

INSTITUTE OF ADULT EDUCATION



**INCREASING ACCESS TO SECONDARY SCHOOL
LEVEL EDUCATION THROUGH THE
PRODUCTION OF QUALITY
LEARNING MATERIALS**

JUNIOR SECONDARY LEVEL

BIOLOGY

Module 1:

**Introduction to Biology and the
Classifications of Living Things**



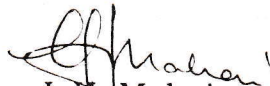
COMMONWEALTH OF LEARNING

ACKNOWLEDGMENT

The Institute of Adult Education on behalf of the Government of Tanzania takes this opportunity to express its heart felt thanks to the Common Wealth of Learning (COL) for involving Tanzania in the project, **Increasing Access to Secondary School Level Education Through the Production of Quality Learning Materials for SADC member countries** and being appointed country coordinator of the project; as well as Coordinator of Mathematics subject.

Special thanks go to Ms Susan Phillip, **COL Education specialist in materials development and open schooling**. In her capacity, she has been coming to Tanzania to give guidance and advice on the project, from syllabus development, materials writing, piloting up to material production.

The first phase of piloting the materials at the intended junior level, has been very beneficial, not only to the learners who study through Distance Education but, also, to class room students and their teachers, in addition to serving as reference materials.


L.H. Mahai,

DIRECTOR

Institute of Adult Education



COMMONWEALTH OF LEARNING

**INCREASING ACCESS TO SECONDARY
SCHOOL LEVEL EDUCATION THROUGH THE
PRODUCTION OF QUALITY LEARNING MATERIALS**

JUNIOR SECONDARY LEVEL

BIOLOGY

**Module 1:
Introduction to Biology and the
Classifications of Living Things**

Partners:

Ministry of Education and Botswana College of Distance and Open Learning (BOCODOL), Botswana
Ministry of Education, Science and Technology and the Malawi College of Distance Education (MCDE), Malawi
Ministry of Education, Mozambique
Ministry of Basic Education, Sport and Culture, and the Namibian College of Open Learning (NAMCOL), Namibia
Ministry of Education and the Emlalatini Development Centre, Swaziland
Ministry of Education and Culture and the Institute of Adult Education, Tanzania
Ministry of Education, Zambia
Ministry of Education, Sport and Culture, Zimbabwe
Commonwealth of Learning



COMMONWEALTH of LEARNING

Partners:

Commonwealth of Learning

Ministry of Education and Botswana College of Distance and Open Learning (BOCODOL), Botswana

Ministry of Education, Science and Technology and the Malawi College of Distance Education (MCDE), Malawi

Ministry of Education, Mozambique

Ministry of Basic Education, Sport & Culture, and the Namibian College of Open Learning (NAMCOL), Namibia

Ministry of Education and the Emlalalini Development Centre, Swaziland

Ministry of Education and Culture and the Institute of Adult Education, Tanzania

Ministry of Education, Zambia

Ministry of Education, Sport and Culture, Zimbabwe

Mauritius College of the Air, Mauritius

COMMONWEALTH *of* LEARNING

Suite 600 - 1285 West Broadway, Vancouver, BC V6H 3X8 CANADA

PH: +1-604-775-8200 | FAX: +1-604-775-8210 | WEB: www.col.org | E-MAIL: info@col.org

COL is an intergovernmental organisation created by Commonwealth Heads of Government to encourage the development and sharing of open learning and distance education knowledge, resources and technologies.

© Commonwealth of Learning, January 2004

ISBN 1-895369-89-4

These materials have been published jointly by the Commonwealth of Learning and the partner Ministries and institutions.

All rights are reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form, or by any means, electronic or mechanical, including photocopying, revising or otherwise, without the written permission of the Commonwealth of Learning on behalf of the publishers.

The views expressed in this document do not necessarily reflect the opinions or policies of the publishers.

The authors and the Commonwealth of Learning have made all efforts to ensure that clearance has been obtained to include any third-party copyrighted material. Any omissions should be brought to the attention of the Commonwealth of Learning.

INTRODUCTION TO BIOLOGY AND THE CLASSIFICATION OF LIVING THINGS

MODULE INTRODUCTION

Biology is the study of life. We study Biology to understand our own body, to know how it functions. We interact with the living and non-living components around us. Biology helps us to understand all this so that we respect our environment and ourselves. We can also make maximum use of all our resources most efficiently.

Look at all the living organisms around you. All of them have certain common characteristics. There is such a wide variety of living organisms on earth that they have been grouped together according to common features they possess. This is **classification**.

Biology is a science. We therefore need to know how to use biological apparatuses safely, record observations and interpret them properly.

MODULE OBJECTIVES

At the end of this Module, you should be able to

- identify living things
- define Biology
- describe the characteristics of organisms
- explain the scientific method
- describe a controlled experiment.

Course Writers

Mrs. S. Tirbhowan

V. Kurrumchand

Course Reviewer

S. Tirbhowan

Course Co-ordinator

R. Dhurbarrylall

Instructional Systems Designer

R. Dhurbarrylall

Editor

C. Sooben

Text Entry

Mrs. S. Deenanath

Mrs. P. Hurgobin

Mrs. S. Chengalanee

F. Bredel

Graphic Artist

Mrs. M. A. Frivole

Lay-out and Formatting

Miss. N. Narain

Biology student

Mauritius College of the Air

Science Course Materials Management

REVIEW TEAM

Botswana College of Distance and Open Learning

Lawrence Tshipana

Malawi College of Distance Education

Chris F. Layamaman

Namibian College of Open Learning

Joseph Amon

Institute of Adult Education, Tanzania

Andrew Dominick Swai

Emlalati Development Centre, Swaziland

Simon Sipho Maseko

NDOLA Institute for Skills Training, Zambia

Christopher Chiluband

Ministry of Education, Sport and Culture, Zimbabwe

Luwis Hlombe

PILOTING TUTORS

Botswana College of Distance and Open Learning

Thandie Keetsaletse

Namibian College of Open Learning

Jona Mushelenga

Sifundzain High School, Swaziland

Saide Richards

Kibasila Secondary School, Tanzania (Ministry of Education)

John Anania

Nilrumah Teacher's College, Zambia

F. Mubanga

NDOLA Institute for Skills Training, Zambia

Christopher Chiluband

Ministry of Education, Sport and Culture, Zimbabwe

Luwis Hlombe

JUNIOR SECONDARY LEVEL SCIENCE - BIOLOGY



MODULE 1 – Introduction to Biology and the Classification of Living Things

Unit 1 The Science of Life

Unit 2 Biological Skills

MODULE 2 – The Living Cell

Unit 1 Cell Structure and Organisation

Unit 2 Levels of Organisation

Unit 3 Compounds of Life

MODULE 3 – Energy and Life

Unit 1 The Need for Energy

Unit 2 Respiration

MODULE 4 – Nutrition and Digestion

Unit 1 Nutrition in Living Organisms

Unit 2 Human Digestive System

MODULE 5 – Transport

Unit 1 Transport in Plants

Unit 2 Transport in Humans

MODULE 6 – Support, Movement and Control

Unit 1 Support and Movement

Unit 2 Hormonal and Nervous Control

Unit 3 Control and Regulation

MODULE 7 – Continuity of Life

Unit 1 Reproduction

MODULE 8 – Organisms and the Environment

Unit 1 Ecological Principles

Unit 2 Population Growth and Regulation

Unit 3 Human Influence on the Environment

1.3	VARIABLES	12
1.3.1	DEPENDENT VARIABLE	13
1.3.2	INDEPENDENT VARIABLE	13
1.4	INTERPRETATION AND CONCLUSION	16
1.5	HYPOTHESIS - WHAT IS IT?	14
1.6	A THEORY	16
	POINTS TO REMEMBER	17

MODULE 1 – Introduction to Biology and the Classification of Living Things

Unit 1 The Science of Life

Unit 2 Biological Skills

MODULE 2 – The Living Cell

Unit 1 Cell Structure and Organisation

Unit 2 Levels of Organisation

Unit 3 Compounds of Life

MODULE 3 – Energy and Life

Unit 1 The Need for Energy

Unit 2 Respiration

MODULE 4 – Nutrition and Digestion

Unit 1 Nutrition in Living Organisms

Unit 2 Human Digestive System

REVIEW TEAM

MODULE 5 – Transport

Unit 1 Transport in Plants

Unit 2 Transport in Humans

MODULE 6 – Support, Movement and Control

Unit 1 Support and Movement

Unit 2 Hormonal and Nervous Control

Unit 3 Control and Regulation

MODULE 7 – Community of Life

Unit 1 Reproduction

PILOTING TUTORS

MODULE 8 – Organisms and the Environment	
Unit 1 Ecological Principles	
Unit 2 Population Growth and Regulation	
Unit 3 Human Influence on the Environment	
Nambian College of Open Learning	John Mushianga
Sturgeson High School, Swaziland	Saïdo Richards
Obesha Secondary School, Tanzania (Ministry of Education)	John Amaria
Muchach Teacher's College, Zambia	F. Mubanga
NQA, A Institute for Skills Training, Zambia	Christopher Chikwano
Ministry of Education, Sport and Culture, Zimbabwe	Louis Hwinda

UNIT 1

THE SCIENCE OF LIFE

TABLE OF CONTENTS

MODULE INTRODUCTION	1
MODULE OBJECTIVES	1
INTRODUCTION.....	5
OBJECTIVES.....	5
1.0 WHAT IS BIOLOGY?	5
1.1 CHARACTERISTICS OF LIVING ORGANISMS.....	7
1.1.1 NUTRITION.....	7
1.1.2 RESPIRATION.....	7
1.1.3 EXCRETION.....	7
1.1.4 IRRITABILITY (OR SENSITIVITY).....	8
1.1.5 GROWTH	8
1.1.6 MOVEMENT.....	8
1.1.7 REPRODUCTION	9
1.2 BIOLOGY AS A SCIENCE.....	10
1.2.1 THE SCIENTIFIC METHOD	10
1.2.2 INDUCTION - DEDUCTION.....	10
1.2.3 DOING THE EXPERIMENT.....	11
1.3 VARIABLE.....	12
1.3.1 DEPENDENT VARIABLE	13
1.3.2 INDEPENDENT VARIABLE	13
1.4 INTERPRETATION AND CONCLUSION	14
1.5 HYPOTHESIS - WHAT IS IT?.....	14
1.6 A THEORY.....	16
POINTS TO REMEMBER.....	17



UNIT 1

THE SCIENCE OF LIFE

TABLE OF CONTENTS

MODULE INTRODUCTION	1
MODULE OBJECTIVES	1
INTRODUCTION.....	5
OBJECTIVES.....	5
1.0 WHAT IS BIOLOGY?	5
1.1 CHARACTERISTICS OF LIVING ORGANISMS.....	7
1.1.1 NUTRITION.....	7
1.1.2 RESPIRATION.....	7
1.1.3 EXCRETION.....	7
1.1.4 IRRITABILITY (OR SENSITIVITY).....	8
1.1.5 GROWTH	8
1.1.6 MOVEMENT.....	8
1.1.7 REPRODUCTION	9
1.2 BIOLOGY AS A SCIENCE	10
1.2.1 THE SCIENTIFIC METHOD	10
1.2.2 INDUCTION - DEDUCTION.....	10
1.2.3 DOING THE EXPERIMENT.....	11
1.3 VARIABLE.....	12
1.3.1 DEPENDENT VARIABLE	13
1.3.2 INDEPENDENT VARIABLE	13
1.4 INTERPRETATION AND CONCLUSION	14
1.5 HYPOTHESIS - WHAT IS IT?.....	14
1.6 A THEORY.....	16
POINTS TO REMEMBER.....	17

UNIT 1

THE SCIENCE OF LIFE

TABLE OF CONTENTS

1	MODULE INTRODUCTION
1	MODULE OBJECTIVES
2	INTRODUCTION
2	OBJECTIVES
2	1.0 WHAT IS BIOLOGY?
7	1.1 CHARACTERISTICS OF LIVING ORGANISMS
7	1.1.1 NUTRITION
7	1.1.2 RESPIRATION
7	1.1.3 EXCRETION
8	1.1.4 IRRITABILITY (OR SENSITIVITY)
8	1.1.5 GROWTH
8	1.1.6 MOVEMENT
9	1.1.7 REPRODUCTION
10	1.2 BIOLOGY AS A SCIENCE
10	1.2.1 THE SCIENTIFIC METHOD
10	1.2.2 INDUCTION - DEDUCTION
11	1.2.3 DOING THE EXPERIMENT
12	1.3 VARIABLE
13	1.3.1 DEPENDENT VARIABLE
13	1.3.2 INDEPENDENT VARIABLE
14	1.4 INTERPRETATION AND CONCLUSION
14	1.5 HYPOTHESIS - WHAT IS IT?
16	1.6 A THEORY
17	POINTS TO REMEMBER

UNIT 1

THE SCIENCE OF LIFE

INTRODUCTION

Biology is the study of life. Look around you. Can you distinguish between the *living* and *non-living* things? I'm sure you can. This is because the living organisms have certain characteristics which non-living things don't possess.

In this Unit, you will learn about their characteristics and the way in which we study them.

OBJECTIVES

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

- identify living things
- describe the **characteristics** of living things
- solve a biological problem
- explain a **variable**, **dependent variable** and an **independent variable**
- assess the importance of a controlled experiment
- design and carry out an experiment.

1.0 WHAT IS BIOLOGY?

The term biology comes from Greek-Bios: life, Logos: study. Biology therefore means the study of living things or organisms.

Living things have certain features that are common to all of them. These are called the **characteristics of life**.

Let's now turn to them.

1.1 CHARACTERISTICS OF LIVING ORGANISMS

1.1.1 NUTRITION

Nutrition is the way in which living organisms obtain their food.

Food:

- provides energy for daily activities,
- supplies materials for growth and
- keeps the body healthy.

Animals and plants feed in different ways. You obtain your food from other animals or from plants.

Plants are different. They make their own food by a process called **photosynthesis**.

1.1.2 RESPIRATION

During respiration, living things break down food substances in the presence of oxygen to release energy. Carbon dioxide and water are also produced.

Respiration: Food + Oxygen → Energy + Carbon Dioxide + Water

The organisms use this energy to move, grow and repair worn-out tissues.

1.1.3 EXCRETION

Excretion is the removal of waste products from the body. If these are allowed to accumulate in the body they become poisonous and can kill.

Let us have a look at the waste substances that your body produces:

1. Carbon Dioxide

It is removed through the lungs.

2. Urea

It is removed through the kidneys in the form of urine.

A little urea is also excreted through the skin as sweat.

3. Salts and Water

These are excreted in urine and sweat.

1.1.4 IRRITABILITY (OR SENSITIVITY)

It is the process by which organisms sense and feel changes in their environment and respond to them.

Let's illustrate this with something very simple which you must have experienced time and time again. What happens to you when you see or smell food? Your mouth starts to water, doesn't it? In other words, you detect changes in your environment through your sense organs.

Plants don't have sense organs but they too can respond to stimuli. For example, the shoot of the plant grows towards light.

1.1.5 GROWTH

Growth is the increase in size and development of an organism. Animals stop growing once they reach their adult size while plants keep on growing all through their life.

1.1.6 MOVEMENT

Movement is easy to see in animals. You can move from one place to another, or you can move only your body parts like your arms or your legs. Most animals can move in the same way.

Movement in plants however, is not very obvious. Only part of a plant can move.

For example, if you place a potted plant near a window, after a few days you'll observe that it has grown and bent towards the light. Try it for yourself to confirm what we've said.

1.1.7 REPRODUCTION

Living things produce young ones similar to themselves. Both animals and plants reproduce. Animals lay eggs or have babies. Many plants produce seeds which grow into new plants.

✍ Before proceeding further, complete the following activity.

ACTIVITY 1

1. Define the term Biology.

.....
.....
.....

2. List three functions of food in the bodies of living organisms.

.....
.....
.....

3. Give two ways that urea is excreted from the body.

.....
.....

4. What are the differences in movement between animals and plants?

.....
.....

You will find the answers at the end of the Module.

1.2 BIOLOGY AS A SCIENCE

Any biological problem that arises must be solved following a scientific process. Scientists first observe things and then ask questions about them. Then, to answer these questions they must use the scientific method.

1.2.1 THE SCIENTIFIC METHOD

Now we will have a look at the steps involved in the scientific method.

These are as follows:

- Making observations.
- Coming up with a Hypothesis.
- Designing and carrying out an experiment.
- Recording the results.
- Deducing from the results whether the experiment supports or rejects the hypothesis.

NOTE: *Don't worry too much about the term Hypothesis now. It will become clearer soon.*

I will now illustrate the above with an example: - *You must have observed that seeds germinate only in wet soil. So you may put forward a hypothesis that seeds need water for germination.*

1.2.2 INDUCTION - DEDUCTION

The scientific method is not complete without two important concepts i.e.

- Induction and
- Deduction

Let's now differentiate between the two:

Induction is a reasoning process by which we start from particular experiences and proceed to generalisation. It is the basis of common sense on which we act. It is not a certainty.

Deduction is a process of reasoning by which we draw conclusions by logical inference from given assumptions.

Progress in science is due to these two combined together.

Let us make this clearer.

Induction is used together with deduction to make scientific discoveries. By using induction, scientists obtain general theories. From these theories, they then deduce new predictions. These predictions are then tested by observations and experiments.

1.2.3 DOING THE EXPERIMENT

To prove your hypothesis you will have to design an experiment.

Take some seeds and sow them in a pot containing dry soil. Then you water the soil daily and observe if the seeds germinate. If they do, you conclude that water is required for germination. However, your experiment needs a **control**.

A control provides a standard with which to compare the result of your experiment.

In this experiment, your control will be another batch of seeds which you'll sow in dry soil without watering.

It is very important that both groups of seeds are kept in the same conditions except for the water they receive or not. That is, all the other experimental conditions or **variables** of the experiment must be constant.

We shall now look at variables in slightly more detail.

✍ Before proceeding further, complete the following activity.

ACTIVITY 2

1. List five steps which are involved in the scientific method:

.....

2. Complete the following sentences:

(a) Induction is a

.....

(b) Deduction is a

.....

3. Why is a control important to your experiment?

.....

You will find the answers at the end of the Module.

1.3 VARIABLE

A **variable** is a factor which may change during an experiment. Examples of variables in your experiment are light intensity and temperature.

A variable can be a dependent **variable** or an **independent variable**.

1.3.1 DEPENDENT VARIABLE

The **dependent variable** is what you measure during an experiment, the readings depend on something which you are varying.

1.3.2 INDEPENDENT VARIABLE

The **independent variable** is what you control and vary during the experiment.

Such an experiment where you control the conditions is called a **controlled experiment**. This is important because then you are making sure that no other factor is influencing your results.

Result

Let us come back to our experiment. After a few days, you will observe which batch of seeds has germinated. This will be your result.

 **Before proceeding further, complete the following activity.**

ACTIVITY 3

1. **What is a variable?**

.....

2. **Mention two types of variables:**

.....

3. **Complete the following:**

The values of a depend on something which you vary during an experiment.

4 **What is an independent variable?**

.....

You will find the answers at the end of the Module.

1.4 INTERPRETATION AND CONCLUSION

Now you will see whether your results support your hypothesis or reject it.

For example, let us imagine the results of your experiment as follows: the batch of seeds, which received water germinated, and the batch, which did not receive water, failed to germinate.

This result therefore shows that water is required for germination. This supports your hypothesis.

1.5 HYPOTHESIS - WHAT IS IT?

We can say that a hypothesis is a trial idea made in science which needs further investigation. During and after the investigation, we can either confirm or reject a hypothesis. In fact a hypothesis is an intelligent or educated guess.

Every scientific discovery begins with a hypothesis. Let's illustrate this with an example:

A scientist name John Priestley put forward the following hypothesis while working with an unknown gas. He got the idea that the gas would make a glowing candle burn brighter. It did when he tested his idea. This gas was later named oxygen.

We can now proceed with the following investigation.



INVESTIGATION 2

You will have to record your answers in the space provided.

Now design and carry out a controlled experiment.

Write up an experiment using the example we have just considered on seed germination. This must include the following headings:

1. Aim of experiment

Why did you do the experiment?

.....
.....
.....

2. Procedure

What did you do?

Give your method step by step and remember to include your control

.....
.....
.....

3. Results

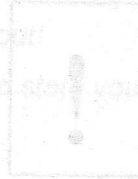
.....
.....
.....
.....
.....
.....



POINTS TO REMEMBER

- Biology is the study of life.
- The characteristics of living things are nutrition, excretion, respiration, irritability, growth, movement and reproduction.
- The scientific method used is to solve biological problems.
- The scientific method involves the following steps:
 - Making observations
 - Stating a hypothesis
 - Doing experiments
 - Interpreting the results
 - Concluding whether we have proved the hypothesis or not.
- A variable is a factor which can change during an experiment.
- The values of a dependent variable depend on something which you vary during an experiment.
- An independent variable is a factor which you control and vary during your experiment.
- Experiments must be controlled to get reliable results.

POINTS TO REMEMBER



- Biology is the study of life.
- The characteristics of living things are nutrition, excretion, respiration, irritability, growth, movement and reproduction.
- The scientific method used is to solve biological problems.
- The scientific method involves the following steps:
 - Making observations
 - Stating a hypothesis
 - Doing experiments
 - Interpreting the results
 - Concluding whether we have proved the hypothesis or not

1.6 A THEORY

A variable is a factor which can change during an experiment. The values of a dependent variable change in response to the change in the values of an independent variable. Scientists sometimes have to make an experiment to even something which is not as clear cut as that. An independent variable is a factor which you control and vary during your experiment. The dependent variable is the variable which you observe and measure during your experiment. We can say it gains a promotion to become a theory. Experiments must be controlled to get reliable results. Experiments must be controlled to get reliable results.

UNIT 2

BIOLOGICAL SKILLS

TABLE OF CONTENTS

INTRODUCTION.....	21
OBJECTIVES.....	21
2.0 BIOLOGICAL EQUIPMENT	22
2.1 SAFETY IN THE LABORATORY	23
2.2 OBSERVING AND MEASURING.....	24
2.2.1 OBSERVING SMALL ORGANISMS	25
2.2.2 MAKING MEASUREMENTS.....	31
2.3 RECORDING AND PRESENTATION OF RESULTS	32
2.4 CALCULATING MAGNIFICATIONS FOR DRAWINGS.....	38
2.5 INTERPRETATION OF RESULTS	41
POINTS TO REMEMBER.....	42

UNIT 2

BIOLOGICAL SKILLS

TABLE OF CONTENTS

21	INTRODUCTION
21	OBJECTIVES
22	2.0 BIOLOGICAL EQUIPMENT
28	2.1 SAFETY IN THE LABORATORY
24	2.2 OBSERVING AND MEASURING
25	2.2.1 OBSERVING SMALL ORGANISMS
31	2.2.2 MAKING MEASUREMENTS
32	2.3 RECORDING AND PRESENTATION OF RESULTS
38	2.4 CALCULATING MAGNIFICATIONS FOR DRAWINGS
41	2.5 INTERPRETATION OF RESULTS
42	POINTS TO REMEMBER

UNIT 2

BIOLOGICAL SKILLS

INTRODUCTION

Good scientists must know how to use apparatuses properly. They must be able to make proper observations, measurements and finally they must interpret the results.

You will now recall that in the previous Unit, we looked at the characteristics of organisms. Some of these characteristics were identified following observations and investigations, sometimes using a specific apparatus before drawing conclusions.

In this Unit we turn to those apparatuses helping us to make accurate observations for a better understanding of those characteristics.

OBJECTIVES

At the end of this Unit you should be able to

- use a hand lens and light microscope to observe organisms
- make proper drawings
- make measurements
- calculate the magnifications of your drawings
- present results in a proper manner
- process your results and draw conclusions from these results.

2.0 BIOLOGICAL EQUIPMENT

In Biology and other science subjects, we normally make use of equipment and apparatuses e.g. a hand lens, a light microscope. These can be very expensive at times e.g. an electron microscope. We must know how to use them properly to get accurate results, but also to make sure they last for a long time.

We must also be able to make proper observations, measurements and record them.

Finally we must interpret them because results without interpretation are meaningless in Science.

Some common apparatuses that you will be using while studying biology are as follows:

- hand lens
- light microscope
- test tube
- scalpel
- bunsen burner
- thermometer
- beaker

Before proceeding further, complete the following activity.

ACTIVITY 1

1. Give two reasons why it is important to use biological equipment properly.

.....
.....

2. *Why is it important to interpret results?*

.....
.....
.....

3. *List ten apparatuses found in a laboratory.*


.....
.....
.....

You will find the answers at the end of the Module.

2.1 SAFETY IN THE LABORATORY

You should always keep in mind your safety while working with any apparatus. You are strongly advised to follow these safety rules whenever you are doing an experiment.

- Follow the procedure for the experiment carefully.
- Keep long hair tied back and wear cotton clothing.
- If possible, wear a lab coat when handling chemicals or biological specimens.
- Wear goggles to protect your eyes.
- Wash your hands thoroughly after using chemicals or touching biological specimens.
- If you are unsure about how to carry out a procedure, ask your tutor first.
- Handle glass equipment with care; make sure they cannot roll off or be knocked onto the floor.
- Treat any minor accidents like cuts and burns **immediately**.

 Before proceeding further, complete the following activity.

ACTIVITY 2

1. Why is it important to wear goggles when you are working with laboratory apparatuses?

2. What can you do if you are not sure how to carry out an experiment safely?

3. The following are some laboratory safety rules, please answer true or false:
 - (a) Follow the procedure for the experiment carefully
 - (b) Store food in the laboratory's refrigerator.....
 - (c) Treat any minor accidents
 - (d) Eat in a laboratory
 - (e) Wear a lab coat

You will find the answers at the end of the Module.

2.2 OBSERVING AND MEASURING

Note: Also refer to Physics - Module 1: 1.1

In the previous Unit we saw how to devise experiments to prove a hypothesis.
 Now, you will learn how to make observations.

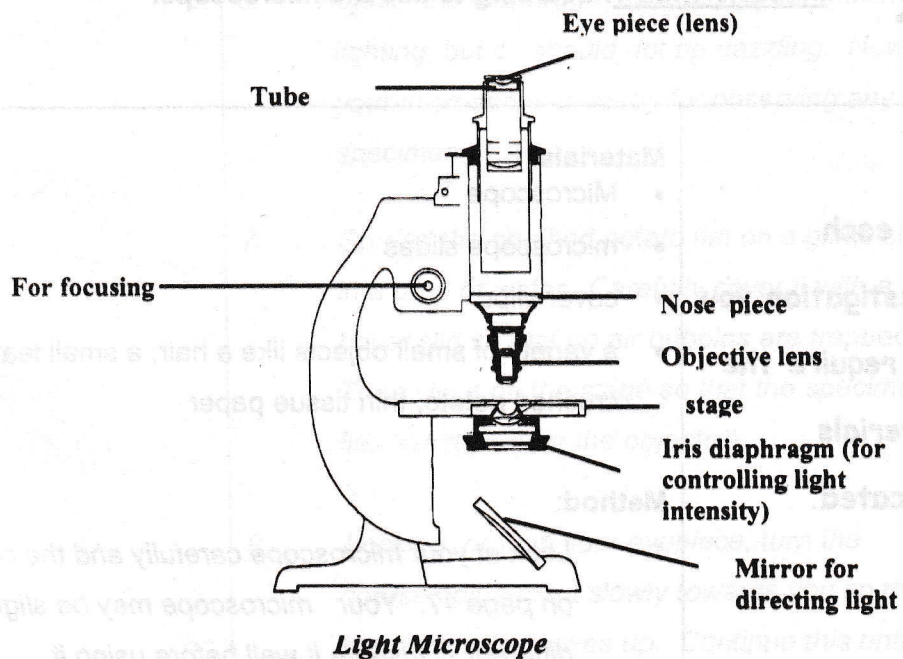
2.2.1 OBSERVING SMALL ORGANISMS

Very often in biology, you will have to look at details in small organisms. This may not be possible with the naked eye. We need a hand lens.



A hand lens can magnify an object about 10 times, that is, it makes the object look 10 times bigger than it is.

If even then the object is too small, then you use a **light microscope**.



In Investigation 1, on page 19, we'll take you through the stages to use a microscope correctly.

When you observe small organisms, you'll often have to record your observations in the form of drawings. A drawing must look like the real specimen, but it must be kept as simple as possible. You have to avoid shadings in a biological drawing. Your lines must be clear and well-defined.

Here is an example of a good and a bad drawing of a leaf.



Bad drawing



Good drawing

We can now proceed with the following investigations.



INVESTIGATION 1: Learning to use the microscope.

<p>For each investigation you will require the materials indicated.</p>	<p>Materials:</p> <ul style="list-style-type: none"> • Microscope • microscope slides • cover slips • a variety of small objects like a hair, a small leaf, crushed potato, thin tissue paper <p>Method:</p> <ol style="list-style-type: none"> 1. <i>Look at your microscope carefully and the one on page 17. Your microscope may be slightly different. Observe it well before using it.</i> 2. <i>Put the microscope on the table in front of you</i>
--	---

with the arms towards you and the stage away from you. You must face a light source like a lamp or a window.

3. Turn the nosepiece until the low power objective clicks into position.

Note : You will find 'X10' written on the low power objective. This is its magnification.

4. Now look at the microscope from the side and turn the coarse adjustment to lower the objective to about 5 mm from the stage.
5. Look into the microscope and turn the mirror until you get bright light, reflecting through it.
6. Adjust the diaphragm so that you get maximum lighting, but it should not be dazzling. Now your microscope is ready for observing any specimen
7. Spread the crushed potato flat on a glass slide in a drop of water. Carefully cover it with a cover slip so that no air bubbles are trapped. Then clip it on the stage so that the specimen lies exactly under the objective.
8. Looking through your eyepiece, turn the coarse adjustment slowly towards you so that the body tube moves up. Continue this until your specimen comes into focus, that is until you get a clear image of your specimen.

	<p>9. Now turn the fine adjustment until you get the sharpest image of your specimen.</p> <p>10. Now draw what you observe. Remember you must draw only what you see as precisely as you can. Avoid shading your drawing.</p> <p>11. Remove your prepared slide and repeat procedures 7 to 10 with your other specimen.</p>
--	---



INVESTIGATION 2: Using the light microscope to look at organisms in water

<p>For each investigation you will require the materials indicated.</p>	<p>Materials:</p> <ul style="list-style-type: none"> • Microscope • microscope slide • cover slip • dropper • a beaker of dirty stagnant water from a river or pond <p>Method:</p> <ol style="list-style-type: none"> 1. Carry out procedures 1 to 6 from investigation 1 to adjust your microscope. 2. Place a drop of the dirty water on the slide and carefully cover it with the cover slip. 3. Examine this specimen under the microscope.
--	---

	<p>Move your slide slowly up and down, right and left and look at the organisms found in the dirty water. You may see small pieces of plants, algae and small organisms that will be moving about.</p> <p>4. You can repeat the experiment to observe other organisms in the dirty water.</p>
--	---

Note : You can also collect water from a stagnant pond or puddles to repeat your observations.



INVESTIGATION 3: Using a hand lens to observe common organisms.

<p>For each investigation you will require the materials indicated.</p>	<p>Materials:</p> <ul style="list-style-type: none"> • Hand lens • a variety of small plant and animal species like a flower leaf • an ant • worm <p>Method:</p> <ol style="list-style-type: none"> 1. Place your flower on a flat surface and observe it with the hand lens. Place the hand lens near your specimen and move it up slowly so that you get a fine image. 2. Cut the flower along its length and observe each of the flower parts
--	--

	<p>3. Now observe the other specimen. Look for fine details which you would not see with the naked eye.</p>
--	---

✎ Before proceeding further, complete the following activity.

ACTIVITY 3

1. Why do we use hand lenses and microscopes in observing small organisms?

.....
.....
.....

2. Name two lenses found in a light microscope.

.....
.....

3. What is the function of an iris diaphragm in the light microscope?

.....
.....
.....

4. Name any five parts of the light microscope.

.....
.....
.....

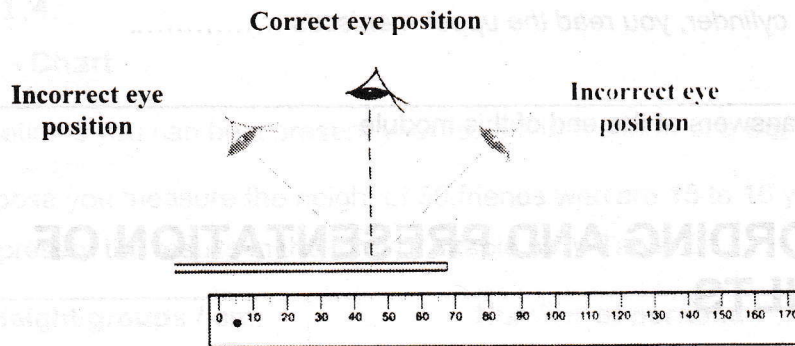
You will find the answers at the end of this module

2.2.2 MAKING MEASUREMENTS

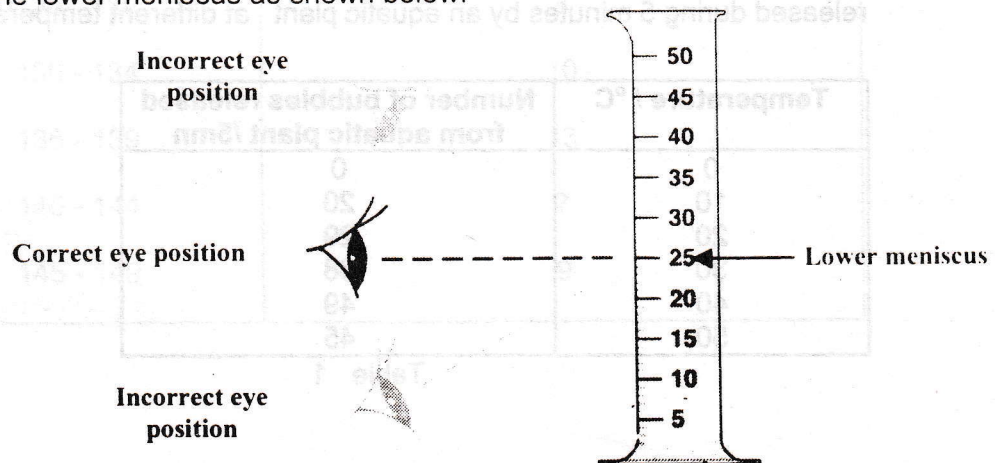
During your observation you will often have to make measurements. This may be in different forms. You may have to

- 1) use a meter rule, for example, to measure the height of 40 persons.
- 2) Take readings from a thermometer or any other graduated apparatus, e.g. a potometer. (See fig.7, module 5, Unit 1 - 3.3)
- 3) Count the number of organisms in an identified area e.g. number of frogs you can find on a playground.


It is very important to make accurate measurements. You must take precautions to obtain accurate readings. For example, if you are taking a reading from a graduated apparatus like a ruler, you should place your eyes directly opposite the mark to be read.



If you are measuring the volume of a liquid, pour it into a measuring cylinder. Then place the cylinder on a level table and place your eyes at the meniscus. Read the lower meniscus as shown below.



As you carry out an experiment, you will observe things and very often make measurements. This is your result. You must present your results in a clear and logical manner.

 **Before proceeding further, complete the following activity.**

ACTIVITY 4

1. *In each of the statements, write True or False:*
 - (a) *We use a meter rule to measure height*
 - (b) *A thermometer is an instrument used to measure volume of liquid*
 - (c) *You can use a measuring cylinder to measure the volume of water*
 - (d) *In measuring a volume of water contained in a measuring cylinder, you read the upper meniscus*

You will find the answers at the end of this module

2.3 RECORDING AND PRESENTATION OF RESULTS

The best way to present a result is in the form of a table.

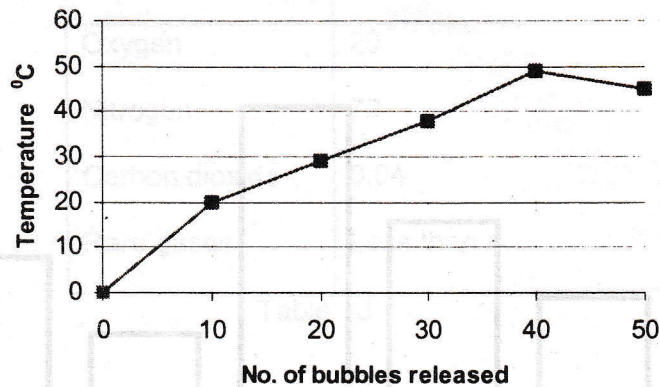
For example, look at Table 1 below which shows the number of bubbles released during 5 minutes by an aquatic plant at different temperatures.

Temperature / °C	Number of bubbles released from aquatic plant /5mn
0	0
10	20
20	29
30	38
40	49
50	45

Table 1

Line Graph

You can also present your result in the form of a **line graph**. For example, you can take the results in Table 1 and present them as a line graph.



Note: Also refer to Chemistry - Module 1 - Unit 1: 1.6 and Physics - Module 1 - 1.4.

Bar - Chart

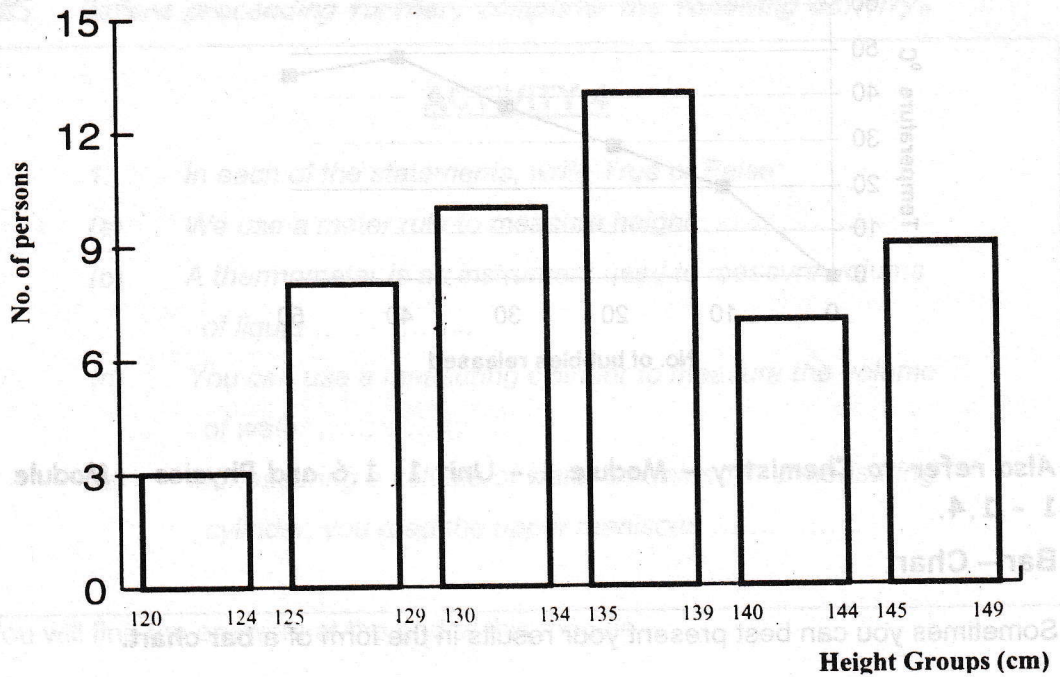
Sometimes you can best present your results in the form of a **bar chart**.

Suppose you measure the height of 50 friends who are 15 to 16 years old. You can present the results in the form of a table as in Table 2.

Height groups / cm.	Number of persons in each group
120 - 124	3
125 - 129	8
130 - 134	10
135 - 139	13
140 - 144	7
145 - 149	9

Table 2

You can represent such a result as a bar chart.



2.3 RECORDING AND PRESENTING RESULTS

Height groups / cm.	Number of persons in each group
120 - 124	3
125 - 129	8
130 - 134	10
135 - 139	13
140 - 144	7
145 - 149	9

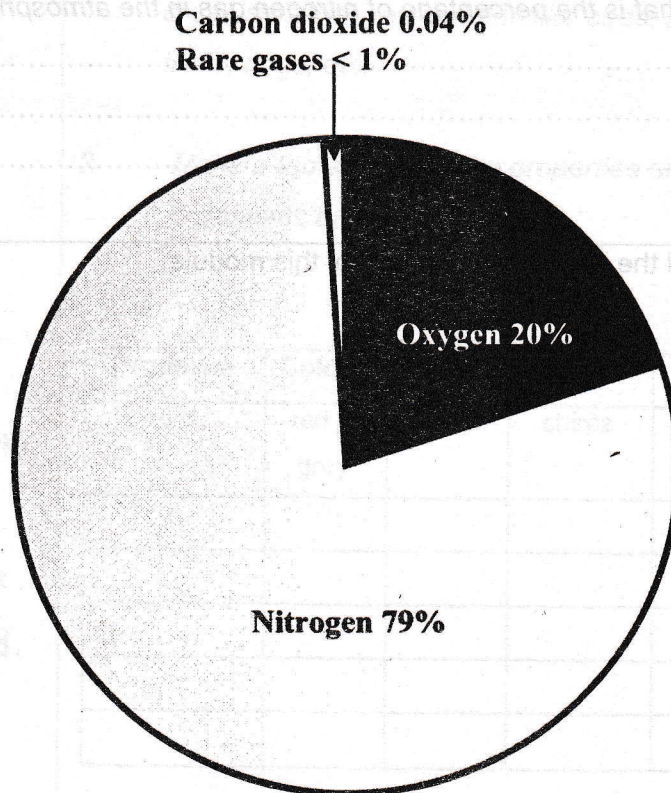
Pie Chart

Consider Table 3 showing the composition of air in the atmosphere.

Gas	Percentage of Gas (%)
Oxygen	20
Nitrogen	79
Carbon dioxide	0.04
Rare gases	Less than 1

Table 3

You can show this result in the form of a circle with each gas as sectors of the circle.



This is a pie chart.

✍ Before proceeding further, complete the following activity.

ACTIVITY 5

1. *List four forms you can use to present experiment results.*

.....
.....
.....
.....

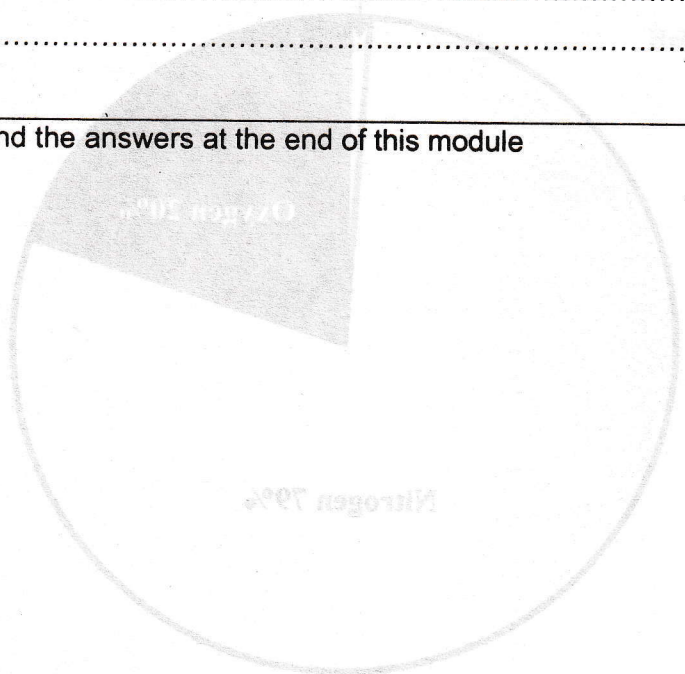
2. *The best way to present a result is in the form of a*

.....
.....

3. *What is the percentage of nitrogen gas in the atmosphere?*

.....
.....
.....

You will find the answers at the end of this module



We can now proceed with the following investigation.



INVESTIGATION 4: Observing some properties of common organisms.

For each investigation you will require the materials indicated.

Materials:

- Paper
- Pen
- Hand lens

Method:

1. Take a walk outside and observe all the common organisms that you can find like birds, flowers, fruits, dogs, etc.
2. Make a table to show the properties of these organisms as follows:

You will have to record your answers in the space provided.

Organism	Colour	Size	Sound	Smell
Bird	red & grey	20 cm.	chirps	None

2.4 CALCULATING MAGNIFICATIONS FOR DRAWINGS

When you draw a specimen, you must always specify the number of times your drawing is larger than the actual specimen. In other words its magnification.

You calculate magnification as follows: -

$$\text{Magnification} = \frac{\text{Size of drawing}}{\text{Size of actual specimen}}$$

Let us imagine that you are drawing an insect.

To calculate its magnification, measure the largest part of the insect's body.

Take it to be 20 mm.

Now, on your drawing, measure the region of the insect's body. Let us say it is 43 mm.

$$\text{Magnification} = \frac{43}{20} \approx 2.$$

Therefore below your drawing you will write x2 . This shows that your drawing is about two times bigger than the actual specimen.

✎ Before proceeding further, complete the following activity.

ACTIVITY 6

1. What is a magnification of a drawing?

.....
.....

2. How can you calculate the magnification of a drawing?

.....

3. Lucy measured the largest part of an insect's body and found it to be 30mm in length. After that she drew the insect on a piece of paper. She then measured the insect's body on her drawing and it was 60mm in length.

(a) Calculate its magnification.....

(b) What number will Lucy write below the drawing?.....

(c) What does the number show?

You will find the answers at the end of this module

Repeat the above procedure for the insect.	space provided.
Calculate its magnification and note it below your drawing.	answers in the
	record your
	You will have to

NOTE: Remember to measure the same regions on your drawings and on the specimen.

We can now proceed with the following investigation.



INVESTIGATION 5: Working out the magnification of a drawing.

<p>For each investigation you will require the materials indicated.</p>	<p>Materials:</p> <ul style="list-style-type: none"> • Hand lens • small leaf • small insect like grasshopper • paper • pen. <p>Method:</p> <ol style="list-style-type: none"> 1. <i>Spread the leaf on a flat surface.</i> 2. <i>Make a drawing of the leaf.</i>
<p>You will have to record your answers in the space provided.</p>	<ol style="list-style-type: none"> 3. <i>Calculate its magnification and note it below your drawing.</i> <p><i>Repeat the above procedures for the insect.</i></p>

NOTE: Remember to measure the same regions on your drawings and on the specimen.



POINTS TO REMEMBER

All equipment and apparatus must be used safely.

- A hand lens and a microscope are used to magnify objects.
- Drawings must be simple and precise.
- Measurements must be precise and accurate.
- Results are presented in a clear and logical manner. These may be in the form of a
 - table
 - graph
 - bar chart
 - pie chart.
- All drawings must have a magnification
- The magnification of a drawing = $\frac{\text{Size of drawing}}{\text{Size of specimen}}$
- Interpretation of results include
 - answering questions
 - looking for patterns
 - and drawing a conclusion

ANSWERS TO ACTIVITIES

Unit 1

Activity 1

1. Biology is the study of living things or organisms.
2. Provide energy for daily activities
Supplies materials for growth
Keeps the body healthy
3. It is removed through the kidney in the form of urine.
A little urea is also excreted through the skin as sweat.
- 4.

Animals	Plants
Movement is easy	Movement is not obvious
Can move from one place to another	Only part of a plant can move

Activity 2

1. Making observations
Coming up with a hypothesis
Designing and carrying out an experiment
Recording the results
Deducing from the results whether the experiment supports or rejects the hypothesis
2. (a) Is a reasoning process by which we start from particular experiences and proceed to generalisation.
(b) Is a process of reasoning by which we draw conclusions by logical inference from given assumptions.
3. A control provides a standard with which to compare the result of your experiment.

Activity 3

1. It is a factor which may change during an experiment.
2. Dependent variable
Independent variable
3. Dependent variable
4. A factor which you control and vary during your experiment.

Unit 2

Activity 1

1. To get accurate results
To make sure the equipment lasts for a long time
2. Results without interpretation are meaningless in Science
3. Hand lens, light microscope, test tube, scalpel, Bunsen burner, thermometer, beaker, measuring cylinder, pipette, water condenser

Activity 2

1. To protect your eyes
2. Ask your tutor first
3. (a) True, (b) False, (c) True, (d) False, (e) True

Activity 3

1. To magnify objects
2. (i) Eye piece lens, (ii) Objective lens
3. For controlling light intensity
4. (i) Eye piece lens, (ii) tube, (iii) Iris diaphragm, (iv) stage, (v) stage, (vi) nose piece

Activity 4

1. (a) True, (b) False, (c) True, (d) False

Activity 5

1. Table
Line graph
Bar chart
Pie chart
2. Table
3. 79%

Activity 6

1. The number of times your drawing is larger than the actual specimen
2. Magnification = $\frac{\text{size of drawing}}{\text{size of actual specimen}}$
3. (a) Magnification = $\frac{60}{30} = 2$
(b) She will write x 2
(c) The number shows her drawing is about two times bigger than the actual specimen

Printed by the Institute of Adult Education