

Conduct a lesson in the classroom and invite your partner to observe. Let your partner provide feed back to you immediately. Feed back should include, among other things, whether you created opportunities for pupils to ask questions and how you responded to the questions. Discuss your lesson with your partner before and after teaching in order to ensure constructive criticism.

Self Assessment

In what way do you think this teaching/learning approach is of help to you and your pupils? How easy/difficult has it been to phrase good questions? From your experience is it possible that an entire lesson can be dominated by questions? What improvements can you make to the suggested ways of questioning? Are you comfortable letting your pupils ask questions? If so, how have you helped your pupils not to ask unambiguous/silly/trivial questions?

Summary

In this unit, you have discussed **air** and atmosphere. Living things depend on air that is not polluted. Air occupies space and all vessels that appear empty contain air. The questions which should be addressed should be those of what, why, suppose, who, when, where, what do you think, or did you...?

Reflection

Now that you have gone through this unit and have been exposed to the skill of questioning, you must go back to class and see if there are any changes in your teaching. Ask yourself questions such as:

- Do I give my pupils the opportunity to ask questions?
- Who does more talking in class and why?
- How do I respond to “silly” questions?
- When do I ask questions of the class?
- Apart from the skills used in this unit, is it possible to use the skills I learned in other modules?
- If I had to prepare questions on this unit, which type of questions would I ask?

Unit Assignment

1. Which part of air is used up in burning?
2. Name two gases naturally found in the atmosphere, apart from oxygen and nitrogen.
3. List some of the properties of oxygen.
4. Name two industrial and two medical uses of oxygen.

5. In the word search puzzle below, encircle the word that will be an answer to the following:

The words may run across, backwards, downwards, or upwards.

S	I	C	A	I	N	P	S
I	G	A	S	E	S	O	A
R	I	R	E	S	S	M	N
U	N	B	N	E	P	I	E
O	I	O	O	E	U	X	G
P	T	N	X	N	W	T	O
A	R	D	Y	Y	I	U	R
V	O	I	G	G	G	R	I
R	G	O	E	A	E	E	I
E	E	X	N	S	R	S	N
T	N	I	A	I	M	S	N
A	W	D	I	L	O	S	S
W	E	E	D	O	A	I	R

a) A mixture of gases found in the atmosphere.

b) Human beings breathe this gas.

c) The gas from evaporating water and which is 78% of the air.

d) The gas with no fixed % composition.

e) The gas that is active air and is about 0.03% of total air composition.

Check your answers at the end of the Module.

Unit 2: Water

Introduction

Water is the most common liquid found on earth. A liquid is something that flows and changes its shape easily. Usually, it feels wet. Water is made up of two components that are found in the air. These are hydrogen and oxygen.

Water is one of our most precious resources and is necessary to support life. In this unit, you will look at physical and biological uses of water, its sources, supply, and how you can conserve it.

Unit Objectives

By the end of this unit you should be able to:

- describe the water supply systems of a village and a town
- state how pollution of natural water supplies can be reduced
- name some waterborne diseases and how they can be prevented
- list ways to conserve water
- describe the different stages of water purification
- explain how water can be made safe to drink
- describe the effect of soap on different kinds of water

Sources of Water

In this section we will discuss sources of water, some of which you are already familiar with.

Rain water is collected in tanks by means of gutters and pipes from the roof.

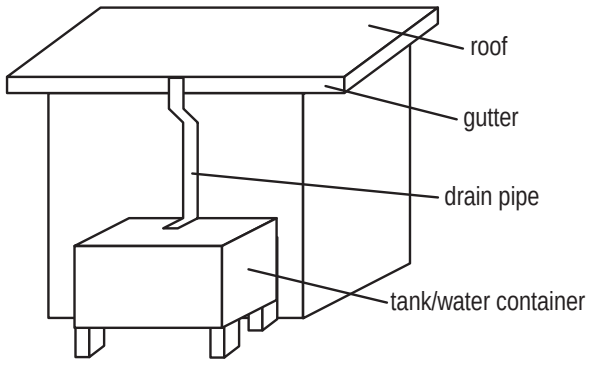


Figure 2.1: Rain water collected by gutters

Spring water is usually clean. The deeper the spring, the cleaner the water. Springs are produced when water sinks into the soil until it reaches a hard layer of rock underground. It flows along until it reaches the surface, usually the side of a hill.

Well water. Wells may be shallow or deep and are a common source of water. If the well is shallow, it must be surrounded with a wall to prevent animals from using it and children from falling into it. A deep well, fitted with a pump, is the best. If there is no pump, the buckets used to draw water should be clean.

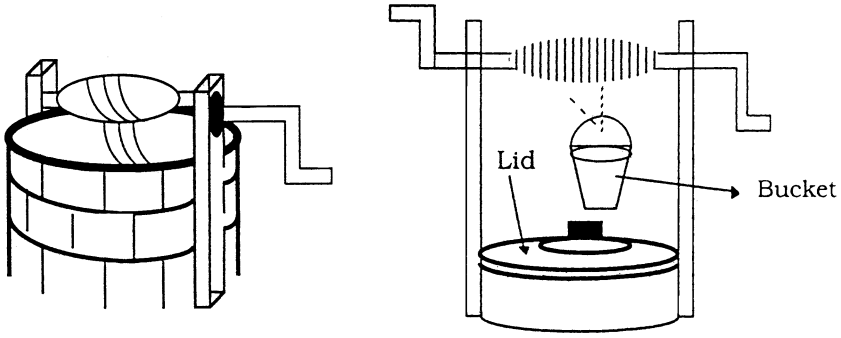


Figure 2.2: Types of wells *A well with a lid*

Boreholes are often very deep and are drilled by machine. The borehole is closed and fitted with either an electric pump or a hand pump. When fitted with an electric pump, it is connected to water pipes and supplies piped water. Boreholes generally provide much safer water to drink than water from wells.

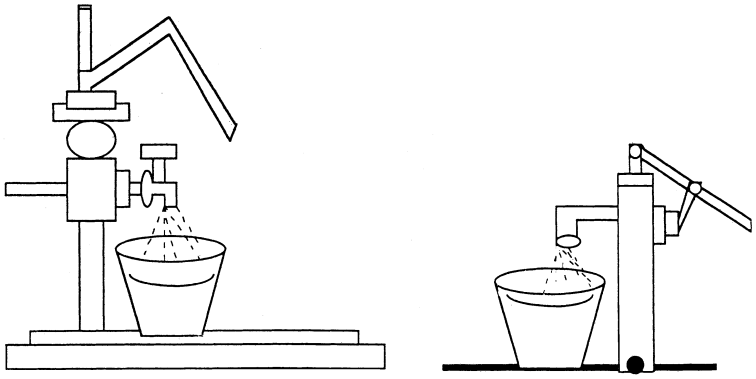


Figure 2.3: Boreholes

Rivers and streams are the most common sources of water. If these sources are far from villages they should be fairly safe from contamination.

Figure 2.4: River

Dams and **reservoirs** are man-made storage places for water. Care must be taken to protect the water against contamination.

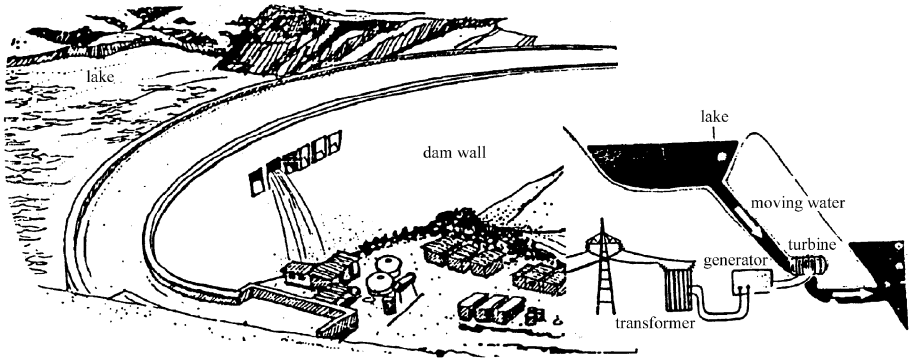


Figure 2.5: Dam

Tap water is very common in urban areas. Water is treated at the water works and then distributed through pipes and taps.

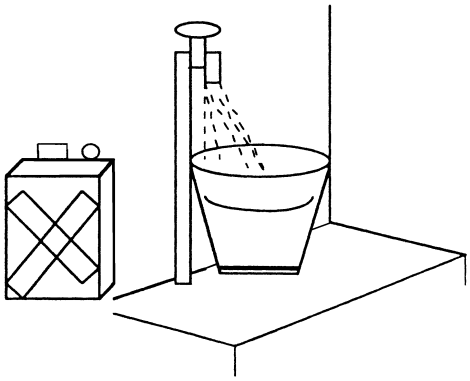


Figure 2.6: Tap Water

Water Supply

Rain is our major natural source of water. It fills lakes, rivers, and oceans. The following illustration shows how rainwater is deliverd to homes in cities.

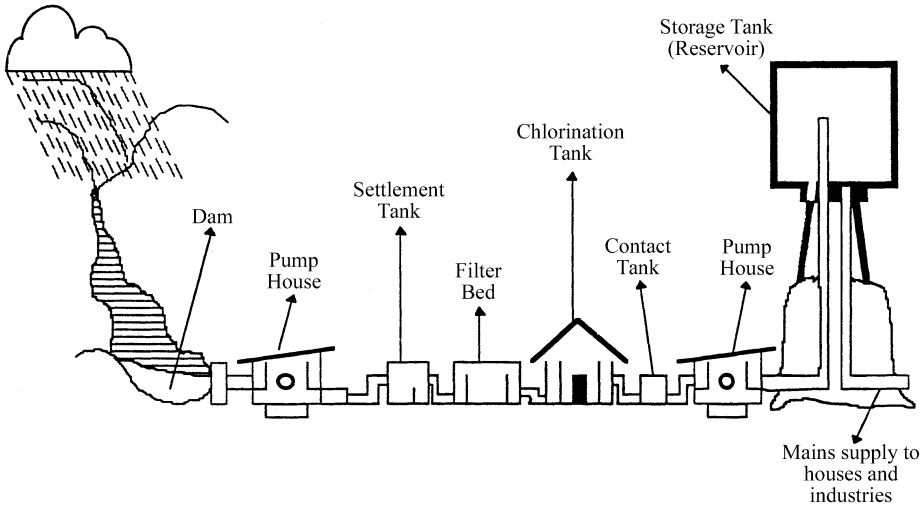


Figure 2.7: Water cycle

In villages, water is drawn from rivers, wells, and boreholes. In most cases it is carried in clay pots and buckets. In towns, water is supplied from sources such as boreholes, rivers, and taps in houses. The water is pumped through big pipes from the source. If there is a water purification plant near your school, please make an effort to visit it.

The purification process is quite complex. It involves the removal of suspended particles by first allowing heavy particles to settle. The water is then filtered, and finally chlorinated to remove bacteria.

Water is not safe to drink if it contains harmful substances and bacteria. Water is contaminated when human, animal, and industrial wastes are allowed to get into sources of water such as wells, rivers, and dams. If the number of people living in an area is large, it becomes difficult to dispose of waste materials effectively. Therefore, more sewage materials are released into rivers and underground water sources.

The use of pesticides and fertilisers by farmers contributes to water contamination when these chemicals are washed into water sources such as rivers, dams, and wells. Other ways water can be contaminated are bathing, swimming, defecating, or urinating in or near a water source.

Figure 2.8: How water is contaminated

When water is contaminated we say that it is polluted. Water pollution is the presence of harmful substances in water. If we drink contaminated water, we can get sick. Some diseases are passed from one person to another through water. Such diseases are known as waterborne diseases. Waterborne diseases often affect the intestines. Examples of such diseases are cholera, dysentery, bilharzias, and typhoid. In the case of bilharzias, the disease normally affects the bladder and the affected person passes urine with blood.

Sickness reduces the ability of people to earn enough money to support their families. People need a good income to pay for education and health services, food, and many other important things in their lives. The spread of diseases can result in many deaths. Death deprives families of those people who are the source of income. The nation also loses people who are productive.

The government or councils spend a lot of money trying to purify water so that enough safe water is available.

It is usually taken for granted that the tap water is clean water, having been subjected to all the purification processes. While the water appears to be free of suspended particles it may not be clean in terms of getting rid of germs through chlorination. In this regard it is strongly advised that the water be boiled to kill the germs.

Water Conservation. Water is important to us because we need it in our daily lives for growing crops, washing, cooking food, etc.

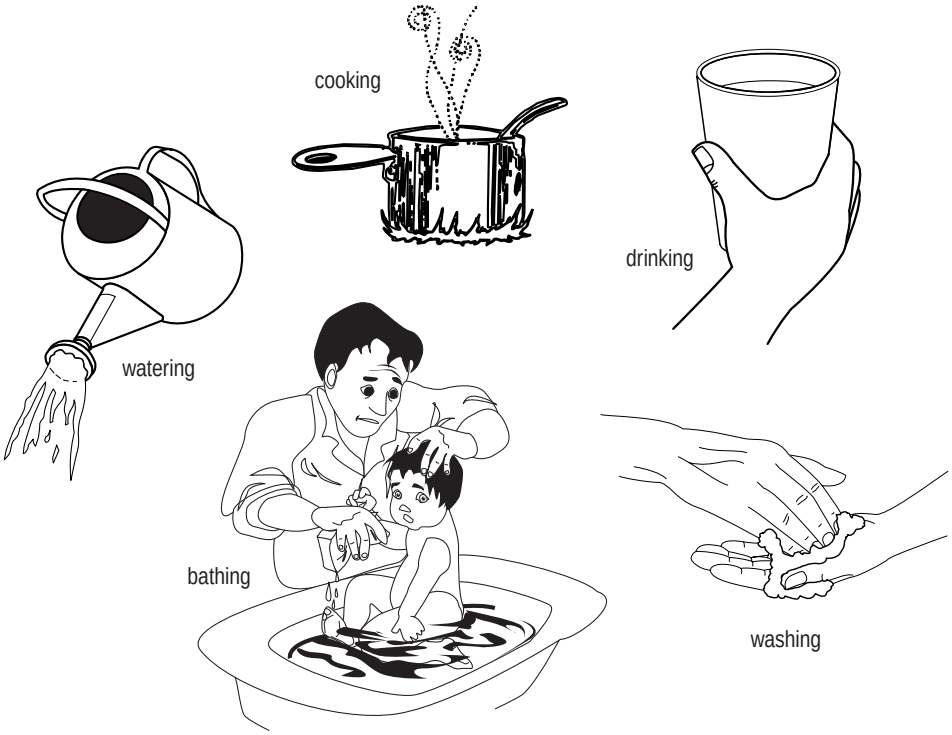


Figure 2.9: Importance of Water

Since water is vitally important in our lives, we should take steps to conserve it so that it can last for a long time. Some of the steps we can take, particularly if we live in towns or villages supplied with piped water, include the following:

- Repair dripping taps.
- Turn taps off after use.
- Water gardens using buckets.

Individual Activity

In Unit 1 the emphasis was on questioning skills for learning and teaching. This skill can also be used in this unit. However, in this unit you will focus on using worksheets to carry out investigations in your local community.

Instructions on how to make worksheets were given in Module One. Refer to Module One to remind yourself how to make good worksheets.

Worksheet 1

Instructions

Working individually or in pairs, go into your local community. Collect as much information as possible on how the local community depends on its water supply, and how water is collected and stored for house or farm use.

	Town	**Village**	**School**
Water Supply Water Storage How Water is Collected			

Worksheet 2

Prepare a worksheet on water pollution in your area. Write enough suitable questions on the worksheet that they will help pupils come up with the required information.

Individual Activities

Now that you have practised how to construct good questions and design worksheets, design questions and worksheets to be used with your pupils in class.

Activity 1

Get as many ideas as possible from your pupils as to what water is and why they think it is important. The questioning approach should be used.

Activity 2

Using the local environment, prepare a worksheet/work card for your pupils to use in the surrounding community to find out how the people use and conserve water in their homes. To do this, arrange a visit to the comunity and prepare a series of questions.

Self-Marking Exercise

Read the story that follows and answer all the questions below it.

People from a certain village far away decided to construct a dam on a nearby stream so they could get water which would collect in the reservoir.

They washed their clothes, bathed, and swam in the dam. Their animals drank from the dam, too. Everyone was happy because they did not have to travel long distances to fetch water.

However, after some time, people of this village started to get sick. One of the boys, Dick, started passing urine with blood.

1. What do you think was wrong with Dick?
2. How do you think he caught this disease?
3. How can this disease be prevented?
4. Another boy, Simon, started having stomach pains and had to go to the toilet often. He also had a high fever. Which three diseases do you think may have infected Simon?
5. List some teaching strategies that can be included in this unit apart from questioning skills.

Summary

In this unit we have looked at sources of water being rain, springs, wells, rivers and streams, dams and reservoirs, water tap, etc.

We have also discussed that drinking water must be treated with chlorine or boiled so that you do not contract waterborne diseases such as cholera, bilharzias, and dysentery.

We have also discussed the ways water can be conserved.

- Repair dripping taps.
- Turning off taps after use.
- Water gardens using buckets.

Apart from questioning skills, you can use other teaching techniques as well.

Reflection

Before you prepared your lesson for your grades, did you have a chance to think about the type of questions you would ask? Did you ask questions before, during, or after the lesson.

List the things you were criticised on during the time you were observed by your partner. Which things have you considered changing after being observed? Are you open to criticism from your partner and why?

Unit Assignment

1. List four main sources of water.
2. Which process in the water purification process kills germs?
3. Describe how water is contaminated.
4. Name the most common waterborne diseases.
5. Why should filtered water also be boiled?
6. Briefly describe how water is purified in a modern water purification system.
7. State some ways to conserve water.

Unit 3: Soil

Introduction

Soil is a familiar topic to most learners. Soil is very important because plants grow in the soil and animals live on or in the soil. In general, soil is important for agriculture, construction, and is a habitat for a number of organisms. In this unit, you are going to focus on the formation of soil, its properties, the different types of soil, and how you can conserve it.

Unit Objectives

At the end of this unit you will be able to:

- describe the formation and composition of soil
- compare and contrast the composition and properties of sand, clay, and loamy soil
- describe the causes of soil erosion
- describe methods of conserving soil by preventing soil erosion

Unit Content

What is soil?

Soil varies in thickness from a few millimetres to several metres. It is the lifeblood of our agriculture which is the source of nearly all food. Animals and plants interact with each other as well as with the weathered rocks to form soil. Soil is composed of solid particles of different sizes, organic material, air, and water.

Formation of Soil

Since soils are so important, we must understand how they form. The layer of soil on the earth has resulted from many process—physical, chemical, and biological—acting over a long period of time.

The mineral part of soil comes from rock, referred to as the **parent rock**. Chemical and physical processes gradually break down the rock into smaller and smaller components. These weathering processes include changes in temperature (causing the rock to expand and contract), friction from the wind and water, abrasion, chemical weathering, and dissolution.

Chemical weathering of rocks is a slow, almost unnoticed, process. Rain water contains dissolved carbon dioxide that forms a weak carbonic acid. The acid reacts with certain minerals in the rock and breaks them down into soluble mineral salts. Some rock types are more affected by acids than others.

The sand, silt, and clay that are produced from weathered and eroded rock make up the mineral component of soil. Material added by the biological activities of plants and animals make up the organic component of soil. The time required to produce soil varies, depending on the type of parent rock, the climate, and the types of living organisms that are present. It can take as long as 1000 years.

Components of Soil

From the description of soil formation, you can see that soil has physical, chemical, and biological components. To investigate the components, you can carry out a simple test.

You will need soil, a large jam jar, soil, and water. After collecting the materials, do the following:

- Shake a sample of soil in a jam jar filled with water.
- Ensure that the water and soil are well-mixed.
- Allow the mixture to stand for awhile.
- Observe what happens—after a short period and after a whole day—with different soils.

The biggest particles rest in the bottom and smaller particles occupy previous layers. This process is called soil sedimentation.

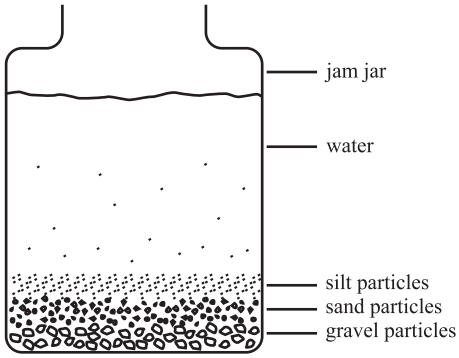


Figure 3.1: Soil sedimentation

From this test, you can see that the soil contains different sized particles and organic material. Small organisms may also be present. Other components not investigated in this unit so far include air, water, and substances dissolved in the water.

Soil contains micro-organisms and organic matter (dead plants and animals that have decomposed into humus). Larger organisms, such as worms and termites, are involved in soil production. Below is a summary of useful and harmful soil organisms.

Soil-building Organisms

Useful		**Harmful**	
Soil Organism	*Function*	*Soil Organism*	*Effect*
Earth worms	Aeration, improve fertility	Insect larva	Destroy crop roots
Bacteria	Cycling of nutrients	Millipedes	Eat crop roots
Fungi	Decomposition	Cutworms	Eat crop roots
Woodlice	Break up plant material	Mole rats	Eat crop roots
Termites	Break up plant material	Nematodes	Destroy crop roots

Many organisms live in the soil and contribute to soil production. This table shows two types of soil producers: those that are considered harmless and those that are harmful to human crops.

Soil Fertility

Crops obtain nutrients from the soil and for more crops to grow, the nutrients must be put back into the soil. In this section, you will look at:

1. using manure or compost
2. how to improve soil using fertilizer

Compost is made of materials that are rotting. These materials can be grass, dead plants, and animal droppings.

A compost heap is made by layering dead grass/plants and soil in a pit. The materials will rot faster if water is added. Every seven days, the compost heap has to be turned with a garden fork. If a stick can be easily pushed into the heap, then the materials in the compost heap are rotting. The compost will be ready for use after three or four months.

Apart from using the compost to improve soil fertility, we can use artificial fertilisers. These are chemical compounds made in factories by mixing different chemicals.

We can divide fertilisers into two groups. There are straight and compound fertilisers. A straight fertiliser usually contains one nutrient. Common straight fertilizers are put in the soil when the crops are already growing. Compound fertilisers contain two or more of the main nutrients. Examples include compound D, compound X, compound A, etc. Compound fertilisers are applied during planting. This is called basal dressing.

Soil Erosion

Some of the ways soil can lose its fertility are soil erosion, leaching, ranching, growth of weeds, overcrowding, monoculture, and even harvesting of crops. In this section, you will look at soil erosion.

You have learned how rocks are eroded and help to make the soil. Some of the forces that make the soil can also erode so that it is not useful to the farmer.

Soil erosion is mainly caused by running water, wind, and sun.

Erosion By Water

Soil can be carried away by moving water. Unfortunately, it is the top soil (the best soil) that is lost first. On a slope, water does not soak into the ground and as a result less water is stored underground. Water removes a thin layer of soil from sloping land and though the quantity of soil lost may be small, it is washed away and lost. Heavy raindrops first loosen the bare soil and the soil particles are moved downhill by the running water.

If the running water is not stopped, it can remove subsoil and create gulleys. Sedimentation can also be caused by running water. In this process the heaviest particles are deposited first because they sink more quickly through the water. The sediment may be enough to cover crops growing in the lower areas, causing great loss, and it may also spoil lowland soil by covering it with poor quality sediment such as sand.

Erosion by Wind and Sun

Wind and sun always act together to cause erosion. Soil that is not protected by plants can easily be eroded. Such bare soil is quickly dried by the sun, which destroys the humus that holds soil particles together. After this, the wind blows away the soil. In most African countries, much soil can be lost because the wind is often strong during hot weather. Fire is another danger during the hot season as it can destroy trees and other plants, leaving the soil exposed to erosion.

Soil Conservation

Soil erosion becomes a danger when we clear land to grow field crops. Soil conservation methods should be practised when growing field crops. The common conservation methods are described below.

Ploughing across the slope reduces erosion on slopes. Bench terraces are made by moving the soil to form benches across the slope. They look like steps cut in the slope and usually follow the contours. The terraces catch the rain water, preventing it from eroding the hillside. The bench terraces are planted with grass for protection. In this way, the soil is not eroded.

Mulching and adding manure to the soil can help retain moisture. What is meant by mulching? Mulch is a material used to cover the soil. Crop remains such as straw and maize stalks can be used as mulch to protect bare soil from heavy rain, sun, and strong winds. After a rainstorm mulch slows the rate of water run off.

Alternative strip-cropping reduces run off. Here different crops are grown on narrow strips of land across the slope, following the contours. Strips of cover crops, such as grass, are grown between crops. On sloping land, the strips of cover crops slow the flow of rainwater down the slope, allowing more water to soak into the soil.

Soil type	Rate of Water Rise
Sand	Slow
Clay	Fast
Loam	Moderate

Crop Rotation

In crop rotation we grow different crops in the same area in a regular order. A rotation keeps the soil fertile and also improves the amount of humus in the soil by ploughing in grasses and remains of crops. The humus in the soil acts like a sponge and allows more water to be absorbed by the soil therefore reducing run off.

Individual Activity

The teaching skill you will be looking at in this unit is questioning. Using the activities in this unit, you should make use of this skill.

Activity 1 - Field trip

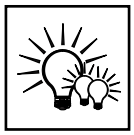
Go to a farm where erosion has taken place and observe the effects.

- Identify the type of erosion that has taken place.
- What problems does the farmer face in relation to soil erosion?
- How does the farmer prevent soil erosion?
- Does the farmer improve or retain fertility?
- What are the methods used to improve and retain soil fertility?

Activity 2 - Experiment

Carry out a soil investigation by taking a sample from your garden soil. Shake the soil with water in a glass jar and allow it to stand for 24 hours. What happens?

- Can you suggest another method for separating the solid components of soil?
- Think of a way to determine the organic (humus) content of a soil and write answers in point form.



Classroom Activities

Activity 1 - Planning Lesson

As a teacher, you will be required to construct good questions for a lesson. Are these soils good for plants to grow in? Why? Ask your pupils to identify type of soils in their area and through good questioning, let them decide through discussion if soils are good for plants to grow in. You could also ask your pupils to explain the causes of soil erosion in their area and how it is prevented.

Activity 2 - Compost

You have the following materials available for making compost:

- wood
- ash
- dung
- dried grass
- branches pruned from fruit trees
- waste food from a school kitchen
- banana leaves

Have your pupils make a drawing to show how they would build the compost heap.

Self-Marking Exercise

1. Give an example of soil erosion that you have seen. Explain what caused the erosion.
2. How do water and wind cause soil erosion?
3. How do terraces help to prevent soil erosion?
4. How can you maintain soil fertility?
5. Mention two methods of poor farming that can cause loss of soil fertility.

Summary

In this unit, you have looked at the formation and composition of soil, properties of soil, soil erosion, and how you can conserve soil through preventing soil erosion. The skill you are using when dealing with this content is questioning. You may use other skills apart from those discussed in this unit.

Reflection

1. Imagine that you have shaken a handful of loam soil and water in a jar. Make a drawing of the different layers you would expect to find after the soil has settled.
2. Think of a way to determine the organic (humus) content of a soil. Devise questions that will lead your students to give answers in point form.
3. Visit your local farmers and using the skill of questioning find out from the farmers the methods they use to prevent soil erosion.

Unit Assignment

1. What is humus?
2. Why is humus an important part of soil?
3. What is soil made of?
4. How is soil formed?
5. The table concerns the rate at which water rises in three soil types. Copy the table and complete it.

Soil type	Rate of Water Rise
	Slow
	Fast
	Moderate

Unit 4: Light

Introduction

This unit is about light. In this unit we will discuss sources, properties, and uses of light. In order to further sharpen your questioning skills, you will be expected to practice this as well as other related skills in readiness for classroom use.

Unit Objectives

At the end of this unit you should be able to:

- classify sources of light as natural and artificial
- demonstrate that light travels in straight lines
- classify materials as transparent and opaque
- explain the uses of light
- demonstrate the properties of light
- use questioning as a skill for effective teaching

Unit Content

What is light?

Light is a form of energy that is detected by the eye.

Where does light come from?

Light comes from two sources, i.e., natural and artificial. From the list below, can you identify which are natural or artificial light sources?

- burning candles
- fires
- the sun
- stars
- hot filament of an electric bulb

Natural sources as well as artificial sources give out some form of light and these are luminous objects. Non-luminous objects such as the moon, a tree or human beings do not give out light of their own. How do we know that they are there?

What are the characteristic features of light?

You will carry out the following simple activities to establish the characteristics features of light.

Place a round opaque object in the path of light from a point source as in *Figure 4.1*. Describe what you see on the screen.

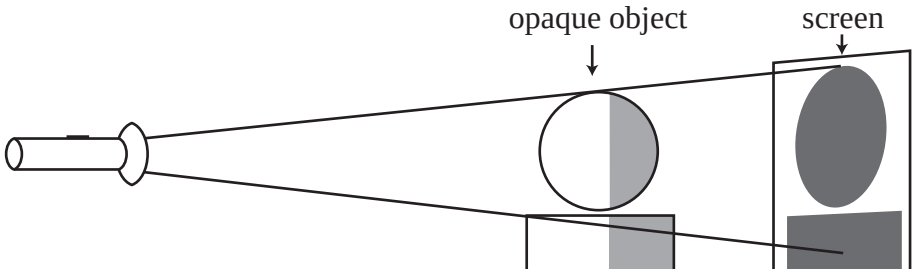


Figure 4.1: An object in the ray of light casting a shadow on the screen.

Make a pin hole in the centre of three cards. Line up a burning candle with the three cards as shown in *Figure 4.2* below. Look through the pinhole to see the light from the candle. Move one card so that they are no longer in line. Are you still able to see the light?

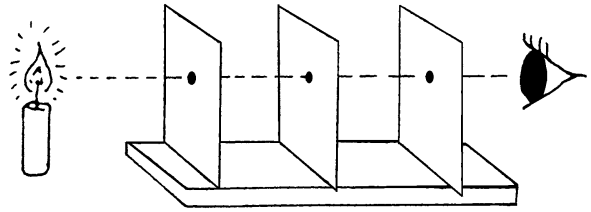


Figure 4.2: Light travels in a straight line.

These two activities illustrate an important property of light, i.e., that it travels in a straight line.

When light strikes a surface, it will bounce back, but as you are aware, the bouncing back will depend on the nature of the surface. On a rough surface, the bouncing back scatters the light in all directions. We call this a **diffuse reflection**. However if the surface is smooth, the bouncing back occurs without scattering. We call this a **regular reflection**.

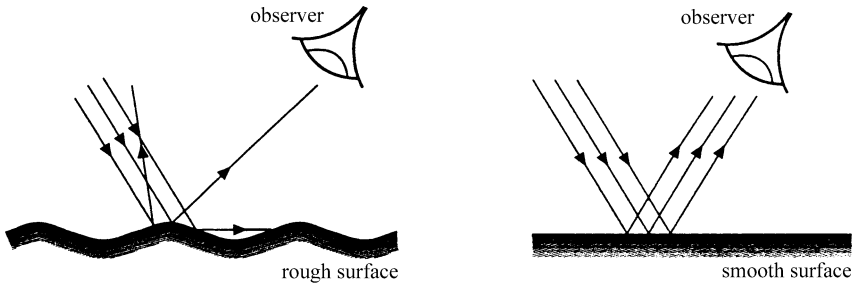


Figure 4.3: Reflection

This leads to two other properties of light, which are that light can be reflected and scattered.

Opaque bodies allow light to bounce back a little, so the light gives them a dull appearance.

Transparent bodies, like clear glass or water, will allow light to pass through.

Light passing from one medium to another of a different density experiences some bending. The bending effect (**refraction**) is due to changes in the speed of light as a result of changes in the density of the medium.

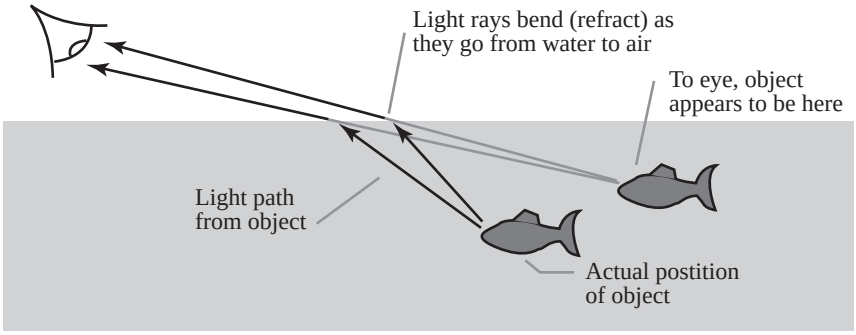


Figure 4.4: Refraction

With the help of ray diagrams explain some effects of refraction that causes:

- a pond to appear shallower than it really is
- a stick to appear bent when one end is inserted in a river (or container of water)

Effects of Light

The sun supports all life on earth. Try to imagine for a moment what it would be like without this natural source of light. Can you list some of the problems that would arise from the absence of light?

Some of the problems you may have considered could include:

- We could not see anything because of darkness.
- Plants could not manufacture their food.
- There would be no food for us and other animals.

With these problems in mind, you should now appreciate the reasons for developing man-made sources of light as a way of making life possible for animals (including us) and plants.

The white light that comes from the sun is the only visible part of the spectrum. When split, white light gives seven colours of the rainbow. Can you name the colours of the rainbow in their correct order? To help you with naming the colours, here is a sentence (mnemonic) that will enable you to remember the colours.

Richard	**O**f	**Y**ork	**G**ained	**B**attle	**I**n	**V**ain
Red	**O**range	**Y**ellow	**G**reen	**B**lue	**I**ndigo	**V**iolet

Try this ROYGBIV or the reverse word VIBGYOR. Which one helps you to remember colours of the rainbow better?

Uses of Light

Now you will consider the uses of light from the sun.

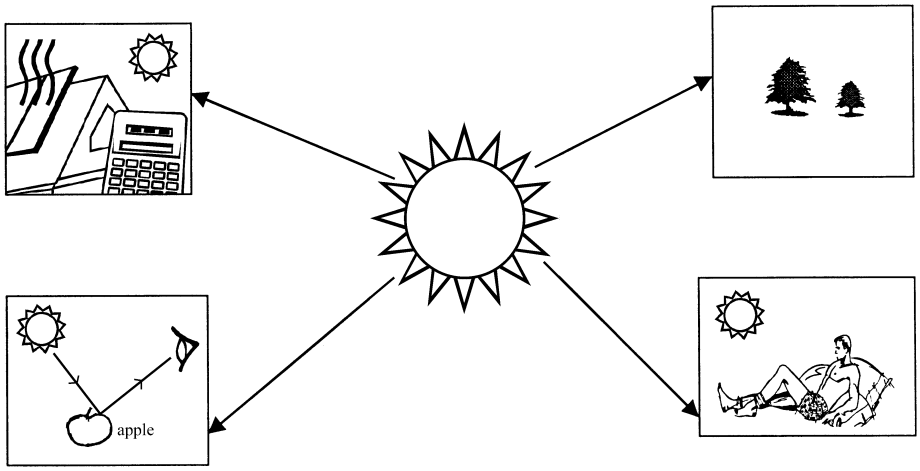


Figure 4.5: Examples of sunlight usefulness

Study *Figure 4.5* and explain each picture in terms of the usefulness of the sunlight.

Individual Activity

Activity 1 – Harmful Effects of Sunlight

Reflect on what you have read about light in this unit so far. You may/may not agree that what has been mentioned so far are the good aspects of light. Can you now identify some harmful effects of sunlight?

Caution—When discussing the sun's light with your students, remind them to **never** look directly at the sun. Looking at the sun, even for a few seconds, can cause permanent damage to the eyes.

In what ways is sunlight harmful?

In order to identify the harmful effects you may need to go out in the environment and make observations. Some of the things you will be able to notice are:

- plants wilt and die because of too much sunshine
- rivers dry up

Activity 2 – Examining Shadows

Why are shadows different at different times of the day? You are probably aware that this question requires some research work. You will have to refer to Module 2, which has a unit on research/project work. For this activity you will need to go outside and stand in the sun. You will also need to work in pairs.

Consider the following questions and as you go through them, attempt to find solutions by doing the activity.

While standing in the sun, have your partner draw your shadow, indicating your position as you turn in different directions.

- does your shadow look like you?
- does your shadow change positions as you turn round?
- at what time of the day is your shadow:
  - longest?
  - shortest?
  - the same size as you?

In answering these questions and from your responses, are you able get useful information about your shadow?

Activity 3 – Do plants need light?

To test this, use two similar potted plants labelled A and B, growing in the same type of soil. Place plant A in the light and plant B in the dark. Think of a way to create darkness even during the day. Ensure that both plants are given the same amount of water. Examine the plants after a week.

What is the difference between the two plants in terms of appearance of the leaves (colour) and health.

In these three activities, in what ways have the questions been helpful? What improvements can you make to the questions so that the responses enable you to get the most information?

Classroom Activity

1. Working in groups of two, ask the pupils to bring a bottle top, ball, pencil, match stick, umbrella, cup, and any other suitable items that they can bring to the classroom. What sort of shadow will these objects produce?
2. Refer to unit activities 2 and 3 and make these into a classroom activity. Design the activity in such a way that it is group work and involves research.

Self-Marking Exercise

1. How easy was it to try the teaching approach you have been practising in the classroom situation?
2. What advantages have you found in having pupils do the activities in groups as opposed to you doing them alone?
3. From your experiences, what modifications can you suggest when using questioning as an approach to teaching and learning?

Summary

In this unit we have been discussing some aspects of light as it relates to our natural environment. This topic is closely related to the topics of air, water, and soil which are essential to our life. Can you imagine what life would be like without light? Apart from being engulfed in darkness, there are certain processes in life that depend on light. The pupils may take it for granted that light will always be there.

The science lessons are meant to create an awareness, knowledge, and understanding of light so that this resource can be managed well. The classroom, which is the learning environment, is the place to develop skills and attitudes that are desirable. Teaching strategies that emphasise hands-on experience and questioning techniques have been the focus of this unit.

Reflection

Now that you have come to the end of this unit, ask yourself if what you have experienced can be translated into classroom practice.

You should be thinking of improving the questions that are asked before, during, and after each lesson. Whatever questions you put across to the pupils must have a purpose. The nature of the questions you pose will depend on the nature of the topic. Another issue to reflect on is whether it is possible that a lesson can have only one teaching strategy, i.e., in this case using questions only instead of combining with other teaching strategies.

Unit Assignment

1. Draw ray diagrams to demonstrate both complete and partial shadows.
2. Draw ray diagrams to demonstrate a pool appearing shallower than it really is.
3. Light travels in rays or beams. There are three types of beams—diverging, parallel, and converging. Draw diagrams to show each type of beam.
4. Plants manufacture their own food through the process of photosynthesis. Write the word equation for this.
5. State the energy changes in each of the following:
   a) Electric bulb
   b) Solar cell
   c) Burning candle
   d) Manufacture of plant food in the green leaf in the presence of sunlight

Unit 5: Plants

Introduction

We can put plants into two groups, namely flowering plants and non-flowering plants. In this unit, you will look at flowering plants, their structures, their transport system, and usefulness.

Plants are made up of different types of cells. They have different parts such as stems, roots, and leaves which have special functions.

Humans are totally dependent on plants for food, either directly or indirectly. Indirectly we depend on animals that eat plants. We also depend on plants for building materials, rope, dyes, and useful chemicals (drugs). Careful farming of plants and the protection of those growing wild is therefore very important. Your pupils should be made aware of the importance of plants and how we use them.

Unit Objectives

By the end of this unit you should be able to:

- draw and label the main external features of plant (root, stem, flower, fruit, seed)
- state the functions of the root, stem, leaf, flower, buds, and fruits of the plant
- state some uses of plants and their role in the environment
- identify useful plants and name the products we get from them
- describe how leaves get dissolved minerals from the soil
- demonstrate movement of dissolved material in the plant stem
- demonstrate the importance of chlorophyll, water, light, etc., in starch production
- describe the process of photosynthesis
- describe how transpiration takes place through the stomata

Introduction to Plants: Anatomy, Physiology and Uses

External structure of a plant

A plant has two main parts. The part that grows into the ground is the **root system** and the part that grows above the ground is the **shoot system.**

As you know, the root system consists mainly of the roots and the shoot system consists of the stem, leaves, buds, flowers, and fruits.

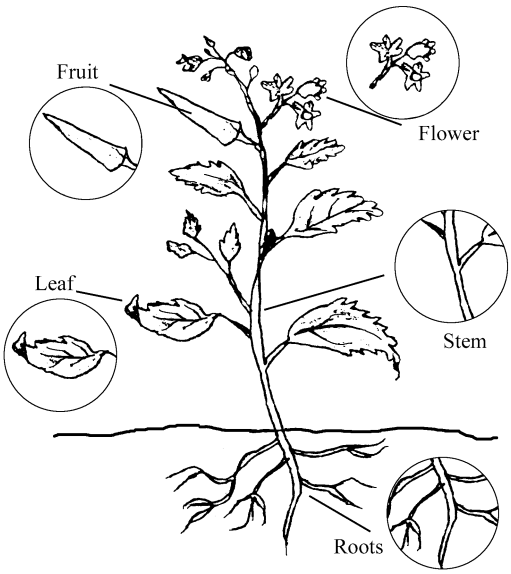


Figure 5.1: External features of a plant

Different parts of the plant have special functions. Stems support the plant and allow transport of materials up and down. Roots anchor the plant in the soil and are responsible for the absorption of water and dissolved substances. Leaves manufacture carbohydrates and allow water to evaporate during transpiration.

Internal Structure of a Plant

All plants are made up of very small units called cells. Cells are so small that we must use a microscope to see them. There are different types and sizes of plant cells, but generally they have regular outlines and fixed shapes. *Figure 5.2* shows a generalised structure of a plant cell. Note the main parts of the cell.

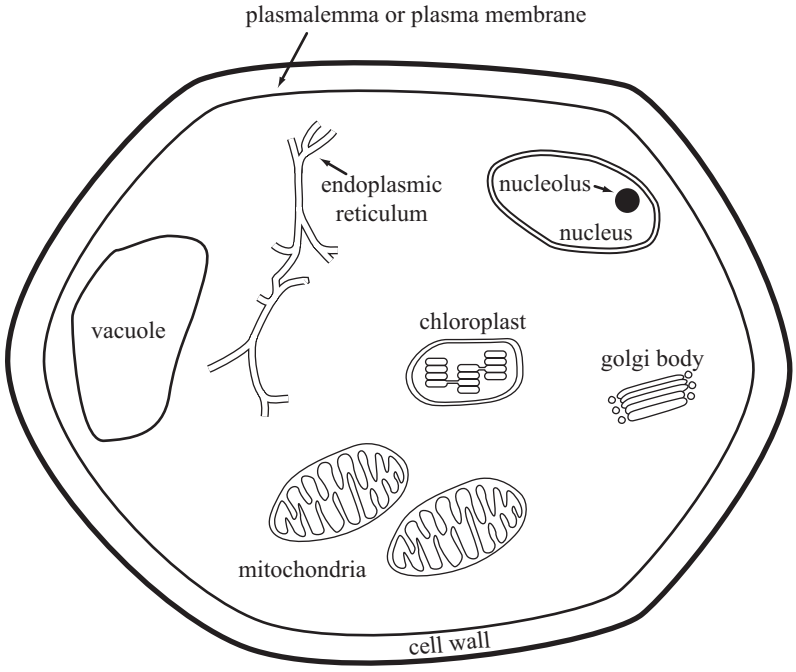


Figure 5.2: General structure of a plant cell

The plant cell is made up of a double cell wall, cell membrane, cytoplasm, vacuole, nucleus, mitochondria, and other smaller parts.

The **cell wall** gives the shape of the cell and also protects it. Solution can pass into and out of the cell through the cell wall. The **cell membrane** is on the inside of the cell wall and allows some substances to pass through it. Next to the cell membrane is the **cytoplasm**, a semi-fluid in which most of the activities in the cell take place. In a leaf cell, you can see some tiny particles inside the cytoplasm. These are called **chloroplasts**. Chloroplasts contain a green pigment called chlorophyll, the substance that helps the plant make its food and gives the leaf its green colour. Inside the cytoplasm of a plant cell is a **nucleus**. The nucleus controls all the activities of the cell. The cell membrane, the nucleus and the cytoplasm together form the **protoplasm**, which is the living part of the cell. A cell also contains a **vacuole,** which is a space where the cell sap is stored. The cell sap is a solution of dissolved mineral salts, sugars, and water. Animal cells don't have a cell wall, chloroplasts, and vacuoles.

Vascular bundles

If you cut a cross-section of a plant and observe it under a microscope, you would see that plants contain **vascular bundles**. These are groups of specialised cells that conduct water, dissolved salts, and food up or down the stem. The vascular bundles in the roots, stem, leaf stalks, and leaf veins all connect to form a transport system throughout the entire plant.

The two main tissues in the vascular bundles are called **xylem** and **phloem.** Food substances travel in the phloem; water and salt travel mainly in the xylem. The cells in each tissue form elongated tubes called vessels (in the xylem) or sieve tubes (in the phloem) and they are surrounded and supported by other cells. *Figures 5.3* and *5.4* show cross-sections through the stem and root.

A vessel is made up of a series of long cells joined end to end. Once a region of the plant has ceased growing, the end walls of these cells are digested away to form a continuous, fine tube. At the same time, the cell walls are thickened and impregnated with a substance called **lignin**, which makes the cell wall very strong and impermeable. Since the lignified cell walls prevent the free passage of water and nutrients into the cell, the cytoplasm dies. This does not affect the passage of water in the vessels. Xylem also contain many elongated lignified supporting cells called fibres.

The conducting cells in the phloem remain alive and form sieve tubes. Like vessels, they are formed by columns of cells. Perforations appear in the walls, allowing substances to pass from cell to cell, but the cell walls are not lignified and the cell contents do not die, although they do lose nuclei. The perforated end walls are called sieve plates. Phloem contains supporting cells as well as sieve fibres.

Vascular bundles have a supporting function as well as a transport function because they contain vessels, fibres and other thick-walled elongated cells. In many stems, the vascular bundles are arranged in a cylinder, a little way in from the epidermis. This pattern of distribution helps the stem to resist the

side-ways bending forces caused by the wind. In a root the vascular bundles are in the centre where they resist the pulling forces which the root is likely to experience when the shoot is being blown about by the wind.

The network of veins in many leaves supports the soft control tissues and resist stresses which could lead to tearing.

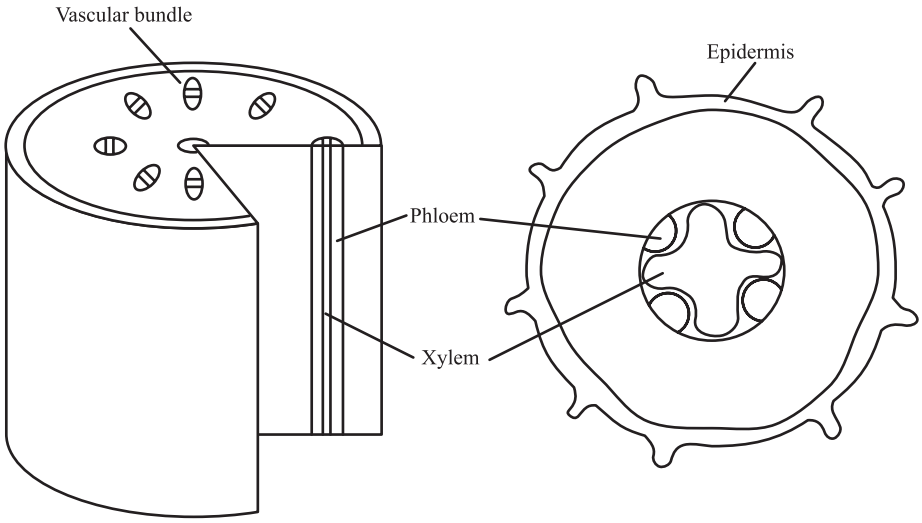


Figure 5.3: A section through a stem Figure 5.4: A section through a root

Transpiration in Plants

Plants require mineral salts, sunlight, carbon dioxide, and water to make food. In this section, we will discuss transport of mineral salts and how water is lost from the plant. You will do this through a series of experiments.

Experiment 1

For this experiment, you will need red or blue ink, a bottle, some cotton wool, water, and a young plant (preferably black jack).

Mix some water and ink in the bottle. What is the colour of the mixture? What is the colour of the stem and leaves of the young plant? Now place the young plant in the bottle as shown in *Figure 5.5* and set it aside.

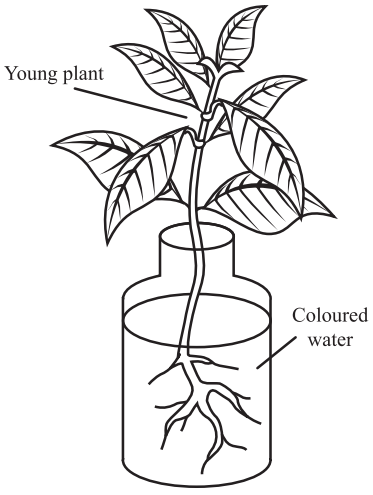


Figure 5.5: Transport of water and minerals in a plant

After about two hours, examine the plant carefully and suggest reasons for any change in the appearance of the plant.

In this experiment, ink is transported from the roots, up the stem, and into leaves. The colour of the ink acts as a marker and shows how the solution moves. It is a relatively slow process. Plants use the same process to absorb minerals from the soil. You do not normally see this happening because the mineral salts are not coloured.

Experiment 2

This second experiment will emphasise how you can show that a plant loses water. You will need a leafy plant, a transparent plastic bag, a piece of string, a piece of blue cobalt chloride paper, a pair of forceps, and some anhydrous copper sulphate.

Place a leafy branch in a plastic bag. Using the forceps, place the cobalt chloride paper in the plastic bag and tie the bag with the string as shown in *Figure 5.6*.

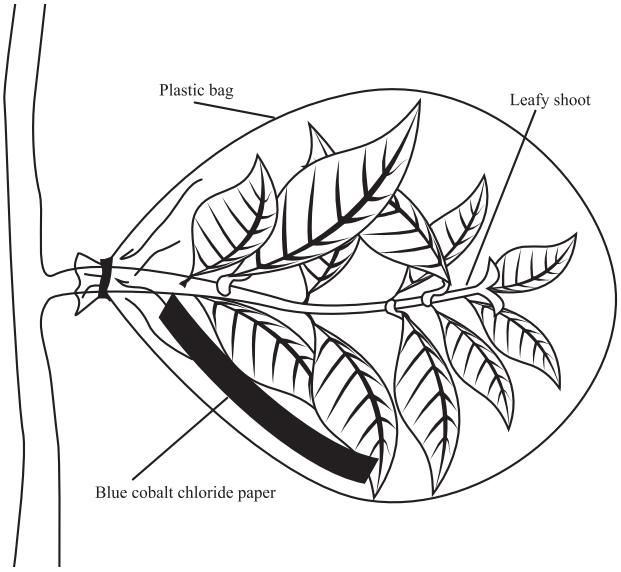


Figure 5.6: Plant transpiration experiment

What happens to the blue cobalt chloride paper after a few minutes? What do you observe in the plastic bag after ten minutes? After twenty minutes? Carefully remove the plastic bag from the branch without losing the contents. Suggest what the liquid collected in the plastic bag might be. Where did it come from? How would you identify this liquid? Test the liquid collected by adding it to some anhydrous copper sulphate and observe what happens.

Water is identified either by using cobalt chloride paper or anhydrous copper sulphate. In the above experiment, you saw that the piece of blue cobalt chloride paper changed to pink. You also observed that the liquid collected inside the plastic bag turned anhydrous copper sulphate from white to blue. This indicates that the liquid collected was water.

In order to find out where the water came from, you need to look at the internal structure of the leaf. The water diffuses from the cells and evaporates into the air space. As a result, the air space usually contains a lot of water vapour.

Chloroplasts are found mostly in green leaves and green stems. Chlorophyll in the chloroplasts traps light energy from the sun. This energy enables carbon dioxide and water to combine and form sugar. Some of the sugar is combined to form starch. The starch formed is usually stored in the leaves during daytime. For this reason, we test leaves for starch to confirm if photosynthesis has taken place.

Most of the oxygen produced during photosynthesis diffuses into the atmosphere and becomes part of the air. Photosynthesis can be summarised in a simple way by using the following work equation:

$$\text{Carbon dioxide + water} \xrightarrow[\text{sun light}]{\text{chlorophyll}} \text{sugar and oxygen}$$

In the above chemical equation, carbon dioxide and water are called the reactants while sugar and oxygen are called the products. Light and chlorophyll are merely conditions under which photosynthesis occurs. Much of the sugar is soon converted into starch, which is why the starch test indicates active photosynthesis.

The simple word equation given earlier may be extended to produce a chemical equation representing the photosynthesis.

$$6CO_2 + 6H_2O \xrightarrow[\text{sun light}]{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$$

We can now look at steps in the chemistry of photosynthesis.

The process of carbohydrate synthesis involves a series of reactions in two stages—the light stage and the dark stage of photosynthesis.

Light passing into the leaf is “trapped” by chlorophyll molecules and is converted to chemical energy known as ATP (adenosine triphosphate). This temporarily stores energy for use in photosynthesis. This part of the reaction requires light and is therefore light dependent.

The ATP is used to split water into hydrogen and oxygen (photolysis). These two elements are used later in the dark reaction. The oxygen is released as a gas through the stomata.

The hydrogen is combined with carbon dioxide from the atmosphere to form carbohydrate molecules. The ATP is used for this build-up of inorganic molecules into organic carbon compounds, such as glucose. This part of the reaction can occur in the dark and is therefore referred to as light independent.

A green leaf requires very little light to trigger the chlorophyll energy conversion. Once energy is available as ATP, the carbon dioxide from the air is reduced by the addition of hydrogen to form glucose. This compound may then be converted to other forms of carbohydrate in the leaf. These reactions are far more complex than indicated, involving many enzyme-controlled stages. The water molecules in the leaf are used as the source of hydrogen and oxygen released to the atmosphere through the stomata (*Figure 5.7*).

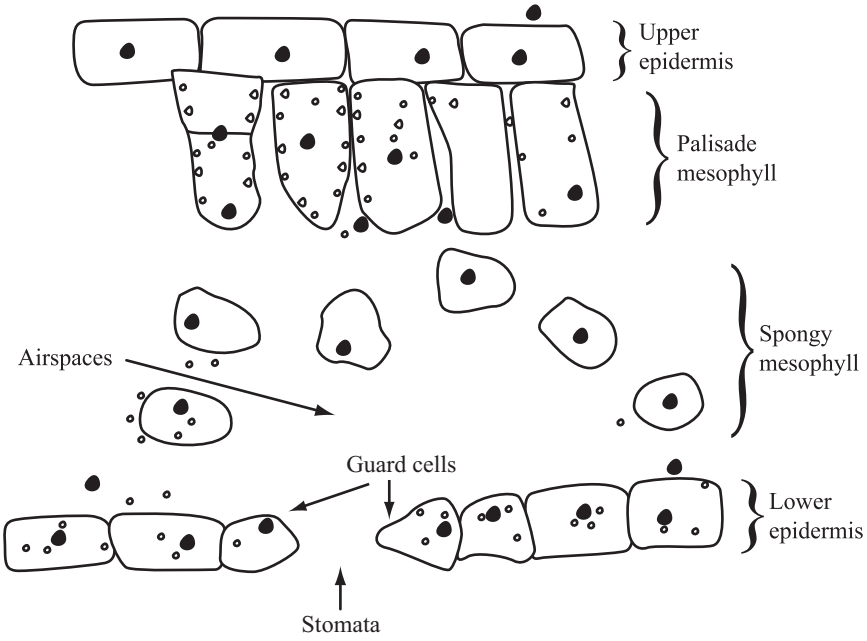


Figure 5.7: Internal structure of a leaf

When the stomata open, the water vapour diffuses from the leaf into the atmosphere. This process of losing water in the form of water vapour by plants into the atmosphere is known as transpiration.

In general, most plants have more stomata on the lower surface than on the upper surface. This distribution helps the plant to reduce transpiration. In addition to fewer stomata on the upper surface of the leaf, the surface is shiny so it reflects some of the direct light it receives from the sun. Consequently the amount of water lost through transpiration from the upper surface is reduced. There is more transpiration on hot, dry, windy days.

Plants found in areas where rain is seasonal have specially developed features to overcome excessive loss of water by transpiration. Shedding of leaves greatly reduces the rate of transpiration, enabling the plant to retain enough water to survive the dry season. Some plants may have leaves with hairy surfaces or sunken stomata. These structures may be there mainly for the reduction of transpiration.

Photosynthesis

Photosynthesis is a process by which green plants manufacture carbohydrates using water and carbon dioxide as raw materials, light as a source of energy and releasing oxygen as a by product. (Photo = light, synthesis = building up). Photosynthesis is a long and complicated process which occurs in the plant.

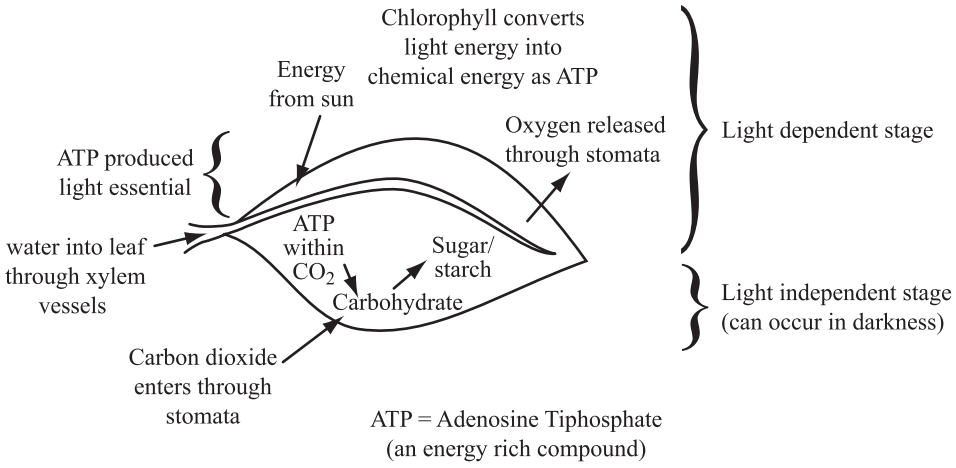


Figure 5.8: Photosynthesis

The unique process of photosynthesis by all green plants is vital for producing all the food on earth as well as oxygen for the respiration of all living organisms.

Usefulness of Plants

You have read in the introduction to this unit that humans are totally dependent on plants for food, either directly or indirectly. Earlier modules have also addressed the importance of plants for human survival.

Before you discuss the details of how useful plants are, it is better to first identify the types of plants. Here are a few hints to help you to identify them.

Shrubs

Shrubs are generally much smaller than trees and have several stems (*Figure 5.9*).

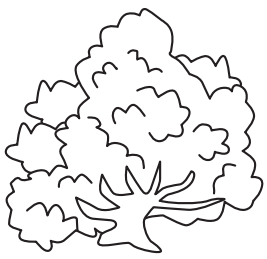


Figure 5.9: Shrub

Leaves

You should easily be able to identify leaves. Leaves come in various shapes and sizes and can be broad, wide, long, short, thin, or flat. Some leaves are needle-like and are usually evergreen like conifers. Some plants have their leaves growing at the top like palm trees. Here are some examples:

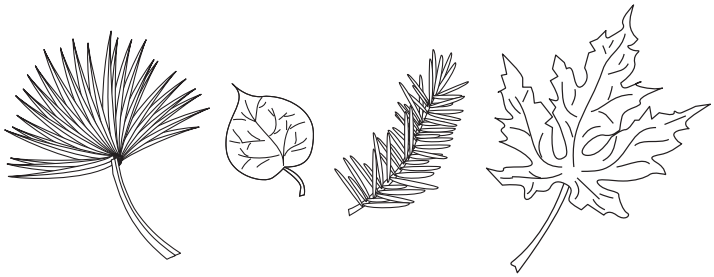


Figure 5.10: Leaves

Bark

You can recognise some trees from their size, shape and type of bark. The pattern of their bark can be a good guide to what plant it is. The bark characteristics include pattern, hardness, thickness, and colour.

Buds

Apart from leaves, the shape of the buds will often help you identify the plant.

Figure 5.11: Buds

Flowers

In spring or summer, many plants produce colourful flowers that make their identification easy.

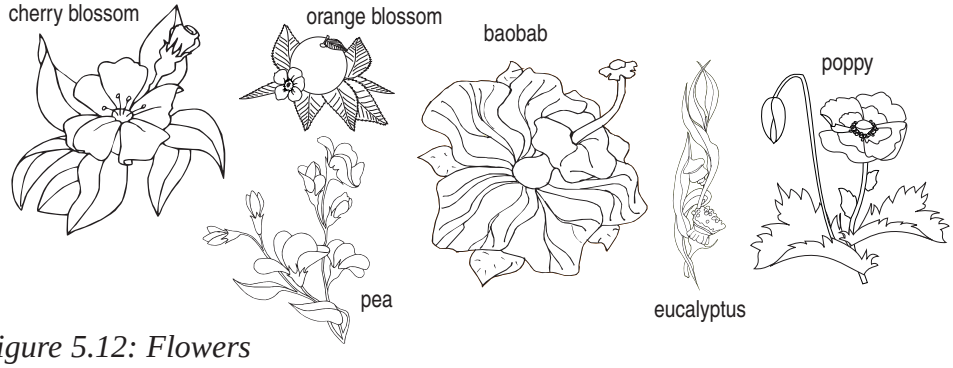


Figure 5.12: Flowers

Fruits and Seeds

Plants produce seeds or fruits from which new plants grow. Describe the shape of *msasa* (*Cordia ovalis*—also called sandpaper bush) and baobab fruits. What other fruits are produced in your region? Describe their differences and similarities.

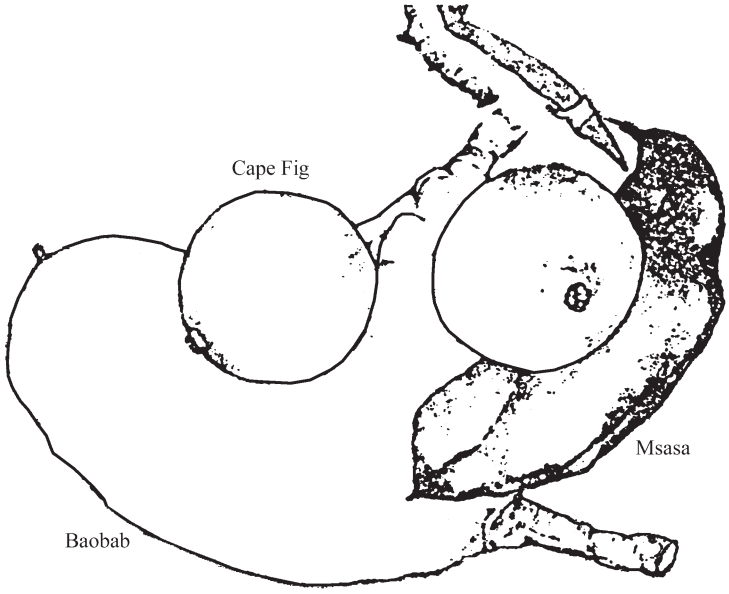


Figure 5.13: Fruits

"Natural" Medicines

Many plants are used to produce natural medicines which come from plant products and can cure illness, correct sight, or even kill. Traditional healers have long known about the value of extracts made from plants. In our culture the leaves, seeds, bark, flowers, and roots of certain trees have all been used to treat diarrhoea, colds, and snake bites.

Powder from the roots of the cassia tree is used to treat diarrhoea. Powdered bark from the shepherd tree is used as a toothache cure. The sap from the cape fig is used to treat burns.

In India, the neem tree is known as the "village pharmacy". Extracts from neem seeds and leaves contain chemicals which can be used against over 200 types of insect pests. Extracts made from the tree are used for curing high blood pressure, treating ulcers, and preventing pregnancy.

Did you know that the pain killer aspirin was originally developed from the bark of the white willow tree? Today, hundred of products sold to kill pain or lower fever are based on it. Quinine, still the most effective agent against malaria, is made from the bark of the South American cinchona tree.

The various uses of these plants are summarised for you in the table below.

Plant	Uses
Eucalyptus	Oil has medicinal properties and is used in perfumes. Wood is used for telegraph poles.
Bamboo	Poles used for building and supporting plants.
Muombo/Miombo *(Brachystegia longifolia)*	String and rope from bark. String for fishing net from roots. Wood used for some building work and for tool handles.
Mango	Fruit provides food. Leaves and bark have medicinal properties e.g. treatment of diarrhoea.
Sisal Elephant grass Thatching grass	Rope and string from strong fibre. Thatching, baskets, weaving. Thatching houses.
Musekese	Pools made into 'cattle cake'. Red dye from bark and roots. Blue dye from seeds and pods.
Sausage tree	Beer. Red dyes made from fruits. Wood used in medicine.
Cassava	Tubers provide food. Flowers makes a temporary glue.
Mubanse	Wood used for shelves and boxes. Gum used as glue and cosmetics.
Mukwa *(Pterocarpus angolensis)*	Wood used for furniture and carpentry (exported). Red gum has medicinal uses. Used in dye. Food for primates and elephants. Bark is used to produce a remedy to treat malaria and "black water fever". Drinking remedies made from the roots treat a range of abdominal diseases including diarrhoea and bilharzia. Bark dye used in painting pots.

Individual Activity

In this activity, you will continue to look at questioning as a teaching skill. Questions will be used in the context of a field trip. You will need to read through Module 1 to remind yourself on how to organise a field trip. Also refer to Unit 1 of this module to construct good questions.

In this activity, you will make a field trip to the nearest area of natural vegetation. Make sure you carry your notebook and pencil to use when you do the following tasks:

- Identify as many plants as you can.
- Draw the plants you have seen.
- List any differences you see in the plants you come across.
- Take note of where they grow.

- Write down as much information as you can on each plant, e.g., What animals visit the plant? Does the plant produce fruits/seeds? What is the plant used for?

In order to enable you to make a thorough study of the plants in your area, carry out the following:

1. Classify the plants into flowering and non-flowering categories.
2. Draw the plants and name them using both local and English names where possible.
3. State the kind of areas in which the named plants grow, i.e., wet places, rocky places, etc.
4. State the difference between flowering and non-flowering plants.
5. Construct a table to summarise the information you have collected.

Below is an example of a table.

Name of plant (Local)	**Name of plant (English)**	**Flowering/ Non-flowering**	**Animals that visit the plant**	**Area in which the plant grows**	**Uses**

Classroom Activity

Divide your pupils into small groups and give tasks to each group. Make sure that your instructions are clear and that each group understands the task.

1. Collect as many different leaves as possible.
   - Classify the leaves according to shape and size, then draw them.
   - State how each leaf collected is suited or not suited for transpiration.
   - State any difference between leaves of flowering and non-flowering plants.
2. Collect as many different flowers as possible.
   - Draw well-labelled diagrams of the flowers you collected.
   - List the animals that visit each flower.
   - Suggest how each flower is pollinated.
   - Classify flowers in name groups and state the characteristic difference(s) between the groups you have identified.
3. Collect as many fruits and seeds as you can.
   - State which fruits and seeds are edible and which are not.
   - Classify your fruits and explain why you have used such a classification.

- How is each fruit and seed collected and dispersed?

Design a table with your pupils in which they fill in the information.

During the field trip, allow your pupils to discuss their findings. Then let each group choose one representative to present their findings to the whole class. Allow other pupils to make comments and contributions. After making corrections, let the group write their findings in table form on a large piece of manila paper. Pin these papers around the classroom. Make sure that all pupils copy the table into their notebooks.

Self Marking Exercise

1. What precautions should your pupils take when handling plants?
2. What preparations do you need to make when you are preparing a field trip?
3. Why is it necessary to allow pupils to discuss their findings?
4. Match the parts of a cell with its function.

Summary

In this unit, we have discussed the importance of plants and how you can use plants for building materials, string and rope, medicine, and food, to mention a few. We have also discussed how the plants use light energy to manufacture food that animals depend on, directly or indirectly. Good plant husbandry is therefore important. Using the questioning skills which have been dealt with in this unit, you should have developed an understanding of how to come up with good questions for your pupils.

Reflection

1. Look around your area and identify shrubs from trees.
2. With the help of the questions below, identify useful plants.
   - Which plants do you use for food?
   - Which plants do you use for building?
   - Which plants do you use for medicine?
3. What would happen to plants if there was no air, water and light in our environment?
4. Using the questioning skill, construct discussion questions for pupils. Include the question: Why does the oxygen in the air remain constant (21%)? Clever ones should remember that oxygen is produced during photosynthesis.

Unit Assignment

1. Name the different parts of plants.
2. What do the shoot and the root systems consist of?
3. State the functions of:
   - leaves
   - stems
   - roots
4. Choose a plant and list the uses of its parts.
5. List any three factors that affect the rate of transpiration.

Unit 6: Animals

Introduction

Animals, like plants, are living organisms that carry out all the life processes. We can group animals according to where they live and what they eat. Animals either have backbones or they do not have backbones. We call animals with backbones vertebrates and animals without backbones invertebrates.

Animals depend on each other, on other living organisms, and on non-living things for survival.

In studying animals with your class, you will use questioning as a teaching strategy.

Unit Objectives

At the end of this unit you should be able to:

- classify animals with and without backbones
- list the features that distinguish one group of animals from another
- place animals in an appropriate group
- draw a simple classification table
- construct a food chain and food web
- predict what would happen if one species was removed from the environment
- discuss animal responses
- explain interrelationships that exist in the environment

Unit Content

There are many different kinds of animals in our environment. In order to make the study of animals easier we sort them into groups. We can group them according to where they live, what they eat, their size, colour, or according to their physical features. One way to sort animals is to look at their characteristics. Here we will sort animals into those that have a backbone and those that do not have a backbone.

Animal Classification

We call animals with backbones vertebrates. We can divide them further as shown in *Figure 6.1* using particular features.

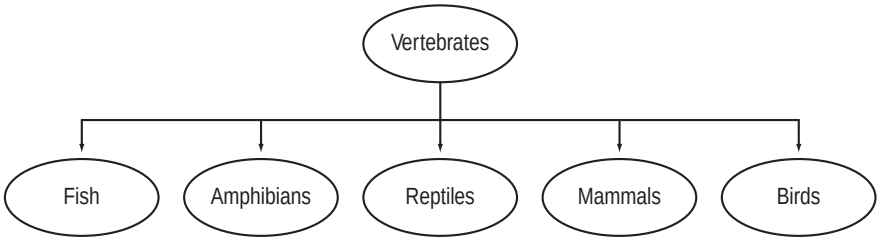


Figure 6.1: Vertebrates

Fish

Fish are animals that live in both fresh and salt water. Most fish have fins, scales and they breathe through gills.

Example of fish include tilapia, tuna, and bream.

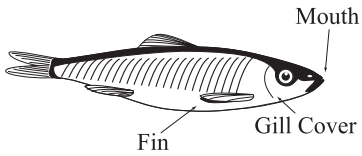


Figure 6.2: Fish

Amphibians

Amphibians include frogs, toads, newts, and salamanders. These are animals that live both in water and on land. Amphibians lay their eggs in water and the eggs hatch in the water, but when amphibians reach the adult stage they leave the water and live on the land.

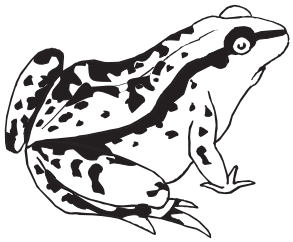


Figure 6.3 Frog

Reptiles

Reptiles are covered with hard dry scales. They lay their eggs on land. Some reptiles, such as crocodiles, turtles, and alligators, live on the land and in the water while others such as snakes and lizards live on land.

Figure 6.4: Salamander

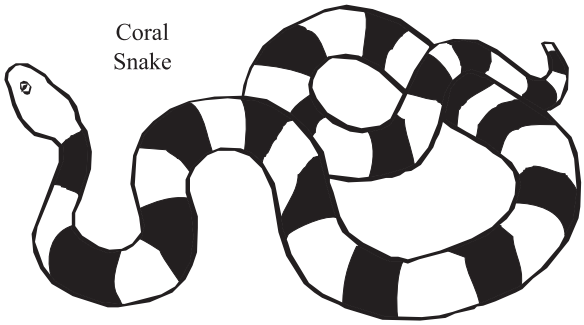


Figure 6.5: Snake

Birds

Birds are the only animals covered with feathers. They have wings and the majority of them fly and lay eggs. You are familiar with chickens, parrots, pigeons, penguins, and ostriches.

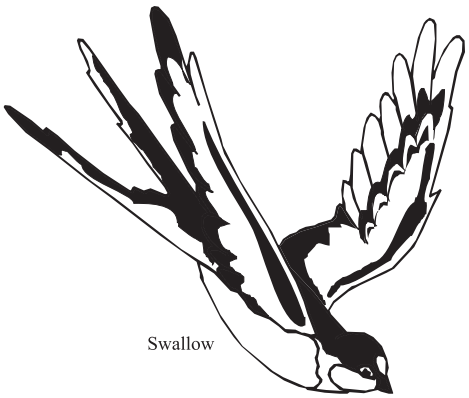


Figure 6.6: Bird

Mammals

Mammals are animals covered with hair. Humans fall into this group. They give birth to live young and feed their young with mother's milk. However, there are some mammals that lay eggs. These are called monotremes, e.g., duckbilled platypus and the echidna, or spiny anteater, of Australia.

Examples of other mammals include kangaroos (marsupials), mice, bats, dolphins, whales, rabbits, cats, dogs, zebras, elephants, lions, monkeys, humans, etc.

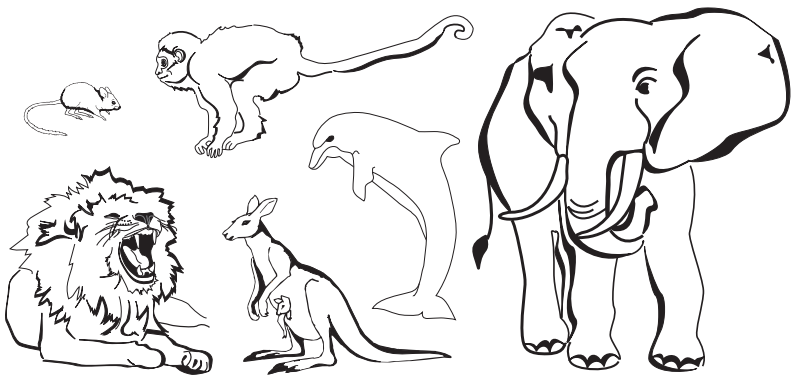


Figure 6.7: Mammals

Animals Without Backbones

Animals that do not have bones in their bodies are called invertebrates. Can you give some examples of invertebrates? There are many groups of animals that have no backbones, but we will only consider a few.

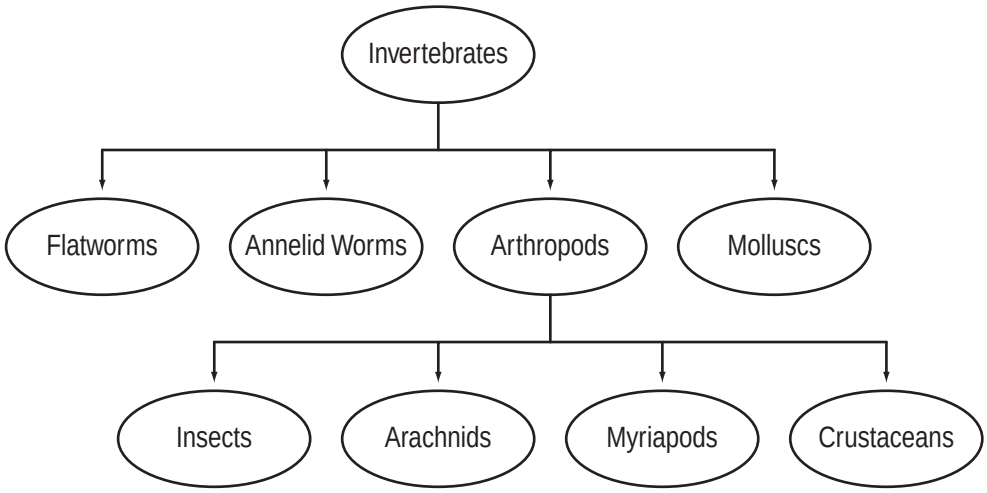


Figure 6.8: Invertebrates

Flatworms

Flatworms have flat bodies covered with cilia. However other members of this group do not have cilia, e.g., tapeworms and flukes.

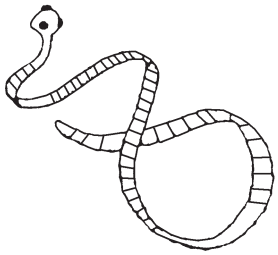


Figure 6.9: Flat worm

Annelids

Annelid worms are animals whose body is encircled with many rings, for example, earthworms, lug worms, and leeches.

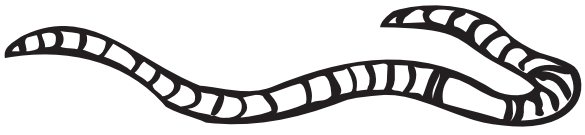


Figure 6.10: Annelid Worm

Molluscs

Molluscs include snails, slugs, clams, squid, oysters, and octopus. They have soft bodies and some are protected by hard shells. Those that have shells may have either one coiled shell or two uncoiled shells.

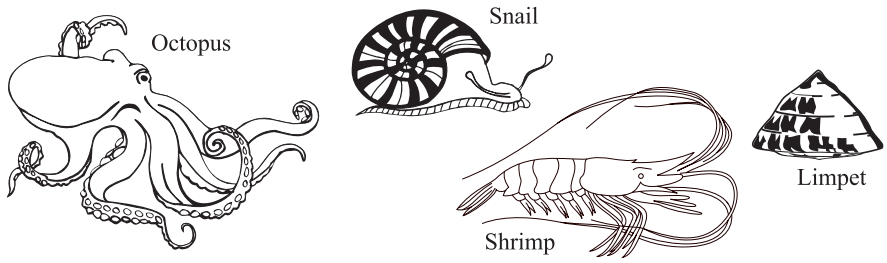


Figure 6.11: Molluscs

Arthropods

Animals in this group can be further subdivided into myriapods, arachnids, crustaceans, and insects.

Crustaceans are crabs, shrimps, and barnacles. They all have a hard outer case which protects their bodies. Most of these animals live in water except for woodlice, which live on land.

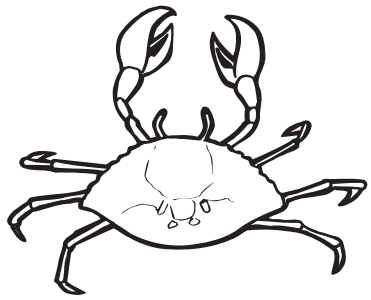


Figure 6.12: A Crustacean

Arachnids are spiders, scorpions, and ticks. They have eight legs and their bodies are divided into two parts. They do not have wings.

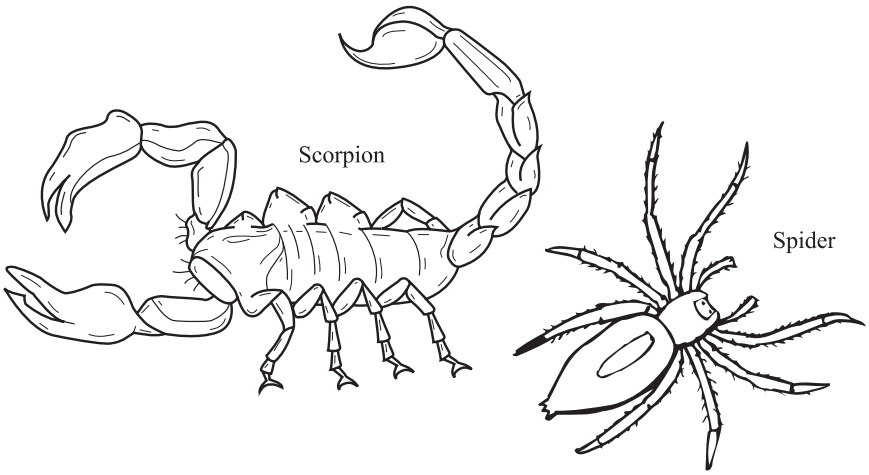


Figure 6.13: Arachnid

Myriapods have many pairs of legs, e.g., centipedes and millipedes.

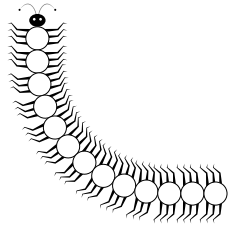


Figure 6.14: Centipede

Insects are one of the most successful groups of animals that live in water, on land, and in the air. They can be found almost anywhere because of their adaptability.

They have six legs, usually two pairs of wings, although some are wingless, and a body which is divided into three parts, the head, thorax, and abdomen.

This group includes ants, bees, butterflies, beetles, and moths.

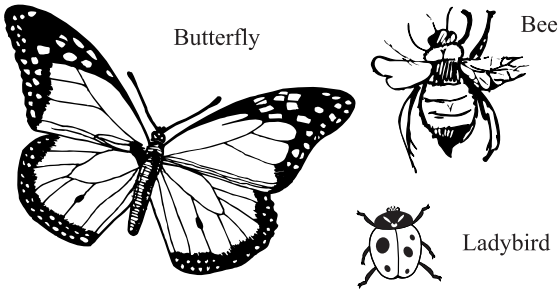


Figure 6.15: Insects

Dependence of Animals

Animals and plants have a place where they are found or live. We call the place a habitat. All living things in one habitat form a community. In a community different plants and animals live together, depending on each other and on everything around them.

All living organisms are affected by both living and non-living factors.

Living factors include competition between and among plants, animals feeding on plants, and other animals competing amongst themselves. Plants are competing for resources such as water and light while animals compete for food.

This competition creates a food relationship. Non-living factors such as climate, landscape, and soil affect both plants and animals. These factors will affect plant growth and distribution, which in turn affects the animals.

Animals depend on plants and other non-living factors for their survival and well-being and they have developed special features and ways of life to help them cope with changing conditions.

Living organisms have developed food relationships, such as predator and prey, producer and consumer, and many others.

In these relationships we see a delicate balance, known as biological equilibrium. If this equilibrium is upset in one way or another, it adversely affects all living things in that particular community and some may die.

Animal Nutrition

Animals, like all other living organisms, need energy. They get their energy from food, which they get directly or indirectly from plants. Plants are called producers because they make their own food while animals are consumers because they eat or consume plants, or other animals that consume plants.

We can represent how plants and animals feed by a food chain which not only shows how one living organism is food for another but also how energy is passed from the producer to the consumer.

Figure 6.16: Simple Food Chain

In a food chain, not all the energy taken in by one organism is passed on to the next. In order to cope with this, the consumers become smaller in number. This forms ecological pyramids. Using the same example of the food chain, the ecological pyramid would be as follows.

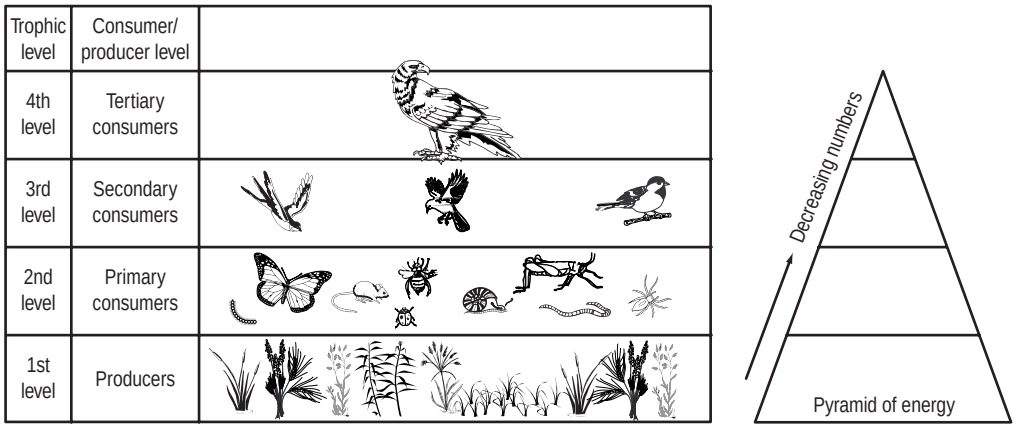


Figure 6.17: Trophic data collection and illustration with a pyramid of energy.

Some of the energy at each trophic level is lost through respiration, excretion, or death of an organism before it can be consumed, etc. Therefore, the amount of energy available to the next highest trophic level does not represent the total energy available.

This results in a progressively lower biomass at each level, which usually corresponds to lower numbers as well. This is illustrated graphically in *Figures 6.18* and *6.19* below.

Note—The numbers used in these two pyramids are for illustration only, and are not based on actual data collected.

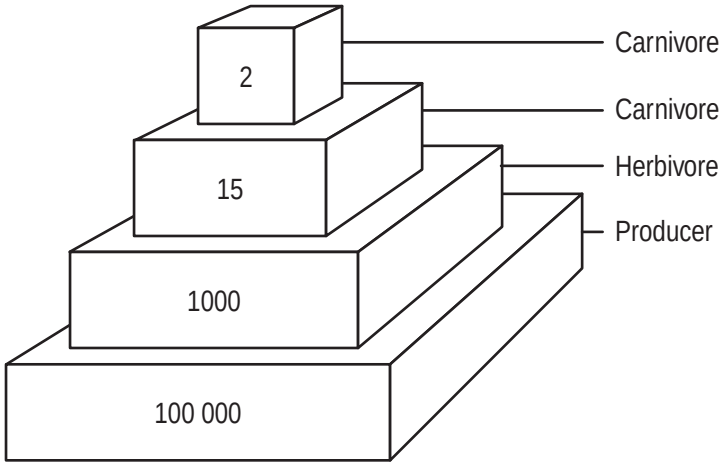


Figure 6.18: Pyramid of Numbers

The pyramid of numbers shows the numbers of producers and consumers in a community, however, it does not reflect the amount of energy stored at each trophic level. The pyramid of biomass more accurately represents the amount of energy available to consumers at the next level.

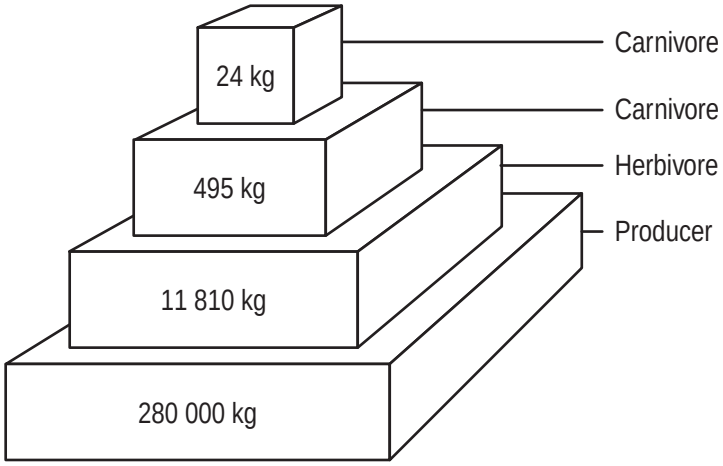


Figure 6.19: Pyramid of Biomass

Food relationships are never as simple and straightforward as represented by a food chain. One plant or one animal can belong to more than one food chain thus forming a food web. A food web is an interconnection of food chains, and it can be represented as follows.

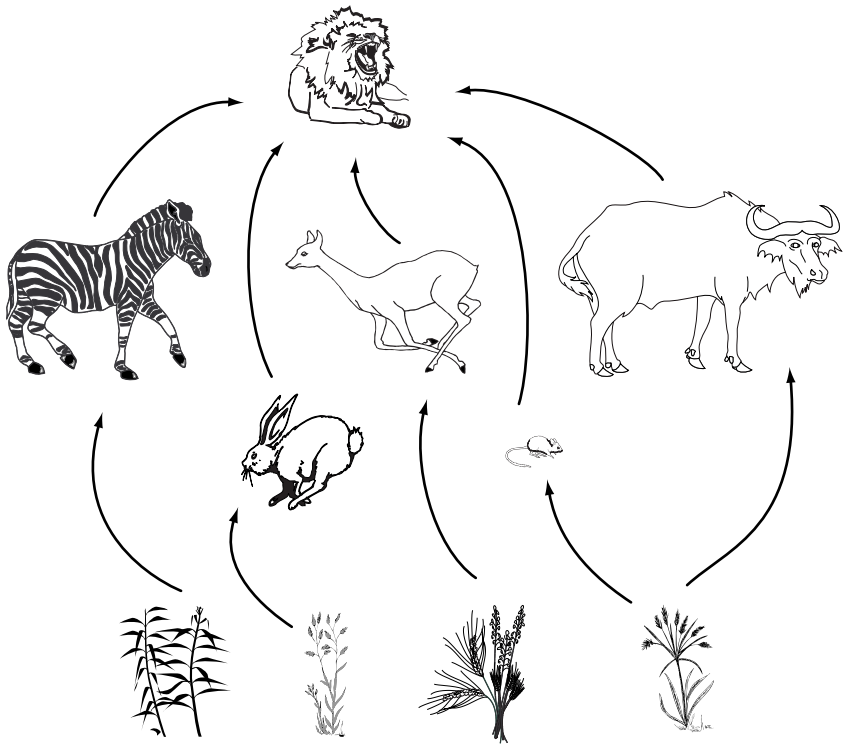


Figure 6.20: Food Web

In a food web we also talk about decomposers. These include many bacteria and fungi that feed on the remains of dead plants and animals. Decomposers produce digestive enzymes that make dead things rot. The rotting substances are changed to liquid and the decomposers then absorb the liquid. Rotting is also known as decomposition.

Decomposers are important because they get rid of dead plants and animals and they release useful chemicals and nutrients back into the soil. These substances add to the soil fertility.

Materials that decompose are described as biodegradable while those that don't decompose are non-biodegradable. Examples of biodegradable materials are paper, wool, cotton, and any natural product. Non-biodegradable are usually synthetic substances such as plastic.

Recycling Atoms

Like everything else, living things are made of atoms which are joined together to make the different materials that make the body. When plants and animals die, these atoms are used over and over again and thus they are recycled. How nature recycles atoms can be represented by carbon and nitrogen cycles.

Carbon Cycle

The small amount of carbon in the atmosphere remains constant because carbon is recycled. We can represent this by a carbon cycle.

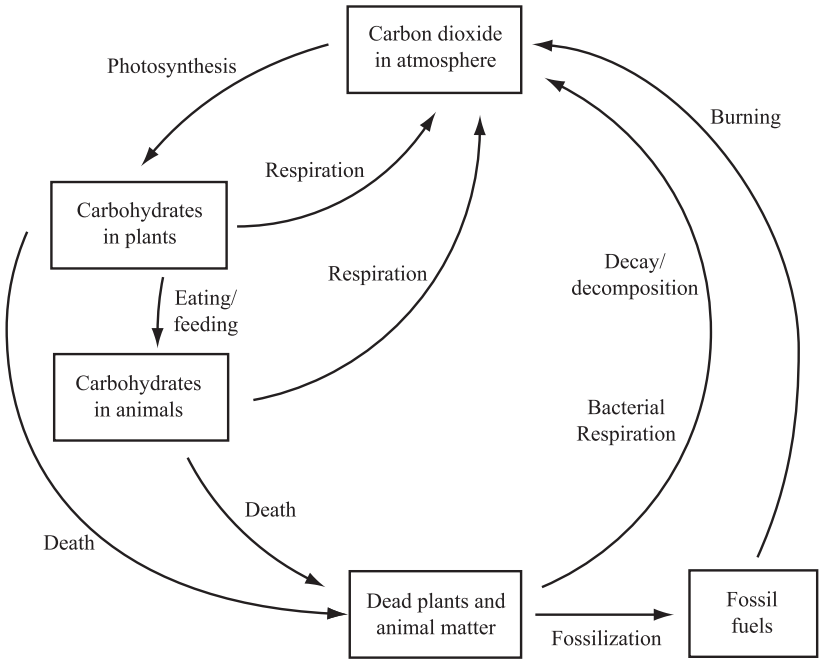


Figure 6.21: Carbon Cycle

Nitrogen Cycle

All living things need nitrogen to help them make protein for body tissue. Although there is a large percentage of nitrogen in the air, it is not readily available for use. For the nitrogen to be used it must go through a chemical process that converts it into nitrates. Plants absorb the dissolved nitrates and make them into proteins and other products which will be eaten by animals.

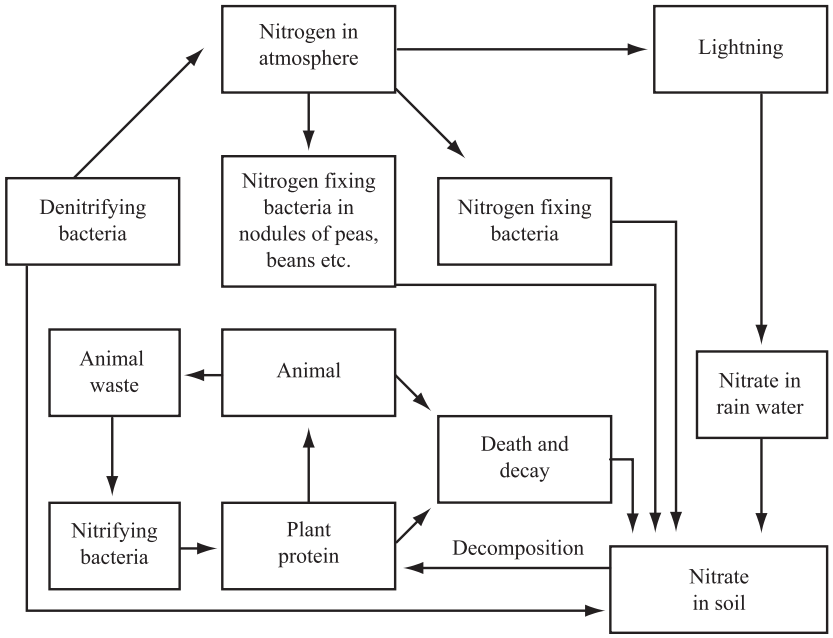


Figure 6.22: Nitrogen Cycle

Animal Responses

Animals and plants respond to both living and non-living factors. This response is important because it helps organisms adapt and adjust to change, allowing them to survive. Animal responses are generally more noticeable. In general, animals respond to things like light, climate, hunger, and thirst.

Environmental conditions change, e.g., some places become hotter, wetter, windier or the opposite. These changes take place from day to day and from season and season. Animals respond to these changes either by moving away from the undesirable conditions or changing their behaviour to suit the changes. For instance, in cold weather, animals will either generate heat or hibernate to avoid the cold.

Their response to sound, chemical and other external factors varies. Animals can use smell as a means of finding food or avoiding predators.

Similarly, animals respond to internal factors such as hunger and thirst. Animals respond to hunger by looking or hunting for their food. They also look for and drink water in response to thirst.

Responses of animals can be illustrated by the responses of earthworms to light, water and type of soil. Earthworms are not easy to study in their natural environment because they live in the ground, however, you can keep them in a wormery in the laboratory so that you can observe their behaviour.

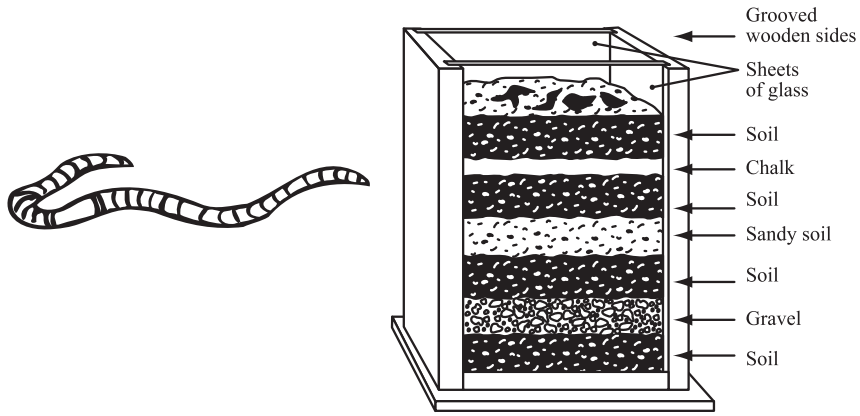


Figure 6.23 Worm and Wormery

Individual Activity

Step 1 Fill the wormery with layers of different kinds of soil: dark, damp soil; fine gravel; more soil; sandy soil; soil chalk, and so on as shown in the diagram (*Figure 6.23*).

Step 2 Level off the layers neatly. Put a few worms on top of the soil and cover with fresh and rotting leaves, seeds, fragments of cloth, and feathers. Cover the top with a metal sheet and the sides with pieces of cardboard.

- Why have you done this?

Step 3 Every few days, remove the covers to see what is happening. Notice what happens to the different things left on the surface.

- What do earthworms feed on?
- How do earthworms move in their burrows?
- How are worm casts formed and what are they made of?
- What is happening to the different soil layers?
- When is the best time to look for earthworms in the garden? When it is wet or dry?

Step 4 Watch how earthworms move. Place an earthworm on a sheet of paper and listen carefully.

- How is the sound produced?
- Why are earthworms useful in the garden? Make a list of the important roles they play.

Individual Activity

In this activity you will design questions that can be used in group work. Group work is a teaching method which you have already considered in earlier modules.

Remember that to make group work successful you must carefully plan it. Select the pupils for each group and encourage pupils to respect each others opinions. You need to have carefully planned questions that will guide your pupils through the discussion.

The activities below give you an idea of the kinds of questions you could ask to guide a discussion. If possible, get together with two or more of your colleagues and hold a discussion.

Activity 1

Below are pictures of a number of animals. Study these pictures and classify the animals, giving reasons for your classification. After you have agreed on a classification, decide what each animal eats and where it lives (air, water, or land).

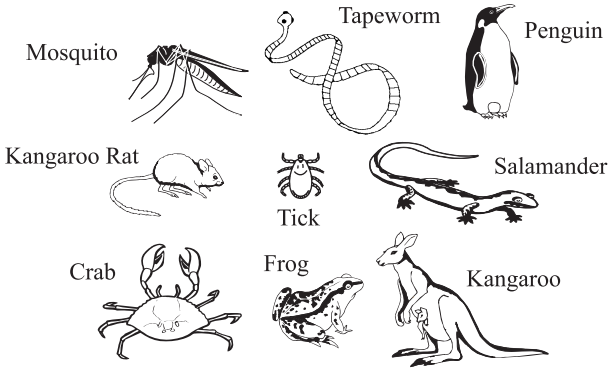


Figure 6.24: Some Animals

Activity 2

Below is a simple food web. What would happen if all the snakes were killed? Why is it that there are fewer big birds than small birds? What would happen if the reverse was true?

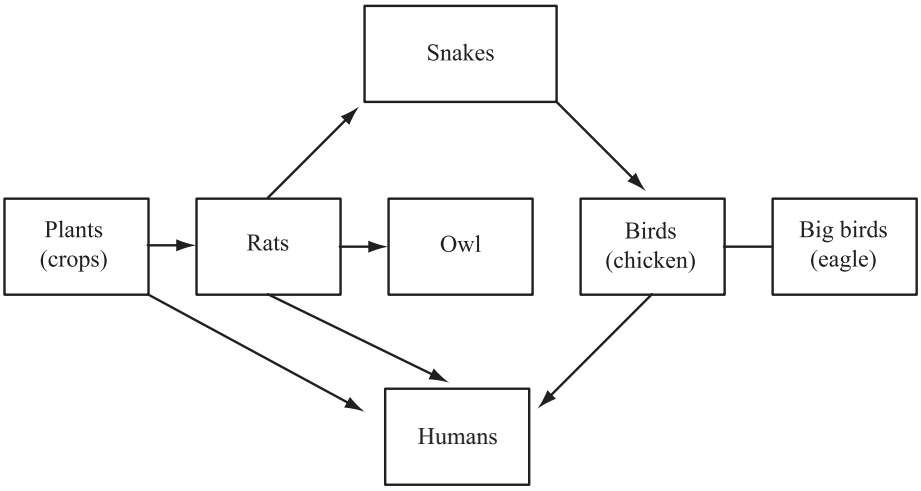


Figure 6.25: Simple Food Web

Individual Activity

From the topics covered in the syllabus on animals, design an activity in which pupils will be involved in a group discussion. Depending on the size of your class, you could design more than one activity and each group could be given a separate question.

While the pupils are having their discussion, you should assess their levels of discussion and assess the questions you have set.

Do the questions encourage discussion?
Are the questions clearly understood?

Self-Marking Exercise

1. Reflect on the questions that you asked and suggest what makes a question good for group discussion.
2. How can you keep a discussion lively?
3. What do you need to do to ensure that your class has a good group discussion?

Summary

In this unit you have briefly looked at animals, how they are classified and why they are classified. Classification is important as it helps you study organisms. You also had an opportunity to look at the relationship between living and non-living things and why this is important. Relationships can be represented by food chains, food webs, and carbon and nitrogen cycles.

You also considered some general responses of animals to both external and internal environment.

As a teaching activity you looked at the use of questions in group discussion.

Reflection

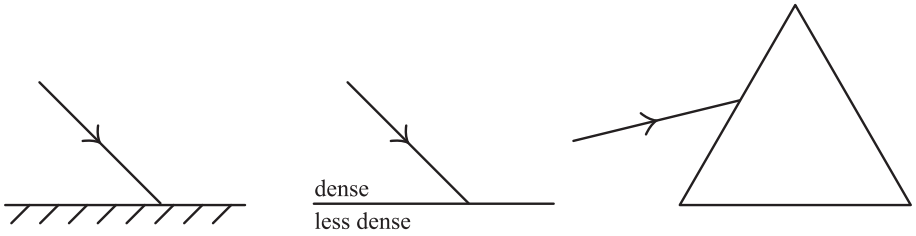
What other aspects of animals do you think are important to consider when classifying them? Do all animals fit into the classification groups that have been given? If the answer is no, how would you group the animals so that all of them fit into some group?

Unit Assignment

1. Suggest a way to control pests like rats without completely disrupting the food chain/web.
2. How can the biological equilibrium be disrupted?
3. What feature(s) do all insects have in common?
4. What is a biodegradable material?
5. Why is it more accurate to represent a food pyramid by pyramid of biomass rather than pyramid of numbers?
6. Describe how a lump of carbon in coal can end up as part of the body of an animal.
7. Why do living things need nitrogen?

Module Test

1. Explain why:
   - a stick looks bent when it is lowered into water
   - a pool looks shallower than it really is
   - spear fishing is difficult
2. Copy and complete the diagrams below to show what will happen to the white ray of light.



a) mirror b) refracting surface c) prism

   Which of the above is an example of:
   - refraction?
   - reflection?
3. Draw a simplified structure of a plant cell that should contain a nucleus, chloroplasts, vacuole, and cell wall.

   In which part of the plant cell does photosynthesis take place?

   Write a balanced equation to represent photosynthesis.
4. Compound C, D, and X are **basal dressing fertilizers** and are commonly used in agriculture. What are the proportions of nitrogen, phosphorus and potassium in each of these fertilizers?

   Ammonium nitrate and urea are **top dressing fertilizers**. Which of these two has a higher proportion of nitrogen, phosphorus, and potassium?
5. Give an outline of the composition of soil.

   Compare and contrast the properties of sandy soil and clay soil.

Answers to Unit 1 Self-Marking Exercise

1. air
2. space
3. same
4. less
5. lost air
6. weight
7. occupies

Suggested Answers to Unit 1 Assignment

1. Oxygen is used up in burning.
2. Carbon dioxide and any one of the inert gases.
3. The properties of oxygen are that it is colourless and has no smell, does not dissolve very easily in water, is denser than air, and supports combustion.
4. Industrial uses are welding and cutting. Medical uses of oxygen are to help people who have difficulties breathing and patients who undergo surgical operations.
5. These described air-related terms should be encircled.

   a) air b) oxygen c) nitrogen d) water vapour e) carbon dioxide

Suggested Answers to Unit 2 Self-Marking Exercise

1. He was suffering from bilharzias.
2. Through drinking contaminated water.
3. By boiling the water or treating water with chlorine.
4. Simon may have been infected with cholera, dysentery, or typhoid.
5. Work cards/worksheets, field work, role play, debate, project work, etc.

Possible Answers to Unit 2 Assignment

1. Wells, boreholes, springs, taps, rivers/streams.
2. Chlorination.
3. Water is contaminated by:
   - washing clothes, bathing, swimming
   - animal and industrial wastes (defecating and urinating)
   - sewage materials released into rivers and underground sources
   - pesticides, fertilisers, and other chemicals washed into water
4. Cholera, dysentery, bilharzias, typhoid.
5. Filtration does not kill germs; boil water to kill germs.

6. Water is:
   - filtered to remove suspended impurities
   - chlorinated to kill germs
   - stored in tanks and later pumped to house/industries
7. - turn off the taps—do not allow taps to drip
   - avoid prolonged use of water hoses and sprinklers
   - repair or replace all broken taps or pipes
   - have a shower rather than a bath
   - use a basin for washing

Suggested Answers to Unit 3 Self-Marking Exercise

1. Sheet erosion, rill erosion, gully erosion caused by water, wind, and sun.
2. Erosion by water is usually caused by run off. This is when water does not sink into the ground and instead carries soil away. Wind acts on bare land to cause erosion. Soil that is not protected by plants can easily be eroded, especially when it is dried by the sun. The wind blows away the soil.
3. Terraces help to prevent soil erosion by catching the rain water and preventing it from eroding the hillside.
4. Rotation of crops helps to improve soil structure and to keep a good level of humus in the soil.
5. - Growing one crop continuously without crop rotation depletes nutrients in the soil.
   - Continuous use of chemical fertilisers.
   - Ploughing up and down the slope encourages soil erosion.

Possible Answers to Unit 3 Assignment

1. Humus is decomposed plant and animal remains.
2. Humus is important as it makes the soil fertile.
3. Soil is made of sand, clay, gravel, humus, air, water, and dissolved mineral salts.
4. Soil is formed by weathering of rocks.
5.

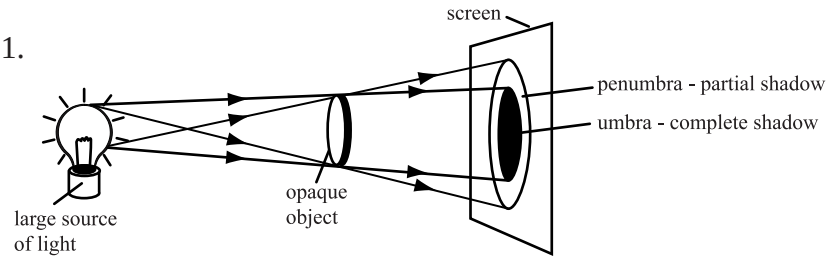
Soil type	Rate of Water Rise
Sand	Slow
Clay	Fast
Loam	Moderate

Suggested Answers to Unit 4 Self-Marking Exercise

1. It is not that easy because learning situations are not the same and can be unpredictable. What should be noted is, that as a teacher, you should continuously reflect on your performance. You are in a stronger position in the sense that you know your pupils best and, with very clear learning outcomes, you know how best to achieve them through the choice of an appropriate teaching approach.
2. Working in groups enables your pupils to communicate as they try to understand the question. Any question asked should provoke some discussion before solutions are sought. You can also include other good aspects of group work.
3. The modifications may include rephrasing the questions and deciding on the nature of questions to be asked before, during, and after an activity.

Suggested Answers to Unit 4 Assignment

1.



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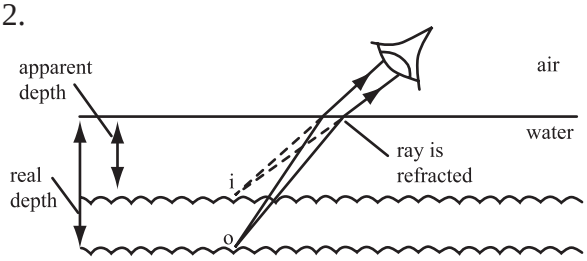
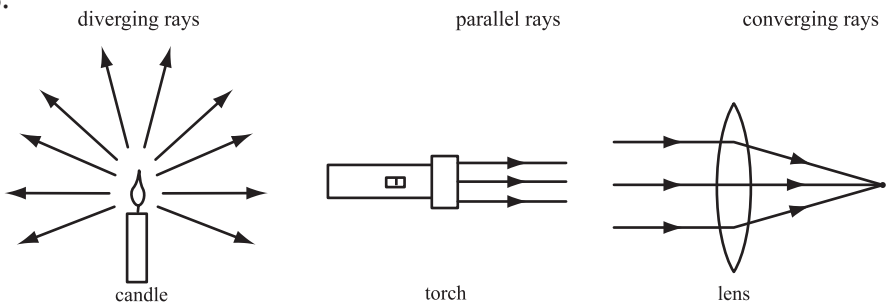
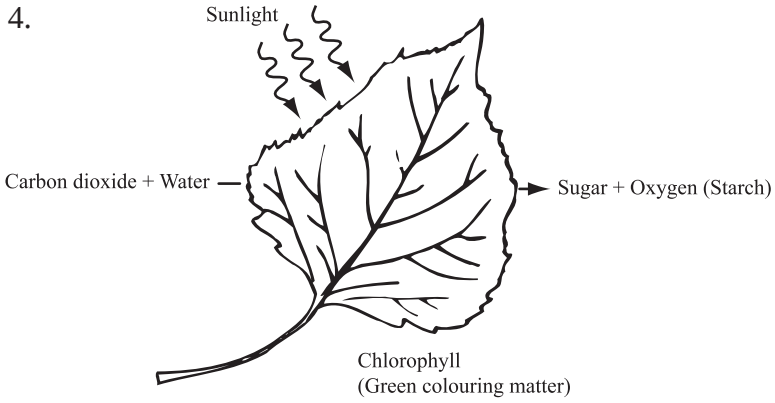


3.



A beam of light rays can be diverging, parallel, or converging.

4.



The word equation for photosynthesis is:

Carbon dioxide + water $\xrightarrow[\text{chlorophyll}]{\text{sunlight*}}$ glucose + oxygen

*sunlight (or light energy)

5.

(a) electric bulb:	electric	heat	light
(b) solar cell:	light (solar)	electric	
(c) burning candle:	chemical	heat	light
(d) plant food manufacture:	light	chemical	

Answers to Unit 5 Self-Marking Exercise

1. Pupils should wash hands after handling plants.
   Pupils should not eat any plant because some plants are poisonous.
   Pupils should take extra care to avoid contact with thorns, hairs, etc.
2. Visit the site before the pupils go on the field trip.
   Take note of what you want your pupils to see.
   Give clear instructions, and tell your pupils what they should bring with them. Arrange for transportation if necessary.
3. Allow pupils to share ideas.

Answers to Unit 5 Assignment

1. The different parts of a plant are flower, leaves, buds, stems, and roots.
2. The shoot system consists of stem, leaves, buds, flowers, fruits, and the root system consists of roots.
3. Functions of:
   - Leaves—manufactures food, exchanges gases, transpiration.
   - Stem—supports the shoot, carries food and water to other parts of the plant.
   - Roots—holds the plant firmly in the soil, absorbs water and mineral salts from soil.

4. The following answers would be correct for an avocado plant (quarter pear):
   - Fruit as food
   - Seed as medicine

   Other plants could provide spices, ornaments, rope, etc. You could also list uncommon uses.
5. Dry days, hot sunny days, windy days will increase the rate of transpiration.

Answers to Unit 6 Self-Marking Exercise

1. The question should be open ended (does not have one correct answer).

   They should be higher level questions—analysis.

   Ask thought provoking questions.
2. Give pupils two or more contradicting views.
3. All pupils should participate, no pupil should be allowed to dominate.

   Pupils should not be allowed to wander from the questions.

   The discussion should be timed.

   Listen to pupils' contributions and ask more searching and thought provoking questions.

Answers to Unit 6 Assignment

1. Do not use chemicals.

   Make it difficult for rats to have access to food crops.

   Increase the number of natural rat predators.
2. When one member of the food chain is reduced in number or completely wiped out.
3. Three body segments: head, thorax, and abdomen.
   - Segmented abdomen
   - Three or six pairs of legs
   - One or two pairs of wings
4. Materials that decompose or rot by the action of decomposers.
5. Pyramid of numbers is less accurate because you will need to count each individual plant and animal in a food chain. A pyramid of bio mass is the average weight of all the plants and animals involved.
6. Burning coal releases carbon dioxide.

   Carbon dioxide is taken in by plants and used in carbohydrates.

   Carbon dioxide is made into carbohydrates.

   Plants taken in by animals become part of animal.
7. For making protein.

Glossary

G

Aeration: circulation of air.

Air: a mixture of gases found in the atmosphere.

Atmosphere: the space occupied by air surrounding the earth.

ATP: adenosine triphosphate.

Biodegradable: materials that rot or decay.

Buckle: crumple under pressure.

Compound A: fertiliser which contains nitrogen, phosphate, and potassium.

Compound D: urea for top dressing.

Compound X: ammonium nitrate for top dressing.

Community: all living things found in one place or habitat.

Consumers: animals that eat other organisms or organic matter.

Decompose: to break down or be broken down into constituents by bacteria or fungal action.

Decomposers: microbes that feed on plant and animal remains causing them to rot or decay.

Dispersion: splitting of light into its colours.

Environment: everything around living things which affect them, i.e., climate, soil, other organisms.

Erosion: the wearing away of soil.

Food chain: a simple relationship that shows how living things feed on other living things.

Food web: a complex of interconnected food chains.

Gullies: cuts made by running water on the ground.

Habitat: the natural home of an animal or plant.

Hydrocarbons: organic chemical compounds that contain only carbon and hydrogen.

Invertebrates: animals that do not have backbones.

Luminous: objects like the sun and candle flames that give out light of their own.

Non-luminous: objects such as the moon and trees that do not give out light of their own.

Organic: relating to or derived from living plants and animals.

Organism:	any living animal or plant, including any bacterium or virus.
Sedimentation:	materials that have been deposited by water or wind.
Opaque:	solid objects like stones that do not allow light to pass through them and will usually form a shadow.
Predator:	an animal that feeds on another animal.
Prey:	an animal that is eaten by other(s).
Producers:	living things that make their own food, e.g., plants.
Stomata:	part of plant that mainly permits the exchange of gases between plants and the atmosphere.
Translucent:	objects that allow some light to pass through.
Transparent:	objects like clear glass that allow light to pass through them.
Ventilation:	air entering or circulating freely.
Vertebrates:	animals that have backbones.
Winnowing:	fanning or tossing (grain) to free it of chaff.

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