BIOLOGY
SOURCE BOOK
FOR ENJOYABLE TEACHING AND LEARNING

SOURCE BOOK

IDEAS FOR TEACHING BIOLOGY TO BEGINNERS WITH LOCALLY AVAILABLE MATERIALS

IDEAS FOR TEACHING, LEARNING AND ASSESSMENT BY DOING

MZUMBE BOOK PROJECT
P.O. Box 19, MZUMBE,
MOROGORO - TANZANIA

This source book is the result of a workshop held at Morogoro Secondary School (Tanzania) from July 13th to 25th 1992. The workshop was organised by the Ministry of Education and Culture in cooperation with the Goeth - Institut (German Cultural Institute).

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This workshop project was sponsored by:

- Ministry of Education and Culture, Tanzania.
- Ministry of Education and Culture,
- Hessen, Germany.
- Goeth e-Institut, Dar es Salaam.

This low-priced edition is sponsored by:

- Canadian Organisation for Development through Education (CODE).
- Partnership Furtherance with the Third World (APDW), Karlsruhe, Germany.
- Voluntary Service Overseas (VSO).

Special technical assistance was sponsored by:

- Fa, Merck, Darmastadt, Germany.

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ISBN 9987 552 12 9

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Mzumbe Book Project
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Foreword

Biology is about the living world. It concerns the structure and organization of living things and how they work. It is becoming increasingly obvious that such a knowledge is essential in order to derive the maximum benefit from our environment without damaging it for ever. Debates on such issues now range from local to global level, and increasing public awareness and media coverage of environmental matters has served to focus attention on the importance of Biology more than ever before.

In the past, Biology as a subject was often regarded as academically inferior to and intellectually less demanding than the other pure sciences. However, recent advances in areas such as biotechnology and genetic engineering have shown this to be totally untrue. Even at its simplest levels, Biology is a fascinating subject, dealing as it does with ourselves, our surroundings, the complex interaction between physical and chemical processes.

Biology is essentially a practical subject based on enquiry, observation and experimentation. This book follows that theme throughout, whilst also drawing on the natural curiosity of the young person. By emphasizing the use of locally available materials, the text becomes a starting point for a learning process, which is easily related to the familiar surroundings of the pupil! Thus Biology ceases to be an abstract topic and becomes relevant to everyday life. Another major feature of this approach is "learning by doing," that is the active involvement of the pupils, and a movement away from traditional and considerably less effective teaching strategies such as the familiar "chalk and talk education". This book is intended to provide a stimulating source of ideas for both teacher and pupil and above all to make Biology enjoyable. For that reason, the environmental approach can be justified on both psychological and educational grounds. The simplicity of some of the activities and of the local materials used, should not be seen as an inferior substitute for complicated investigations involving expensive and sophisticated scientific equipment. Rather it is an acknowledgment that science is more about developing an enquiring mind, than memorizing facts (following the pattern from the simple to the complex, from the familiar to the unknown). Furthermore the science of Biology is all around us, and so, even more than in other sciences, its teaching should not be restricted to the classroom. The shamba, the village or the school compound can provide fruitful areas of study and rich sources of material. For this reason many of the activities can be done by the pupils without assistance, even at home.

It is hoped that this book will have a wide appeal to pupils, teachers, student teachers and teacher trainers, and its use will contribute not only to the improved teaching and learning of Biology but to a general awareness of the importance of Biological issues in every aspect of modern life.

L.K. MSAKI
Commissioner for Education

Preface

This sourcebook is addresssed to all those who are concerned with the teaching of Science at the Junior Secondary School level. This includes the Teachers, Teacher Training College Tutors and University Lecturers. Nevertheless, the book will also be useful to Science Club Organisers, the Student or Anyone who wants to experiment on their own. The main audience is the teacher and tutor who work in inadequate teaching and learning conditions trying to encourage students to develop skills to understand, control and wisely use science in their daily life.

This sourcebook is the result of an International Workshop which drew participants from Uganda, Tanzania, Germany and Great Britain.

This participants developed and tested ideas, experiments and activities which can be quickly performed in any classroom using a few low or even no cost materials. Moreover, these practicals do not require a great deal of preparation.

Such easy and enjoyable activities and experiments have a long standing tradition in the history of teaching science. They are often called "hand experiments" because most can be performed without commercial equipment but by hands alone.

You will find ideas and suggestions which are not normally found in science textbooks. We assume that teachers are familiar with most of the traditional experiments which are found in the set textbooks. Therefore we feel there is no need to repeat all of them here. The reader will welcome the ideas on how to bring teaching up to date, since this book provides not only "how to do it" and "what to do", but "why" with clear, simple explanations.

Going through this book, the reader will find that many traditional experiments can be performed as "hand experiments" too. They are more illustrative and more appealing to the students than "black-box experiments" with sophisticated commercial equipment. They encourage the students' creativity to invent other experiments and activities and stimulate their natural curiosity to understand the biology of everyday life.

The suggestions in this sourcebook are stimulants to modern teaching and learning i.e. *teaching and learning by doing.* They should be supplemented with the teachers' own ideas, the students' ideas and ideas from other sources.

We acknowledge with gratitude the professional, technical and financial assistance of all who have contributed to publish this sourcebook particularly to the Ministry of Education and Culture of the State of Hessen (Germany) and the Goethe-Institut for sponsoring the workshop.

Last but not least, we thank Morogoro Secondary School for hosting the workshop from which this source book resulted.

A.S. NDEKI

Chairman of the Executive Committee

Mzumbe Book Project

How to Use This Book

This source book may be used with any Biology textbook. It offers such as variety of ideas that any teacher should find something that fits into their own pattern of teaching. Teaching is such a personal art, that it would be wrong to suggest one simple approach to teaching Biology. To enrich Biology learning we must consider *how* to teach the subject as well as *what* we teach.

This book incorporates a selection of activities for lower secondary level (Form 1 and 2) most of which can be carried out with materials to be found around the school and home. These activities do not require a lot of materials and in many cases none. Wherever possible we selected low cost or no cost materials.

With a basic tool kit of just ten items most of the suggested activities and models can be performed or constructed. These ten tools are all available locally (see appendix).

Time is also a limiting factor for many teachers. The preparation for and carrying out of activities may seem to use up the time available for covering the syllabus. For this reason we have, especially selected so called "hand experiments" which can be done in a very short time and with a minimum of preparation or even with none! So the editorial team has considered the reality of daily school life, to overcome difficulties imposed by lack of time and facilities.

It should not be forgotten that work done outside school time is an essential and integral part of biology as is the classroom teaching. The suggested activities can be carried out and enjoyed by science clubs and individuals. However it should be noted that some of these activities need the guidance and supervision of an experienced adult in order to avoid any risk and to derive the utmost benefit. A pupil may not be aware of the risks of a harmless looking experiment. For this reason our book is not directly addressed to the unsupervised pupil.

P: The *procedure* describes what is needed and how to carry out the activity.

Q: These are suggested *questions,* which the teacher may ask themself or the student. A guide to proper observation and explanation.

O: Possible *observations* are described.

E: The *explanation* of the observation is outlined. The teacher should insist that all observations be discussed and as far as possible, explained. This is an integral part of scientific working.

I: Some activities give *additional information.* Important safety precautions are printed in italics.

We warmly welcome your opinions, suggestions and constructive criticisms of the content and layout of this sourcebook. Please fill in the questionnaire at the back of this volume and send it to us. With your help we can improve the future editions of this book.

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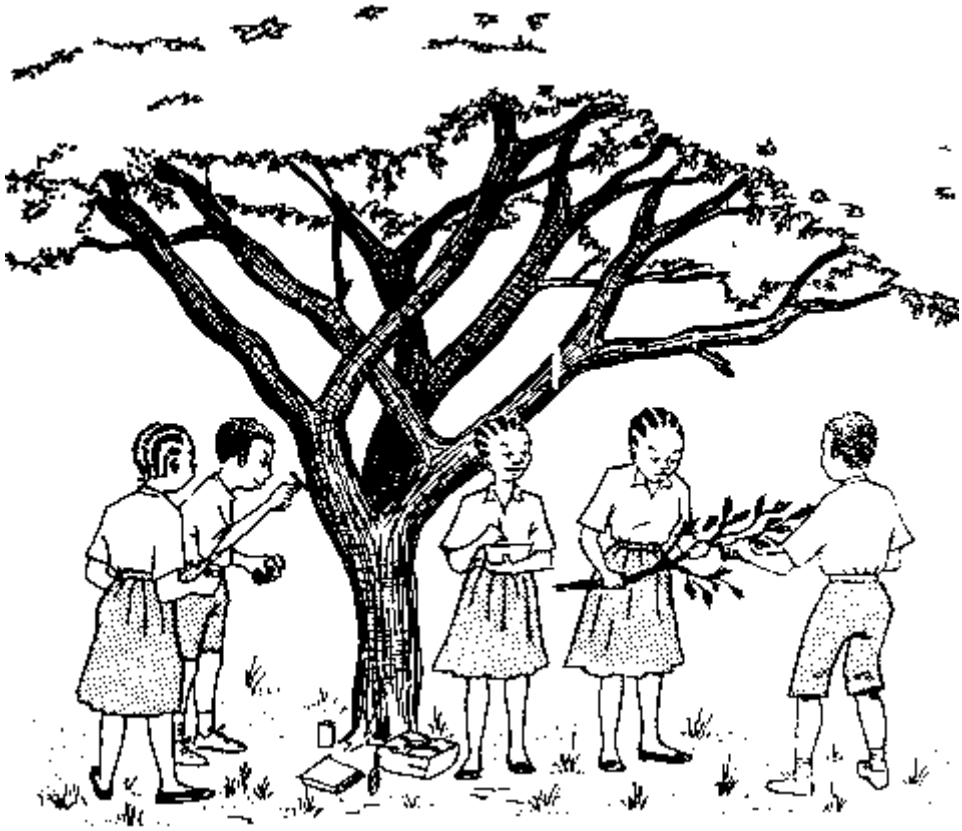
1. Introduction to Biology



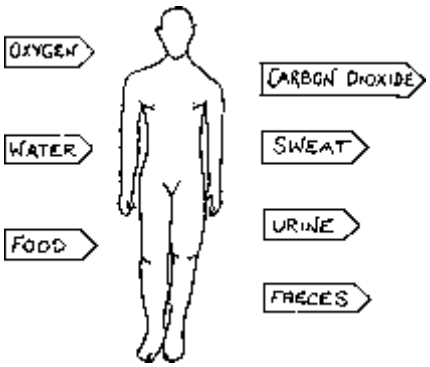
1.1. Characteristics of Living Things

The study of living organisms is called *Biology.* All living things have certain characteristics in common with each other. They are in dynamic equilibrium with their surroundings, constantly taking in some substances and giving out others;. While inside the organism many of these substances undergo changes. This process is called *metabolism* and it enables the organism to maintain a constant internal environment, regardless of external changes. Maintaining such an internal equilibrium is called *homeostasis.*

Seven specific characteristics can be identified, which are shown by all living organisms at some stage during their life. These are growth, respiration, response to stimuli, movement, nutrition, excretion, and reproduction.

Some of these characteristics can be shown by non-living things, but only living organisms carry out all seven of them. In addition living organisms are controlled by a programme of instructions contained in their genes, which can be passed on from one generation to the next. The smallest biological structure which is capable of showing all these characteristics of life is the cell. It can therefore be thought of as the basic unit of life.

1.1.1 Metabolism

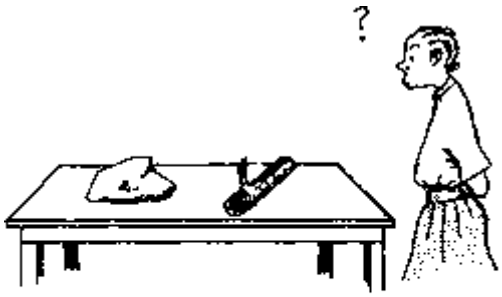


P: Draw an outline sketch of a human being, and make a list of the main substances taken into and given out from the body.

Q: Why are the substances taken in different from those given out?

E: Changes to these substances occur as a result of metabolism. Useful substances are retained by the body while useless ones are removed.

1.1.2 Obvious Characteristics of Living Things



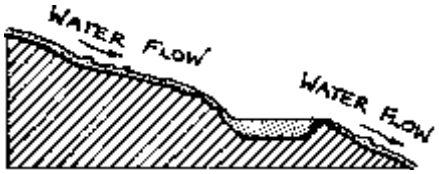
CHARACTERISTICS	
Non-living things	Living things

P: Display some non-living things such as a stone, piece of wood, glass of water etc., and list any obvious differences between these things and a living organism (i.e. man). Produce a table from the whole class response.

1.1.3 Other Characteristics of Living Things

P: Display a potted flowering plant and identify the main characteristics of life. Note that many of these are less obvious in plants than in animals.

1.1.4 Equilibrium in Non-living Things



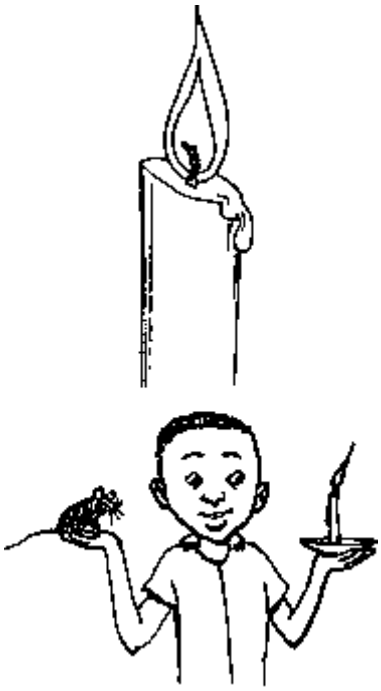
P: Construct a small pond on the school compound with an inlet and an outlet for the water.

Q: What do you observe about the water flow and the water level in the pond?

O: Although the water flows constantly, the level remains the same.

E: Such a phenomenon is called a dynamic equilibrium. Other examples are the flame of a candle and living organisms.

1.1.5 Is a Candle Flame Living?



P: Look at a burning candle. The candle flame can be considered as an example of a process in a state of dynamic equilibrium.

Q: What are the similarities and differences between a candle flame and a living organism.?

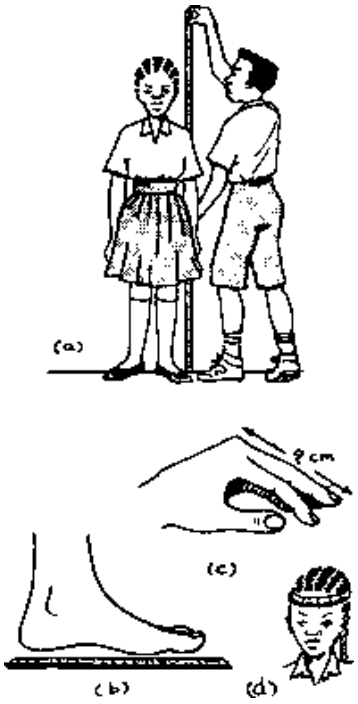
E: A candle flame is the result of a metabolic process. The candle wax is burnt to carbon (soot) and other gaseous substances. The shape, colour and brightness of the flame remains fairly constant, but only as long as there is a supply of wax and air. The flame is not self-sustained and cannot reproduce itself.

1.2. Variation in Living Things

In Science we are constantly concerned with measuring things in order to make observations and collect data. However, it is a feature of living things that they vary. When we talk about typical features these are based on average data taken from many observations. The differences between individuals determine how they are grouped together or classified. For instance the differences between separate species will be greater than that normally occuring

within the same species. These differences are the result of variation, which can be investigated by observing and measuring various examples of "typical features".

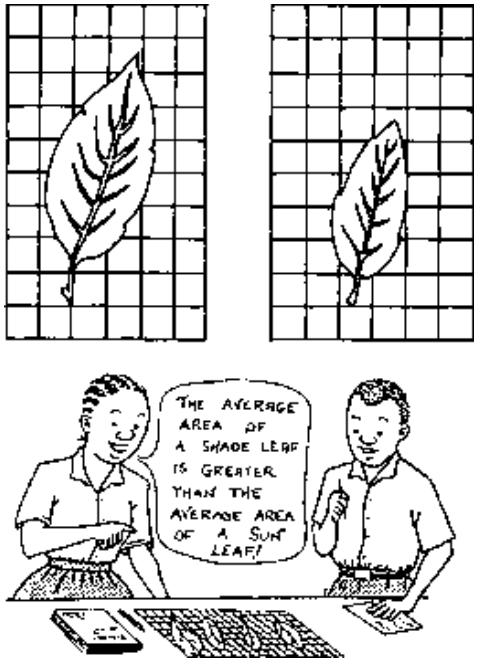
1.2.1 Variation in Humans



P: Using adults measure (a) their height, (b) length of middle finger, (c) length of foot, (d) circumference of head (taken just above the eyebrows). Adults should be used, since in children, variation will be due to different stages of growth.

Q: What is the range of values (maximum and minimum) and the average values for each measurement taken?

1.2.2 Variation in Leaves



P: Take some leaves from the same plant (or from a plant of the same species) choosing

some in the sun and some in the shadow. Measure the surface area of each leaf by placing on squared paper. Count only the squares which are more than half covered. Calculate the average leaf area for each type (i.e. shade leaves and sun leaves).

Q: What are your results?

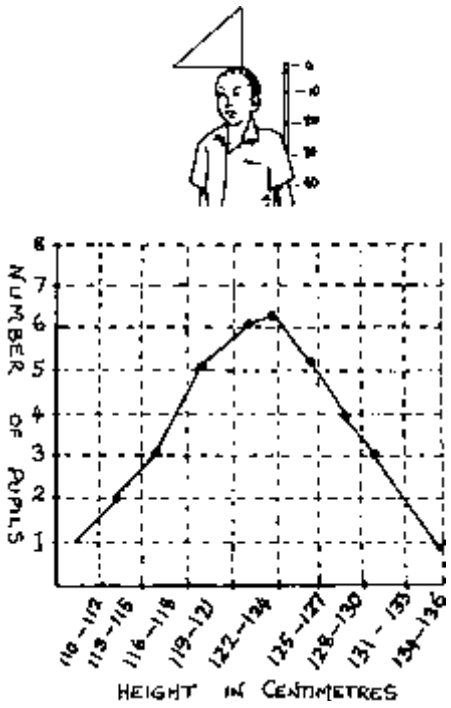
O: Shade leaves are normally bigger than sun leaves.

E: Shade leaves get less light, so in order to absorb sufficient light for photosynthesis, the surface area is usually larger.

1.3. Collecting and Recording Data

Human progress is due largely to his ability to measure and collect data with ever greater precision and accuracy. Pupils should be taught general skills in obtaining data by carrying out simple experiments. They should be introduced to basic measuring techniques and encouraged to develop skills in the recording and graphical analysis of data. It should be stressed that data be compiled from as many measurements as possible in order to improve their validity.

1.3.1 Data on Height



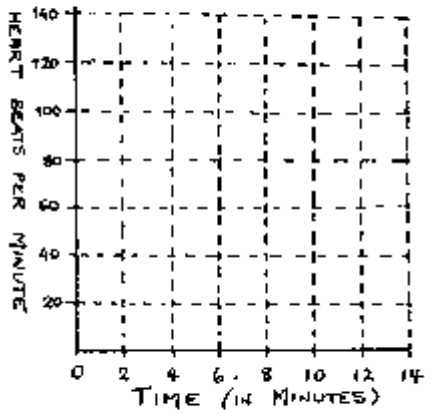
P: Obtain the heights of all the student in the class (in centimetres). Use these heights to divide the students into groups (i.e. 110-112 cms, 113-115 cms etc). Count the number of pupils in each group. Plot a graph of height against numbers.

Q: What does the graph look like and what does this show?

O: A normal distribution curve is obtained showing that a few students are very tall, a few are short, but most of them come somewhere between these extremes.

E: Members of a species can vary in size between a maximum and a minimum value, but most individuals are near the middle of this range.

1.3.2 Analysis of Pulse Rate



	STRESS					REST				
MINUTES	0	2	4	6	8	10	12	14	16	18	20
FIRST GIRL											
SECOND GIRL											

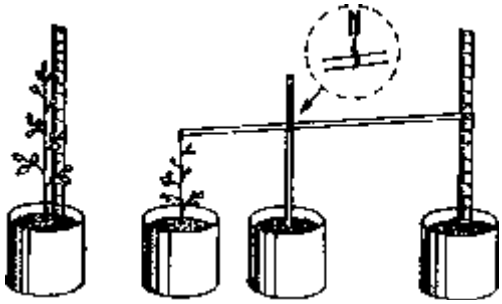
P: Take the resting pulse rate of ten students, then ask them to run around the school compound for two minutes. Take the pulse of each student at two minute intervals until the pulse returns to normal. For each student plot a graph of pulse rate against time.

Q: Which pulse rate was the highest and which pulse returned to normal most quickly?

O: Each curve of pulse rate will be slightly different

E: This is due to differences in levels of physical fitness of each student. The less fit ones generally reach a higher pulse rate, which takes longer to return to normal.

1.3.3 Growth Measurement



P: Take a seedling in a pot (or use a plant in its natural environment) and attach a fine thread to a light stick (as shown above). Alternatively use the simple method for measuring growth. Make measurements at fixed intervals (say 2 or 3 days). Devise a method of presenting your data graphically.

1.3.4 Weight Increase by Germinating Seeds

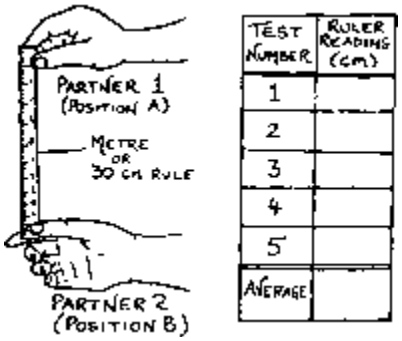
P: Place 10 bean seeds between pieces of wet newspaper. Place a second group of 10 beans between dry paper. Measure the weight of each group of beans at daily intervals, and also record any observations.

Q: What are the differences in weight between the two groups of seeds?

O: The soaked beans swell and the weight increases. No change occurs in the beans on dry paper.

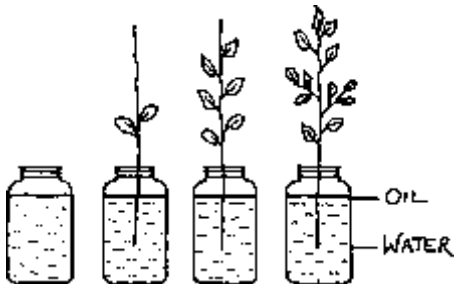
E: The beans on the wet paper have absorbed water and started germinating. The dry beans did not.

1.3.5 Obtaining Averages



P: Hold a ruler or strip of wood as shown. Ask your friend to place a thumb and forefinger on either side of the ruler at mark O, but without touching it. Release the ruler. Your friend should try to catch it as quickly as possible. Note where the ruler was caught and measure the distance of the point from mark O. Repeat 5 times and take the average.

1.3.6 Keeping a Written Record



P: Pick branches with different numbers of leaves and place each one in containers with the same volume of water (To avoid loss by evaporation pour some oil on the surface). Record the daily loss of water in each container

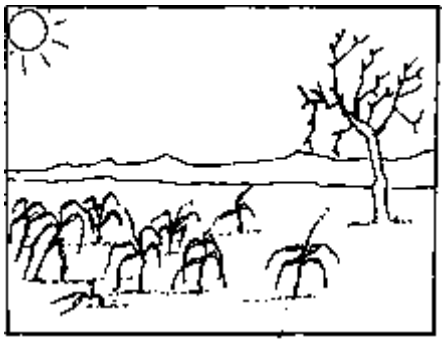
O: The more leaves on the branch, the greater the loss of water.

E: Leaves are the organs where most water is lost by the plant

1.4. Scientific Method

Being a scientist is not just a matter of learning a lot of facts. It is more a way of thinking. Being scientific means first making careful observations of objects, organisms or events and then suggesting possible explanations. This explanation is called an *hypothesis.* This should then be tested by designing a suitable experiment or series of investigations. If it does not turn out to be true then a new hypothesis must be proposed and tested by a different set of experiments. As soon as an hypothesis is found to be true it can be applied to other, similar situations.

1.4.1 From Observation to Application



Observation - Without water from rain or by irrigation, the soil around plants eventually becomes dry. This is particularly obvious when plants are grown in pots or other containers. In extreme cases the soil gets so dry that the plant dies.

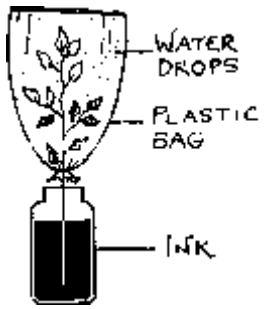
Hypothesis - the plant requires water, which it absorbs from the soil through its roots. This water is then transported through the plant.

Experiment 1: Place a branch of a non woody plant in a solution of coloured ink.

Observation: After some time the coloured ink is seen in the stem and leaves of the plant. (Also in the petals of the flowers - if they are present). A lot of liquid has been absorbed.

Conclusion: The plant transports water upwards through the stem to the leaves where most of it is probably lost.

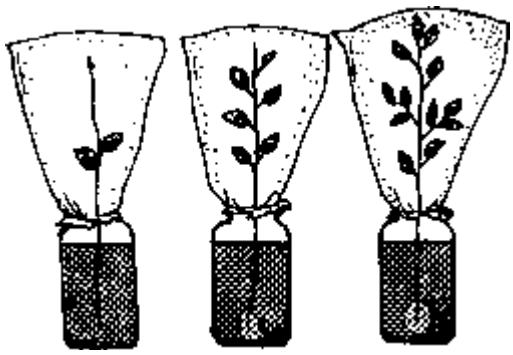
Hypothesis: Water is transported to the leaves where it is lost.



Experiment 2: Using the same materials, as experiment 1, place a plastic bag around one of the branches and tie it tightly to the stem with string or rubber bands.

Observation: Clear (uncoloured) water collects in the plastic bag.

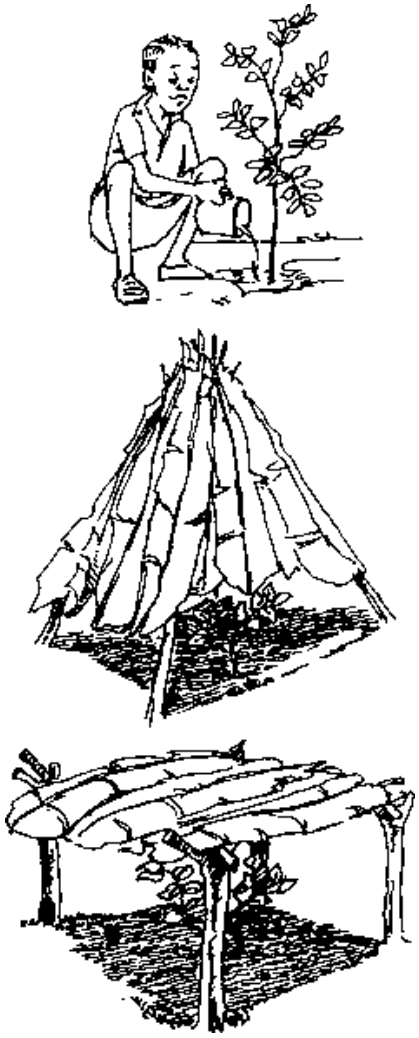
Conclusion: Water evaporates from the leaves and condenses in the plastic bag. The dissolved materials (the colour in the ink) remain in the plant.



Experiment 3: Using the same materials, place one plastic bag around a single leaf and another around a branch with many leaves.

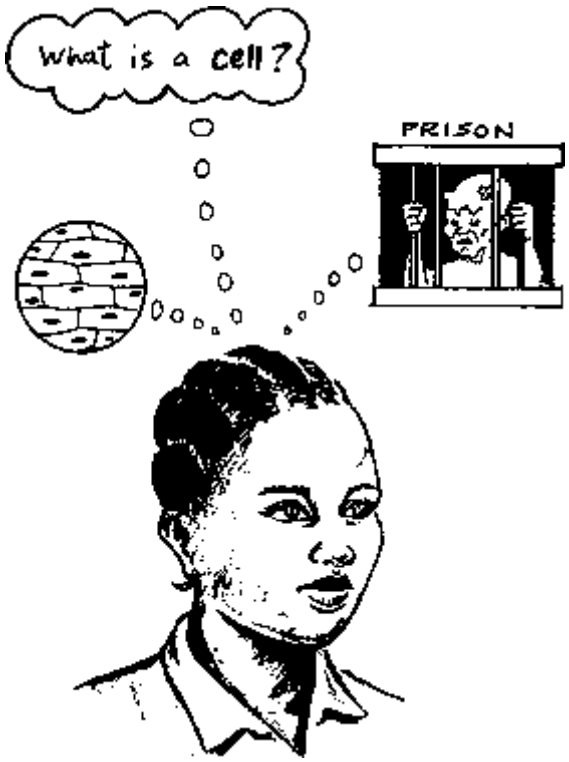
Observation: More water collects in the bag enclosing the larger number of leaves.

Conclusion: Since water is lost from the leaves of a plant, the larger the number of leaves, the greater the amount of water lost.



Application. For better growth, plants need to be Supplied with an adequate amount of water. To reduce excessive water losses by transpiration, special methods of cultivation are used. Can you match the above pictures to these methods?

2. Cell Structure and Organisation



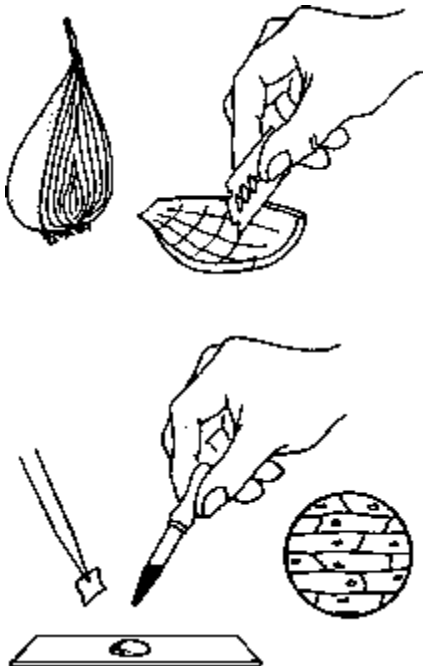
2.1. Cells - Tissues - Organs

Cells are the basic units of all organisms. Some organisms, e.g. protozoa, are composed of only one cell (unicellular), but most consist of very many cells (multicellular). Certain features like cell membranes, cytoplasm and nucleus are common to all cells. Most cells are specially adapted in their size, shape and chemistry to carry out particular functions (for example animal and plant cells). There is a constant movement of substances into and out of cells which is controlled by the membrane. Almost all cells are too small to be seen with the unaided eye, and so a microscope is needed to observe them.

Cells of the same function group together to form tissues. Different tissues form organs and different organs form organ systems. All organ systems together make up the complete organism.

2.1.1 Looking at Onion Cells

P: Slice an onion into two, lengthways and take out one of the thick leaves from inside it. Cut the inner thin surface of the leaf into squares of 2 x 2 mm. With a pin or needle place one of these squares in a drop of water on a slide or any small piece of window glass. Lower a cover slip carefully on to it and examine the cells with a microscope as described in the appendix. Make a drawing of what you see.

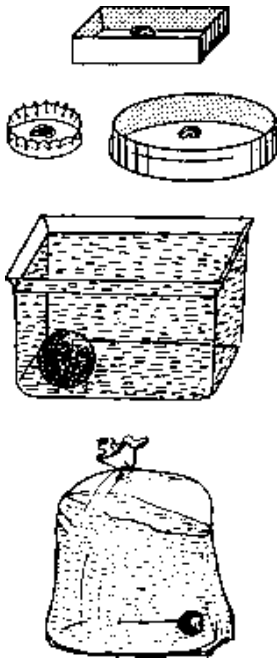


Q: What do the cells look like?

O: Onion cells appear with a dark line around them (the cell wall) and with a dark oval body inside (the nucleus). They are usually packed closely together.

I: The cells can be seen more clearly if a drop of iodine is added to the slide.

2.1.2 Simple Models of Cells

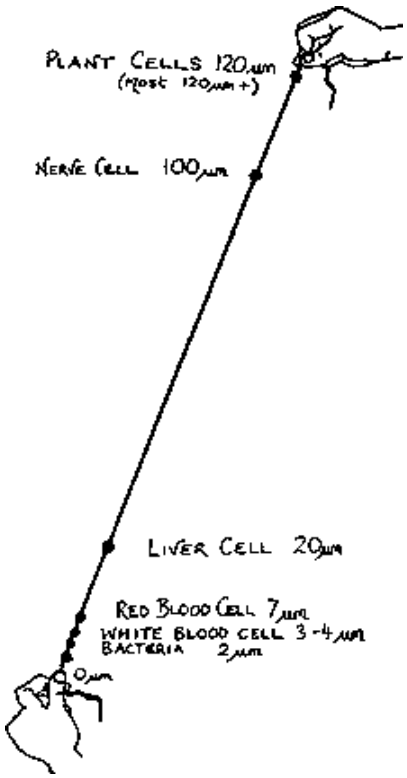


P: Take a small stone or seed and place it in the tray of an empty match box, in a soda bottle top or in any other small container. Prepare a water filled container or plastic bag with seed or stone to represent a nucleus.

Q: What do the sides of the containers, the seed and the space between them represent?

E: The sides represent the cell membrane, the seed, the nucleus and the space between shows the cytoplasm.

2.1.3 Size of Cells



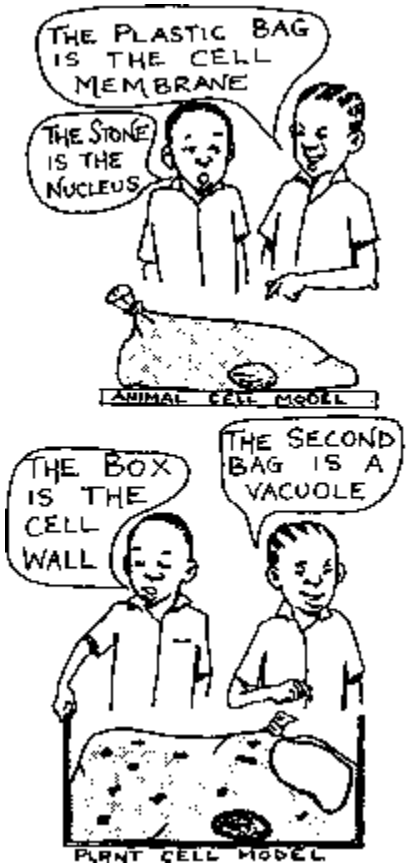
P: Take a piece of string (or chalk a line on the ground) about 60 cm long. Mark distances as shown in the diagram above. The lengths represent the sizes of different types of cells enlarged one thousand times.

Q: How many times bigger is a plant stem cell than a blood cell?

E: 50 times.

I: Although almost all cells are too small to be seen with the unaided eye, they show a wide range of sizes (about the same range as a mouse and an elephant).

2.1.4 Animal and Plant Cells

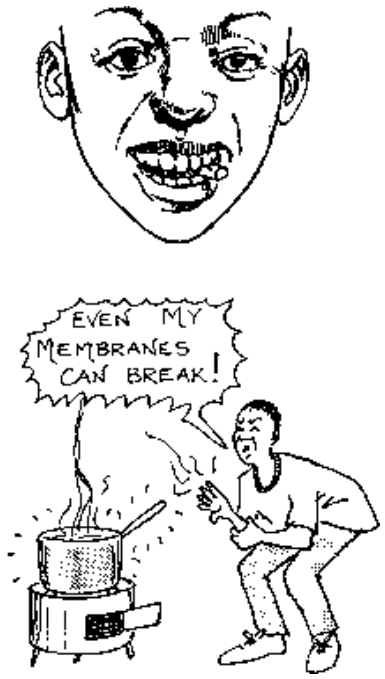


P: Use a plastic bag to represent the cell membrane, a large seed or a stone to show the nucleus and water in the bag for the cytoplasm. For the plant cell place the bag into a cardboard box to show the cell wall. Trapped air or a small air filled plastic bag will act as vacuoles. Small cuttings of leaves can represent the chloroplasts.

Q: What are the main differences between an animal and a plant cell?

E: Plant cells have chloroplasts, cell wall and a large vacuole whereas animal cells do not. Also plant cells are usually larger and have a more definite shape than animal cells.

2.1.5 Breaking Membranes



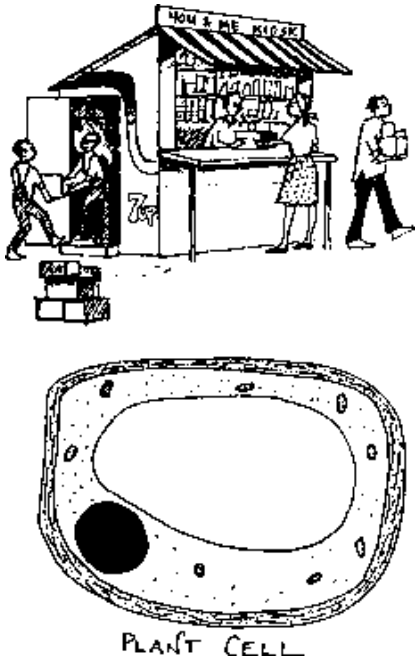
P: (a) Put a grape or an uncut segment of orange in your mouth. Leave it for a few moments without moving your mouth, then chew it slowly. (b) Heat a deep coloured fruit, flower, leaf etc. in water.

Q: Do you taste the fruit before or after chewing? What can you observe about the colour after heating?

O: The fruit can be tasted after chewing and colour is found in the water after heating.

E: The juices containing sugar and other chemicals, which give the fruit its particular flavour, are found inside the cells. They are only released when the membranes are broken, for instance by mechanical forces like chewing and heating.

2.1.6 "Kioski" as a Cell



P: Observe what happens at a kiosk where goods are sold.

Q: How does the activity at a kiosk compare with a living cell?

E: A kiosk is partly like a cell because

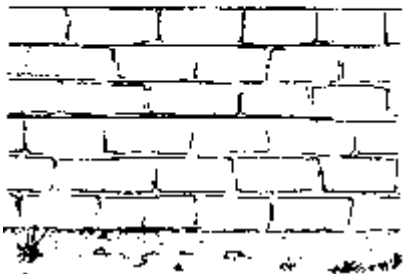
- in a kiosk only specific things move in and out.

- things are taken in and passed out at different rates.

- different types of kiosk sell different goods (just as different cells carry out different functions).

Unlike a cell, the kiosk is not self sustaining and the things given out are the same as those taken in.

2.1.7 Models of Tissues

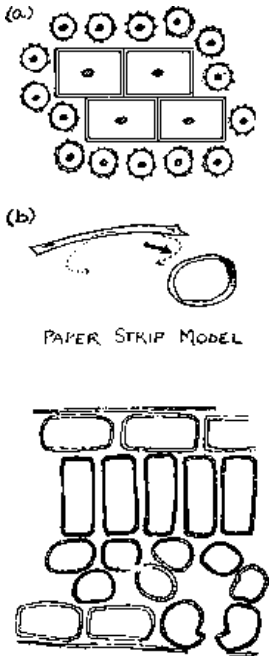


P: Group match box "cells" and bottle tops (see 2.1.2) together to form tissues. Cells and tissues can also be demonstrated by bubbling air through a soap solution with a drinking straw.

Q: How are cells arranged to form tissues?

E: In tissues the cells are all of the same type and are closely packed together like bricks in a wall.

2.1.8 Models of Organs

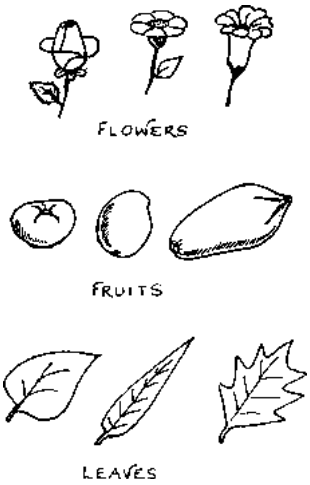


P: Arrange different types of tissues together to form the basic structure of an organ. This can be done by using the tissues formed from match boxes and soda bottle tops (a).

Q: How are tissues arranged to form organs?

I: A model of an actual organ (like a leaf) can be constructed from strips of paper, to show the different types of cells and tissues present (b).

2.1.9 Display of Organs

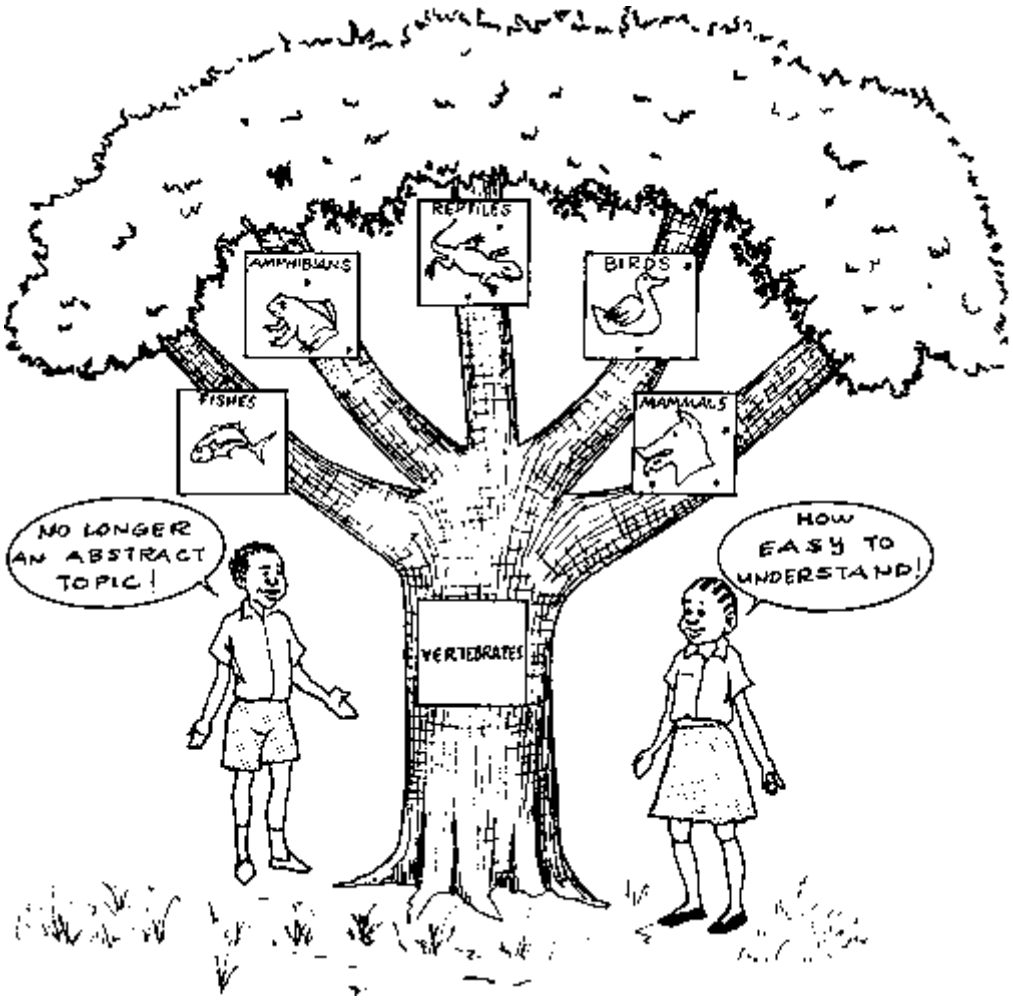


P: Collect leaves, flowers, seeds and roots from different plants and arrange them in a display. List the function of each structure.

Q: What are the structural similarities between organs performing the same functions?

E: Organs carrying out similar functions are similar in structure, i.e. food storage organs are swollen, leaves are thin and flat, flowers are coloured etc.

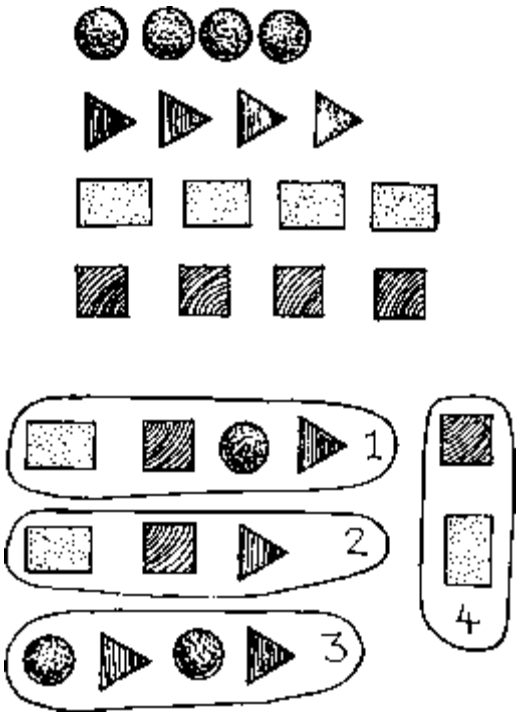
3. Classification of Living Things



3.1. Biological Classification

Classification is the sorting of things into separate groups in such a way that all items in the same group have certain features in common. Books in a library, types of goods in a shop, vegetables in a market and notes in a bank are all examples of a simple system of classification. Biological classification is more complicated because of the large numbers and diversity of living things, but the general principle is the same. Organisms are placed into groups according to their structure, appearance and the way they live, based on similarities and differences between them. Organisms are first placed into large groups, whose members may only have a few common features, then into increasingly smaller groups where the members have a greater number of similarities. The smallest such group is called a *species.* Organisms of the same species can usually be recognised because they look very similar to each other. Human Beings all belong to the same species. Other examples of a species include a lion, a chicken, a mango tree or a cassava plant. Classifying organisms in this way allows us to recognise them, to study them more easily and to investigate the relationships between them.

3.1.1 Arranging Shapes



P: Make four of each of the following shapes: squares (3 cm x 3 cm) triangle (3 cm sides) rectangles (3 x 4 cm) circles (3 cm diameter). Mix the shapes and then sort them according to a chosen feature.

Q: How many different ways can you find of grouping the shapes?

O: At least 4 can be found.

3.1.2 Classification at the Duka

P: Observe how the goods at the local shop are arranged on the shelves

Q: Can you find a pattern in the arrangements on the shelves?

E: The goods will be arranged firstly in large groups, ie. foodstuffs, non-food stuffs (medicines etc.), and then into smaller groups such as foods in tins, foods in bottles, etc..

3.1.3 Find a Missing Person

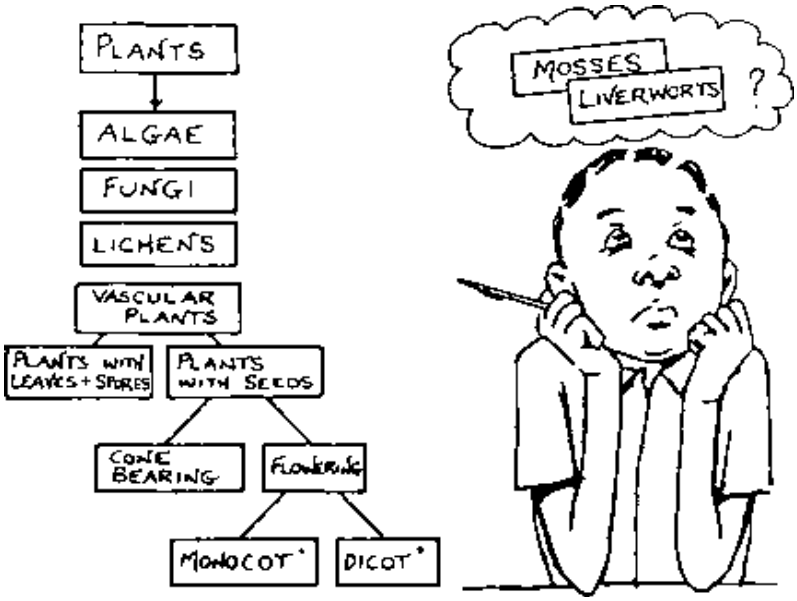
P: Imagine that you have been asked to find one particular person on earth.

Q: What information would you require?

O: Continent, country, region, district, ten cell block, house, name of person.

E: This procedure can be compared to the process of classifying organisms, firstly in large groups. (equivalent to a continent) then smaller groups (equivalent to country, region etc).

3.1.4 Classification Charts

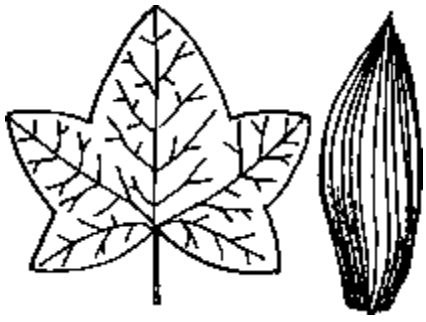


P: Prepare cards giving the names of the main groups of living organisms. Arrange them to show how the living world can be classified into kingdoms, phyla and so on.

E: Kingdoms can be arranged horizontally, phyla vertically.

I: Pictures from magazines or newspapers can be used to illustrate the cards. After mixing use the cards for oral assessment.

3.1.5 Classifying Leaves



P: Collect leaves from different plants. Make large groups and small groups using as many different characteristics as possible.

Q: How many ways did you find to group the leaves?

E: Characteristics like shape, colour, vein pattern, leaf margin etc. can all be used.

3.1.6 Variety in Insects

P: Collect at least 5 different types of insect. Identify the obvious external characteristics of each specimen.

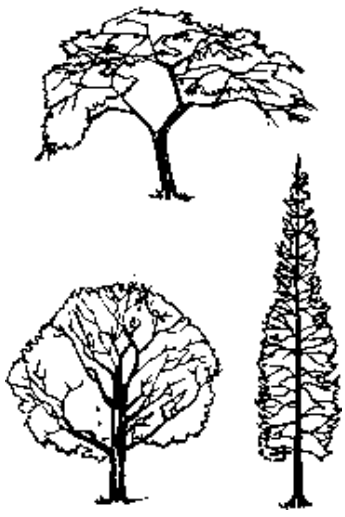
Q: What features are common to all insects, and which ones are found only in one particular type?

O: Features like jointed legs, external skeleton, wings and three body regions are found in all insects. Features such as number of wings, shape of wings, shape of body etc., are specific to one type.

3.2. Looking at the Diversity of Organisms

The concept of classification should not be learned by memorising long lists of complicated names, or attempting time - consuming and difficult identification exercises. The diversity of living organisms and the complex interactions between them, should be studied by field work wherever possible. The school compound can provide a rich source of material which is readily accessible. When necessary specimens can be collected and further investigation carried out in the classroom. Please note, however, that removing of organisms from their natural habitat should be restricted to common types and any disturbance of the environment kept to a minimum.

3.2.1 Identifying Trees



P: Try to find as many different types of trees as possible in the school compound. Make a note of their particular characteristics, such as overall shape, the arrangement of branches, colour of trunk, colour and shape of leaves etc.. Record the names of any trees which you recognise.

Q: Which characteristics are most useful for identifying the trees and which are the least useful?

E: Best features are shape of leaves, types of fruit and flowers. Arrangement of branches, bark colour and size are less useful as they are more variable.

3.2.2 Food Plants

P: Take a walk around your local shambas and record all the types of food plant you see. Make a brief description of each plant. Exchange your description with a friend and see if they can identify the plants you have seen.

3.2.3 Sampling with Squares

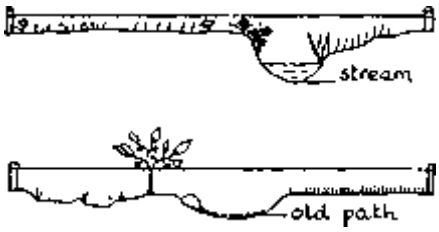
P: Construct a square with 1 m sides from sticks or thin pieces of wood. Choose an overgrown piece of ground on the school compound and place the square on it. Record the names or descriptions of organisms found inside the square.

Q: What differences do you find in the organisms found in different places?

E: The differences will depend on various factors, such as whether the ground is cultivated or not, if it is flat or on a slope, dry or wet and so on.

I: This method can also be used to compare the numbers of organisms found in different habitats. Squares used for sampling are called *quadrats.*

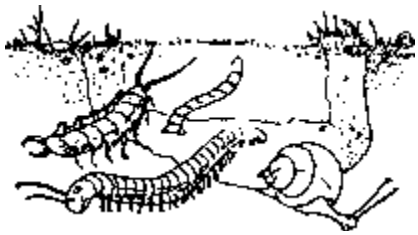
3.2.4 Sampling with Lines



P: Take a piece of string 20m long and divided into 1 m lengths by tying knots. Stretch the string over a piece of ground between two sticks. Working from one end, record all the organisms which the line touches and their distance from the beginning.

E: The organisms found will vary according to the ground over which the string passes. By choosing a site which shows variation, more differences will be found. This technique is called a *line transect.*

3.2.5 Life under a Stone



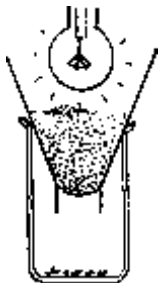
P: Choose a large stone which has not been disturbed for some time. Lift it and record all the organisms you find there.

Q: Can you explain why there are no plants present?

E: No plants will be found since there is no light under the stone. This means this is a very specialised habitat and only certain organisms can live there.

I: Compare the organisms under the stone with those living on top of it (i.e. mosses, lichens and other small plants.)

3.2.6 Life in the Soil



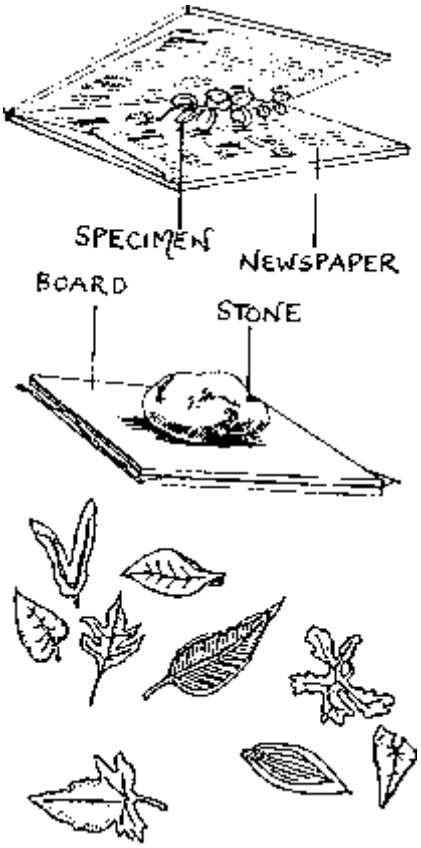
P: Collect about 250g of fresh soil and place in a funnel with a piece of gauze across the neck. Arrange a lamp directly above the funnel and a small container below.

O: Small organisms from the soil collect in the container.

E: Soil organisms usually prefer dark, damp and cool conditions, so the heat and light from the lamp drives them downwards until they drop out of the funnel. The organisms collected can be used to show the range of organisms found in the soil.

3.3. Collecting and Displaying Specimens

3.3.1 Simple Plant Press



P: Cut two pieces of stiff cardboard, hardboard or thin wood about 30 cm square. Place layers of newspaper between the squares, and arrange the plant specimens between the sheets of paper. Tie together with string or put a heavy weight like a brick or stone on top and leave until the plants are dry.

I: The newspaper may need to be replaced with dry paper to dry the specimens completely.

3.3.2 Making an Herbarium

SPECIMEN: Leaf
NAME: mango tree
LOCAL NAME: M.wembe
LOCALITY: Boma Road, Morogoro
HABITAT: Road side
DATE: 22nd July, 1992

P: An herbarium is a collection of plant leaves or flowers. After drying in a press they can be fixed to paper with sellotape or glue. Thick paper in a loose leaf file is best, but exercise books can be used instead. Whenever possible give the name of the specimens in English. The place where it was collected and the date should be included. The work of individual pupils can be built into a reference collection or used as a display.

3.3.3 Making a Species Collection

P: Plants which cannot be pressed or other specimens, such as branches of trees, seeds,

fruits and small animals can be displayed on a science table or science corner. Many such specimens can be allowed to dry, but if this causes too many changes, they can be kept in jars of water for short periods or in spirit for longer periods.

I: A few drops of domestic bleach in the water will reduce rotting of the specimen by fungi or bacteria. Make sure all specimens are properly labelled and arranged in a systematic and logical way, with a clear indication of what the display is intended to show. This could be organisms in a pond, plants by the roadside, insects found in the home etc.

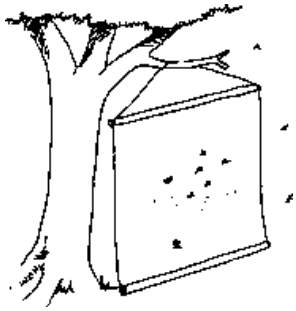
3.3.4 Collecting Nets

P: A wide mouthed sweep net can be made easily from a stick, some wire and mosquito netting. With this net insects can be knocked off plants. Wire netting is more suitable for water sweep nets.

3.3.5 Pitfall Traps

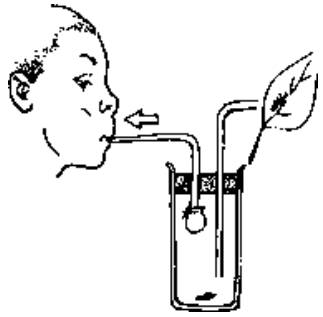
P: A jam jar or tin can be buried in the soil with the rim at ground level. Punch a few holes in the bottom of the tin to let water escape. Cover the tin with wood or a stone to keep rain out. Some fresh food will attract insects.

3.3.6 Sticky Paper Trap



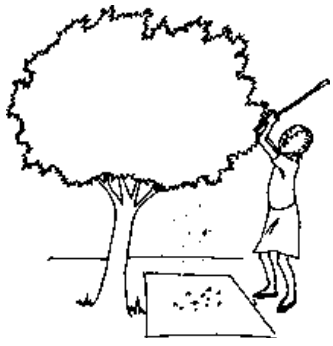
P: Coat a piece of stiff paper with honey, jam or a strong sugar solution. Hang it from a tree. Small flying insects will become stuck to the paper.

3.3.7 Pooter



P: A pooter for collecting small animals can be constructed as shown above, from a variety of jars or tins. Cover the tube through which air is sucked with net or cloth to avoid the specimen being sucked into the mouth!

3.3.8 Beating with a Stick



P: Place a white cloth or sheet of newspaper under a tree or bush. Beat the branches with a long stick and the insects fall onto the sheet.

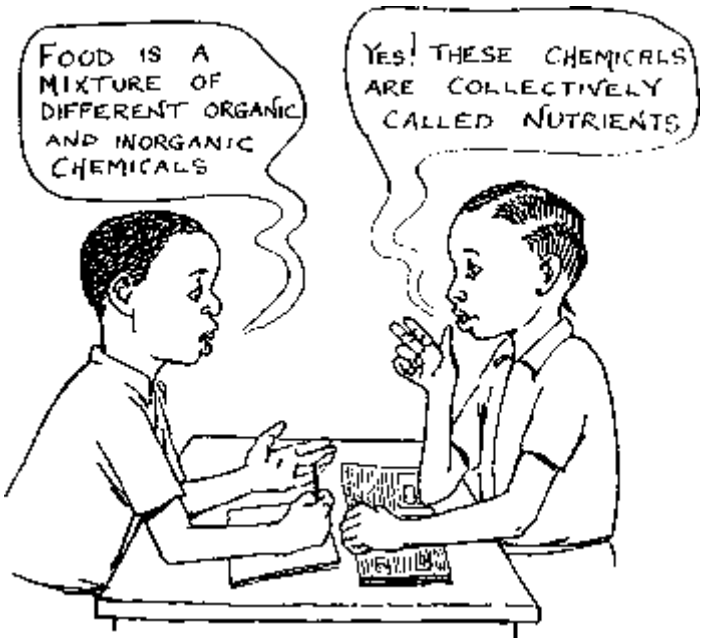
4. Nutrition

4.1. Organic and Inorganic Food Substances

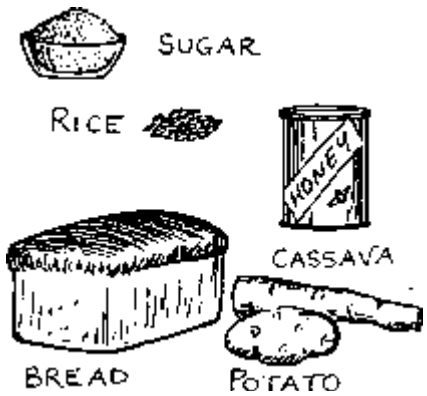
Foods are a mixture of different organic and inorganic chemicals, collectively called *nutrients.* These provide the body with (i) energy (ii) materials for growth and repair (iii) substances for regulating metabolic processes. The main classes of nutrients are carbohydrates, lipids (fats and oils), proteins, vitamins and minerals. Carbohydrates contain the elements carbon (C), hydrogen (H) and oxygen (O), and include sugars, starch and cellulose. With the exception of cellulose, the tough fibrous material found in plant cell walls, they usually provide energy.

Lipids also contain C, H and O, but in different proportions to the carbohydrates. Their main function is storage of energy but they are also important for insulation, protection, formation of hormones and synthesis of cell membranes. Proteins contain C, H and O, but also very importantly the element nitrogen. (They sometimes contain sulphur and phosphorous as well). Proteins are very large and complex molecules, composed of long chains of smaller molecules called amino acids. These provide materials for growth and repair of tissues.

Vitamins are a diverse group of organic compounds which are involved in cell metabolism. They are only required in very small amounts but they are vital for good health. Minerals are small, inorganic ions such as calcium (found in bones), iron (found in red blood cells) and iodine (a component of the hormone thyroxine). Although not really a nutrient, water forms an essential constituent of food. It performs so many functions that life would not be possible without it.

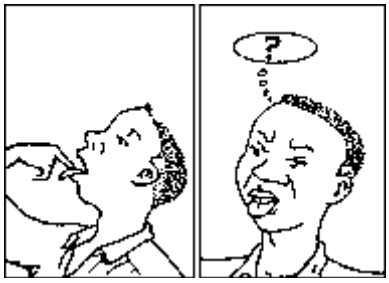


4.1.1 Carbohydrate Collection



P: Make a collection of food-stuff: containing carbohydrates and display these in a science corner of the classroom. Clearly label all specimens.

4.1.2 Tasting Carbohydrates



P: Place a little starch on the tongue and note the taste. Next place a little sugar on the tongue and also note its taste.

Q: Describe the taste of starch and sugar

O: Starch is tasteless while sugar tastes sweet.

E: Sugar molecules are small and soluble. They can be detected by the taste buds, to

produce a sweet taste. Starch molecules are large and insoluble and cannot be tasted.

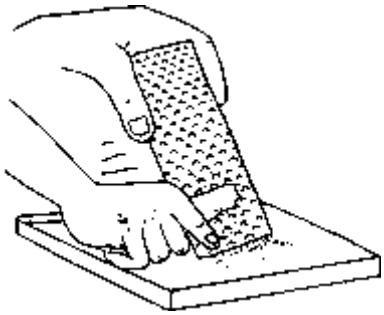
4.1.3 Carbohydrate Solubility

P: Place a teaspoon of sugar in a glass of water and stir. Repeat the experiment using a teaspoon of starch in a glass of water.

Q: What happens to sugar and starch?

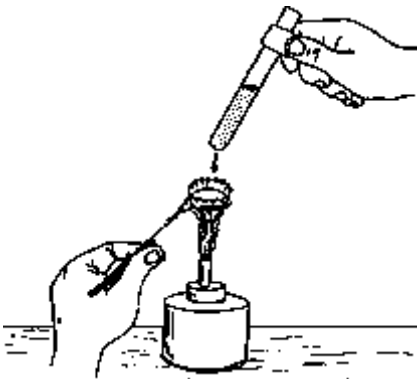
O: Sugar dissolves in water while starch does not.

4.1.4 Preparation of Starch from Cassava



P: Grate the cassava and soak the resulting material in water mixing thoroughly. Strain the liquid from the fibres. Leave the liquid to settle and the starch can be easily seen at the bottom of the container. Decant off the water. Starch could then be dried and stored for future use.

4.1.5 Heating Carbohydrates



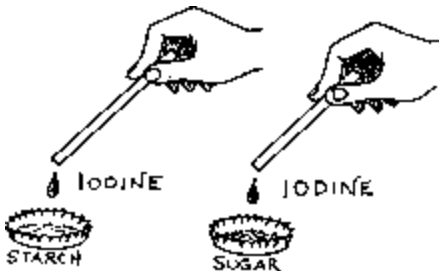
P: Place a small amount of sugar in a bottle cap and heat as shown. Hold a water filled test tube or glass over the vapour from the cap. Repeat the experiment using starch.

Q: What do you observe?

O: Water will condense on the tube and black carbon will remain in the cap.

E: Carbon and water are produced when carbohydrates like sugar and starch break down.

4.1.6 Iodine Test



P: Place a small amount of sugar in a bottle cap and a small amount of starch in another. Drop a little iodine into each cap.

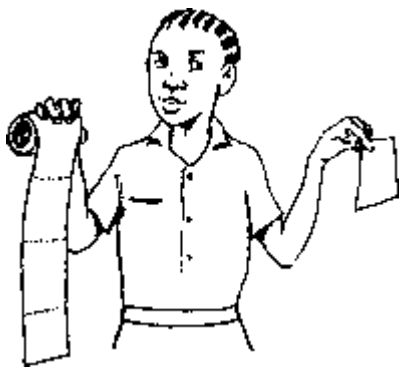
O: The starch and iodine produces a blue black colour while there is no colour change with sugar and iodine.

I: Test other foods such as bread, potatoes etc..

4.1.7 Simple Sugars in Plants

P: Plants contain mono and disaccharides. Sucrose (cane sugar or table sugar) is formed from joining together of a fructose molecule and a glucose molecule. Grapes contain glucose. Simple tasting of fruits will confirm the presence of simple sugars by sweetness. Try heating fruits in water to obtain extract.

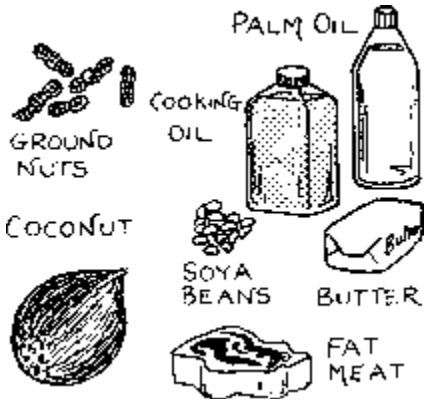
4.1.8 Simple Sugar Model



P: To illustrate the long chain structure of polysaccharides use strings of beads, toilet roll or a chain of pupils. Each long chain is formed by smaller units which represent simple sugars.

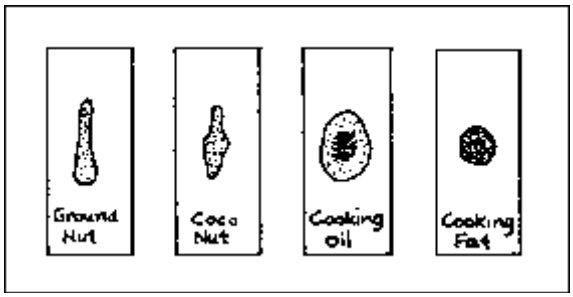
Can you think of any other simple examples using bottle caps, beans, seeds and stones?

4.1.9 Foods Rich in Fats and Oils



P: Make a collection of foods rich in fats or oils. These could be butter, margarine, animal fat, milk, egg yolk, palm oil, groundnut oil, cod-liver oil and coconut oil

4.1.10 Effect of Fats and Oils on Paper



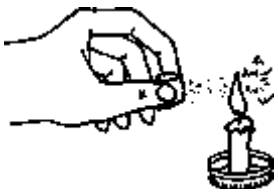
P: Press or rub groundnuts, coconut, cooking oil, milk, butter and cooking fat onto paper.

Q: What happens to the paper?

O: The substances make a grease mark which is transluscent when held up to the light, but looks dark when placed on a desk.

E: The grease marks show the presence of fats and oils in the food items. Simple carbohydrates manufactured by plants can be changed into oils for storage purposes in fruits and seeds.

4.1.11 Orange Peel Oils



P: Squeeze a fresh orange or orange peel near a flame.

Q: What happens?

O: The spray from the peel burns with bright flashes

E: The peel of oranges contains volatile oils. These do not make a lasting grease spot.

4.1.12 Solubility of Fats and Oils

P: Mix fats or oil with water. Then in a separate container mix fats or oils with a small amount of petrol.

Q: Look through the two liquids is there a difference?

O: Oils and fats dissolve in organic solvents such as petrol or alcohol, but not in water. However, vigorous shaking with water will produce a cloudy or milky emulsion of suspended fat droplets.

4.1.13 Stable and Unstable Emulsions

P: To demonstrate stable and unstable emulsions, add oil to water and shake. In another container add oil and a little soap solution to water and shake.

Q: What is the difference between the two samples?

O: Oil forms a suspension with water which separates later into two layers, while a milky suspension in soap and water persists longer.

E: The soap acts as an emulsifier breaking down the oil into smaller droplets. In human digestion bile acts in a similar way by emulsifying fats and oils.

4.1.14 Dangerous Oils

P: Mineral oils are not edible and can be dangerous. Heat carefully small samples of mineral oils.

Q: What do you notice about the smell?

I: *It is dangerous to inhale petrol or mineral oil fumes?*

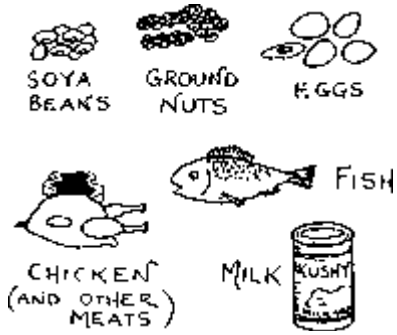
4.1.15 Hot Oils

P: Hot oils are dangerous. Never add water to hot oil (which boils at 300 degrees C).

Q: Why does adding water make the oil spit?

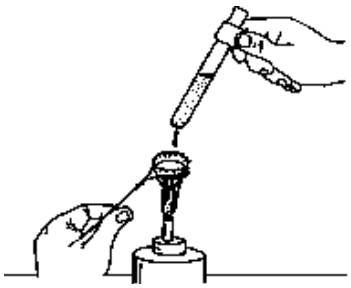
E: *Water in the oil evaporates so quickly that the vapour causes fat to spit out with it and this may catch fire.*

4.1.16 Protein Collection



P: All plants contain a certain amount of protein, but some have a high concentration particularly seeds like cow pea, groundnut, soya bean. Collect samples of plant food stuffs and make a display or drawings for the science corner.

4.1.17 Carbon and Water in Protein



P: Heat pieces of egg-white in a bottle cap. Hold a water filled test-tube over the vapour.

Q: Is carbon present in egg-white? Is water present in egg-white?

O: Water condenses on the test tube. Black carbon deposit will be left in the bottle cap.

E: Protein in egg-white, contains water which evaporates on heating and condenses on the test tube. Carbon remains in the bottle cup.

4.1.18 Protein Contains Other Elements

P: Heat pieces of the white of egg with some limestone (or basic substance).

Q: What do you notice about the smell?

O: A pungent smell is produced.

E: On heating, nitrogen in the egg-white combines with hydrogen to produce ammonia. This has a pungent smell.

4.1.19 Burning Hair and Horn

P: Heat some samples of hair and horn over a flame.

O: A pungent smell is produced.

4.1.20 Straightening Hair

P: Some Tanzanian women use a hot comb to straighten their hair.

Q: Why can't we use a cold comb?

E: The protein keratin, which is present in hair, has sulphur bonds between protein chains. Combing the hair with a hot comb can break these bonds temporarily and thus straighten the hair. The bonds soon rejoin and the hair becomes kinky again.

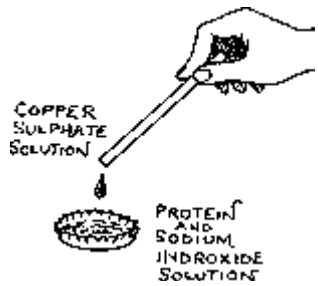
4.1.21 Coagulated Protein

P: Examine an egg before and after cooking. Place a small amount of egg-white in a bottle cap and heat.

Q: The jelly like egg-white turns into a white solid mass.

E: Amino acids and proteins are very sensitive to certain physical changes such as temperature. When heated, protein molecules lose their special properties and become denatured.

4.1.22 Biuret Test for Protein



P: Mix a little protein solution with the same amount of 10 per cent sodium hydroxide solution. Add a few drops of 0.5 per cent copper sulphate solution drop by drop, shaking well after each drop.

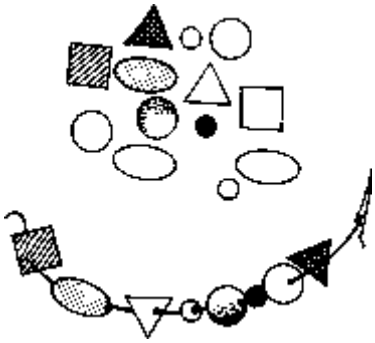
Q: What colour change do you see?

O: The solution turns purple.

E: Purple colour confirms the presence of protein.

I: Test other foods for protein.

4.1.23 Models of Proteins

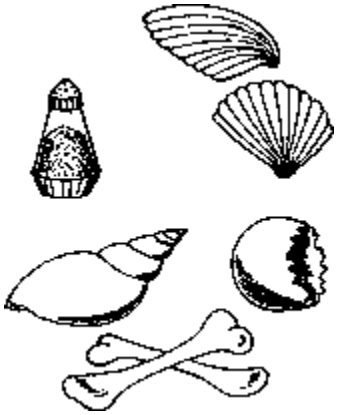


P: Using different types of beads or seeds to represent the different amino acids, string together simple models of protein chains.

Q: How could this also show protein digestion?

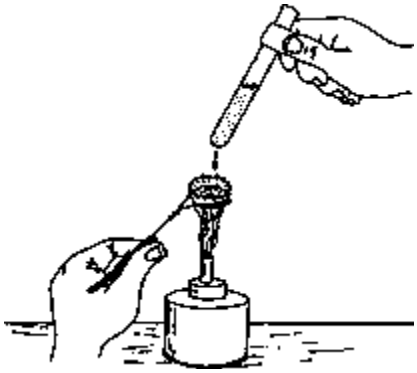
E: A pair of scissors could be used to represent an enzyme breaking down protein into amino acids.

4.1.24 Mineral Collection



P: Make a collection of sea shells, snail shells, bones, egg shells and other materials from living things rich in mineral salts.

4.1.25 Heating Items rich in Mineral Salts



P: Heat some samples of living things rich in mineral salts.

Q: What happens if egg shell is heated?

O: The shell does not burst into flames although burning may occur on the inner surface of the shell where organic membrane is present

E: Calcium present in the egg shell is inorganic and so it does not burn.

4.1.26 Sweat and Tears

P: Taste your sweat or tears.

Q: What does it taste like?

O: They taste salty.

E: The mineral salts dissolved in these fluids give a distinctive taste.

I: When you have cut yourself what did blood taste of?

4.1.27 Mineral Salts in Wood Ash

P: Mix some ash from plants (wood etc.) with water and heat. Then filter and evaporate off the water.

Q: What is left in the test tube?

O: Salt crystals can be seen

E: Plant materials contain salts which are left in the ash when the organic material burns off.

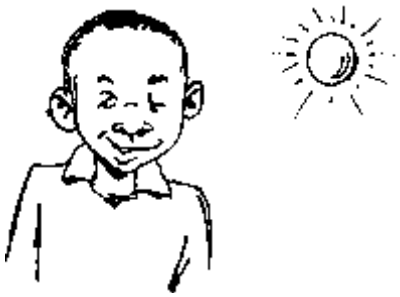
4.1.28 Foods containing Vitamins

P: Make a collection of foods containing vitamins. These could include eggs, milk, beans and peas, groundnuts and citrus fruits. A vitamin is an organic substance which an animal must obtain in order to be healthy. Vitamins are only needed in small amounts, and part of the need may be synthesized by an animal, although this does not often happen. Different animals require different vitamins. Every vitamin is available from another plant or animal and many can be synthesized in factories.

4.1.29 Baby's Milk

P: Babies fed from a bottle on modified cow's milk need extra vitamin C (e.g. from orange juice) because the vitamin C in milk is destroyed by boiling. All babies need extra vitamin C as they grow (e.g. from cod-liver oil). Proprietary brands of baby milk powders may be harmful if they are mixed unhygienically or in the wrong proportions.

4.1.30 Sunlight Vitamin



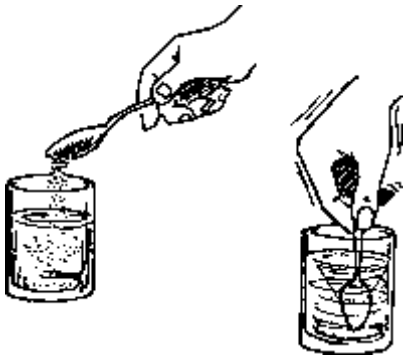
P: Small amounts of Vitamin D can be produced by the body in sunlight. Other sources are milk, eggs and liver. Vitamin D deficiency causes rickets in babies and young children and bone softening in adults. Vitamin D maintains the level of calcium in the blood to form strong bones and teeth.

4.1.31 Vitamin B Group

Q: What happens if our diet is deficient in B group vitamins?

E: Lack of energy is a major symptom of Beri-beri (nerve and muscle wasting) and Pellagra (skin, gut and nerve disorders).

4.1.32 Water as a Solvent



P: Mix a little salt (or sugar) in water.

Q: What happens?

O: The salt dissolves.

E: Mineral Salts and other body nutrients dissolve in water for transport and absorption.

4.1.33 Wilting Plants

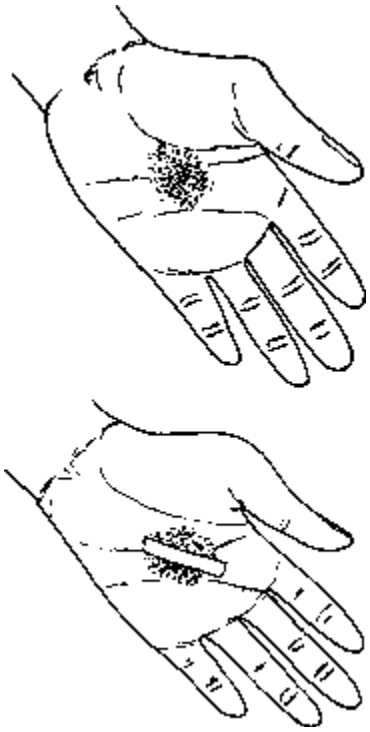
P: Look at plants during the dry season or unwatered seedlings after transplanting.

Q: What happens to the plants?

O: The plants and seedlings wilt or droop until supplied with water.

E: Water is essential in maintaining cell turgor and thus plant structure.

4.1.34 Water and Sweat



P: Rub iodine solution on to the palm of the hand. Allow this to dry. Place a piece of dry starch paper on to the iodine stained skin. Hold in position for 1-2 minutes. Remove the starch paper and examine it.

Q: What has happened to the starch paper?

O: Dark dots of blue black colour appear on the paper.

E: Dry iodine and dry starch do not react to produce a colour change. Only when water is present does the colour appear.

I: Repeat this experiment after vigorous exercise. Compare the marks with the first test. What can you deduce about and output of sweat by the skin?

4.2. Balanced Diet

Living organisms could be described as machines doing work, the fuel being the food. In addition, like machines, our bodies must first be built up and then have worn out parts replaced. In order to function properly the body needs a balanced diet. A balanced diet should contain adequate amounts of carbohydrates, proteins, fats and oils, mineral salts and vitamins. Although not a nutrient, water is also an essential constituent of food.

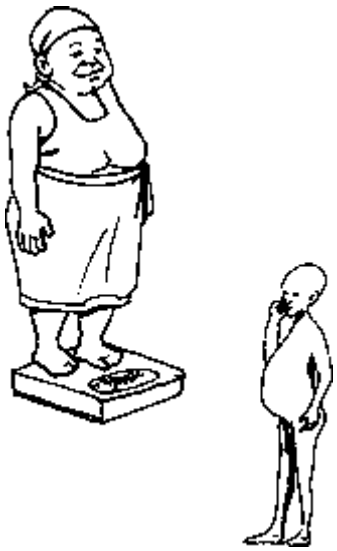
4.2.1 Functions of Nutrients

P: Use boxes or containers to represent the five components of food.

Q: Which foods appear under two headings?

E: Proteins and minerals appear under two function headings.

4.2.2 Malnutrition



P: Learn how to identify some of the signs of malnutrition (both under and over nutrition)

E: Our food should contain an adequate total amount of nutrients. If it does not, then we suffer from *under nutrition* or perhaps *starvation.* Our diets should contain the correct amount of each nutrient, but if they do not, we suffer from malnutrition. The person who becomes fat because of eating more carbohydrates in the form of sweets and cakes than are needed by the body suffers from malnutrition, that is *over nutrition.*

4.2.3 Reasons For Deficiency Disease

P: Ask the pupils to give reasons why a person may not get a balanced diet

Q: Give three reasons why some people may be malnourished

E: The pupils should be able to state that

a) A shortage of the right kinds of food (such as protein) in certain areas means the normal diet consists of mainly cereals or starchy foods.

b) The low income of some families means that they may be too poor to buy the right kinds of food, such as protein-rich meats, eggs etc..

c) Superstitition and lack of education on concepts of a balanced diet. Local customs can dictate what is eaten and even if suitable foods are available, people may be unwilling to try them. In the past some traditions dictated that pregnant women should not eat eggs even though the protein would help the growing baby's development. Other foods were considered to possess magical properties and to eat them would bring bad luck.

I: Are there any traditional food customs in your area which may affect having a balanced diet?

4.2.4 Daily Energy Needs

P: Make an illustrated bar chart with paper strips, to show the different energy needs of a sedentary person, a moderately active person and a very active person for an 8 hours working day.

Q: Can you clearly show the different energy needs of different occupations?

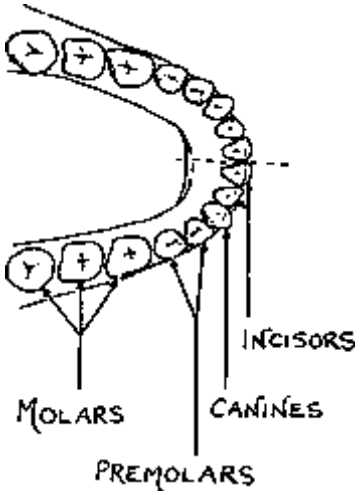
E: The very active person needs more energy than a moderately active person who in turn needs more than a sedentary person.

4.3. Digestion in Mammals

Digestion is carried out in the alimentary canal. The alimentary canal is a very long tube which begins at the *mouth* and ends at the *anus.* It has several parts namely buccal cavity, oesohagus, stomach, duodenum, ileum, caecum, appendix, colon and rectum. Each of these

parts is modified for specific functions. Associated with the canal are various glands. Food undergoes physical and chemical digestion as it moves along the canal.

4.3.1 Four Types of Teeth



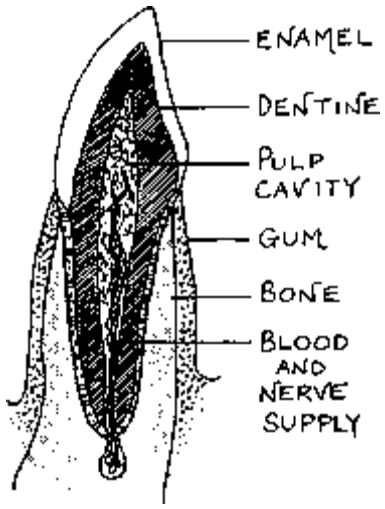
P: Look into a friend's mouth. Examine the teeth and differentiate between them. Count the number of each type present. Try to identify the function of each.

Q: How many are there altogether of each type?

O: There are four types of teeth in the buccal cavity 32 teeth in all.

E: The four different types of teeth perform different functions. The front ones, the incisors, are used for cutting. The canines are used for tearing. The premolars may have one or more points for cutting, or flat surfaces for grinding. Behind the premolars are the molars with flat surfaces for grinding. Molars are not present in young children.

4.3.2 Tooth Models



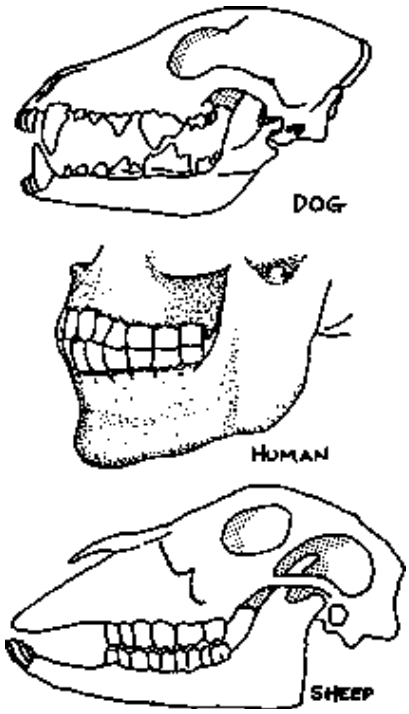
P: Split different types of teeth longitudinally with a sharp knife or tool. Identify the different parts. Using modelling clay or paper mache (soaked paper pieces and paste) make a model using the tooth and text book diagrams as a guide.

Q: Does the tooth cross section exactly match the text book drawing?

O: No. Each tooth is unique.

I: Label your model for display. Try models of different tooth types. Each tooth consists of the *crown,* the *neck* and the *root. A* longitudinal section of the tooth shows the *enamel, dentine* and the *pulp cavity* (which contains nerves and blood vessels). The tooth is cemented to the jaw bone which is covered by the gum.

4.3.3 Dentition in Mammals



P: Collect examples of dentures and teeth from different animals. Display these to show the dental formulae of omnivores, carnivores and herbivores. Dental formulae of different animal differ with the type of food they eat.

O: Carnivorous mammals are flesh eaters and must be able to kill, tear up and slice the prey, prior to swallowing it. Large fang-like canines and sharp ridges on other teeth act like scissor blades to slice flesh. Herbivorous mammals must be able to crop and grind the tough vegetation. The incisors in the lower jaw are large and chisel shaped. The upper incisors and canines are replaced by a horny pad; the lower incisors and canines act against the pad to crop grass. A gap separates newly cropped grass from that being ground by the premolars and molars.

4.3.4 Human Dentition Model

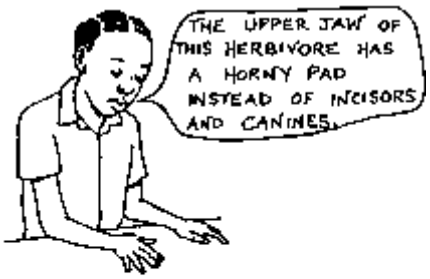
P: Prepare two shaped pieces of wood or cardboard to represent the upper and lower jaw. Make a hinge of rubber on the straight edge between the pieces. Paint, draw or stick a drawing of the teeth around the edge of the wooden shapes.

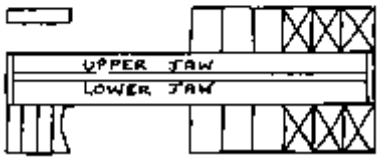
4.3.5 Dental Formulae Game

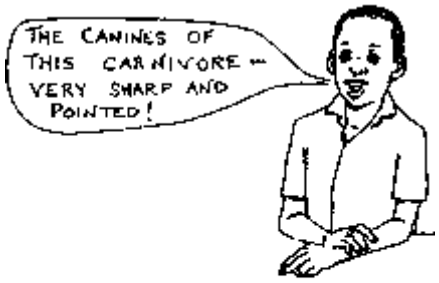
MAMMALIAN DENTITION		INCISOR	CANINE	PREMOLAR	MOLAR
CARNIVORE (DOG)	1/2 UPPER JAW	3	1	4	2
	1/2 LOWER JAW	3	1	4	3
OMNIVORE (HUMAN)	1/2 UPPER	2	1	2	3
	1/2 LOWER	2	1	2	3
HERBIVORE (SHEEP)	1/2 UPPER	0	0	3	3
	1/2 LOWER	3	1	3	3

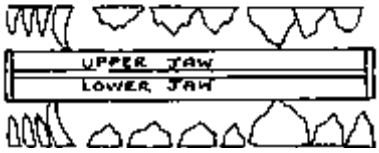
P: Make a table comparing the different dental formulae. Prepare movable cards corresponding to the types of teeth in each dental formula. Mix-up the cards and try to place the correct numbers in the appropriate square. As the numbers are written on movable cards it is easy to correct errors and find the correct solution.

4.3.6 Dental Formulae Cut-Outs









P: Using the illustration in 4.3.3 make large card or paper cut-outs of the teeth shapes of a dog and goat and arrange them along a ruler.

Q: What do you notice?

O: Teeth arrangement in the mouth of a dog and a goat are different.

4.3.7 Functions of Teeth

P: Bite off a small piece of bread and chew it.

Q: In what order are the teeth used?

O: First the front incisors bit off a piece of bread and then the premolars and molars do the chewing.

E: Different teeth have different functions.

I: Try biting off a piece of meat or sugar cane. Are the same teeth involved?

4.3.8 Dental Hygiene

P: Demonstrate the correct way to clean the teeth using a stick or brush.

Q: What errors do some people make when cleaning their teeth?

E: There are many different ways to clean the teeth. A vertical movement of the teeth brush removes food from between teeth and encourages blood flow in the gums.

4.3.9 Tooth Decay

P: Try and obtain a human tooth which has been subject to decay. Boil it in water to sterilise.

Q: How does it differ from a healthy tooth?

O: It may have holes in the enamel, or show signs of bacterial attack in the pulp cavity.

4.3.10 Decaying Tooth

P: Take a mammalian tooth and examine it closely. Then place it in dilute hydrochloric acid for two or three days. Put a similar tooth in an empty container for comparison.

Q: What do you notice about the teeth?

E: The hydrochloric acid has reacted with the tooth enamel digesting part of it.

I: When a person fails to brush their teeth properly, the food that remains on the teeth is acted upon by the bacteria producing acids. These acids eat away the enamel and dentine causing tooth decay.

4.3.11 Nerves in Teeth

P: Watch someone who has toothache.

Q: What do you observe?

O: They are often in great pain

E: The nerves of the tooth have been attacked making the tooth sensitive.

4.3.12 Licking Lips

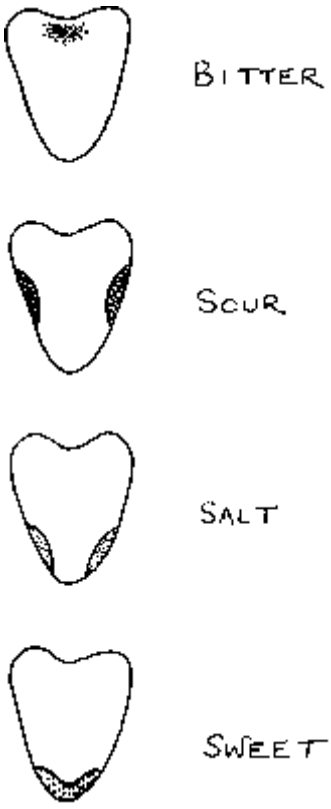
P: Try chewing dry biscuits,

Q: How many dry biscuits can you chew *without* licking your lips?

O: It is often hard to prevent the tongue automatically licking the lip's.

E: The tongue is used for ingestion and helps to spread saliva lubricating the lips.

4.3.13 Taste Map



P: Prepare four solutions (sugar/salt/bitter/sour). The bitter solution may contain chloroquine, lemon peel, strong cold tea or coffee. The sour solution may be vinegar or lemon/lime juice. The subject shuts their eyes and holds out their tongue. Using a dropper or matchstick put drops of each solution on different areas of the tongue. The mouth should be rinsed after every test. Each of the four solutions is felt strongly at a specific place on the tongue, where specific taste buds are present. Draw a large map and mark the appropriate strong taste zones.

4.3.14 Tongue and Chewing

P: Chew some hard seeds or nuts.

Q: What do you notice about the action and position of the tongue?

O: The tongue moves the nuts and pieces of nuts around the mouth to positions where the teeth can break them down.

4.3.15 Multi-purpose Tongue

P: Try holding the tip of your tongue and say, "The tongue is used for speaking". Then say each letter of the alphabet and see which sound the same as normal.

Q: Which letters sound different?

E: The tongue moves inside the mouth to form many of our spoken words.

4.3.16 Tongue Rolling

P: Try to roll your tongue as shown in the diagram.

Q: Can everyone in the class roll their tongue?

O: Not everyone will be able to roll the tongue.

E: The ability is inherited. Can your parents, brothers, sisters and relatives roll their tongues?

4.3.17 Production of Saliva

P: Hold up your tongue and look for the ducts of the sub-lingual glands. Squeeze some lemon juice on the tongue.

Q: What do you notice after squeezing lemon juice on the tongue.

O: The lemon juice stimulates the production of saliva.

E: There are three saliva glands in the buccal cavity.

4.3.18 Stimulation of Saliva Production

P: Pass near a place where food is cooking and there is a nice smell.

Q: What happens in your mouth?

O: Saliva is produced.

E: Smell and even the thought of food can stimulate saliva production.

4.3.19 Enzymes in Saliva

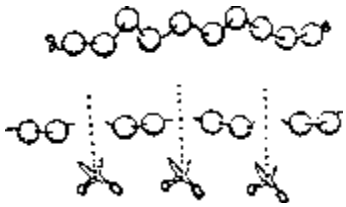
P: Try chewing a piece of dry bread crust *without* swallowing.

Q: What happens to the bread and the taste in your mouth?

O: The bread becomes softer, wetter and sweeter.

E: Saliva breaks down the chains of saccharides (starch) in the bread to form simple saccharides (sugars) which taste sweet.

4.3.20 Action of Salivary Amylase



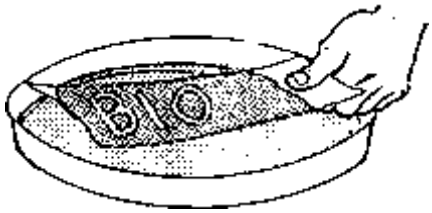
P: The model of starch in 4.1.8 uses a string of beads or seeds to represent simple sugars joined in a long chain. Use scissors to cut up the chain.

Q: What action does cutting with scissors represent?

E: The scissor action represents the action of salivary amylase as it breaks down the long starch chain to simple sugars (maltose).

I: A chain of paper clips or toilet paper could be used as a substitute to a strip of beads.

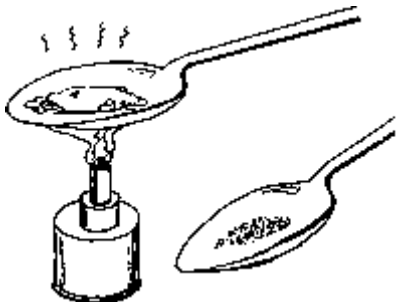
4.3.21 Invisible Saliva Ink



P: Prepare a starch suspension by adding about a teaspoon of maize/cassava flour to half a cup of water. Bring to the boil, then allow to cool and filter (clearer) liquid through a cloth. Soak filter (blotting, news or toilet) paper in the starch suspension and allow to dry. Write your name using saliva on a matchstick. Allow the paper to dry. "Develop" to reveal the hidden writing by dipping in very dilute iodine solution.

E: The saliva digests the starch where it touches the paper.

4.3.22 Salts in Saliva



P: Gently heat some saliva on a clean shiny tin or spoon until it is dry.

Q: What do you observe?

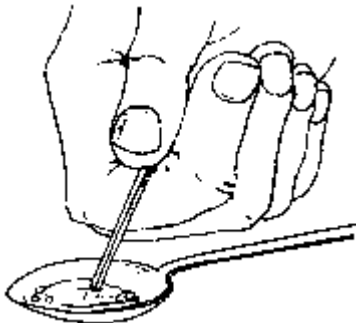
O: A white residue is left.

P: Test this residue with a little dilute hydrochloric acid.

O: Bubbles of carbon dioxide are given off.

E: Calcium carbonate is the residue and this reacts with the hydrochloric acid to produce carbon dioxide.

4.3.23 Saliva and Air



P: Mix some saliva with air on a spoon. Stir gently with a matchstick.

Q: What happens?

O: It goes opaque

E: Hydrogen carbonates (bicarbonates) in the saliva form a precipitate when they come into contact with carbon dioxide in the air.

4.3.24 Saliva as a Lubricant

P: Take a sample of saliva and compare it with water for stickness.

Q: How do they compare?

O: Saliva mucus is; slippery

E: Saliva is used to moisten and lubricate food for ease of swallowing.

4.3.25 Touch Reflex

P: Try to touch the soft palate (at the back of the mouth) with your finger.

Q: What happens?

O: The mouth tries to eject the finger as in vomiting.

E: This is a reflex action to remove a foreign body and prevent it entering the oesophagus.

4.3.26 Epiglottis and Palate

P: Use a spoon to press down the tongue and let another student observe the activity of the epiglottis and soft palate during swallowing.

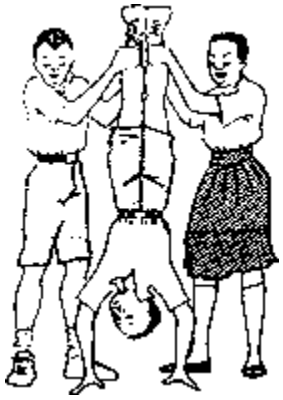
Q: What happens?

O: The epiglottis and soft palate are both open.

E: During swallowing both epiglottis and soft palate close, preventing food entering the trachea and nose.

I: Why is it useful to hold the tongue down while swallowing?

4.3.27 Swallowing Upside Down



P: Drink a mouth full of water from a cup and swallow it. Then fill your mouth again, (without swallowing) and with the help of two friends do a handstand. Then swallow while upside down.

E: You are able to swallow while upside down, but not as easily. The peristalsis of the oesophagus works against the forces of gravity.

4.3.28 Swallowing with Open Mouth

P: Try to swallow food with an open mouth.

Q: Is it easy?

O: No, liquid may escape from the front

E: The mouth is usually shut and the tongue pressed up when swallowing occurs.

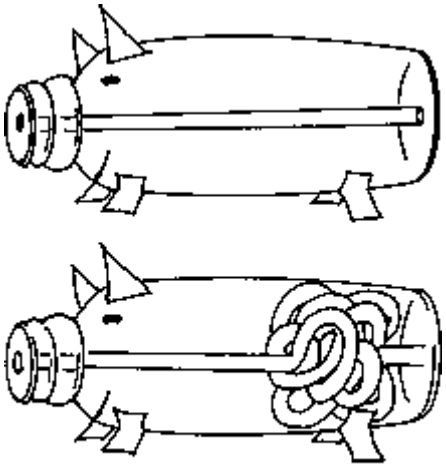
4.3.29 Larynx Movement

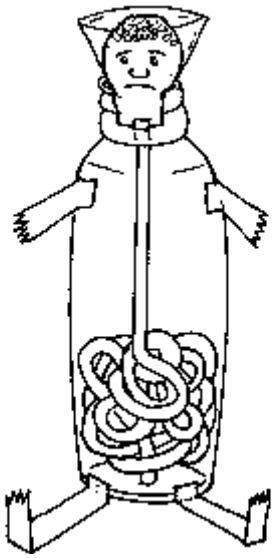
P: Hold your larynx with the fingers of one hand and swallow. Then hold the larynx and breathe in and out

Q: Is there any difference?

E: During swallowing there is more movement around the larynx because of the passing wave action of the muscles.

4.3.30 Food Tube Journey





P: Using a bottle and tube construct the model as shown in the diagram. Pour water into the funnel and see how long it takes to pass through the alimentary canal tube.

4.3.31 Peristalsis Model

P: Demonstrate peristalsis by pushing a marble or stone down a piece of bicycle inner tubing or a self prepared tube made from plastic bags.

Q: How does this show peristalsis?

O: The tube bulges as the marble moves down its length

E: Circular muscles in the oesophagus wall, (behind the food) contract and relax and so propel the food bolus in a wave like motion to the stomach.

4.3.32 My Stomach is?

P: Use a finger to point to the approximate position of your stomach and intestines. Move your hands around and point to other organs?

E: By using themselves as a learning aid students can more easily relate the information in the text book to real life.

4.3.33 Indigestion

Q: How does it feel to have indigestion?

O: Indigestion can be a pain behind or just below the ribs, or just feeling sick.

E: It may be caused by bacteria from foods not hygienically stored or warmed, too much fat or eating too much.

I: Always cook foods thoroughly, cover from flies and keep stored foods cool

4.3.34 Digestion Question?

P: Eat a piece of cooked cow's stomach or intestine meat.

Q: I can eat and digest cow's stomach, why don't the acids digest my own?

E: The stomach wall produces mucus - a slimy thin, watery jelly which lines the stomach and protects its walls from it's own digestive juices.

4.3.35 Indigestion Powders

P: A person with acid indigestion will take stomach powder.

Q: How does this help digestion?

O: Sodium bicarbonate (soda) helps ease indigestion problems.

E: Sodium bicarbonate neutralises the acid.

I: Milk or thick soup also help.

4.3.36 Sloshing Stomach

Q: Why do I sometimes hear a sloshing noise from my stomach as I run?

E: This means there is hot gas in your stomach. A burp to release trapped gases helps.

4.3.37 Plastic Stomach Model

P: Draw the shape of the stomach on a transparent plastic sheet. Cut out four pieces of human stomach shape. Stitch, glue or staple the edges together to make two stomachs. Stuff one stomach model with cotton wool or crumpled up paper.

Q: Observe the size of the two models.

E: The empty model represents an empty stomach and the stuffed model represents a full stomach.

4.3.38 Stomach Volume

P: Fill a large plastic bag or bucket with 2.5 litres of water. Note the space occupied by the 2.5 litres of water. The human stomach bulges to about this volume to accommodate the water and food. The stomach stores food, mixes it and starts digestion.

4.3.39 Acid Heartburn

Q: What is heartburn?

O: A burning sensation in the oesophagus which is near the heart.

E: Acid in your stomach kills off bacteria in your food and helps digestion of food. The stomach makes mucus (a slimy, thin, watery jelly) which lines and protects the stomach from

its own digestive juices. Heartburn is caused as acid splashes up and burns the oesophagus.

4.3.40 Intestine Investigating

P: Ask the pupils to bring parts of the intestine of small animals and investigate the surface which is like soft cloth.

Q: Why is the surface inside the intestine soft?

O: The surface is covered with small villi and microvilli.

E: The small intestine is well adapted for absorption. It has a very large surface area because of its considerable length, its folded walls and its inner surface which consists of numerous finger like projections called *villi.* The surface area is further increased by the epithelial cells (microvilli) covering the villi.

4.3.41 Corrugated Cardboard Villi Model

P: Cut a piece of corrugated cardboard approximately 2 cm by 20 cm. Roll it up with the corrugated surface inside.

Q: What is the relationship of the corrugations to the villi?

O: The folds of the corrugated surface correspond to the villi of the ileum. They increase the surface area for absorption of nutrients.

4.3.42 String Villi Model

P: Take a strip of cardboard (approx 4 cm x 24 cm). Punch holes through it as shown every 2 cm. Loop some thread through the holes and pull it loosely to form loops on one surface. Roll the cardboard so the loops are inside.

Q: How long is the string forming the loops?

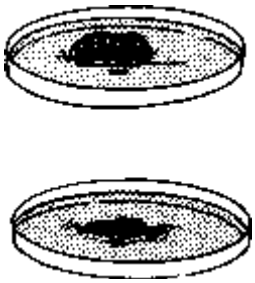
O: The string's length is far longer than the inner circumference of the cardboard. Pull it put and see.

E: This shows how the villi increase surface area for nutrient absorption.

4.3.43 Healthy Eating

P: Ask a doctor, nurse or health officer to give a talk on medical issues related to the digestive system. Students could make a list of questions which may be given to the doctor before the visit. Medical professionals may bring new insights into your lessons.

4.3.44 Paw Paw Enzymes



P: Cut two pieces of meat. Place one in a dish with water and another in a dish of paw paw or pineapple juice.

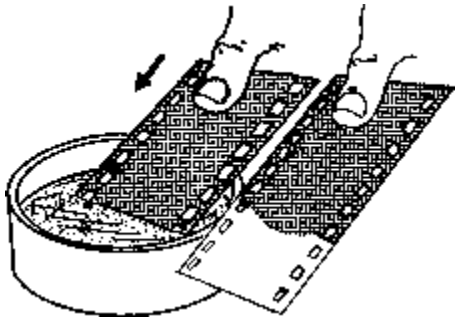
Q: What happens?

O: The meat with juice seems more tender and soft.

E: Enzymes in the paw paw juce denature meat protein and aid digestion.

H: Paw paw is used as a meat tenderiser.

4.3.45 Enzyme Action



P: Cut two strips of exposed photographic film. Place one in a little water and the other one in the juice of paw paw or pineapple.

O: The film in the juice has lost its coating.

E: The enzymes in the juice digest the gelatin containing the silver salts and the plastic is left clean.

H: Would this affect film storage?

4.3.46 Chewing Cud

P: When a cow eats grass it does not seem to chew before it swallows.

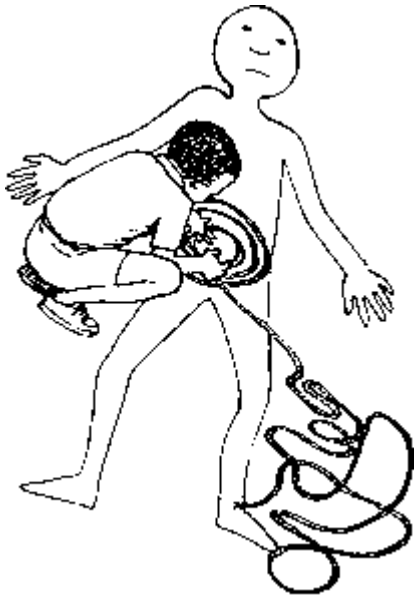
Q: When does a cow chew its food?

O: A cow lies down quietly and chews cud.

E: The cow swallows grass immediately after cutting and then returns it to the mouth by antiperistalsis and grinds it between the back teeth by a side to side movement of the jaw.

H: Sheep and goats also chew cud.

4.3.47 Length of Intestine



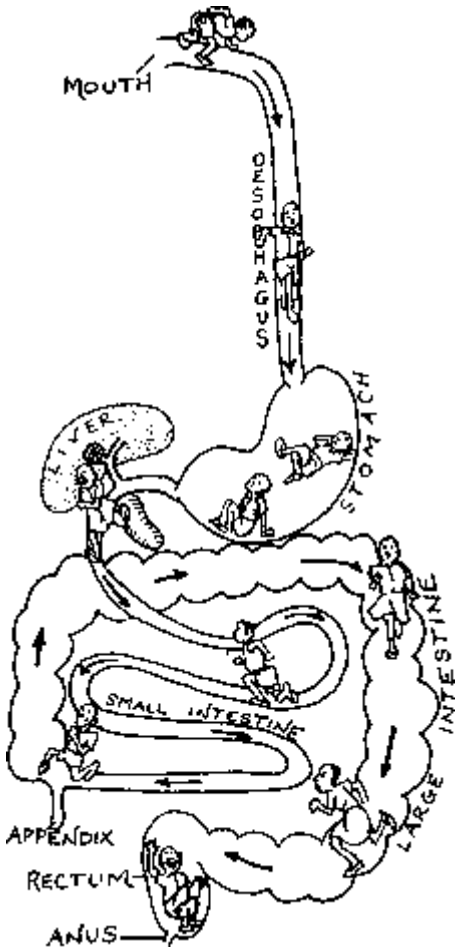
P: Ask pupils to draw on the ground the shapes of different animals. Rabbit, man, cat/dog, pig, cow. Try to draw them life size. Then coil string or strips of paper inside the abdominal cavity area of the animal shape. Here are approximate lengths of intestine: rabbit (1 m) cat/dog (2 - 5 m), pig (24 m), horse (30 m), cow (50 m).

Q: Suggest the reason for the difference in length of the intestine in different animals.

O: Observers may be suprised at the length of some animal intestines.

E: Length of intestine corresponds to the type of diet an animal eats. Herbivores have longer intestines than carnivores while that of omnivores is intermediate in length.

4.3.48 Digestion Game

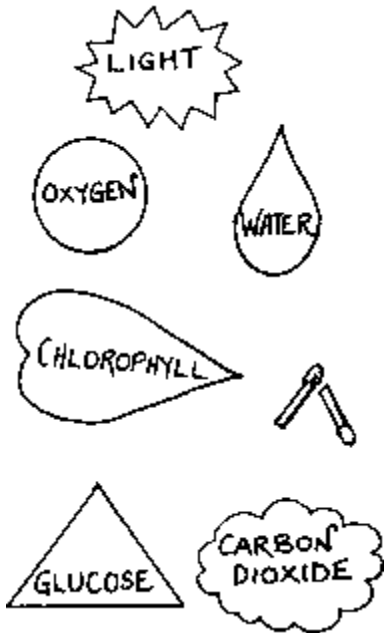


P: Draw a large outline of the digestive system on the classroom floor or mark it out on the playing field, with string and pegs or use stones. Ask the pupil to walk through the outline and describe what happens at the various places. Labels may be added before or during the activity.

4.4. Plant Nutrition

Plants obtain their food by making their own. This type of feeding is known as *autotrophic nutrition.* The process by which plants do this requires water, carbon dioxide, light and a green substance found in plants called chlorophyll. This process is called *photosynthesis.* The first substances manufactured by photosynthesis are simple sugars. These can be converted to starch, cellulose, fats, proteins or any other organic compound needed by the plant. For some of these compounds, additional elements are required, which are obtained as mineral salts from the soil. As well as providing essential compounds for the plant, photosynthessis converts the energy. This can then be used directly by plants themselves, or indirectly by all other living organisms.

4.4.1 Photosynthesis is a Chemical Process



P: Draw and cut out the symbols shown above. Then arrange them in the correct order to show the chemical equation for photosynthesis. Use matchsticks for arrows and + symbols.

I: Repeat the above procedure but replace the words in the shapes with the chemical formulae of the substances involved. These may be written on the reverse side of the first set of cards.

4.4.2 Do Plants Need Light?

P: Cover an area of grass with a large flat brick or stone or with a black plastic bag so that no light reaches the plants. Examine the grass after a few days. An alternative is to place a black plastic bag over green leaves at the end of a branch and seal it by using string, tape or wire.

Q: What changes take place in the appearance of the leaves?

O: The plants and leaves become pale green or yellow in colour and die eventually.

E: Plants need light for photosynthesis. When they lose their green chlorophyll no more light can be absorbed and they die.

4.4.3 Photosynthesis Produces a Gas

P: Cut the neck from a plastic bottle, leaving the screw cap in place. Place in a large container of water making sure the bottle is completely filled with water. Place some aquatic plants under the bottle and leave for a few days in sunlight.

O: The water level goes down. Oxygen produced by photosynthesis forms as bubbles on the leaves, which rise and collect in the bottle neck.

4.4.4 Chrorophyll Extract

P: Pick about 5, large soft green leaves. Cut these into small pieces and grind with a stone. Add a little water to the pulp and pour the mixture into a glass jar or test tune. Leave to settle.

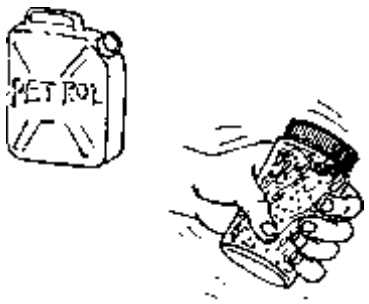
Q: What do you observe?

O: The solid material settles out, leaving a green solution.

E: The green substance in the water is chlorophyll, which has been released from the cells by mechanical breaking of the cell membranes by grinding.

I: The extraction of chlorophyll works better in alcohol or spirit.

4.4.5 Leaf Pigments



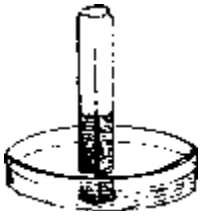
P: Take some chlorophyll extract (see 4.5.4) and mix it with an equal volume of colourless petrol. Shake well.

Q: What do you notice about the colour of the liquid?

O: Some colour from the extract dissolves in petrol leaving it yellow

E: The green colour of leaves is a mixture of several pigments including chlorophyll (green) and xanthophyll (yellow). The yellow colour is more soluble in petrol than in water.

4.4.6 Chromatography

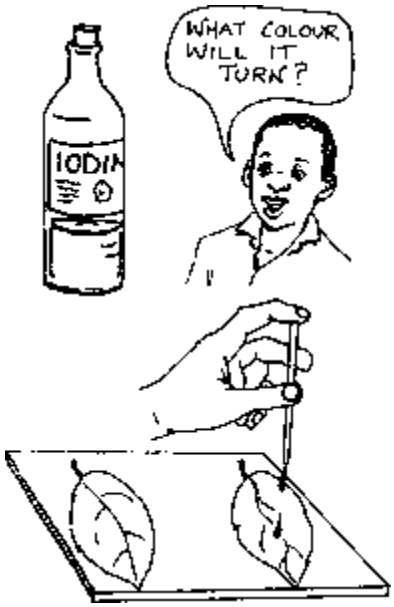


P: Place a few cm 3 of chlorophyll extract (see 4.5.4) in a shallow container. Stand a stick of dry blackboard chalk upright in the extract.

O: The extract rises up the chalk and two colour bands (one yellow and one green) can be seen.

E: By capillary rise leaf pigments are transported with different velocity and thus the green chlorophyll can be separated from the yellow xanthophyll: This process is called chromatography.

4.4.7 Plants make Starch during Photosynthesis



P: Take two plants grown in pots and place one in sunlight and the other in a dark cupboard for 2 days. Pick a leaf from each, but keep them separate. Heat each leaf in some surgical spirit for about 5 minutes to remove some of the green colour. Take each leaf out and lay it on a flat surface. Add a few drops of iodine solution.

Q: What is the result?

O: The leaf from the plant grown in the light became a blue-black colour, whereas the one from the dark was the pale brown colour of iodine.

E: When a leaf is exposed to light, photosynthesis occurs producing sugar, which is then converted to starch for storage. This gives the blue/black colour with iodine. In the dark, no photosynthesis can take place, so no starch is produced.

I: *Never heat spirit directly with a flame or it will catch fire. Place the spirit container in another one filled with water and heat the water container.*

4.4.8 Nutrients from Soil

P: Fill one container (i.e. 250g Tan Bond tin) with pieces of card board or foam packing cut into very small pieces. Fill another container with fertile soil and plant a few seeds (peas, beans or maize) in each one. Water each container with distilled water (prepared by condensing steam from a kettle) or rain water collected in clean jars. Use this water to keep the containers damp throughout the experiments. Examine daily.

Q: What differences do you see in the seedlings in the two containers?

O: Seedlings grown in the container without soil are smaller and less healthy with yellow leaves.

E: As well as water, carbon dioxide and sunlight plants require mineral salts in order to grow and remain healthy. The seedlings grown without soil get only water and so are lacking these salts.

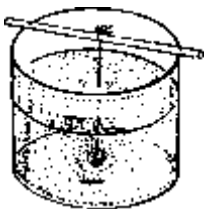
5. Transportation of Materials in Organisms

5.1. Basic Principles of Transportation

Transport is the movement, circulation or flow of substances within living organisms. This can either be with or without a system of tubes (vascular system). The blood circulatory system in animals, and the xylem and phloem in plants are examples of transport systems.

In an individual cell, substances generally move into and out by *diffusion, osmosis* or *active transport.* Diffusion is the free movement of molecules of a substance from regions of high concentration to regions of lower concentration. Osmosis is the diffusion of water molecules through a semi-permeable membrane from a weak solution to a strong solution. Active transport is an energy consuming process, which moves substances through a membrane from a region of low concentration to a region of higher concentration (i.e. the opposite direction to diffusion).

5.1.1 Diffusion in Liquids



P: Carefully, put a crystal of potassium permanganate at the bottom of a jar containing water. Leave undisturbed and observe at 20 minute intervals. Alternatively, knot a piece of string four or five times to make a compact ball. Wax or grease the string above the knot and soak the knot in iodine solution. Hang it in a jar of water and observe at intervals. Starch solution could be used instead of water in the case of the iodine experiment, thus producing a blue-black colour as a result of diffusion.

Q: What happens to the colour of the water or the starch solution?

O: In both cases the colour of potassium permanganate and iodine spread slowly throughout the solutions.

E: Molecules of potassium permanganate or iodine move from where they are more concentrated to the where they are not found at all, until the concentration in both areas is the same. This is diffusion.

5.1.2 Simple Diffusion Model

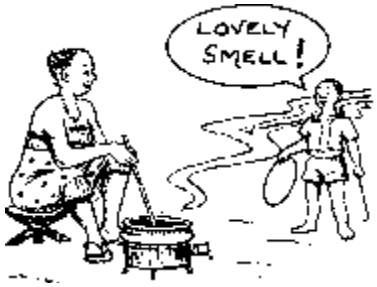
P: Arrange two or three different types of seeds or beads in layers in a container. Cover and shake thoroughly.

Q: What do you observe about the distribution of seeds or beads?

O: They are all mixed together.

E: Since they are free to move, the seeds or beads become evenly distributed. This is similar to the process of diffusion.

5.1.3 Diffusion in Daily Life



P: Pass near a place where meat is being roasted or food is being cooked.

Q: What do you sense?

O: The smell of cooking food

E: The smell from the food can be sensed even at a distance, because the particles producing the smell spread out into the air by diffusion normally by the joint effect of diffusion and wind.

5.1.4 Diffusion and Pollution

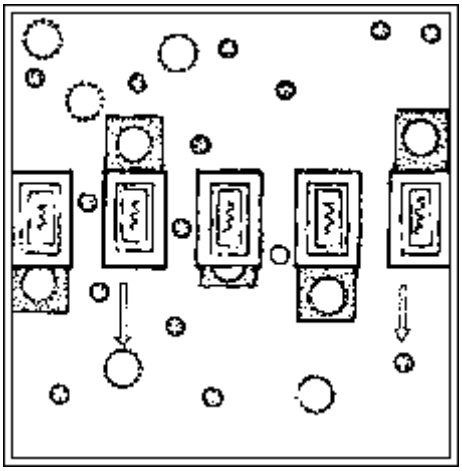
P: Pass near a polluted area (e.g. burning heap of litter, filling station, latrine)

Q: What do you smell?

O: The smell in each case is often unpleasant.

E: See 5.1.3

5.1.5 Osmosis and Active Transport Model



P: Construct the above model using a small cardboard or plastic tray and some matchboxes. The gaps between the boxes should allow small objects to pass (i.e. peas) but prevent movement of larger ones (soda bottle caps). Place ten soda bottle caps and ten peas in one side of the tray and twenty peas in the other side. Shake the tray gently ten times. Count the peas in each side. The matchboxes and the space between them represent a selectively permeable membrane; the peas represent water molecules and the soda caps represent large solute molecules such as glucose. The water molecules can move freely, whereas the glucose molecules cannot. This represents *osmosis.* The process of *active transport* can be demonstrated by placing a soda cap in a matchbox tray and pushing it through the matchbox "membrane". Thus it illustrates that active transport requires energy and is selective for certain substances, since only bodies which fit in the matchbox tray can be carried across.

5.1.6 Osmosis in Plant Cells

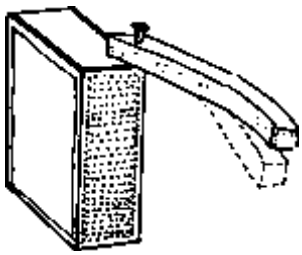
P: Cut a piece of potato or a piece of carrot. Make a shallow hole in the cut surface, and support the potato in a cup or jar. Place a small amount of sugar or salt in the hole. Leave for 3 or 4 hours.

Q: What happens to the sugar or salt in the hole?

O: Water gradually collects in the hole and sugar or salt dissolves.

E: Water is drawn out of the plant cells by osmosis and into the hole. This is because the solution in the cells (the cytoplasm) is weaker than the sugar or salt solution in the hole.

5.1.7 Osmosis and Turgidity



P: Cut some strips of irish or sweet potato about 50 mm long and 5 mm square. Place some in a strong sugar solution (2 or 3 spoonfuls of sugar in half a cup of water) and some in plain water.

Q: What is the difference between the strips?

O: The strip from the sugar solution has lost water by osmosis and so is soft (flaccid). The one in water has not lost water and so remains rigid (turgid).

5.1.8 Changing the Size of an Egg

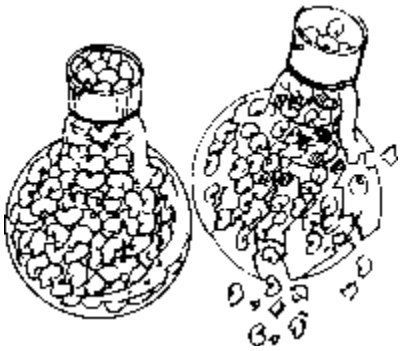
P: Take two eggs and place them in dilute hydrochloric acid until their shells dissolve (about 12 hours). Find the volume of each egg by submerging in a container of water. Place one egg in distilled water and the other in strong salt solution. After several days remove the eggs and find their respective volumes.

Q: What can you say about the volumes of the eggs at the end of the experiment.

O: The egg in distilled water increases in volume whereas the egg in salt solution decreases in volume.

E: The concentration of the liquid inside the egg is higher than water so water moves in by osmosis. However when placed in salt solution the external solution is now stronger so water moves out of the egg by osmosis.

5.1.9 Bursting Osmosis Box



P: Tightly pack a matchbox with dried beans or seeds. Place in a container of water and leave overnight

Q: What do you observe?

O: The seeds swell and burst the box open.

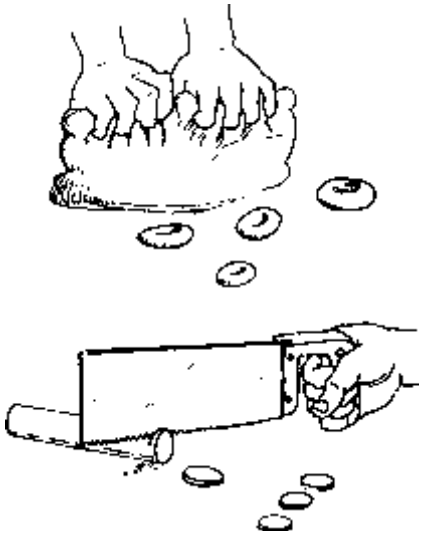
E: Dormant seeds have a low water content. When they start to germinate they take in water by osmosis and increase in size. The forces involved are enough to burst the box.

I: The swelling seeds will even break the glass of a fused bulb.

5.2. Blood and Blood Groups

Blood is a fluid tissue of animals consisting of several different types of cell suspended in a fluid called plasma. The cells include red blood cells, white blood cells and platelets. Blood transports substances from one part of the body to another, helps defend the body against disease and keeps conditions right for the working of our cells.

5.2.1 Red Blood Cell Models



P: (a) Use a modelling material like clay or plastercine to shape red blood cells.

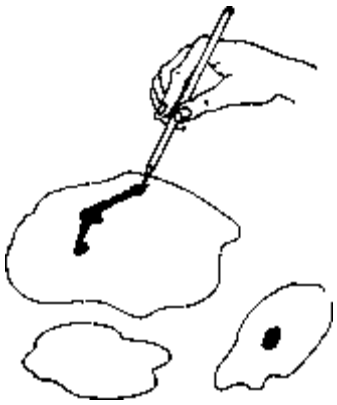
(b) Cut slices of wood from a round straight stick. Use a knife to carve out the concave areas. Paint if necessary.

(c) Cut out circles of thick card board and shade to show concave area.

E: Red blood cells are biconcave discs approximately circular and 7.2 micrometre in diameter. They have no nucleus.

H: Platelet models can be made by cutting red cell models into pieces.

5.2.2 White Blood Cell Models



P: (a) Fill a plastic bag with a little water and add a stone or seed to represent the nucleus of the white cell.

(b) Cut the white blood cell from a thin sheet of sponge rubber. Draw on a nucleus.

(c) Cut the shape of the white cell from cardboard or plastic sheet and draw on a nucleus.

Q: Compare these blood cells with red blood cells.

O: White blood cells have no fixed shape are transluscent and are much larger than red blood cells.

E: Their large size helps them to secrete a lot of antibodies and to engulf bacteria or foreign bodies.

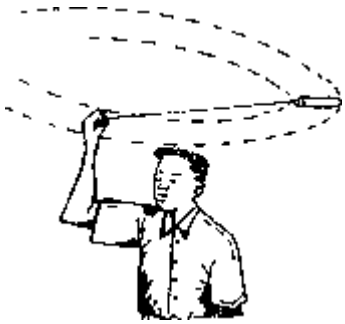
5.2.3 How much Blood?

P: Take a bucket full of water and an empty bucket.

Q: Let the student estimate how many litres would represent the amount of blood in the human body?

O: You would need about 5 litres.

5.2.4 Simple Centrifuge



P: Attach a short string to a test tube neck. Half fill the tube with animal blood and seal securely. Spin the tube very quickly around your head. Shorten the string to make the tube circle faster.

E: The red blood cells being heavier than plasma are pushed to the bottom by centrifugal force.

I: *For safety reasons make sure that both seal and string are attached securely and noone will be hurt.*

5.2.5 Red Blood Cell Factory

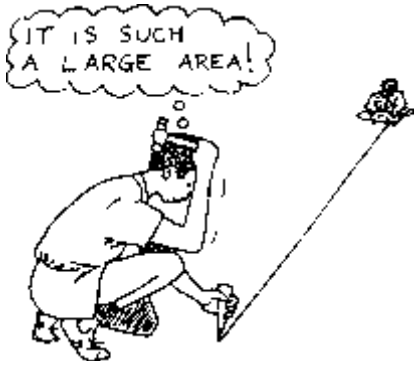
P: Saw or crack open a fresh bone.

Q: What do you notice about the colour?

O: The ends of the bones may look bright red.

E: Red blood cells are' made in the red bone marrow of short bones such as the sternum and vertebrae.

5.2.6 Blood and Football



P: Measure out an area 50 metres by 25 metres on the football field or school compound.

Q: What has this to do with blood?

E: This is the area that could be covered if the body's red blood cells were placed side by side one cell deep! (A quarter of the area of a full size pitch).

5.2.7 Around the World

P: Imagine if all the red blood cells in your body were placed side by side in a line.

Q: How far would the line stretch?

O: The line of red blood cells would stretch over four times round the world.

E: Over 20 billion red cells are present in the blood of an teenage human.

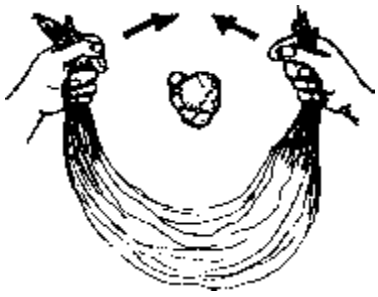
5.2.8 Anaemia

P: Pull down your lower eyelid to expose the surface next to the eyeball. Using a mirror observe its colour. If there is no mirror let your neighbour check the colour.

O: The lower side of the eyelid may be pale or red coloured.

E: The paleness indicates that a person is anaemic and they do not have enough red blood cells. The oxygen carrying capacity is reduced causing tiredness. The most common kind of anaemia happens when women and girls lose blood during menstruation and do not eat enough iron-containing foods.

5.2.9 Engulfing Model



P: Use a white handkerchief to represent a white blood cell and a seed or fruit as an invading foreign body. Shape the handkerchief so that it has two arms representing pseudopoda and then bring those arms around the seed or fruit. White blood cells swarm to a site of infection and devour bacteria by engulfing (phagocytosis).

5.2.10 Blood Loss

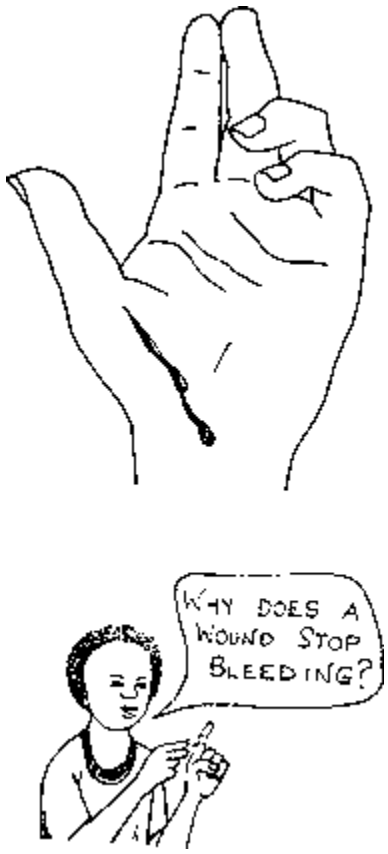
P: In an accident a person may lose blood.

Q: What happens if we lose a lot of blood?

O: We lose consciousness.

E: Death may occur because blood pressure falls, and this slows down the flow of blood around the body. The number of red blood cells falls, so the oxygen-carrying ability of the blood is reduced.

5.2.11 Blood Clotting



P: When you cut yourself the wound will bleed for a few minutes and then begin to clot.

Q: Why does it stop bleeding?

E: Blood clotting is brought about by a series of reactions. *Platelets* release a substance that converts *prothrombin* to *thrombin. Thrombin* converts *fibrinogen* in plasma into *fibrin* a mesh or network of fine threads. Blood corpuscles are entangled in the network that covers the wound. The resulting clot blocks the wound, prevents bleeding and stops germs entering the body, while white blood cells in the network attack bacteria already present.

5.2.12 Blood Clot Model

P: Place some red and white beans in a container to represent red and white blood cells. Move them around by gently shaking. Mix thin strips of grass or paper with the beans and repeat the shaking action. The beans are packed more securely by the strips. The strips represent the fibrin network (see 5.2.11)

5.2.13 The Healing Battle

P: Examine a wound a few hours after it occurred.

Q: What do you notice?

O: The area of the wound has swollen in size, it looks red and causes pain.

E: The body is mending and defending itself against the invasion of foreign germs. Heat is produced during these activities and swelling helps to immobilise the wounded area. Pain warns the brain to take care of the wound.

5.2.14 After the Battle

P: A few weeks after cutting your hand or knee the scab (network of fibrin and cells) comes away

Q: What does the wound look like now?

O: The skin of the wound looks healed but a little tender. There may be some clear fluid behind the scab.

E: The skin under a scab may not have a protective layer of dead cells on it. The fluid is plasma serum.

I: If the scab comes off too early the new skin will pull away and bleeding will result.

5.2.15 Slowing Blood Clotting

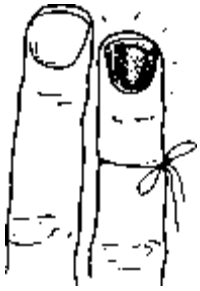
P: Animal blood tends to start clotting soon after leaving the animal. Stir the blood with a rod or stick for 4-5 minutes.

Q: Why do these actions stop Hood clotting?

E: Fibrin collects around the stick

I: Chemicals such as sodium oblate or sodium citrate or heparin also prevent blood clotting.

5.2.16 Finger Nail Indicator



P: Tie a cord or band around your thumb or finger. Examine the nail colour.

Wait for a minute.

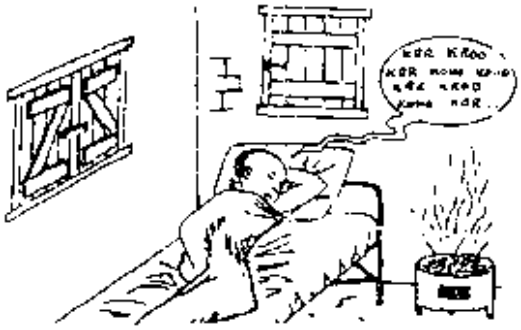
Q: Has the nail colour changed?

O: Yes, It has gone a blue-red colour.

E: The oxygen in the end of the finger is gradually being used up giving the blood a blue tint.

I: *Do not leave the cord on your finger too long*!

5.2.17 Haemoglobin's Favourite



P: Sleeping in a room with a charcoal stove on while the windows are closed may lead to carbon monoxide poisoning.

E: Carbon monoxide is the odourless, colourless, killer component of combustion. Often it is produced when a fuel burning appliance does not work efficiently. Haemoglobin has an even greater liking for carbon monoxide than for oxygen. It combines 300 times more readily than with oxygen. If we breathe it in, less oxygen can combine with the blood, so the tissues are starved of oxygen. Small amounts of CO are found in cigarette smoke.

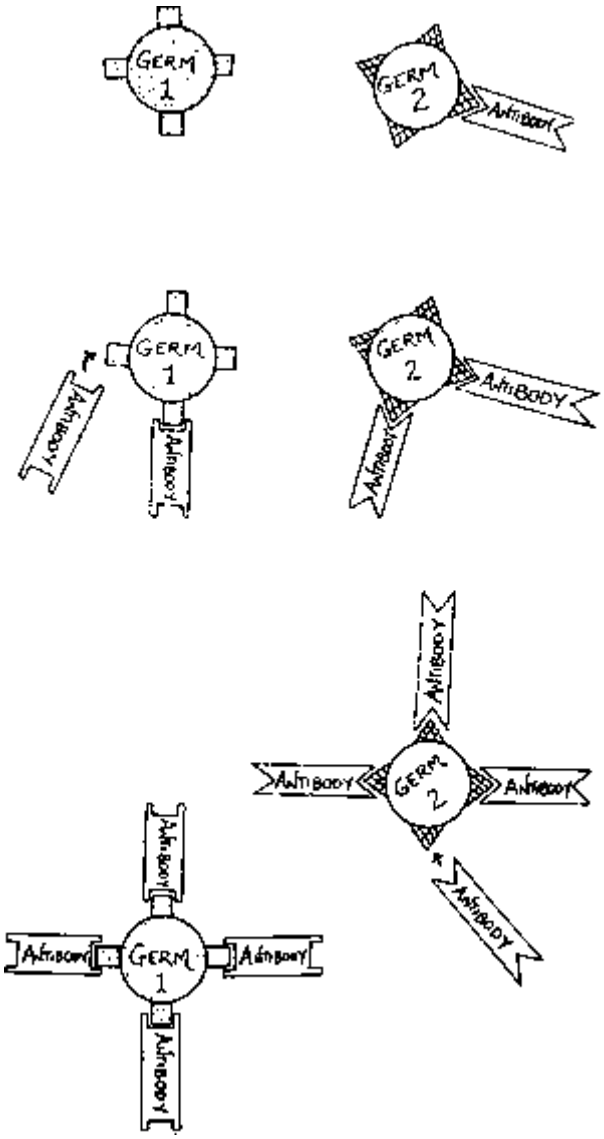
5.2.18 Immunity

P: Inoculation into the body of a vaccine (which may consist of an old strain of the disease; or the dead organisms or live micro-organism) gives immunity.

Q: What is immunity?

E: The inoculation causes the build up of antibodies which may remain in the body for several years. These antibodies are ready to fight infection by the microorganism at any time.

5.2.19 Antibody and Antigen Reaction

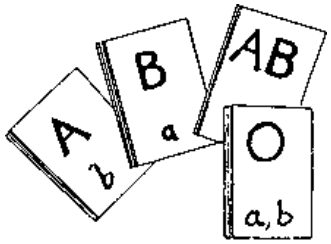


P: Prepare circles of card with different shapes on their edges as shown in the diagram. The circles represent the *germ* and the edge shapes their *antigens.* Now cut strips of card and alter one end of each so it matches the edge shapes of the "germ circles".

Q: How would you use these?

E: The strips of card represent the antibodies produced by the body to combat the antigens of the germs. The antibodes will be able to act on a specific antigen.

5.2.20 Transfusion Card Game



P: Cut out twenty rectangles of card and label five cards for each blood group as shown above. The game is played in the following way: The dealer shuffles the cards and places the pile face down on the table. One card is turned face upwards on the table between two or more players. This card denotes the *patient's* blood group. The next card turned over denotes the *donor's* blood group. Every time a transfusion is possible, the players must call out 'safe'. When the transfusion would be dangerous they call out 'clot'. The first to shout the correct term wins the cards and adds them to their pile. At the end of the game the player with the most cards wins.

5.2.21 Transfusion Checkers

	BLOOD GROUP	DONOR A ANTI-B	DONOR B ANTI-A	DONOR AB –	DONOR O ANTI-A ANTI-B
PATIENT	A ANTI-B				
	B ANTI-A				
	AB –				
	O ANTI-A ANTI-B				

	BLOOD GROUP	DONOR A ANTI-B	DONOR B ANTI-A	DONOR AB –	DONOR O ANTI-A ANTI-B
PATIENT	A ANTI-B	○	●	●	○
	B ANTI-A	●	○	●	○
	AB –	○	○	○	○
	O ANTI-A ANTI-B	●	●	●	○

P: Draw out a grid as shown in the diagram. Prepare two types of bottle tops: one type to represent a clot and the other to represent a safe transfusion.

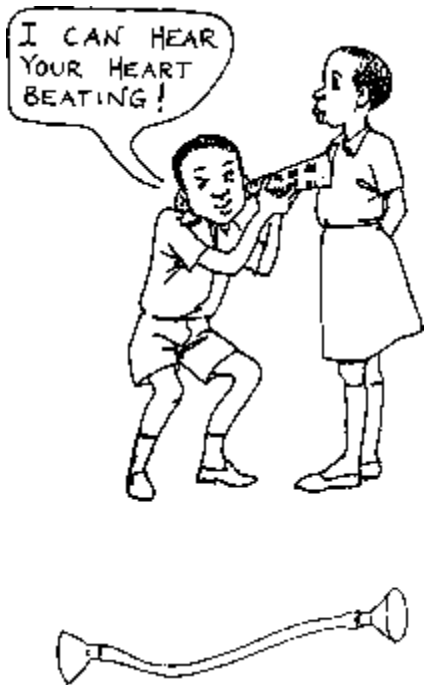
Q: Can you place the tops on the right square to show which blood groups are compatible? Which ones aren't?

E: The main red blood cells contain antigens, classified as blood groups A, B or AB. Blood group O cells do not have antigens. Antibodies in plasma clump blood cells together.

5.3. Blood Circulation

Blood circulation is the continuous flow of blood round the body initiated by the pumping action of the heart. As the heart pumps blood, pulsations can be felt at some points in the body such as wrists and temples. From the heart, blood moves through thick-walled vessels called *arteries,* into very small thin-walled *capillaries* and back through veins. Some animals, such as mammals have a double circulation where blood goes through the heart twice before completing the cycle. As blood moves it carries useful substances such as oxygen from the lungs and food from the intestines to the body tissues. It also removes waste substances like carbon dioxide from the body tissues. Blood is prevented from flowing back by structures called *valves.*

5.3.1 Newspaper Stethoscope



P: Roll a newspaper up into a hollow tube. Place one end of tube against another students rib cage (in the area of the heart).

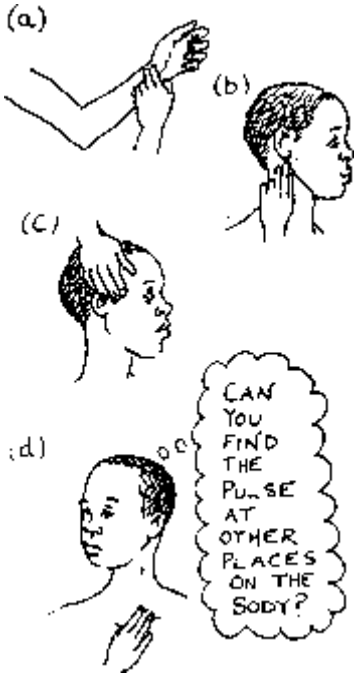
Q: What do you hear?

O: One can hear the heart beats.

E: A doctor uses a stethoscope to focus the sound from the heart. Another stethoscope idea could use funnels and plastic tube.

I: Try listening after vigorous exercise.

5.3.2 Taking the Pulse



P: There are various places on the body where the pulse may be taken for example (a) at the wrists, (b) under the ear beside the, angle of the jaw, (c) at the temple, (d) above the collar bone.

Q: Can you find the pulse at the various locations?

E: Sometimes you may have to move your finger tips around the area to find the exact location of the pulse or apply a little more pressure.

5.3.3 Listening to Blood Flow

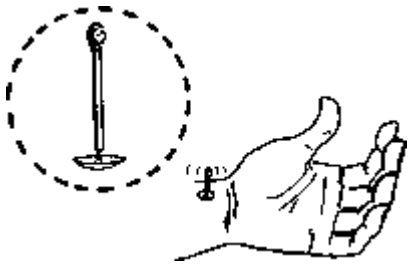
P: Place your index fingers carefully into your ears. This cuts out most external sound. Listen.

Q: What do you hear?

O: A muffled rhythmic beat can be heard.

E: By cutting out external sounds the ears can sense the inner pulse beat of the heart.

5.3.4 Pulse Indicator



P: Attach a matchstick to a drawing pin and place on the wrist where the pulse is strongest. Chewing gum, clay or a small piece of wood may be used if no drawing pin is available.

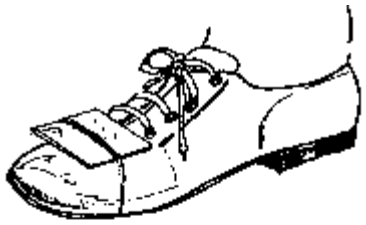
Q: What happens to the matchstick?

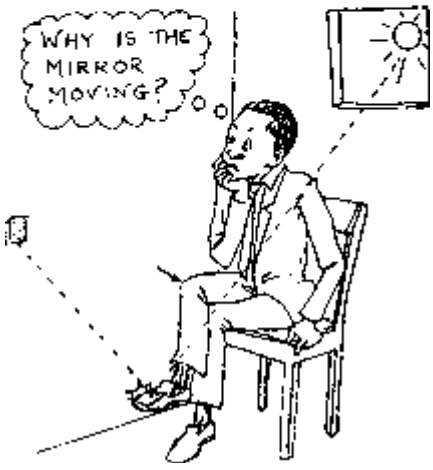
O: The matchstick moves from side to side

E: The matchstick moves every time a pulse beat passes under the pin.

I: Try using the pulse indicator after vigorous exercise.

5.3.5 Pulse Mirror





P: Cross your legs as shown above. Attach a small mirror to the shoe of the crossed limb, so that window light or the light of a torch, is reflected by the mirror onto a wall. Sit with crossed legs for a while and observe the patch of reflected light on the wall.

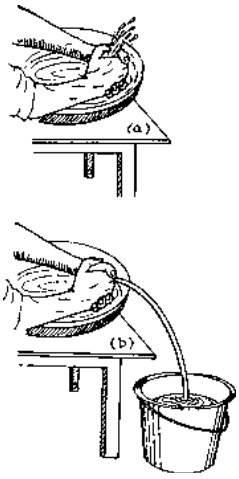
Q: What do you notice about the light reflected onto the wall?

O: The reflected light patch begins to move rhythmically.

E: The crossed leg tends to press on the leg artery and the pulse causes a rhythmic rocking

of the lower leg, thus moving the foot and moving the mirror.

5.3.6 Pumping Heart Action



P: (a) Half fill a basin or bucket with water. Place your hands in the water. Open and close your palms pivoting them at the fingers.

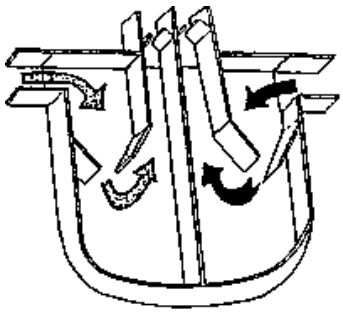
(b) Grip your hands and hold a rubber tube in position as shown in the diagram. Open and close your palms again.

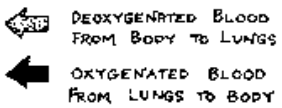
Q: What do you observe at the open end of the hands and at the free end of the tube?

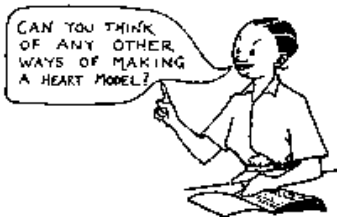
O: When the palms are open, water fills the palm cavity and when closed, water is forced out through the rubber tubing.

E: The opening and closing of the palms represent the relaxation and contraction of the heart muscles. Blood enters the chambers of the heart when the muscles relax and is forced out into the vessels as they contract.

5.3.7 Heart Model





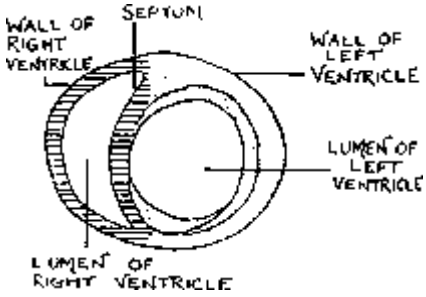


P: Draw a vertical section of the human heart on a piece of hardboard. Cut strips of thick cardboard or stiff paper and glue them on to the board to make a model heart as shown in the diagram. Add arrows. Clay or wood may be used instead of thick paper.

E: The heart is a four-chambered muscular organ. The upper chambers, are thin walled *atria,* which receive blood from the veins. The lower two chambers are the thick-walled *ventricles* which pump blood into arteries.

I: Examine the heart of a large mammal such as a cow or goat.

5.3.8 Ventricle Cross Section



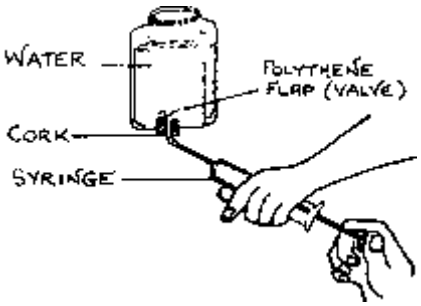
P: Draw and cut out a cross-section though the ventricles from stiff paper.

Q: Are there any differences between the two ventricles?

O: The left ventricle has a thicker wall and larger lumen than the right ventricle.

E: The reason for the difference is that, pumping blood to the nearby lungs, by the right ventricle, takes much less effort than pumping blood to the rest of the body by the left ventricle.

5.3.9 Valves



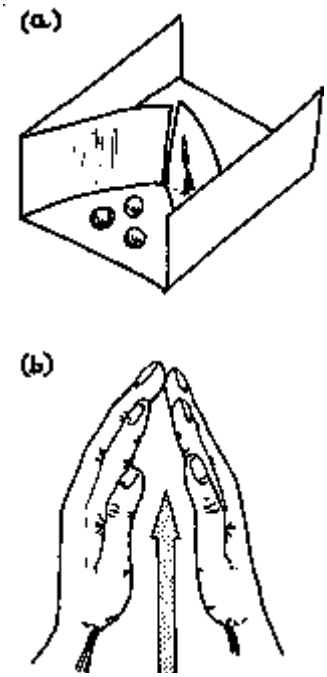
P: Set up the apparatus as shown above. Push in the syringe plunger, then pull it back.

Q: What do you observe?

O: When the plunger is pushed in, the flap opens allowing water into the plastic container. When it is pulled back, the flap closes preventing water from flowing back.

E: The polythene flap acts as a valve allowing forward flow of blood and preventing its back flow.

5.3.10 Valve Models



P: Using a card or paper, make a model valve as shown in the diagram (a). Use pebbles or pieces of chalk to show the flow through the valve in the direction shown. Tilt the model backwards.

Q: What do you observe about the flow?

O: The pebbles pass through the valve, but the valve closed preventing the flow going in the opposite direction when the model is tilted backwards.

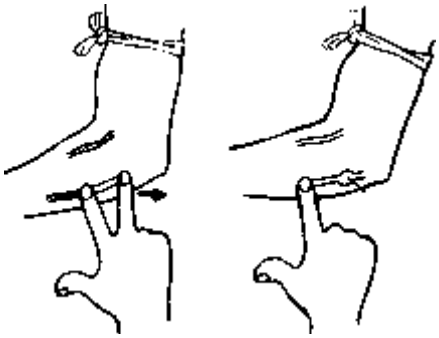
E: The valves allow flow of blood in one direction only.

I: The action of valves can also be illustrated using touching hands as in diagram (b). Let your neighbour push their hand through the touching fingers in the direction of the arrow.

5.3.11 Pulse Rate and Heartbeat

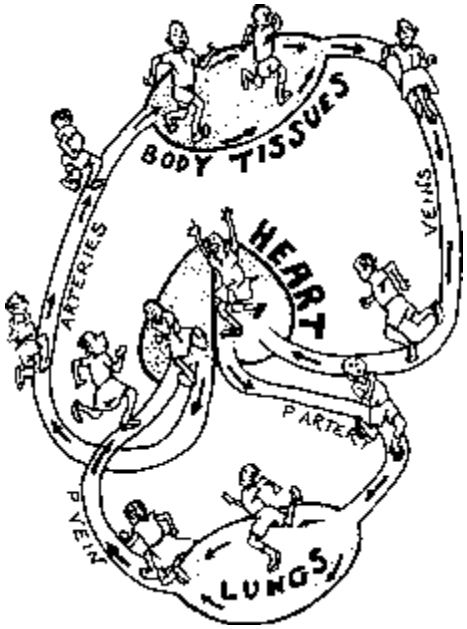
P: See 1.3.2 and 5.3.2.

5.3.12 Harvey's Experiment



P: Carefully tie a piece of cloth round the upper arm. *Keep this tied for only a short time.* Surface veins fill with blood. Harvey found he could empty a vessel by placing a finger on the raised vessel and pushing the blood out and up the arm with another finger. When he released the finger nearest the heart, the blood did not fill up the vessel again.

5.3.13 Circulatory System Game



P: Mark out a model of the circulatory system on the ground using stones, string or chalk. Put pieces of red flowers or paper in the area marked *lungs* and pieces of blue flowers or paper in the area marked *body tissues.* To begin the game two or three pupils pick up blue petals at the body tissues and follow the arrows through to the *heart* and on to the *lungs.* At the lungs the pupils drop the blue flowers and pick up the red and return to the body tissues via the other side of the heart.

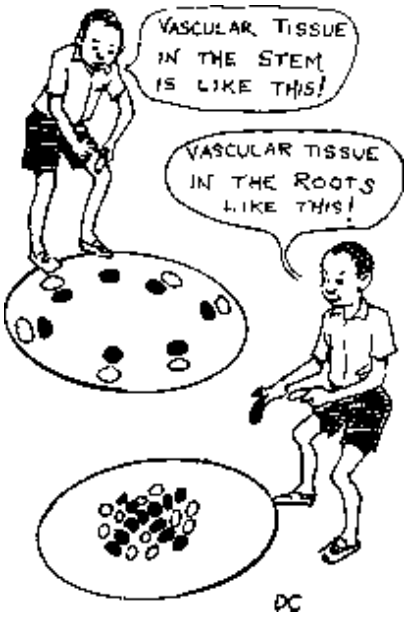
Q: What do the pupils represent?

E: The pupils represent the flow of blood in the body. They must go through the heart twice before completing the cycle of *double circulation.* As blood flows it transports substances such as oxygen (red flowers), carbon dioxide (blue flowers) and food materials. Pupils can also act as *heart valves.*

5.4. Transport in Plants

Most plants, like animals, have a transport system, although its structure and arrangement are quite different. One type of tissue, the *xylem,* forms a system of open tubes which carries absorbed water and mineral salts from the roots, through the stem to the leaves. Another type of tissue, the *phloem,* consists of living cells, which can transport large molecules such as food Substances in either direction, between any parts of the plant. Water moves up through the xylem by a process called the *transpiration stream* and evaporates from the leaf surface by *transpiration.* Movement of materials through the phloem is called *translocation.*

5.4.1 Plant Vascular Tissues

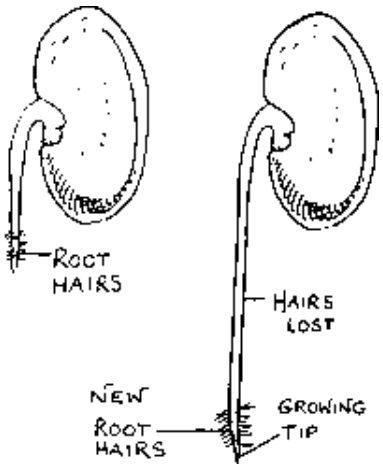


P: Chalk two circles on the floor. Each about one metre in diameter. Cut out 20 discs of newspaper, card or exercise book paper. Colour 10 discs to represent the xylem, the other ten uncoloured discs represent the phloem. Place the different coloured discs of paper in the chalked circles to show the arrangement of the tissues in a stem, and the arrangement in a root.

Q: What are the differences in arrangement between stem and root?

E: Vascular tissue forms a ring of bundles in the stem but a central column in the root.

5.4.2 Root Hairs



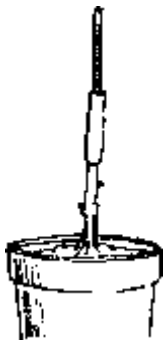
P: Germinate some peas or bean seeds on a damp cloth or newspaper. Leave them until the young root (radicle) emerges. Observe the root tip. (This can be assisted using a simple magnifier).

Q: What is the appearance of the root?

O: A fine covering of thin hair-like structures can be seen, just behind the root tip.

E: A root develops hairs just behind the growing tip. As the root gets older and larger the root hairs are lost. Root hairs increase the surface area of the root for absorption of water and mineral salts.

5.4.3 Root Pressure



P: Cut the stem of a well grown potted plant about 5 cms above soil level. Place a tight fitting piece of tubing over the stem and insert a narrower tube (of glass or plastic) inside. Seal all joints with vaseline.

O: Water collects in the tube and the water level gradually rises.

E: Root pressure is one of the forces which helps water to move up the stem. It is the force which causes the water to rise up the tube.

5.4.4 The Plant as a Straw

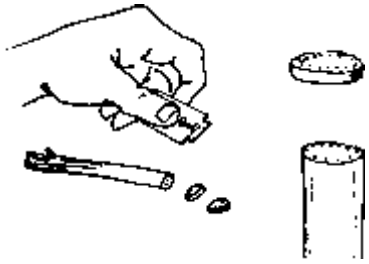
P: Set up the materials as shown. Make sure the clay forms a complete air-tight seal. Suck air through the straw from the air space at the top of the bottle.

E: The plant has a system of tubes (xylem) running from the roots through the stem to the leaves. These tubes end in spaces in the leaf which open to the air through tiny holes called stomata. By sucking, air is drawn in through the stomata and along the xylem tubes to the cut end of the stem and bubbles form.

5.4.5 Movement of Water in a Plant

P: Take a young plant, such as Balsam, which has a semi-transparent stem (Zinnia). Wash the roots well and place in a diluted solution of red or blue ink. Leave for two hours. Coloured ink can be seen moving up the stem and into leaves.

5.4.6 Which parts of the Stem carry Water?



P: Take a plant stem which has been placed in coloured ink or dye. Cut very thin sections with a sharp razor blade. Examine the sections by holding them up to the light on the end of a pin or by using a simple microscope.

O: The colour is located as small dots forming a circle towards the outside of the stem.

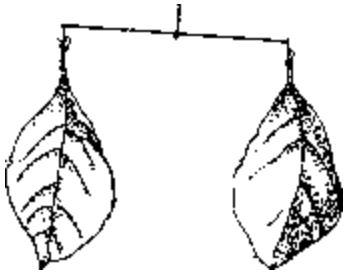
E: Water and the dye are carried in xylem tissue which is found grouped together as separate vascular bundles.

5.4.7 Leaf Transport System

P: Spray or dust paint (or ink) onto the leaf surface. Place a piece of paper on the painted surface, press under a weight. Remove the paper to reveal print.

E: Monocot and dicot leaves of flowering plants have vascular bundles which can be seen as veins in the leaves when holding the leaves to the sun. The veins run parallel to each other in monocots and form a network in dicot leaves.

5.4.8 Transpiration -Weight Loss



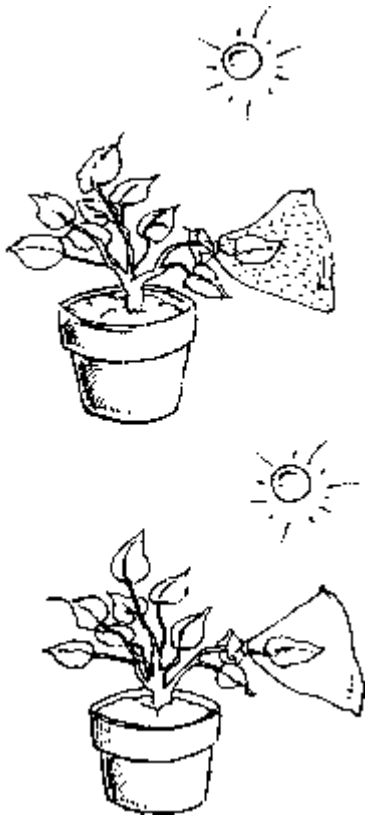
P: Take two leaves of the same size and type. Grease one leaf on both surfaces, then hang each one at opposite ends of a thin stick. Suspend the stick by a thread so that it is balanced

Q: What happens to the balance of the stick?

O: The end of the stick on which the ungreased leaf is hung moves upwards.

E: Leaves lose water by transpiration. This can be prevented by applying a layer of grease. The ungeased leaf loses water and becomes lighter.

5.4.9 Transpiration -Water Loss



P: Place a polythene bag over the leaf of a living plant. Secure the bag to the stem with a thread. Repeat the experiment with a greased leaf of the same size.

Q: What can you see on the inside surface of the bags?

O: Water droplets appear on the inside of the bag placed over the ungreased leaf. Very little or no water collects in the other bag.

E: Water, which is absorbed from the soil by the plant, is lost through the pores (stomata) of

the leaf. This is transpiration. There is no water loss from the greased leaf because the grease blocks the pores.

5.4.10 Leaf Number and Water Loss

P: Take branches of the same plant with a different number of leaves. Take containers and put an equal volume of water in each. Place a few drops of cooking oil or kerosene on the surface of the water in order to avoid evaporation. Measure the volume of water in each container every day.

E: Water is lost through stomata. The larger the number of leaves the more stomata and the more water lost into the air.

5.4.11 Looking at Stomata

P: Take a leaf of comelina, zebrina or similar. Snap it in half to obtain a ragged edge. With forceps peel off a small portion of lower epidermis. Place this in a drop of water on a glass slide, add one drop of dilute iodine and cover with a coverslip. Examine using a simple microscope (see appendix). The irregular, rounded cells of the epidermis can be seen and scattered through these are curved guard cells found in pairs around the stomatal pore.

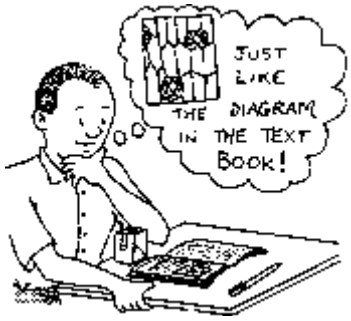
5.4.12 Distribution of Stomata

P: Put a leaf into very hot water and observe the changes on it. Repeat the experiment with various types of leaves (monocots and dicots).

O: Bubbles come from the stomata due to the expansion of the air in the leaf. Dicot leaves show bubbles mainly on the lower surface, but monocot leaves show bubbles on both surfaces.

E: Stomata are found mainly on the lower surface of dicot leaves whereas they are equally distributed on both surfaces of monocot leaves.

5.4.13 Stomata Skin



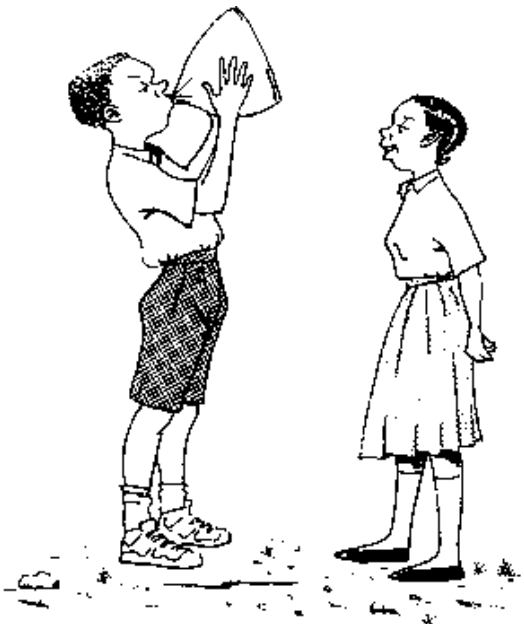
P: Lightly coat the underside of a leaf with clear nail varnish. Allow the varnish to dry then peel it off. Examine the varnish 'skin' under a simple microscope (see appendix).

Q: What do you observe on the varnish 'skin'?

E: Small curved cells are visible around the pores. These are the guard cells of stomata.

I: Try using this technique to examine other surfaces.

6. Gaseous Exchange and Respiration



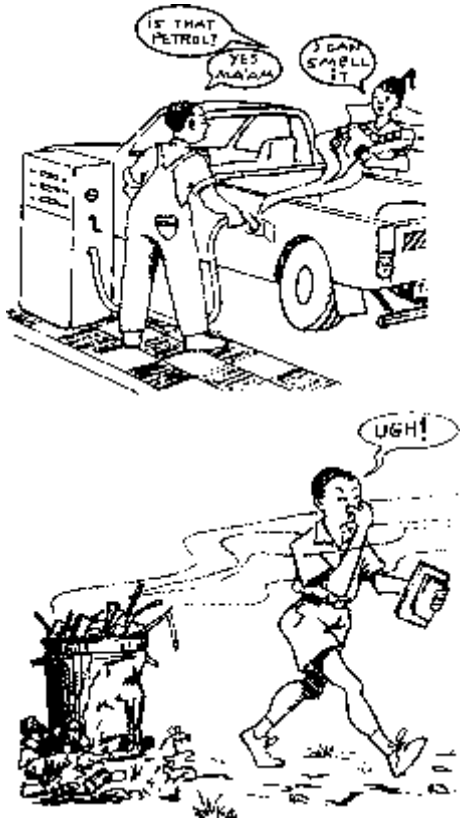
6.1. Ventilation in Vertebrates

Living things use air (oxygen) for the production of energy which is required for carrying out life processes such as movement, growth etc.. *Respiration* is the breakdown of organic substances within cells to release energy (cell respiration). Gaseous exchange of carbon dioxide for oxygen. Gaseous exchange needs a flow of air over a respiratory surface a process called ventilation (or breathing).

6.1.1 Data on Breathing and Fitness

P: Count the number of breaths (on inspiration or expiration) per minute of a number of people a) while sitting, b) while standing and c) after exercise. Tabulate the results and compare. How can you explain the differences?

6.1.2 Air is Not Always Clean



Inspired air is not always clean. It contains many particles which can affect health. Ask the pupils to make a list of areas where air is polluted. Here are a few ideas - a burning waste heap; a car exhaust; latrines that may not be as clean as they should be.

6.1.3 Foreign Bodies in the Throat

P: A foreign body in the throat is a potentially life threatening problem. When something gets stuck in a person's throat it can block the air passage to their lungs. This is called choking. *A small child is in danger because it may like to put things in it's mouth.* Discuss with pupils the dangers caused by foreign bodies in the throat and how to prevent a person choking.

6.1.4 Feeling the Trachea

P: Feel your larynx and then trachea with your fingertips. Repeat while swallowing.

Q: What do you notice about the stability and movement of the larynx and trachea?

O: The larynx moves up and down, while the trachea stays almost static.

6.1.5 Trachea Model

P: Coil a length of flexible wire around a stick. Remove the stick and glue a cover of plastic around the length of the coil, leaving the ends open.

E: The coiled wire represents the rings of cartilage in the trachea which prevent the walls from collapsing. The rings also allow the trachea to be flexible. Demonstrate these properties.

6.1.6 Lung Capacity

P:

a) Fill a two litre plastic bottle with water and invert it in a dish of water. Insert a plastic tube into the neck of the bottle and breathe out gently through the tube. Repeat the experiment but breathe out fully through the tube.

b) Or, blow into an empty plastic bag. Then submerge the bag in a bucket filled to the brim

with water. Collect the overflowing water and measure the volume.

E: During quiet breathing half a litre is exchanged. During maximum forced breathing up to 4 litres can be exchanged.

6.1.7 Chest Expansion

P: Take the chest measurement (circumference of the thorax) of a pupil as they breathe in and out deeply. Take the average of several measurements.

E: During breathing in, the intercostal muscles pull the ribs upwards and outwards resulting in the increase in size of the thoracic cavity. During breathing out the opposite happens.

6.1.8 Expired Air contains Carbon Dioxide

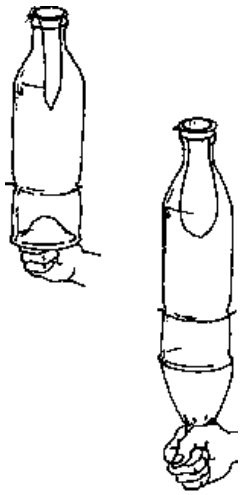
P: Breathe out through a straw or the barrel of a ball point pen into filtered limewater.

Q: How does the limewater change?

O: The limewater goes cloudy then later clear.

E: The exhaled carbon dioxide reacts with the calcium hydroxide solution (lime water) and a precipitation, which later dissolves by more carbon dioxide to soluble calcium hydrogen carbonate.

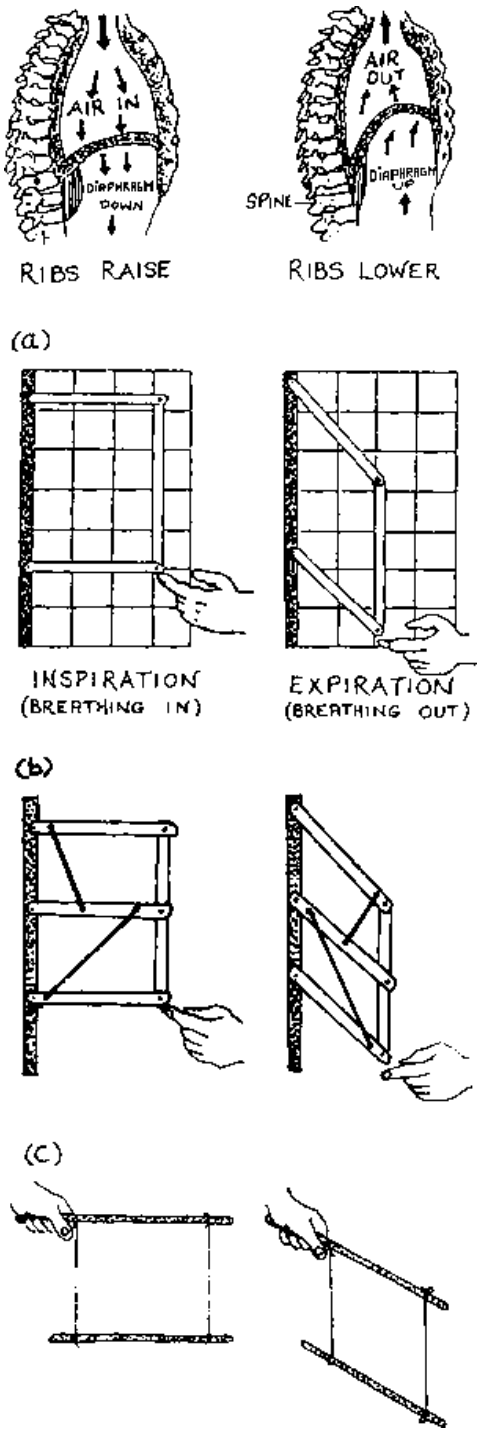
6.1.9 Diaphragm Action



P: Cut off the bottom of a plastic bottle with a sharp knife. Insert the balloon at the mouth of the bottle so that it hangs in the bottle as shown. Tie a piece of plastic bag around the cut base, holding it in place with thread or a rubber band.

E: This simple apparatus can be used to demonstrate the process of inspiration and expiration. The balloon represents one lung. The plastic bag represents the diaphragm and the bottle interior the thoracic cavity. Pulling the plastic sheet down (= diaphragm down) causes an expansion of the (thoracic) cavity bringing about inspiration. The balloon becomes inflated. Expiration can be demonstrated by pushing the plastic sheet to its original position, reducing the volume of the thoracic cavity, thus causing the balloon to deflate.

6.1.10 Rib Movement Model

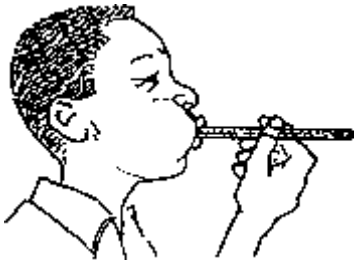


a) Draw squares (3 x 3 cm) on card or hardboard as shown in the diagram. Fix a shaded strip with glue or nails to represent the spinal column. Attach the movable strips to represent the ribs and sternum. By moving the ribs on the model up and down, inspiration can be illustrated. Count only the squares which are over half visible to determine the increase or decrease of the thoracic cavity. Pupils should place their hands on their own ribs to link the model to life. The change in size of the thoracic cavity is due to movements of the ribs and the diaphragm.

b) The model above can be adapted to show the contraction and relaxation of the intercostal muscles.

c) A simple model can be made from two sticks and some thread. Try it.

6.1.11 Exhaled Air contains Moisture

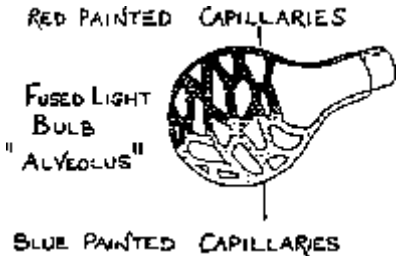


P: Breathe *in* through the transparent barrel of a ball point pen and note what happens. Then breathe *out* through the barrel of the pen and record your observations.

O: When you breathe in the barrel remains clear, but when you breathe out the barrel becomes clouded with water vapour.

E: Expired air contains water vapour which condenses on the inside of the ball point barrel.

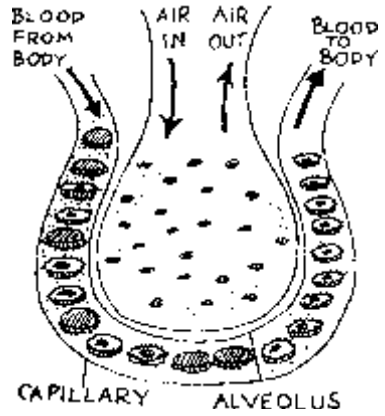
6.1.12 Alveolus Model



P: A fused electric light bulb can be used to represent an alveolus. With red paint or waterproof marker, draw the blood capillaries carrying oxygenated blood. Use blue for the deoxygenated blood vessels.

E: The lungs contain countless alveoli (air sacs). Each sac is supplied with blood capillaries. The blood coming to an alveolus in deoxygenated, while the blood leaving the alveolus is rich in oxygen.

6.1.13 Gaseous Exchange Game

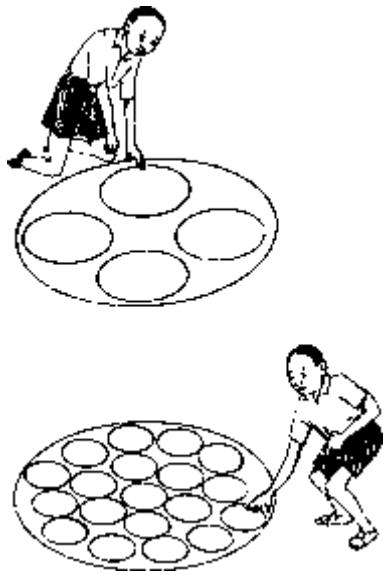


P: Draw the large outline of an alveolus on cardboard or paper (it may also be chalked on table or floor). Draw a surrounding blood capillary. Choose two types of seed, stone or bead. One to represent carbon dioxide (seed) and one to represent oxygen (stone). Paint or mark fifteen bottle tops, red on the inside and blue on the outside. The tops represent red blood cells. Place the tops in the capillary. As the tops (red blood cells) enter the capillary most are turned to blue, to show they contain no stone (oxygen). Carbon dioxide is shown by small seeds in the plasma area of the capillary. Stones (oxygen molecules) are placed inside the alveolus and these are moved into the capillary, to be transported away inside red upturned bottle tops (oxygenated red blood cells). The seeds (carbon dioxide) are moved from the capillary plasma area into the alveolus.

6.1.14 Playing Gaseous Exchange

P: Pupils can act out gaseous exchange. A desk or table can represent an alveolus. Write 'oxygen' on ten sheets of paper and place these on the desk. Some pupils pin the letter 'P' or the word 'Plasma' to their clothing. Others pin letter 'R' or 'Red Blood Cell' to their clothing. Each 'P' pupil is given a paper with 'carbon dioxide' on to carry. The pupils then act out their various roles. As they walk round the table (through the capillary), each 'P' pupil deposits their 'carbon dioxide' paper. Each 'R' pupil picks up an 'oxygen' paper from the table and all continue to walk around the table (through the capillary).

6.1.15 Lung Surface Area



P: Use string or paper to make a circle of 20 cm diameter. Make smaller circles of 10 cm diameter. See how may small circles fit inside the 20 cm circle without overlapping. Measure the circumferences of the large and small circles. Find the total circumference of all the small circles and compare it with the circumference of the big circle. Repeat the procedure using 5,2 and 1 cm diameter circles.

O: As the circles get smaller, their total circumference gets larger compared to the circumference of the big circle.

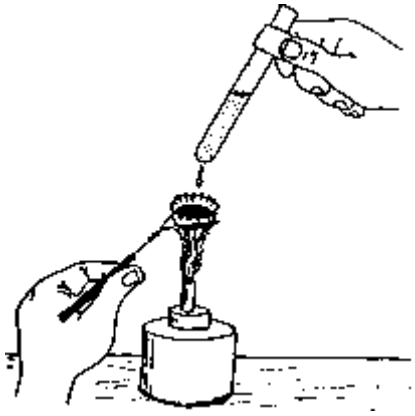
E: This is similar to lungs which are divided into air sacs, to increase surface area for gaseous exchange. There are about 350 million air sacs in each lung. Because they are so small, the air sacs form a very large respiratory surface (about 25 square metres in each lung?

I: The tracheal system of insects and the gills of fishes all have a large surface area for gaseous exchange.

6.2. Cell Respiration

Respiration is one of the seven vital characteristics of living things. The term respiration is often used in referring to breathing and gaseous exchange, but actually it should only be applied to *cell respiration,* or *internal respiration* which is a chemical process. Respiration, in simple terms, may be considered as a process of energy release by the breakdown of carbohydrate-food stuffs like sugar and starch. These are made up of the elements carbon, hydrogen and oxygen. Respiration can be aerobic or anaerobic. *Aerobic respiration* involves the release of energy by the chemical reaction of carbohydrates with oxygen. These are completely broken down to water and carbon-dioxide. *Anaerobic respiration* is the breakdown of carbohydrates to release energy without the use of oxygen. Some single-celled organisms like yeast and bacteria derive most of their energy anaerobically, a process which is also *called fermentation.* Bread, beer and wine production are examples of the application of fermentation.

6.2.1 Carbohydrates contain Combustible Elements



P: Heat some sugar in a soda bottle top using a kerosene burner (kibatari). Hold a water filled glass or test tube above the bottle top.

Q: What do you observe?

O: The sugar first turns dark brown, then black and drops can be observed condensing on the glass.

E: This shows that carhohydrates are made up of carbon, hydrogen and oxygen atoms (the latter two form water).

6.2.2 Combustion and Respiration

P: Heat some sugar in a soda bottle top as in the previous experiment. When the sugar is bubbling remove the cap from the heat. Put your hand above the heated sugar and note the temperature. Feel the temperature of your body with your hand.

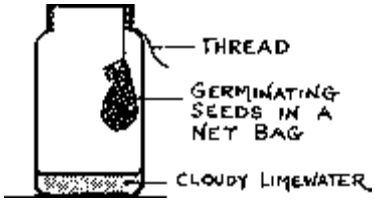
Q: How does the temperature of the your body compare with that of burning sugar?

O: The burning of sugar produces a high temperature. The human body has a constant but moderate temperature (37 degrees C).

E: Combustion (or burning) is the rapid release of energy in an uncontrolled reaction. Respiration is the slow release of energy during a controlled reaction involving enzymes.

6.2.3 Exhaled Air contains Carbon-Dioxide

6.2.4 Germinating Peas produce Carbon Dioxide



P: Put a little lime water into a wide-mouthed glass jar and hang a perforated plastic bag, containing soaked and germinating peas. Make sure that the peas are separated from the liquid. Seal the jar well and leave it to stand for a few hours.

Q: What happens to lime water?

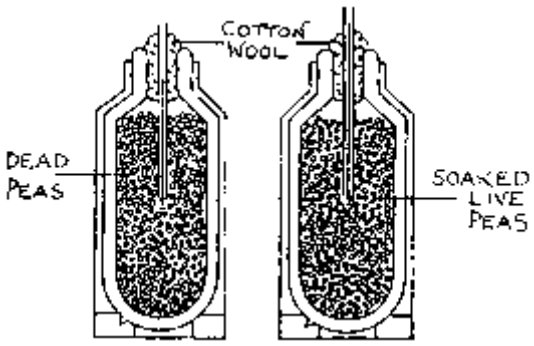
O: The limewater becomes cloudy.

E: The germinating peas respire giving out carbon dioxide

I: Different kinds of germinating seeds, plant shoots and small animals can be used instead of peas.

6.2.5 Temperature Change

6.2.6 Measuring Temperature Change



P: Fill a thermos flask with germinating pea seeds or wheat grains. Place a thermometer into the peas and close the mouth with cotton wool. Set up a control test with seeds which have been boiled.

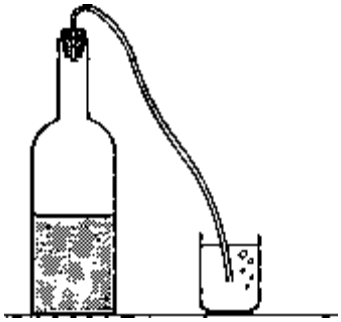
Q: What happens to the temperature?

O: The temperature rises in the flask with the living seeds, but not in the one containing boiled

seeds.

E: Respiration produces heat.

6.2.7 Fermenting Sugar



P: Half fill a bottle with a solution prepared from 1 cup of water, 1 tablespoon of sugar and 1 tablespoon of yeast. The gas produced can be directed into lime water.

Q: What do you observe?

O: The bubbles of gas turn lime water cloudy.

E: The yeast cells ferment the sugar giving off carbon dioxide gas.

6.2.8 Fermenting Fruit

P: Prepare a pulp of paw paw. Put the pulp into a glass. Let it stand for some time in a warm place.

Q: What can be observed?

O: Gas bubbles are formed in the pulp.

E: The pulp is fermented because the sugar contained in it is acted on by wild yeast, which grows on the skin of the fruit. Yeasts are also found in air.

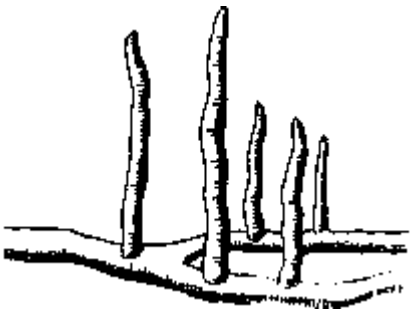
6.2.9 Local Alcoholic Drinks

P: Try to find out the names of as many locally made alcoholic drinks as you can.

Q: From what ingredients are they made?

E: Mbege, kangara, dengeluwa and tembo are examples of locally made alcoholic drinks. They are made from different cereals, honey and many other sugar and starch-containing raw materials. Fermentation (anaerobic respiration) takes place in the process of making each of these drinks.

6.2.10 Plants reach for Oxygen

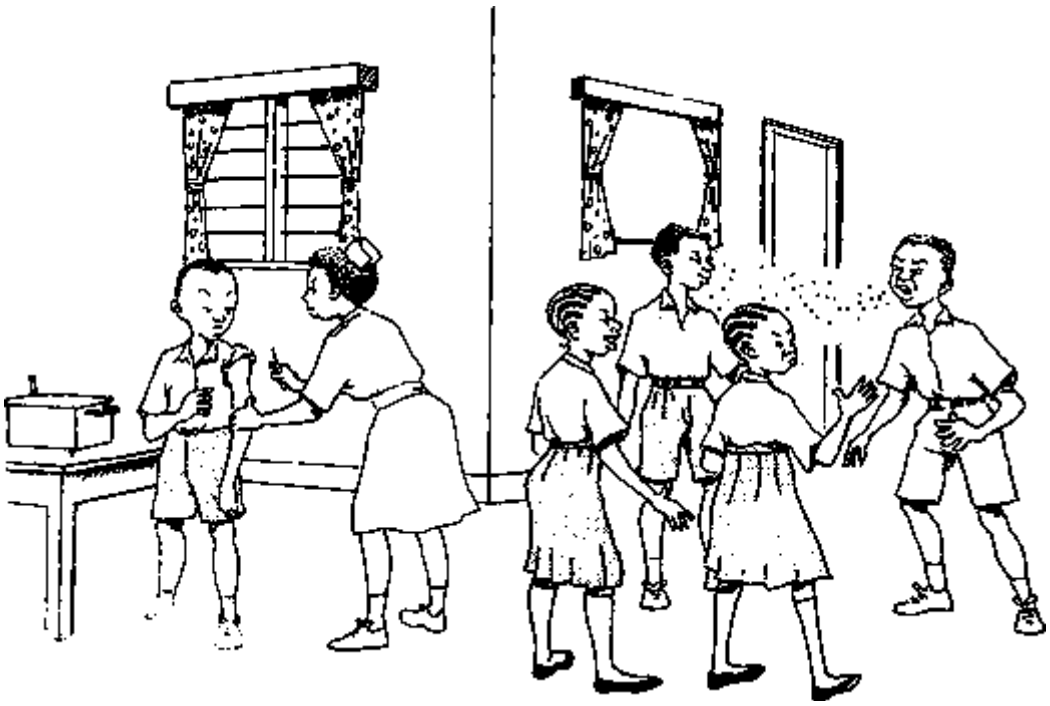


P: Go for a field trip and look for mangrove trees. Observe the kind of ground they grow in and the special roots they have developed.

Q: Why do parts of their roots grow in air?

E: The ground where they grow is water logged and therefore does not contain much air (oxygen). Red mangroves develop stilt roots and white mangroves breathing roots for obtaining oxygen from the atmosphere.

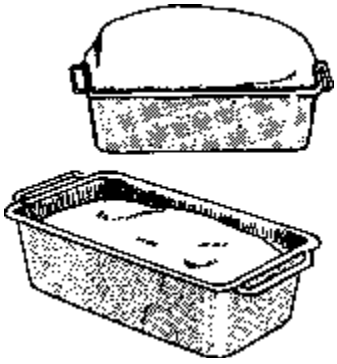
7. Micro-Organisms



7.1. Microbes in Daily Life

Microbes are tiny living organisms which are too small to be seen with the naked eye. They are found in very large numbers almost everywhere on this planet. They inhabit water, soil, air, food, clothes, the surface and tissues of animals and plants as well as many other places. The main types of microbes are *bacterial fungi, viruses* and *protozoa.* Microbes are important to us because many of them can be either beneficial or harmful. The harmful ones cause animal and plant diseases, spoilage of food stuffs, and attack textiles and other materials. Useful microbes include those used in industry and medicine and the decomposers responsible for the recycling of useful materials in the ecosystem More specialised types are the nitrogen fixers and the symbiotic cellulose digesters found in the gut of herbivores. In fact without microbes, life on earth, in its present form would not be possible.

7.1.1 Bread Making



P: Mix 100 g of plain flour and 5 g sugar with a little water. Separate evenly into two containers. In one container, mix in 7 g of yeast. Mix the contents in both containers to make a dough. Cover the containers and leave them to stand for a few hours.

Q: What happens?

O: The dough which contains the yeast rises.

E: Yeasts are living cells which respire, grow and reproduce. The carbon dioxide produced by yeast during respiration causes the dough to rise. The gas lightens the heavy starch mixture and when it is baked, the yeast dies, but the gas bubbles remain as small holes in the bread.

I: Yeasts are also widely used to produce alcoholic drinks during the fermentation of naturally occuring sugar solutions or starch.

7.1.2 Nitrogen Circulation

P: Watch what happens to dead plant or animal material over a period of several weeks.

Q: What do you observe?

O: It rots and breaks down into small particles

E: When a plant or animal dies, its tissues are decomposed by fungi and bacteria to form humus. Animal faeces is similarly broken down. The ammonia formed is washed into the soil, where it is acted upon by different types of bacteria, eventually converting them into nitrates essential for plant growth.

7.1.3 Nitrogen Fixers

P: Examine the roots of leguminous plants such as peas and beans.

Q: What do you see on the roots?

O: Small knot-like swellings.

E: Swellings called *root nodules* are found on leguminous plants. They contain bacteria, which fix nitrogen from the air to form nitrogenous compounds, which can be used by plants. In this way, they restore the nitrogen content of the soil.

7.1.4 Grass - Milk Link

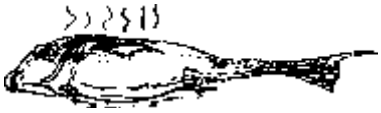
P: Watch what a cow drinks and eats.

Q: Does it eat anything special?

O: It eats grass and drinks water.

E: The cow like any other ruminant has a modified stomach for digesting plant material. Digestion is possible because of the presence of *symbiotic bacteria* in the stomach, which produce cellulase enzyme for catalysing the breakdown of plant cellulose into useful nutrients. Thus, milk is produced as a result of enzyme action on the vegetation that a cow takes in.

7.1.5 Preserved Food



P: Take three small fishes and wash them thoroughly. Remove all the scales and intestines. Smoke the first fish on a ready-lit sigiri. Salt the second fish and leave the third one untreated. Leave the fishes overnight.

O: The salted and smoked fishes are still good, whereas the untreated one has gone bad.

E: Microbes grow on the untreated fish but do not survive on salty surfaces. Smoking preserves the fish and so it is not easily attacked by bacteria. Since microbes are numerous in the environment, we should know how to control their growth and therefore be able to preserve our food.

7.1.6 Helping Healing

P: When the body is wounded clean the cut with water and little antiseptic, removing all foreign bodies.

Q: Why do this?

O: The wound heals more swiftly if foreign bodies are washed from it as these may include infections microbes.

E: The antiseptic kills certain microbes not removed by washing.

7.1.7 The Rot Spreads

P: Put two fresh tomatoes in a small container and cover them. Place another tomato together with a rotting tomato in a similar container. Cover it.

Q: Examine daily. What happens to the tomatoes?

O: The tomato with the bad tomato is likely to rot faster that those without.

E: Microbial growth spreads very fast with rotting food as a source.

I: It is advisable to separate rotting food from fresh food as soon as possible or else all of it will go bad.

7.1.8 Mouldy Food

P: Place different types of food such as very ripe orange or tomato, half a pawpaw or coconut or even old bread, in a dark damp cupboard. Examine the food after 2 days.

Q: What does it look like?

O: The food becomes mouldy and patches of different colours appear on the surfaces, most of which look hairy.

E: These are the moulds which belong to a group of non-green plants called fungi. Like any other living micro-organism, they need food in order to grow and reproduce.

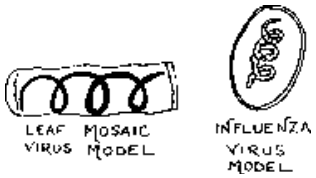
7.1.9 Healthy Living

P: List as many examples as you can of unhygienic practices.

Q: Explain why they are likely to lead to the spread of disease and suggest how they could be improved.

E: An unhealthy environment enhances the spread of diseases such as cholera and typhoid. Proper disposal of human and domestic waste will create a good environment to live in. Drinking clean water and eating properly prepared food with clean hands helps to ensure healthy living.

7.1.10 Virus Models



P: Model a leaf mosaic virus (a) or influenza virus (b) using polythene, paper, thick string and coiled wire.

Q: What does each material represent?

O: The thick string and polythene represent the protein coat; the coiled wire the nuclear material.

E: Infuenza and leaf mosaic viruses are examples of viruses that affect our health -and our crops. They are basically made up of proteins and nucleic acids. Other examples of viruses are poliomyelitis, measles, AIDS, yellow fever, and small pox.

7.1.11 Why Milk Goes Bad

Q: Why does milk become sour?

E: Milk goes bad because bacteria have begun to feed on the milk. The sour taste is due to lactic acid which is formed as a waste product of bacterial growth.

I: Mothers who bottle-feed their babies should ensure that the milk they give their babies has been boiled and that all equipment they use is sterile.

7.1.12 Mind Your Body

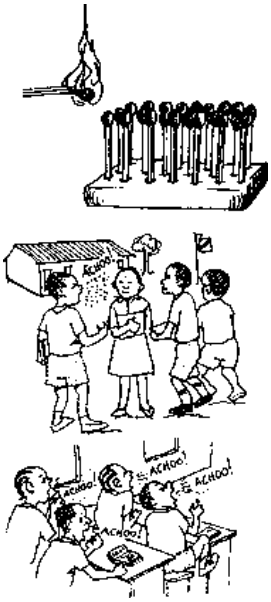
P: Put baby powder or flour over pupil's arms and face. Let another pupil touch them.

Q: What happens?

O: The pupil who had no powder on his body now has some.

E: Some diseases such as scabies, ringworm, and conjuctivitus are spread by direct or indirect contact with another person. Care has to be taken to avoid unnecessary contact, sharing of unclean combs, clothes and any such items which can spread harmful microbes.

7.1.13 Coughs and Sneezes Spread Diseases



P: Place the matches in the clay as shown and ignite one.

Q: Why is it dangerous to cough or sneeze without covering the mouth or nose?

E: Moisture may be seen leaving an uncovered mouth or nose. The water droplets contain microbes. If one is suffering from an airborne disease such as influenza or tuberculosis sneezing or coughing could be a source of spreading the harmful microbes. It is necessary to be aware of this when coughing/sneezing, so that we do not spread the germs to others. Doctors and nurses wear masks to stop germs from their noses and mouths getting on to people having operations or on to newborn babies.

7.1.14 Diarrhoea

P: Note occasions when something irritates your bowel and diarrhoea starts quickly and unexpectedly.

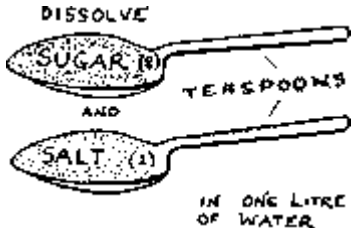
Q: Why should it happen so quickly?

E: If you eat contaminated food or various foods which your bowel is not used to, the bowel

muscles work hard pushing out the remains of the food before the canal walls have had time to absorb the water. If it stayed there long enough, the food poisoning bacteria could get into your blood. The bowel muscles can push so hard, that they force the end of the bowel open and you have to run!

I: The harmful microbes present in contaminated food could be bacteria and protozoans. In addition to diarrhoea, one can get rid of the unwanted food by vomiting.

7.1.15 ORS Miracle

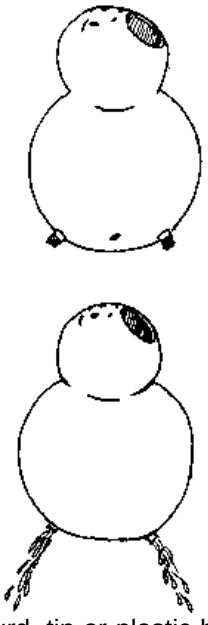


P: Dehydration caused by diarrhoea is the biggest single killer of children in today's world!

Q: How can death be prevented?

E: When people suffer from diarrhoea and/or vomiting or from severe burns, they may lose much more water than they take in. This is life threatening, since the body needs a lot of water for normal functioning. With the water the body loses essential electrolytes (like Na, K, Cl.) Mix 8 teaspoons of sugar and 1 teaspoon of salt with a litre of clean water. Gently make the patient drink cups of this *oral rehydration solution* to replace lost water and salts.

7.1.16 Water Baby



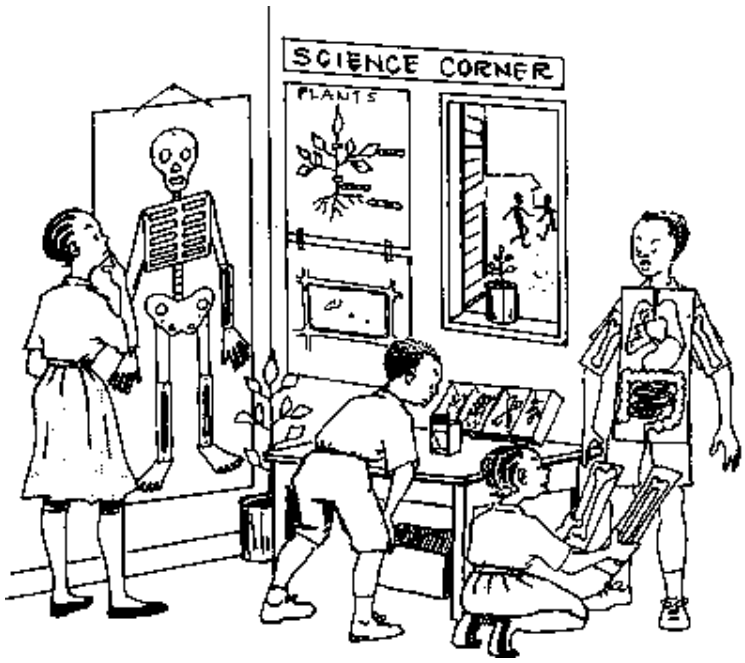
P: Make a model baby from a dry gourd, tin or plastic bottle. Put a hole in the top and two at the base, as shown. Place corks or plugs in the lower holes. Fill with water then remove plugs.

Q: What does this model show?

E: Diarrhoea causes loss of body water. This must be replaced or the person will die. Babies with diarrhoea, can die very quickly if not given enough water to drink. See previous activity 7.1.15.

I: Diarrhoea is usually caused by microorganisms which are spread by dirty water or food, or poor hygiene.

Appendix



Basic Equipment

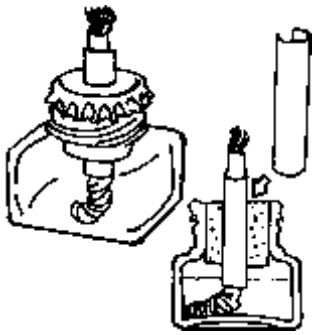
The majority of activities described in this sourcebook can be carried out using readily available, everyday materials. Within these activities there are many "hand experiments" because the main equipment needed is a pair of hands! A few experiments require additional items and these are described below, along with some simple instructions for their use. If you require more specialised equipment refer to the chemistry sourcebook in this series where a complete minilab is described.

1. Burners

Many experiments in biology do not require heating. However there are important experiments which do need heating. Hence we have tested different types of low-cost burners.

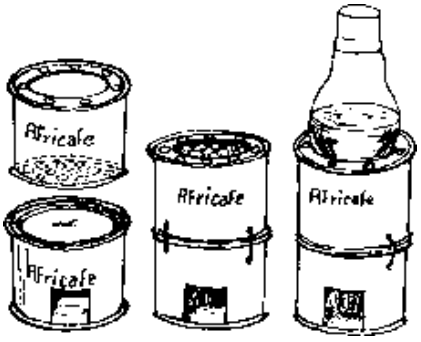
Always be careful when using burners, especially when liquid fuels are involved and. inflammable vapours are formed. Therefore avoid warming up fuel containers. Use only the suggested fuels never use petrol.

1.1 Alcohol Burner



Alcohol (spirit) burners are the best substitute for bunsen burners. Their flame is sootless. However spirit is not always available, it is expensive and sometimes diluted with water. Alcohol burners must have a small glass bottle as container for the liquid in order to avoid rusting. The wick holder consists of a metal tube (made by rolling a piece of tin into a cylinder), a perforated soda bottle top and a wooden stopper. Rubber stoppers are *not* suitable. *Kibatari from tins will do, but filled with alcohol they rust inside and are then dangerous (alcohol always contains water).*

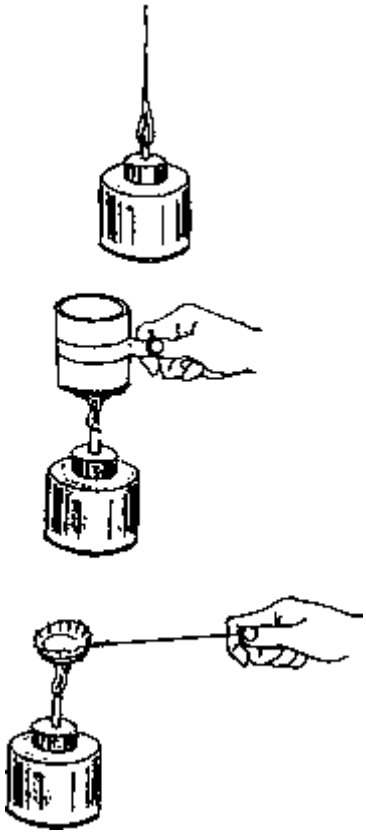
1.2 Charcoal Burner



Charcoal burners also produce sootless flames. But it is more difficult to keep the charcoal burning. However blowing slightly using a blow pipe or a straw will solve this problem.

Take two coffee tins. The lower one has a hole in it (a door) to give a good draught and for removal of the ash. The upper one has some holes (which should not be too small) at the bottom and in the upper rim for a good draught. Both tins are fixed together with wire. We achieved good results in tests with this burner.

1.3 Kerosene Burner



Kerosene burners (Vibatari) produce a lot of soot, but the fuel is cheap, easily available and the burners can be bought on the market. Such burners are suitable for the heating of tins and other containers when soot does not matter.

1.4 Blowpipe

You may need a higher temperature or a directed flame. An empty metal ballpoint pen refill with the tip cut off and connected to a short length of infusion tubing. Discarded injection needles will also serve the same purpose. *However injection needles must be sterilised in boiling water for at least 15 minutes.*

1.5 Heat Source Temperatures

The workshop team has measured the approximate temperatures achieved with different types of burners:

Temperature of different heat sources:

Type	Average temp	Highest temp
Candle	650°C	700°C
Kerosene burner	650°C	800°C
Alcohol burner	650°C	800°C
Matches	600°C	650C
Bunsen burner	1400°C	1500°C
Candle/Kibatari + blow pipe	800°C	
Alcohol burner with blow pipe	1000°C	

1.6 Sootless Kerosene Burner

The *sootless kerosene burner* solves all the problems mentioned above. During the workshop from which this book originates we designed and tested such a burner. It was later constructed by a craftsman in Morogoro. Since this burner seems to solve the heating problems of many schools in many countries, we have published the construction details in a German magazine for Appropriate Technology.

The addition of a simple and cheap device that can be made by the same 'fundi', we get an almost sootless flame from an ordinary kibatari. The principle is to improve the draught of the air stream to the kerosene.

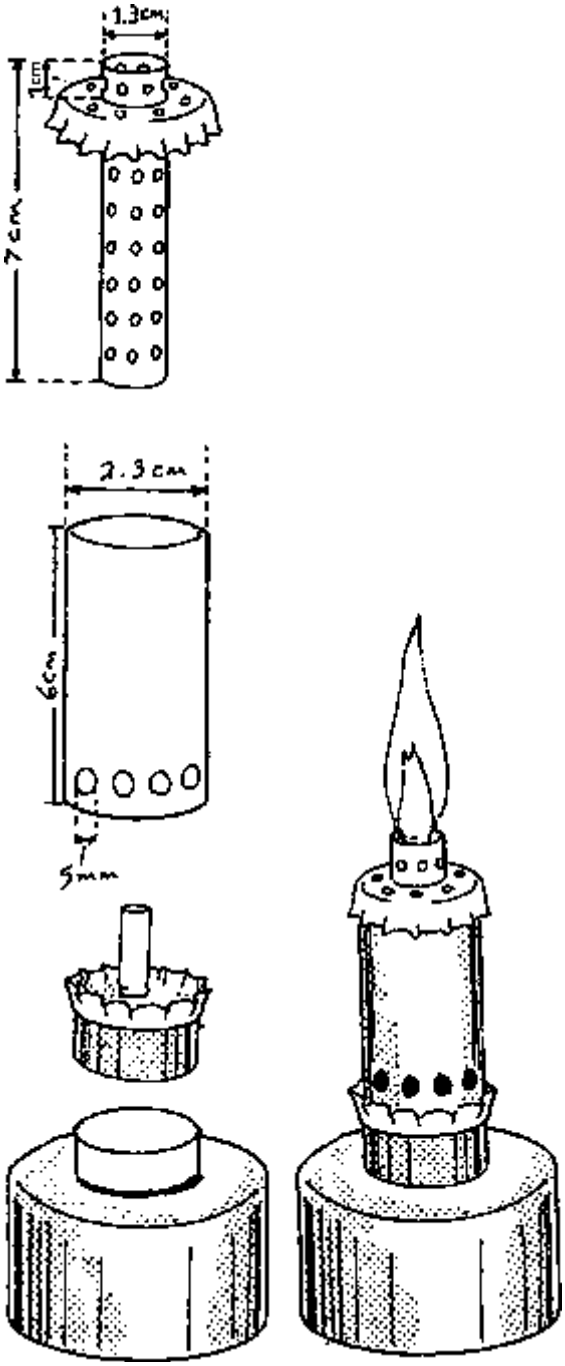
The basic device consists of 4 parts:

- *A perforated inner chimney* is made from a tin which is about 1.3 cm wide and 7 cm long. If the diameter of this tube is too small, the flame will not burn; if it is too wide the effect will be minimal. The holes can be made with a nail and should have a diameter of 2 mm. There should be 3-4 holes per square centimetre.

- *An outer chimney* which also serves as a wind shield. The holes at the lower edge are about 5 mm in diameter.

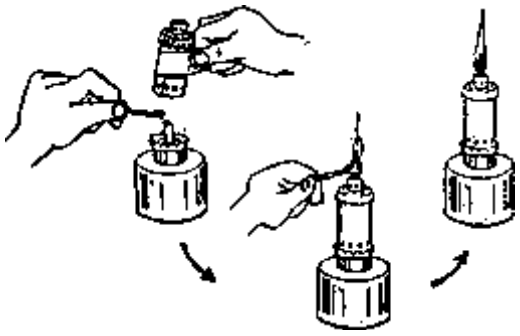
- Both chimneys fit together in a *perforated* soda bottle cap as shown.

- Ask the fundi to solder another soda bottle cap around the *wick holder (d).* This holds the chimneys better.

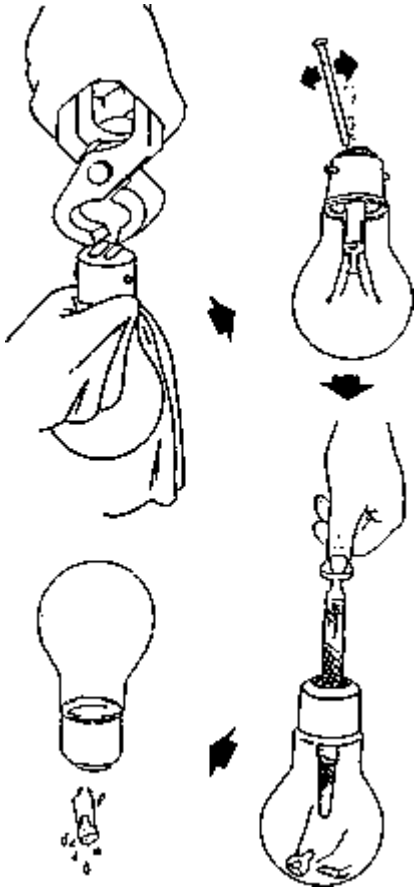


The flame is optimised by adjusting the length and shape of the wick: it should have contact

with the perforated tube. Some tests might be needed to obtain an optimal result. First ignite the wick and slowly place the chimneys in position. You might need to hold a burning match stick above the chimney to ignite the hot gases which produce the sootless flame.



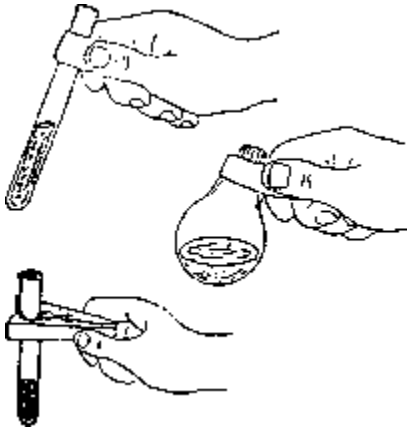
2. Test Tubes and Flasks



A cheap substitute for expensive test tubes and reaction flasks are opened worn out electric bulbs. They resist the temperature of an alcohol or kerosene burner, but *not* the temperature of a bunsen burner. Heat the bulbs carefully. *Do not use them for aggressive substances like concentrated acids and hydroxides.*

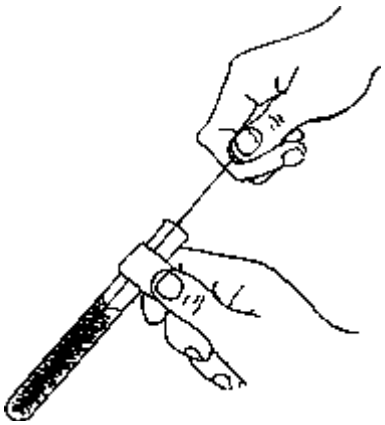
Bulbs can be opened with pliers and a round file or even with a long pointed nail. *Wrap your hand carefully with a piece of cloth.*

3. Glassware Holders



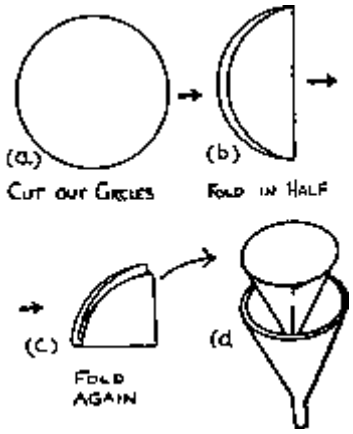
For hand experiments clamps are not essential. A folded paper strip will do as a test tube (or bulb) holder. Wooden clothes pegs are cheap substitutes for test tube clamps.

4. Test Tube Brush



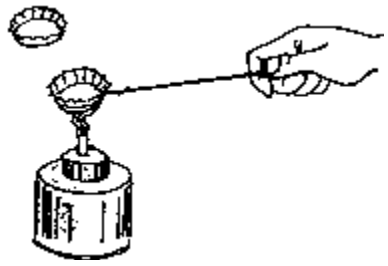
This brush can be made using a piece of cloth, sisal fibres, polythene material etc.. It can be fastened between two twisted wires. Sterilised old tooth brushes may be used. Test tube brushes are also available in shops.

5. Filter Paper



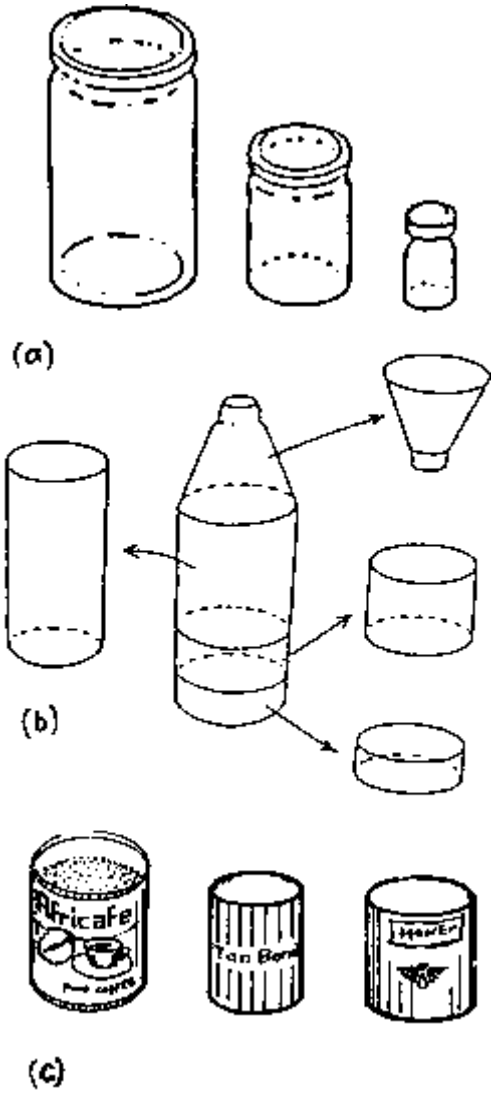
The best substitute for filter paper is unprinted cement bag paper (the inner cleaner layers from bags). Clean it before use. Sometimes the filtrate may have a light colour due to the colour of the paper.

6. Soda Bottle Tops



Before use remove the plastic material inside the soda bottle tops. They may be used for heating small amounts of undangerous substances. After use they may be thrown away.

7. Containers



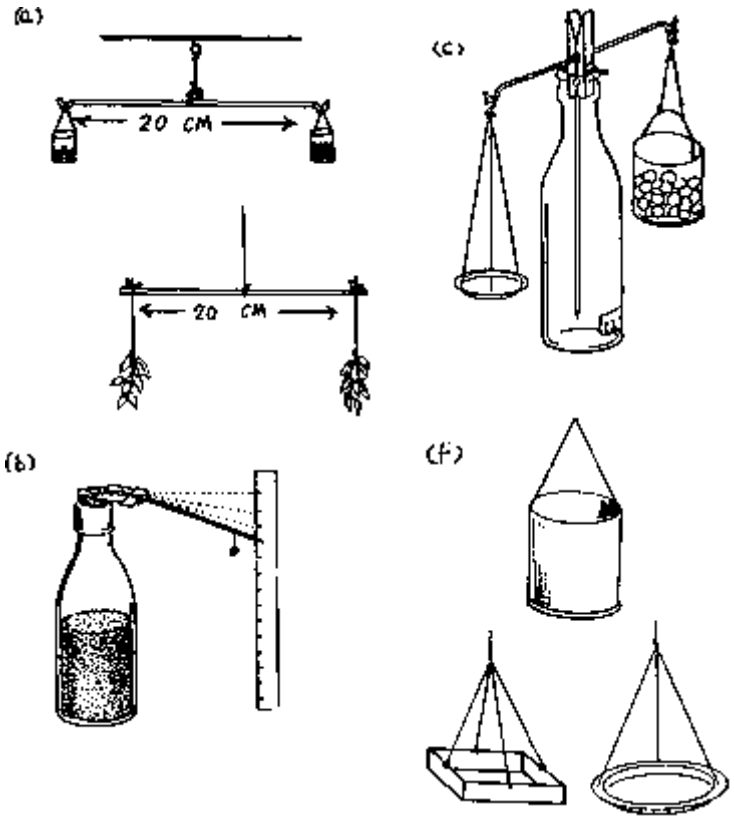
(a) For many experiments at room temperature (e.g. filtration etc.) glasses or plastic vessels may be used. Small medicine bottles (e.g. injection bottles) are useful for many experiments at room temperature and for the storage of liquids and solids.

(b) A plastic bottle serves many purposes depending on where it is cut. The upper part gives a *funnel.* From the lower part tall or small beakers may be obtained for experiments at room

temperature.

(c) Tin cans are only useful for heating water or aqueous solutions where glassware is not needed.

8. Simple Balances



(a) A *simple balance* to show differences in weight consists of a piece of thin wire or a thin wooden stick hanging from a thread. Hooks for hanging containers can be made from paperclips. Plastic bags can be used as hanging containers.

(b) A *razor blade* balance may be made from a razor blade and a light straw. It is a sensitive balance.

(c) To make a *sensitive balance,* drill a hole through a clothes peg below the spring, for a wire or nail to pass through. Fix a wire right in the spring as a balance beam, and another one in the mouth of the peg as a pointer. (The shorter and thinner the pointer, the more sensitive the balance.)

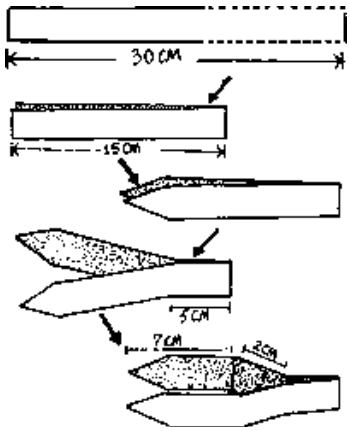
Fit the arrangement in a wide mouthed glass or a plastic bottle marked with a scale.

(d) Fill small plastic bags with sand or small stones and compare them with standard weights. Label and seal the bags with a small flame.

(e) Where there are no standard weights, use syringes or measuring cylinders to fill plastic bags with equal amounts of water. Use the fact that 1 cubic centimetre of water has a mass of 1 gram.

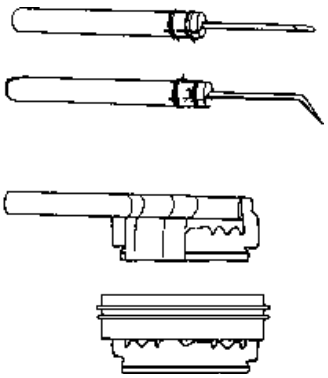
(f) Weighing pans can be made from matchboxes, plastic and tin lids or small plastic bags used for wrapping ground nuts.

9. Pair of Forceps



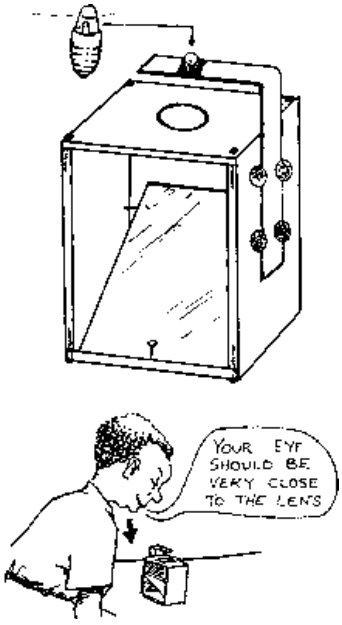
Forceps can be made from the steel bands used for packaging. A 30 cm piece of steel band is cut using a tin snipper and bent in the steps shown.

10. Some Other Instruments



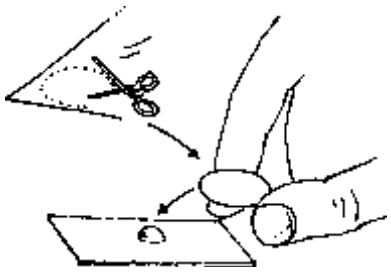
The above instruments are useful for dissection.

11. Simple Microscope



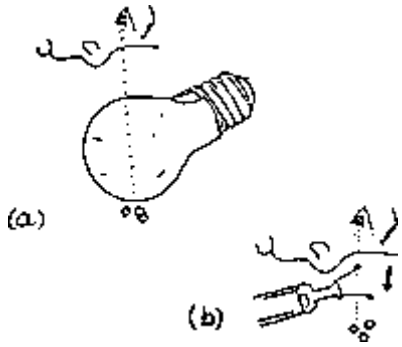
Construct a small wooden box from plywood as shown (or use a small cardboard carton such as a light bulb box). Make a round hole of 2 cm diameter, at the top. Fit a small mirror (glass or polished metal) in the box, angled to reflect light up through the hole. Make a small hole (about 6 mm) in a strip of metal or card. Remove the round lens from a pen-torch bulb and secure in the strip using adhesive tape. Carefully cut off the tape where it may cover the lens. Bend the strip, then fix it to the side of the box so that it can be moved up and down. Drawing pins or nails could be used for this. The object is focused by moving this strip. Note the eye should be placed as near as possible to the lens when viewing.

12. Slide and Cover Slips



A small piece of window glass or the glass from a torch provides a slide for mounting the specimen. The specimen will be seen better if it is covered with a coverslip. These can be made from thin (but stiff) transparent plastic from display packaging. Cut into small squares or circles.

14. Magnifiers from Used Light Bulbs

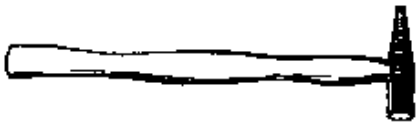


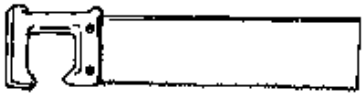
(a) A used transparent light bulb can be filled with water.

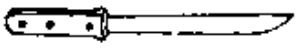
(b) The filament wire of a light bulb or thin wire twisted into a loop, can be used as a magnifier placing a water drop in the loop. (The smaller the loop better the magnification).

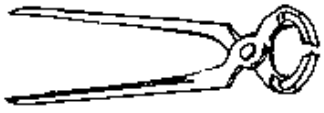
The diagrams above show some aspects of a mini-lab which can be assembled from locally available materials. The cost is so low that they will not overstress limited school budgets. More than 100 simple experiments can be carried out with it. For details see the chemistry source book in this series.

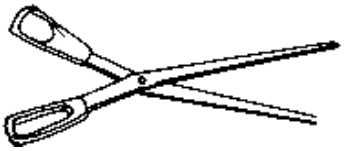
15. Basic Tool Kit











The ten items in the kit are

1. Hammer.
2. Puncher.
3. Hacksaw.
4. Combination pliers.
5. Long flat-nosed pliers.
6. Tin snips.
7. Hand drill or borer.
8. Sharp knife.
9. Pinchers for nail removal.
10. Scissors.

The Science Corner

P: Create a science corner in the classroom.

(a) Push a table into a corner of the classroom.

(b) Put up a few nails or strips of wood above the table from which to hang posters and specimens.

(c) Arrange displays in many different ways. Exhibitions of helpful plants, local wildlife,

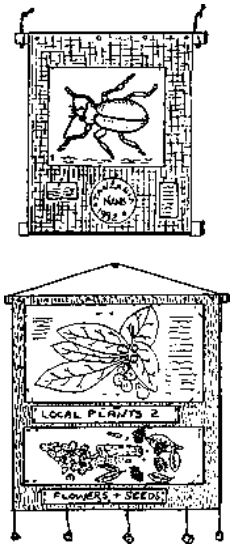
species collections etc..

(d) The corner could be the focus for science club activities.

I: More ideas on display and storage can be found on the following pages.

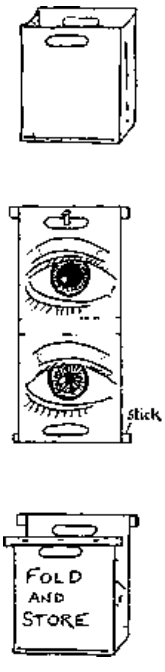
Display and Storage Ideas

1. Display Charts



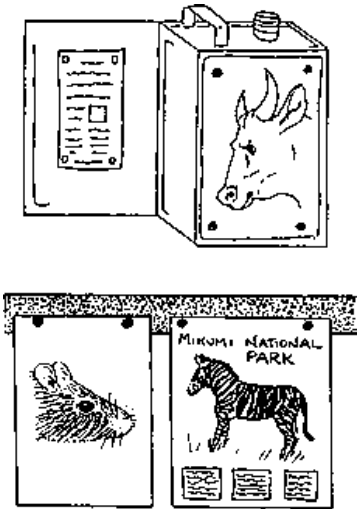
P: Make display charts from durable cement bags, cloth, cardboard boxes, sleeping mats or blankets. To help the chart hang flat and give stength and durability, attach sticks or strips of wood to the top and bottom of the chart. Attach pictures and posters with office pins, cactus needles, sharpened matchsticks or palm frond vanes (broom). Instead of a bottom stick, bottle tops can be used as weights

2. Plastic Bag Display



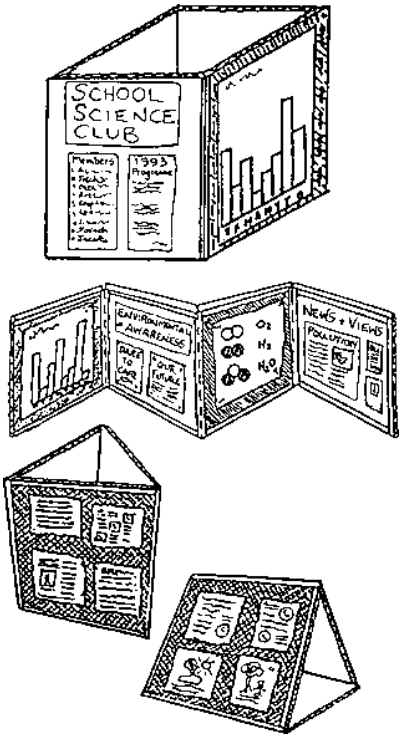
P: Open out a plastic carrier bag and tidy the edges. Add strengthening sticks at the top and bottom. Removable adhesive tape tabs can be used to attach display materials. Starch glued papers can be washed off this type of display chart. Permanent marker pens can produce a durable presentation (most come off with spirit).

3. Magnet Boards and Strips



P: Use the thin sheet metal from a can or a disused car panel, steel shelf, filing cabinet, fridge door or even a sheet of corrugated iron (possibly flattened). You may paint the surface matt black to act as a blackboard. Magnetise small pieces of metal to attach pictures to the sheet. Magnets can be painted white making them less visible on white paper. Pictures that are used regularly can have small magnets permanently attached to their corners. A strip of metal from packing case strapping can be nailed above the blackboard (or display area). Magnets can then be used to hold large posters.

4. Free Standing Display Boards



P: The display boards shown were all made from cardboard boxes.

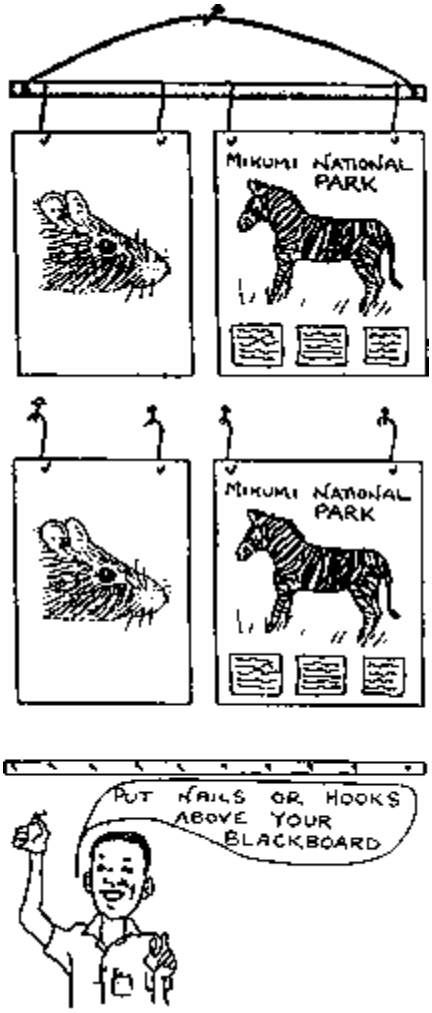
a) The sides of a large upturned box can hold the information and pictures. Specimens can be placed on the box.

b) Cut down one side of the box and open out as shown. Cut off any flaps which don't help support.

c) Cover display boards with paper, cloth or paint for a more permanent appearance.

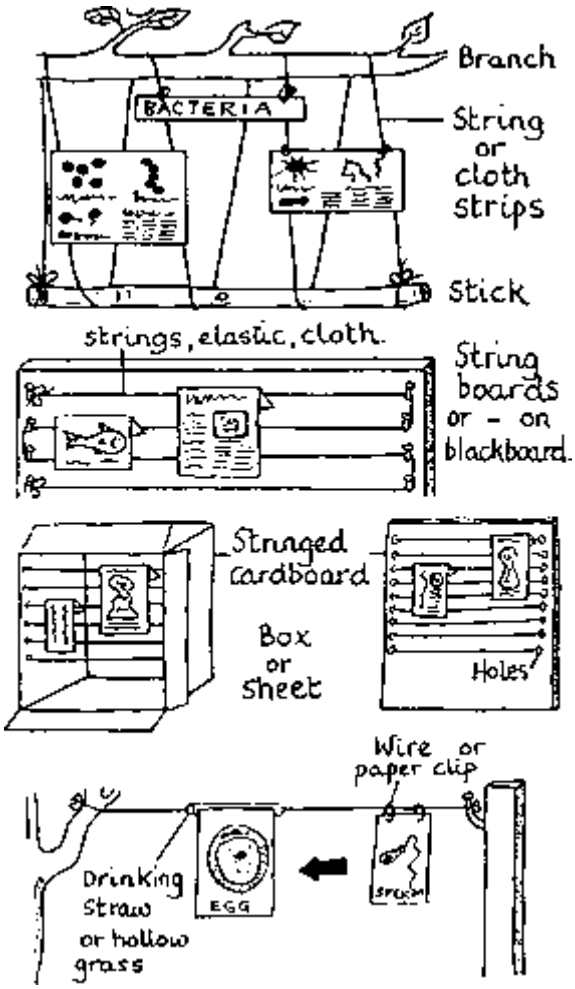
d) Wall pinboards for the science coner can be made from box cardboard.

5. Display Beams and Nails



P: If a teacher regularly has more than one chart to display, a display beam or a series of nails above the blackboard will be useful. Wire hooks from the nails or the beam may help pictures hang flat.

6. Display Lines



P: All the above examples use string, rope, wire, elastic bands or cloth strips.

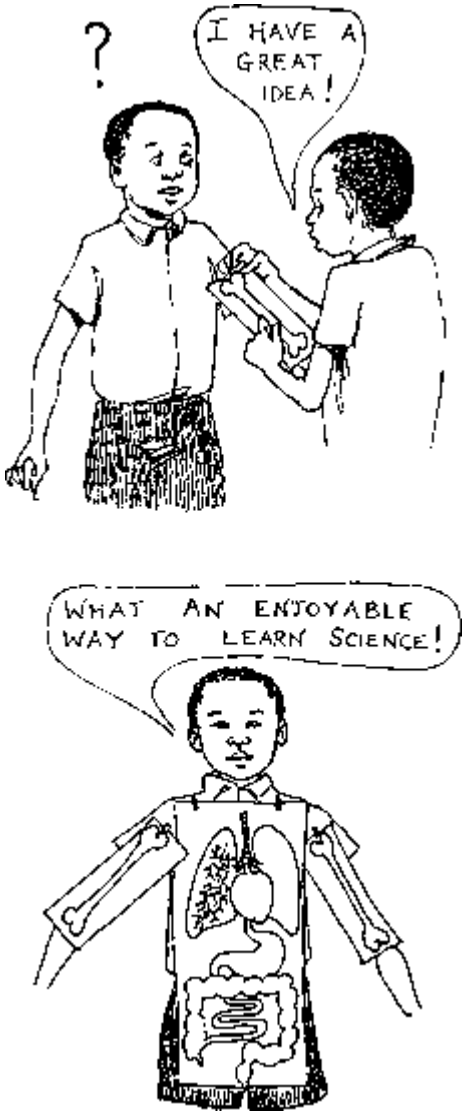
a) The large branch acts as a weight to hold the sting tightly in placed. Hang, peg or pin display items to the lines.

b) Nails or hooks can be placed at the sides of even the widest blackboards. *Find the safest place on your board for nails.*

c) A stringed cardboard sheet or a stringed box are also very portable. After use store your display items in the box!

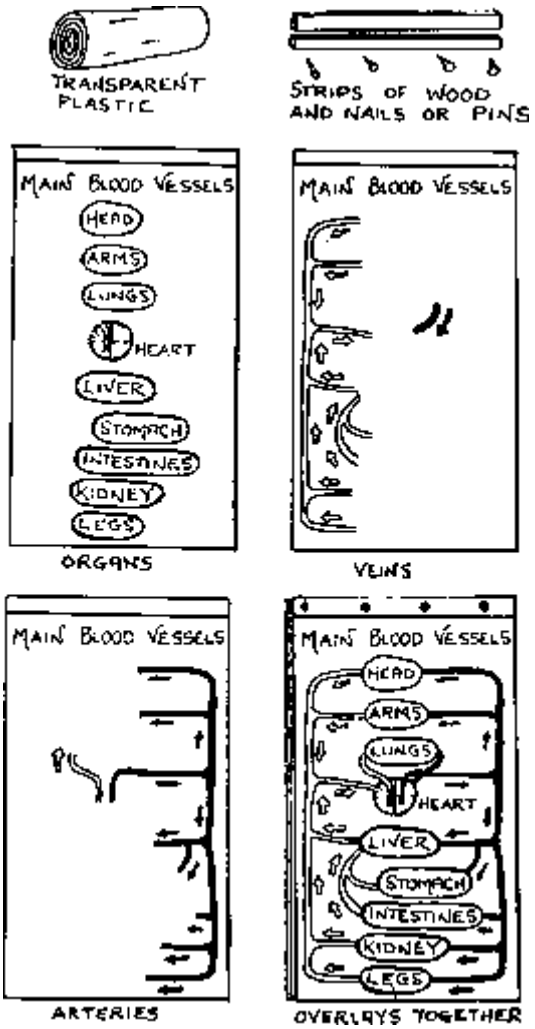
d) Movable mounts for display lines made from wires, paper clips, straws, ballpoint pen outer casings, hollow grasses, toilet roll inner tubes. Or make your own movable mounts from card or paper. Attach your pictures to the mounts with cellotape, paste etc..

7. Pin on Body Posters



P: Draw diagrams of the internal body organs or bones onto paper or cloth. Pin or clothes peg these to clothing.

8. Transparent Overlays



P: (a) Draw the base drawing on paper or board.

b) Place a sheet of transparent plastic over the base drawing. Write the labels to the drawing with permanent marker or biro.

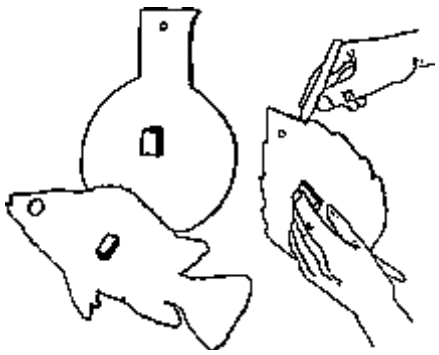
c) Firmly attach the plastic sheet to the base drawing by pinning, pegging or clipping. A bar of wood at the top gives the overlay strength and stability.

d) Why not experiment with small transparent bags. Make an A4 or school writing book sized overlay chart. Try overlay displays of arteries and veins, nitrogen water and carbon cycles, maps.

9. Reversible Body Board

P: Cut a large template shape of the human body from cardboard, hardboard or plywood. Paint one side black, so that you can chalk on it. Varnish or paint the other side so that removable paper body organs and labels can be stuck on. The human body board can also be used as a template to draw accurate, identical human shapes side by side on the back board.

10. Blackboard and Book Templates



P: Cut templates from hardboard, plywood, cardboard or thick plastic. Collect basic and elaborate shapes for quick, uniform and accurate reproduction. Put a hole in the templates if they are to be hung up. You may wish to add a small piece of wood as a handle.

I: Make templates of body organs, types of leaf, animals or scientific equipment.

11. Blackboard and Book Stencils

P: For large and small stencils. First draw the outline of your shape accurately to the correct size. Choose an appropriate material such as paper, box cardboard, hardboard, plywood or plastic. Put small guideline holes along the lines of your drawing. Hold or pin the stencil against the book, blackboard or wall. Dust over the holes with chalk for wall drawings. Remove the stencil and simply join the dots to reproduce human body shapes, maps, charts and other diagrams on a large scale.

12. Size and Storage

P: (a) If posters and charts are not stored safely they are often spoilt. Time and effort are wasted.

b) A school pupil's note book may be the answer. Easily available and teachers often have their lesson notes in similar sized books.

c) Remove the staples from a new note book and open out the double pages (often A4 in size).

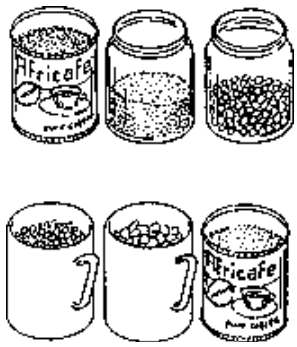
d) Pupils can help design and illustrate school posters and charts.

e) Two, three or four double paged sheets can be joined together to make larger sized posters of different shapes.

f) To store fold along the original fold lines return inside the book cover and store flat under other similar sized books.

g) Build up an ever increasing library of different sized posters, which are all stored between note book covers of the same size.

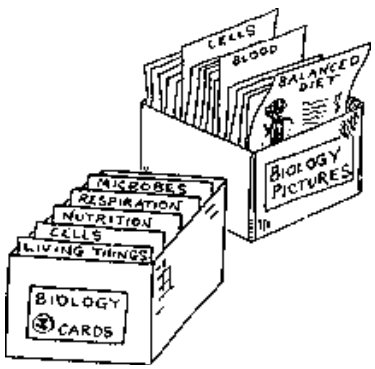
13. Cups, Tins and Bottles



P: Cups, tins and bottles can also be used for display and storage purposes.

14. The Best Ideas

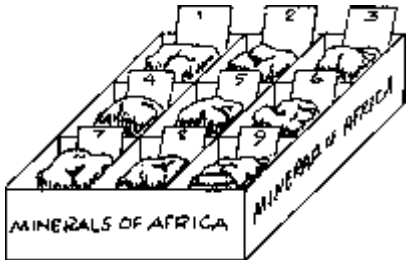
15. Picture and Card Boxes



P: Pictures and cards can be stored in suitably sized boxes. Order them alphabetically or

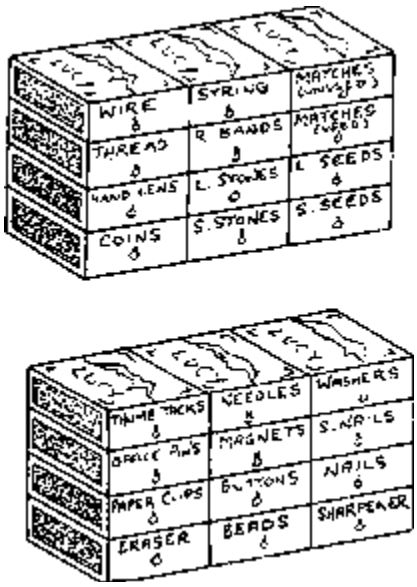
according to the syllabus. Compartments and dividers can be made from cardboard.

16. Storage Boxes



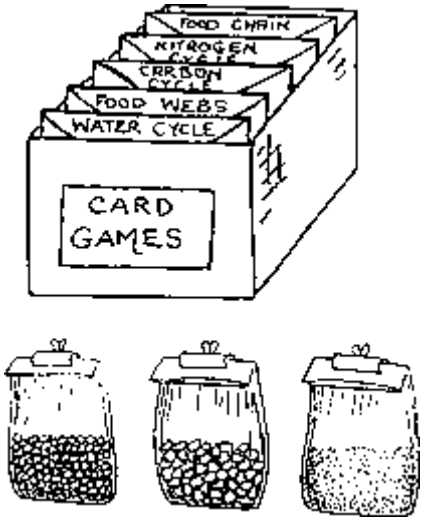
P: Samples can be sorted and stored in packaging boxes divided into several compartments as shown.

17. Matchbox Drawers



P: The matchbox drawers can be made by sticking matchboxes together as shown. Small pieces of string or wire can be used for draw handles.

18. Envelopes and Bags



P: Envelopes and bags of all sizes can be used. Clearly label all containers.

Developing New Ideas

Try to develop the pupil's creativity by setting them simple tasks such as those shown above.

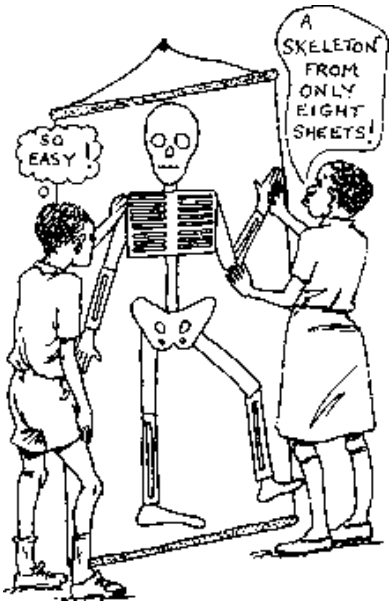
Begin by discussing a task with the whole class. Later pupils can work individually or in groups.

(a) This task starts with a bottle. The pupil or group can look through books and find a suitable use for it.

(b) This task involves solving the problem of showing how long a tape worm can be. The pupil is given additional help by being told to use a newspaper.

Paper Skeleton

What to Do

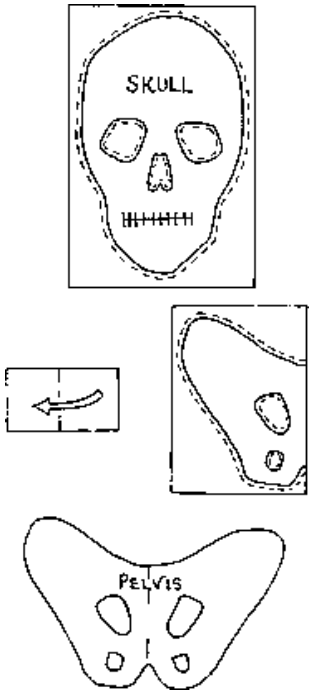


P: A simple paper skeleton can be cut from eight sheets of A4 sized paper (not foolscap!) or eight double pages of a student note book.

Draw fold and cut out as directed. As you gain experience you may be able to cut out the skeleton without drawing any guidelines!

- The bones of the feet and hands may be drawn on the paper shapes.
- The paper limb bones can be shaped to add greater realism.
- Pin or staple the pieces together or mount on a hanging display.

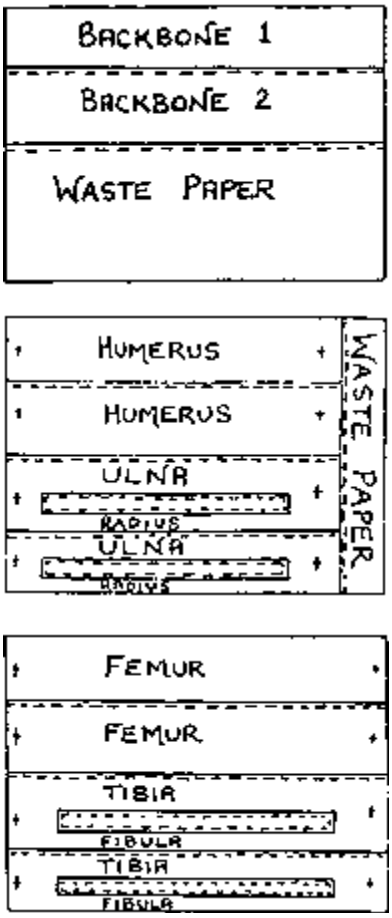
Skull and Pelvis
(Sheets one and two)



P: (a) Skull: After drawing, cut out along the lines. Or fold the sheet and cut out half the skull as shown. The mouth and teeth should be cut without removing any paper.

(b) Pelvis: Fold the sheet in half. Draw half the pelvis and cut out the basic shape when folded. The Pelvis looks like a butterfly.

Backbone and Limbs
(Sheets three, four and five)



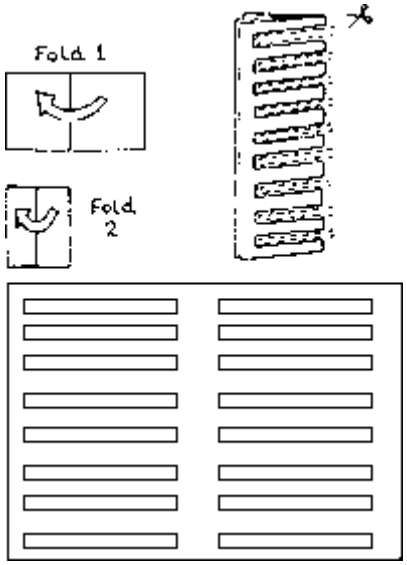
P: Place 3 sheets of paper together. Cut sheets length-ways into quarters as shown.

(a) Backbone: Two strips form the backbone.

(b) Upper limbs: Arms are shorter than legs, so, remove a piece of paper from the end of each upper limb strip.

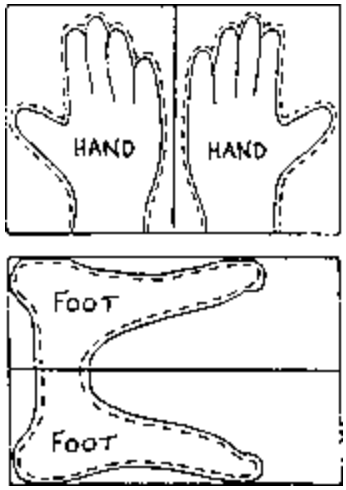
(c) Lower limbs: The space between tibia and fibula and ulna and radius can be removed easily by folding and cutting as shown.

Rib Cage
(Sheet six)



P: For an accurate number of ribs use a ruler to divide the sheet. If accuracy is not essential fold the paper twice and cut along dotted line (or cut along alternate page lines if your sheets are lined).

Hands and Feet
(Sheets seven and eight)



P: (a) Hands: Fold the sheet in half and draw round a hand. Then cut out. (b) Feet: Fold the sheet in half and draw the shape of a foot then cut out.

Aids

Prepared especially for this Sourcebook by Mr. M. Sawaya of the Inspectorate, Ministry of Education and Culture, Dar es Salaam.

Introduction

The purpose of this material is to provide a guide or basis for the school AIDS education program**.** On the grounds that the future of our nation and progress is based on the on going generation - the student. Hence the aim is to promote behaviour which will reduce transmission of HIV among young people.

The main mode of HIV transmission is through unprotected sexual intercourse. Open talk on sex is difficult in our society, thus making discussions on AIDS education a sensitive issue which has to touch on personal, religious cultural and moral perspectives. Initial and continuous communiction on all aspects of the education is expected and requires time, cooperation and participation of many people from the school, the home and the community.

Teacher who are going to do much of the education have to change their attitudes towards students. They have to treat students as individuals and with respect. They have to make students become comfortable and confident to talk about sexuality and related issues freely with them. It is advised that interpersonal relationship between teacher and student is fostered as it is the basis for preventive education and counselling.

The AIDS education provided in this material considers it as part of intergrated health education program ADDS or HIV infection is not treated as a set of isolated disease, but understanding it as disease that needs action to prevent or limit its development through learning and practising positive health behaviour, skills and attitudes. Likewise importance, is linked to Family life Education were self-esteem, respect for self and others, decision making nurturing relationships. That will help students to understand the immediate and long term benefits of abstaining from sexual activity.

AIDS - Current Information

This brief overview provides teachers with a general understanding of AIDS. It should be supplemented as needed with other texts on the subject. Knowledge about the disease and its effects on individuals is constantly being updated.

Teachers should periodically review and update this information to assure that is accurate.

Description and Cause of AIDS

- Acquited Immune Deficiency Syndrome (AIDS) is a disease caused by a virus that attacks the body's immune system, making infected people vulnerable to opportunistic infections, cancer, and neurological disorders.

- The AIDS virus (called Human Immunodeficiency Virus-HIV) primarily attacks certain white blood cells (called T-Lymphocytes or T-4 helper cells) that are part of the body's internal defense against disease. The virus may also attack the central nervous system.

- An infected person's immune system responds by developing antibodies to fight off the invading virus. It is these antibodies to HIV, and not the virus itself, that can be identified by a blood test before a person has any signs of illness. However, the body's ability to produce disease-fighting antibodies eventually becomes limited in HIV-infected persons as the virus reproduces and multiplies, killing the critical T-4 cells it has infected.

Clinical Manifestations

• HIV infection may lead to deasese which can take many forms. It ranges from the complete absence of symptoms to mild illness, to debilitating neurological disorders, and to fatal disease.

• The condition called AIDS represents a syndrome of late-stage diseases in which the immune system is unable to fight off other viruses, bacteria, protozoa, and fungi, resulting in infections and diseases that eventually cause the death o

• The condition called AIDS Related Complex (ARC) refers to individuals who have a suppressed immune system and symptoms of AIDS but no specific opportunistic infections. For an unknown percentage of individuals, ARC is a precursor to AIDS.

• The onset of symptoms associated with either ARC or AIDS may take from six months to five or more years to appear after the virus has entered the body. At this time most individuals exposed to HIV do not develop either ARC or AIDS, although they are carriers of the virus and are capable of infecting others.

• Symptoms related to ARC include:

- loss of appetite
- weight loss
- fever
- night sweats
- skin, rashes
- diarrhoea
- tiredness
- lack of resistance to infection
- swollen lymph glands.

The symptoms are likely to be milder than those found in person with AIDS and generally are present in a cylic fashion with illness followed by periods of wellness.

• The symptoms that individuals with AIDS develop are related to the opportunistic diseases that have taken advantage of the compromised immune response due to HIV infection. These symptoms are usually persistent and difficult to treat, and they progressively debilitate the person to the point of death. They may include:

- extreme tiredness, sometimes combined with headaches, dizziness, or lightheadedness

- continued fever or night sweats

- weight loss of more than 10 pounds that is not due to dieting or increased physical activity

- swollen glands in the neck, armpits, or groin

- purple or discoloured growths on the skin or the mucous membranes (inside the mouth, anus, or nasal passages)

- heavy, continual dry cough that is not from smoking or that has lasted too long to be a cold or flu

- continuing bouts of diarrhoea

- thrush (a thick whitish coating on the tongue or in the throat), which may be accompanied by sore throat

- unexplained bleeding from any body opening or from growths on the skin or mucous membranes

- bruising more easily than usual

- progressive shortness of breath

- confusion, lethargy, forgetfulness, lack of coordination, general mental deterioration.

• Specific diseases that generally don't affect healthy adults are linled with HIV infection.

• The incubation period before any symptoms of HIV disease appear varies significantly from person to person. Many infected people develop symptoms within two years of exposure. Others, infected up to seven years ago, have not yet shown any signs of illness. Since AIDS is a new disease, only recognized in 1981, the maximum incubation period has not yet been identified. Extensive research is in progress to identify potential internal or external cofactors that may cause some infected people to become fatally ill, while others have milder symptoms or remain symptom-free.

Transmission

Unlike flu or measles, HIV is not transmitted through the air; it must get into the bloodstream to cause infection. For this reason, HIV-infected people do not pose a risk to others through any form of casual contact. There is no evidence that AIDS is transmitted through coughing, sneezing, food preparation, drinking fountains, toilet seats, being around an infected person on daily basis, or donating blood.

HIV is carried in blood, semen, vaginal secretions, and other body fluids including tears and saliva of an infected person. It is transmitted from one person to another by three routes: 1) through sexual intercourse (physical sexual contact between individuals that involves the genitalia of at least one peson-includes vaginal intercourse, oral intercourse, and anal intercourse), 2) through parenteral exposure to infected blood, and 3) from infected women to their infants during the perinatal period.

Sexual transmission of the AIDS virus occurs during intercourse. It is thought that it happens through abrasions or tiny, unfelt tears that may occur in delicate tissues. Such tissue breaks can allow infected semen, blood, or vaginal fluid to enter the bloodstream of a sex partner. Anal intercourse is most risky, since tissue tearing and bleeding are likely to occur.

Transmission through parenteral exposure to infected blood occurs in persons sharing contaminated needles, syringes, and works during intravenous (IV) drug use. Small, even invisible, particles of infected blood can remain in the drug paraphernalia and can be injected into the bloodstream of the next user.

The risk of AIDS transmission through blood transfusions has been almost eliminated since all blood banks began testing donated blood for antibodies to HIV in 1985. There may be some risk to receiving blood if it was too early for the virus to show up when donor blood was tested. Blood-donor testing has been so effective it has reduced the risk of AIDS from blood transfusion to one in a million. There is no risk of AIDS from donating blood; blood collection centers use new transfusion equipment for each donor.

All infected people, whether or not they have any symptoms, are presumed capable of transmitting the virus to others through blood-to-blood or semen-to-blood exchange, or through vaginal secretions-to-blood exchange.

An individual can be infected with the virus that causes AIDS without having symptoms of AIDS or appearing ill. Infected individuals without symptoms can transmit the infection to others. Once infected, a person is presumed infected for life, but actual symptoms may not develop for many years. A single exposure to the AIDS virus may result in infection.

How the virus is NOT known to be spread

• There is no evidence that the virus is spread through casual social contact (shaking hands, social kissing, coughing, sneezing; sharing swimming pools, bed linens, eating utensils, office equipment; being next to or served by an infected person in ordinary social contact). There is no reason to avoid an infected person in ordinary social contact.

• It is not spread by the process of giving blood; new transfusion equipment is used for each donor.

• HIV is not transmitted by insects.

• It is not spread by sexual intercourse between individuals who have maintained a sexual relationship exclusively with each other, assuming that they have not been infected through contaminated blood, blood factors, IV drug use, or a previous sexual partner.

Major Risk Factors

Persons at increased risk for being infected with the AIDS virus include:

• homosexual and bisexual men

• sex partners of IV drug abusers

• male or female prostitutes and their sex partners

• sex partners of infected persons

• all persons with haemophilia who received blood-clotting factor and transfusions prior to 1985

• Children born to infected mothers.

Prevention

There is no vaccine against AIDS or any treatment so far that can reverse AIDS damage to the immune system. People must learn how to protect themselves and their loved ones from this infection. It is essential that students gain knowledge and skills to protect themselves before they reach an age at which they might experiment with sex or illegal drugs. Following are some basic elements of AIDS information related to prevention.

How to prevent infection

• Infection through sexual contact can be avoided by practicing abstinence or having a mutually monogamous marriage/relatioship with no known risk factors in either partner. Young people can stay safe from AIDS by not having sex. They need to know it is all right to say NO. In addition to the risk of AIDS, there are other health reasons to postpone sex, including the risk of gonorrhea, syphilis, and herpes, and unplanned pregnancies.

• Do not use IV drugs; do not share needle or works. Young people can stay safe from AIDS by not using IV drugs. They need to know it is all right to say NO not only to IV drugs but to alcohol and drugs of any kind, as these impair judgment. In addition to the risk of AIDS, there are many other health reasons for abstaining from illegal drug use.

• If already sexually active:

- Until you ask a lot of questions about his or her past sexual experience and drug use, don't have sex with anyone.

- The more people you have sex with, the greater the chance you may get infected, so don't have sex with multiple partners.

- With infected persons, using a condom during sex may help keep the virus from getting into your body. A condom is a thin rubber covering that is slipped over the penis before any sexual contact. (See condom)

- The chance of blood or semen entering your bloodstream is very high during anal sex, since it can cause tearing of delicate tissues, so avoid anal sex.

- Drugs and alcohol can lead you to do things you wouldn't do drug-free, so don't drink alcohol or use drugs of any kind.

If there is suspicion of infection

• Abstain from sexual intercourse.

• Seek counseling and AIDS virus antibody testing to be sure of infection status. Be aware that weeks to months may elapse from the time of infection to the time that antibodies to the AIDS virus appear in the blood. During this time persons may be infectious but the test may be negative.

• Obtain counseling and testing if pregnance is being considered.

Information which will emphasize the seriousness of the problem, yet reduce inappropriate fear

• AIDS is a national emergency requiring attention from all citizens.

• If people change their behaviours, the spread of the AIDS virus can be reduced.

• Blood for transfusion in Tanzania is screened for antibodies to the HIV and is now essentially safe, but some risks cannot be eliminated.

• Everyone who engages in high-risk behaviour is at risk for AIDS, regardless of age, race, or socioeconomic status.

Research and Treatment

Researchers in the Tanzania and other countries are working diligently to develop a vaccine to protect people from HIV. Vaccine development is made more difficult because the virus can alter its form in the human body. These is no cure for AIDS at this time, nor is there any treatment that can restore the function of the immune system. A number of antiviral drugs including AZT (Azidothymidine) are being tested on parients. While AZT has shown some promise in curbing the ability of the virus to reproduce itself inside human cells, the drug is highly toxic and has serious side effects. Some drugs used in cancer control, such as Interferon, are also being tried with AIDS patients.

Societal Issues

When a disease epidemic threatens society, the needs of all people must be considered: those already infected with the disease, those threatened by the disease, and those who will provide support for others.

In the past, once treatment or medical prevention for an epidemic infection was easily available, society sought to protect itself by providing information to as many people as possible through school-based courses and educational campaigns and, in some cases, by requiring mass strategies such as immunization (polio) or premarital blood tests (syphilis). As the number of AIDS cases mounts, this epidemic will have a significant and long-term impact on interpersonal and family relationships, medical care delivery, public policies, and health

care resources. Because there is no available treatment, tremendous fears exist. Education must be used to curb those fears that can lead to discriminatory behaviour against people with AIDS. The rights of people with AIDS must be weighed and protected within the framework of disease prevention and with relation to the rights of those not infected.

Condom

A condom is a thin sheath that is placed over the erect penis to retain semen upon ejaculation. A condom is a safe and effective device in the prevention of pregnancy and somewhat effective in the prevention of sexually transmitted diseases, such as gonorrhoea, syphilis, and HIV. When properly used, a condom is theoretically 90 percent effective. However, it should be clear that, the use of condom is not an ABSOLUTE DEFENCE AGAINST HIV INFECTION. YET, YOU WILL BE RESPONSIBLE TO USE SKILL STUDIED TO PREVENT YOURSELF FROM HIV INFECTION.

NOT HAVING SEX IS ONE SURE WAY TO AVOID HIV INFECTION.

How to use the condom

Buy condoms that are stored out of the sun and not yet expired. MAKE SURE that the packet with the condom is intact. Do not use brittle, damaged condoms. Keep condoms in a cool place, away from the body's heat.

1. Wait for the penis to be fully erect before putting on the condom.

2. Take the condom out of the packet carefully so that it does not get torn by finger nails.

3. Pinch the end of the condom with the thumb and finger of one hand (do not let nails tear it!) The purpose is to remove air from the tip. Place the condom on tip of the penis

4. With the other handroll the condom all the way down to the base of the penis.

5. Now its' ready. Only use water-based lubricants. Lubricants containing oil such as grease, vaseline will damage condoms.

6. After ejaculating, take the penis out of the vagina before it goes soft, carefully holding the condom onto the penis so that no sperms spills. Direct the penis downwards and remove the condom gradually.

7. Dispose the condom in the latrine or in a way that children cannot play with it. Do not use condoms more than once.

Topic 1 Good Health

Objective

To enable students to:

- Understand the meaning of good health
- Understand the foundations of good management of life.

Teaching Media

Chart 1 A and 1 B behaviour -Relationship - Decision making

Teaching Approach

1. Show the students charts 1 A and 1 B

2. Ask the students the following questions

a. What do we see?
b. What are the reasons?
c. Does it happen here?
d. What should be done?

Let the students discuss and argue, let them give views and suggestions and encourage self-help solutions. Remember to control and direct the discussion in order to conclude that behaviour relationship and Decision making are foundations in managing good life.

During the discussion remember to point out that:

Health is a quality of life that includes one's physical, mental and social well being.

i) Good physical health in the condition of your body when it is not disrupted by any disease or pain.

ii) Mental health is the condition of one's mind and emotions.

iii) Social health is the way one-relates to other people.

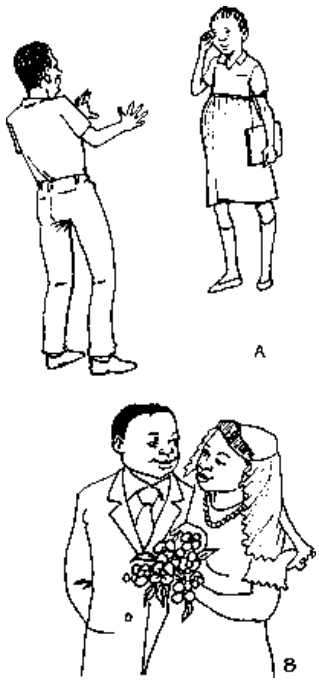
iv) One's health involves a continual state of adjustment of the physical, mental and social well being to one's environment**.**

v) Any change in physical mental and social adjustment results in changes in one's quality of health.

vi) Normally success in life depends on good health which facilitates good life management leading to high quality of life.

vii) There are three important factors which influence the quality of one's life. These are (1) one's behaviour (2) one's relationship and (3) one's decision

viii) One's choice of behaviour and relationship affects one's total life. It is, therefore advisable that to ensure a high quality life are should avoid risk behaviour and risk situations and instead choose good behaviour and good relationship.



Topic 2 Diseases & Disorder

Objective:

To enable students to

- Understand the meaning of disease
- distinguish between communicable and noncommunicable disease
- Understand how communicable diseases are transmitted
- Describe diseases which can and cannot be treated
- Practice good health habits.

Teaching Approach

1. Ask students to brainstorm a list of diseases and disorders which they are familiar and list them on the blackboard.

2. From the list ask them the following questions.

a) Why do they think that it is a disease or disorder?

b) How does the disease spread from one person to another?

c) What causes the disease to spread?

d) What are the ways in which diseases are spread?

e) Are all diseases listed treatable?

f) How can you prevent spread of diseases?

g) What would you like to do in order to have a good life/health?

h) What would you like to see your friends do in order to have good health?

Topic 3 Chain of Infection

Objective

Students should be able to

- recognise how a disease is spread and how the spread of disease can be stopped by breaking the chain of infection

Teaching Approach

1. Show students chart entitled *chain of infection*

2. Ask students to explain the meaning of the words in the chain. Assist students of they are unable.

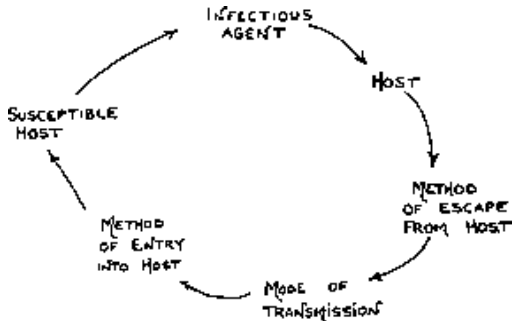
3. Explain what the chain of infection means (A continuous flow of a disease through different stages which can go on for along time unless it is broken at one place to stop the spread).

4. Ask students to think of a disease and ask them to identify factors involved in each stage of the chain.

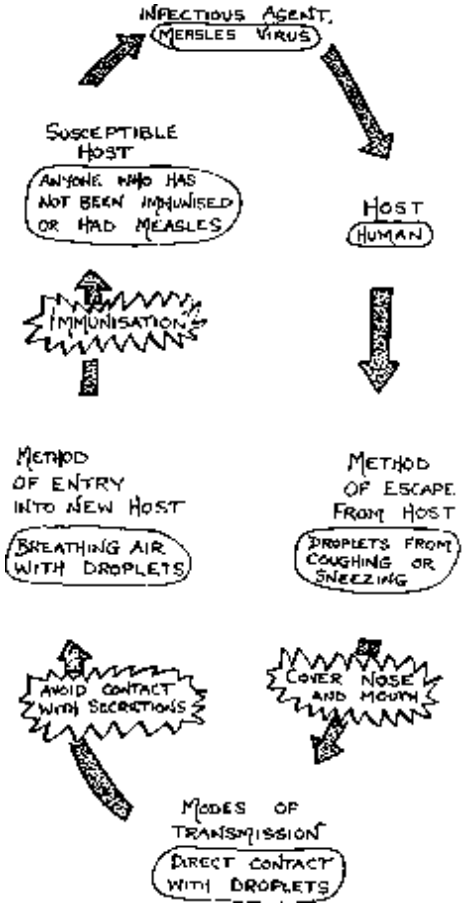
5. Ask them to think at what point of the chain they can break so they can stop spread of the disease.

6. Conclude the lesson by emphasizing that by knowing the chain of infection we can stop spread of diseases. Also good health habits can break the chain **of** infection.

Chain of Infection



Breaking the Chain of infection for Measles



Topic 4 Sexually Transmitted Diseases

Objectives

To enable students

- explain the meaning of STDS
- describe different types of STDS
- explain how STDS can spread and be prevented
- discuss effects of STDS.

Teaching Media

Chart Sexually Transmitted Diseases

Teaching Approach

A1. Ask students to brainstorm the meaning, types mode of transmission and prevention of STDS.

B1 (a) Read out or distribute the Dear Biology Teacher letter to Students.

Dear Biology Teacher,
What is the HIV or (VVU) AIDS or (UKIMWI). What does it mean when someone has the HIV all news stories, and talk in town are confusing

(b) Ask students to brain storm. The definitions of HIV, AIDS VVU (Virusi vya UKIMWI) and UKIMWI. Guide students to connect definitions and correct misinformation and misconception.

(c) (i) Draw the chart of spectrum of HIV infection on the board or floor. (ii) Write the content of the table on pieces of cards or paper and instruct students to place in the correct position in the columns of the table. Ask students to explain the placements in position.

Chart Sexually Transmitted Diseases

Types	Symptoms	Effects
Gonorrhea	Man. Have a thick, greyish yellow plus like discharge from the penis. A burning sensation during urination symptoms appear 2-10 days after infection	• Sterility
	Women: Usually show no signs may have pus-like vaginal discharge, vaginal soreness painful urination and abdominal pain. Appears 2-10 days after infection	• Pelvic Inflammatory inflamatory disease (PID) may follow gonorrhoea if undetected for months
Syphillis	Painless sore on or in the genitals, anus mouth or throat appears 10 days to 3 weeks after infection. If left untreated sore goes away by itself skin rash appears on palms of hands and soles of feet at about 6 weeks	• Untreated syphillis causes loss of hair in patches. Can cause heart failure blindness and damage to brain and spinal cord and finally death. • Women may give birth to babies with syphillis.
Genital Herpes	Painful blister-like lesion on and around penis vagina and anus spread by virus	• Recurring outbreak of painful blisters.
Venereal Warts	Small painless outgrowth of skin in little clusters. In dry areas such as the penis, warts are small and hard. In moist areas like the vulva usually pink-red and soft. They may grow inside the cervix and rectum	• Untreated warts may increase in size and become incomfortable during intercourse • Warts on the cervix may increase risk for future cervical cancer in woman.
Chanchroid	Appears as deep soft sore with greenish yellow pus. Found on glans of penis, vulva and around the anus.	• Deformation of the genitals
Non - Gonococcal Infection (NGL)	Men: Burning on urination and discharge from the penis.	• Untreated may infect epididymus resulting in great pain and even infertility
Non - Gonococcal Urethritis (NGU) (Chlamydia)	Women: Many have cervical discharge or pain during menstruation. Perhaps no symptoms until PID begins.	• In women increase risk of Pelvic Inflammatory Diseases (PID) on severe cases infertility.
Human Immunodeficiency Virus (HIV) Infection/AIDS (Acquired Immune Deficiency Syndrone)	Most people may show no symptoms for many years but are still able to transmit HIV.	• HIV causes a spectrum of conditions from mild symptoms to severe immune deficiency state (AIDS). People with AIDS experience life threating infections, cancers leading to death.

Spectrum of HIV Infection

	Asymptomatic	AIDS Related Complex (ARC)	AIDS
External signs	• No symptoms • looks well	• Fever • Night sweats • Swollenlymph gland • Weight loss • Diarrhoea • Minor infections • Fatigue	• Cancer of the skin *(kaposis sacoma)* • Opportunistic infections T B, pneumonia • Neurological disorders.
Incubation	• Invasion of virus to 3 month	• Several months to 10 years	• Several months to 10 years
Internal level of Infection	• Antibodies are produced • Immune system remains intact • Positive antibodies test	• Antibodies produced • Immune system weakened • Positive antibody	• Immune system deficient • Positive antibody test
Possible to transmit HIV	• Yes	• Yes	• Yes

3. Ask students to brainstorm a list of how HIV infection is different from other STDS

Topic 5 Transmission and Non-transmission of HIV

Objectives

To enable students to

Understand ways HIV is transmitted
Understand ways HIV is not transmitted

Teaching Media

Chart No. 5A 5B 5C 5D Transmission of HIV.

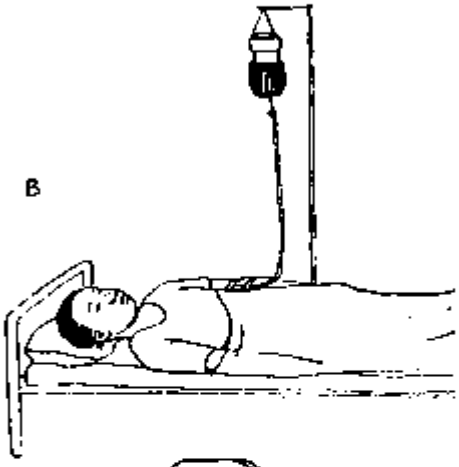
Teaching Approach

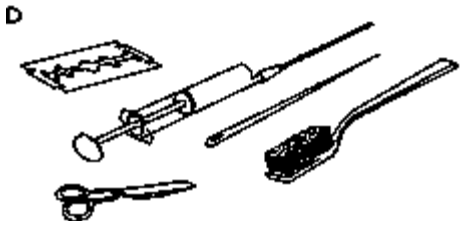
A1. Show the students chart No. 5A, 5B, 5C, and 5D inturn.

A2. Follow question as those of Topic 1 No. 2

A3. During the discussion help students to realize that HIV is transmitted by

- Unprotected sexual intercourse -vaginal anal and oral
- Sharing contaminated blood through syringes, needles and razor blades.
- during pregnancy from an infected women to her unborn or newborn child.
- transfusion infected blood and blood products.





B1. Distribute or Read out to students THE AIDS MYTH-FACT STATEMENTS.

B2. Ask students to Agree or Disagree with each statement giving reasons.

B3. At the end of the lesson conclude by asking students to identify ways in which HIV is transmitted and not transmitted.

AIDS MYTH-FACT STATEMENTS

1. The HIV is only transmitted through infected semen and infected blood.

2. HIV is transmitted by hugging and kissing

3. People can look and feel healthy and still transmit HIV.

4. Women can transmit the HIV

5. Everyone who engages in sexual intercourse is at risk for AIDS if an infected parther is involved

6. A person can get AIDS from giving blood.

7. There is a vaccine to prevent AIDS.

8. Other sexually transmitted diseases increase the risk of HIV.

9. HIV can be transmitted through oral/genital sex.

10. Frequent sexual intercourse reduces risk of HIV infection.

11. You can get HIV infection or AIDS from your fellow student.

12. Mosquitoes, bedbugs and lice can transmit HIV.

13. A person with no symptoms can transmit HIV.

14. You can get infected by drinking from the same glass or eating from the same dishes as a person with HIV infection or AIDS.

15. Use of condom during sex reduce the risk of HIV infection

16. AIDS**,** itself, usually does not kill a person.

17. Everyone engaged in sexual intercourse can be at risk for AIDS.

18. You can tell by looking at someone that he/she has been infected.

Topic 6 Risk Behaviour and Risk Situations

Objective:

To enable students to identify risk behaviour and risk situation that put them at risk of HIV and STD infection.

Teaching Media

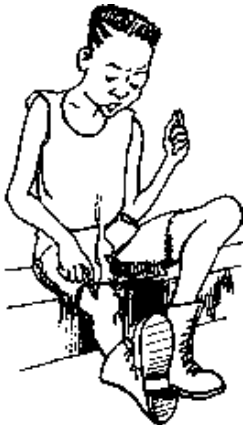
Chart No. 6 Avoid Risk Behaviour and Risk Situation

Teaching Approach.

A.1. Show students chart no. 6A and 6B

A.2. Lead students to discus the charts so they could identify what a risk is, risk behaviour

and risk situations. (You may use questions 1B in topic 5).



B.1. Write the following headings on the blackboard. No Risk Behaviour; Low Risk Behaviour; High Risk Behaviour.

B.2. Ask students to brainstorm behaviour in each category. Keep the group focused on behaviour that place them at risk for HIV infection.

B.3. Ask the students the following question:

a) What would help them to practice safe - behaviour
b) Do you think you are at risk.

Topic 7 Who is at Risk of Getting HIV infection

Objective:

To enable Students to

- Understand that everybody is at risk of being infected.
- Recognize the spectrum of HIV infection
- Understand an outwardly healthly looking person can still infect others.

Teaching Media

Chart no. 7 who is at Risk of Getting AIDS

Teaching Approach:

A.1. Show the students chart no. 7

A.2. Ask students to brainstorm an identity of a person infected with HIV.

A.3. Carefully record their responses on board and discuss, leading them to correct information that everyday is at risk of being infected if involved in risk behaviour, every healthly looking person may have HIV infection but does not show.

B.1. Read or distribute a 'Dear Teacher" letter to the students

Dear Teacher,

What does AIDS have to do with me? None of my friends have AIDS. What's the big idea of telling us to abstrain from sex?

2. Refer students to the spectrum of HIV infection and risk behaviour and situations

3. Leasd students to compose a response to the letter. During the discussion allow students to bring up the following factors.

- How the HIV is transmitted.
- **How** one cannot tell by looking at someone that he/she has been infected.
- Blood test can determine presence of antibodies for HIV but not for the disease.
- Where an individual can get a blood test if there is a suspicion of infection
- How one can develop ARC and AIDS
- The there are numerous other diseases associated with AIDS for which there is no cure.
- And many more things

Complete the lesson by making students know and decide What a realist adolescent should know and Why?

Topic 8 Prevention of HIV Infection

Objectives

To enable students to identify ways of preventing HIV infection

Teaching Approach

1. Ask students to brainstorm a list of ways in which HIV infection may be prevented from spread by

a) Sexual intercourse
b) Bipod transfusion
c) Sharing of piercing instruments like, syringes, blades, and knives
d) mother to child

2. Run over the list explaining each suggestion clearly. Remember to put more emphasis on sexual intercourse. The major mode of transmission of HIV. In your discussion note the following:

a) Sexual Abstinence (Not having sexual intercourse) advantages of abstinence

i) free from pregnancy and sexually transmitted diseases
ii) free from use of contraceptives
iii) free from pressure to marry before your are ready
iv) free from abortion
v) free from guilt, doubt, dissappointment worry and rejection
vi) free to be in control of your life
vii) free to develop a respect for self viii) free to enjoy being a teenager.

b) Safer sex. (Sexual intercourse that limits exchange of body fluids)

i) protective *sexual intercourse* by proper use of condom

ii) non penetrative or *sexual outercourse* e.g. masturbation, hugging, massage, kissing.

c) Stable faithful relationship with uninfected person is safest.

d) Seek early treatment for diseases such as hookworm or malaria which may cause anaemia. Treatment of diseases and eating wall balanced food restores blood volume, and avoids the necessary blood transfusion.

e) Medical personnel can help to prevent HIV infection by using injection or immunising instruments which are sterilized. They should also use new or sterilized skin piercing or piercing instruments.

Topic 9 Caring for People with AIDS

Objective:

To enable students to

a) appreciate the need to take care of persons with AIDS
b) realize the importance of counseling persons with AIDS and their familier
c) understand the danger of discriminating against persons with AIDS.

Teaching Approach

1. Show the students chart no. 9 entitled Caring for people with AIDS and lead the discussion by asking them the following questions:

a) What do we see?
b) What are the reasons?
c) Does it happen here?
d) What should be done?

Lead the students to appreciate the message/statements on the charts. Also let them know that:

a) Everyone is at risk of being infected by HIV.

b) You get infected with HIV once and it has no cure or vaccine.

c) Since they know how HIV is not transmitted there is no need to be afraid of caring for a person with AIDS.

d) People with AIDS are in most case angry with themselves for getting infected. They feel lonely because they are isolated; and friends accuse them of their behaviour which has result to their present state. People with AIDS are usually in great fear of death. Most PWA's end up having no financial resources because of spending much on the untreated disease they are miserable.

e) A responsible approach is not to condemn PWA's. They have the right to love and participate with other people in the society.

f) The responsibility of cash one of us is towards people with AIDS is to support them psychologically giving them information on AIDS current development and offer them material support.

2. Dilemma. Read of distribute the passage below to students

Ben has recently learned he is seropositive for HIV. He goes to a party where he is attracted to Joyce the attraction is matual, and Joyce invites Ben to go outside for kissing and sexual intercourse

Lead a discussion by using the questions

a) What should Ben do?

b) What would it be like to tell someone you are seropositive for HIV. What would be your response?

c) What activities would Ben and Joyce safely engage in?

d) What difference would it make if Ben does not tell Joyce?

Topic 10 Making Responsible Decision

Objective

Students should be able to make informed responsible decision to risk behaviour and situations.

Teaching Aids

Chart no. 10 making decisions.

10A picture showing a responsible decision.

10B picture showning an irresponsible decision.

Teaching Approaches

A.1. Show students chart no. 10A and later no. 10B.

A.2. For each chart ask the students the following questions.

a) What do one see?
b) What are the reasons?
c) Does it happen here?
d) What should be done?

Note: Let students discuss and give views on the two decisions shown in the charts. However, facilitate the students to realize what is a responsible and responsible decision.

3. Explain to the students the responsible decision-making approach steps.

B. Case Study

1. Provide students with the following case study

'We have been going together for two years My boy/girlfriend wants me to sleep with him/her. I love him/her, and I don't want to lose him/her, but I'm not sure this is what I want to do'.

2. Direct students into the process of making informed decision in the case of the boy and girl.

Decision Making Steps

1. Identify the situation.

2. Identify the different decisions that can resolve the situation. (There may be more than one way to resolve a situation).

3. Ask questions about each possible decision to resolve. (There are six question that can be used to identify decisions that lead to responsible actions. the question will not necessarily apply to all situations.

i) Would the result of my decision be morally acceptable?

ii) Would the result of my decision follow my parent's or guardian's guidelines?

iii) Would the result of my decision show respect for myself and others?

iv) Would the result of my decision be healthful?

v) Would the result of my decision be safe?

vi) Would the result of my decision be legal?

4. After you have applied the given question to each possible decision, make a responsible decision and ACT ON IT.

5. Evaluate your decision review your decision to confirm that it was a responsible decision.

Topic 11 Refusal Skills to Reinforce Decision

Objective

Students should be able to use refusal skills to reinforce decision.

Teaching Aids

Chart no. 11 Refusal Skills (11A Boy showing refusal action 11B Girl showing refusal action)

Teaching Approach:

A.1. Show the students chart no. 11A and 11B

A.2. Ask students the following question

a) What do we see?
b) What are the reasons?
c) Does it happen here
d) What should be done?

Let the students discuss and argue, give views and suggestions and encourage self help solutions. Remember to familitate the discassion to include the following refusal skills:

a) Give reason why saying 'NO' is a responsible choice. For example 'I do not want to harm my heath'.

Say 'NO' and keep repeating it, Don't offer reasons or excuses for saying 'NO'.

b) Use your behaviour to show you meaning of what you say: For example stand upright and look firmly at your partner. Avoid being alone with someone who tries to convince you to be sexually active.

c) Use self control and stick to your decision

d) Move out of the situation or refuse to discuss the matter further. 'I am leaving now'

e) Encourage your partner or friend to choose healthful and responsible behaviour or suggest alternatives say, "Instead why don't we.....".

Topic 12 The Impact of HIV Infection and AIDS

Objective

To enable students to increase their level of awareness on how HIV infection and AIDS can affect their lives socially economically and psychologically.

Teaching Approach:

1. a) Ask students to imagine they are living a year from how.

b) Ask them to consider the following question:

i) With whom will they be living?

ii) Who will their friends be?

iii) Will they have a special friend? Why?

iv) What will they do for recreation and pleasure? Will they try drinking, using drugs, smoking loitering stealing or engaging in sexual activities?

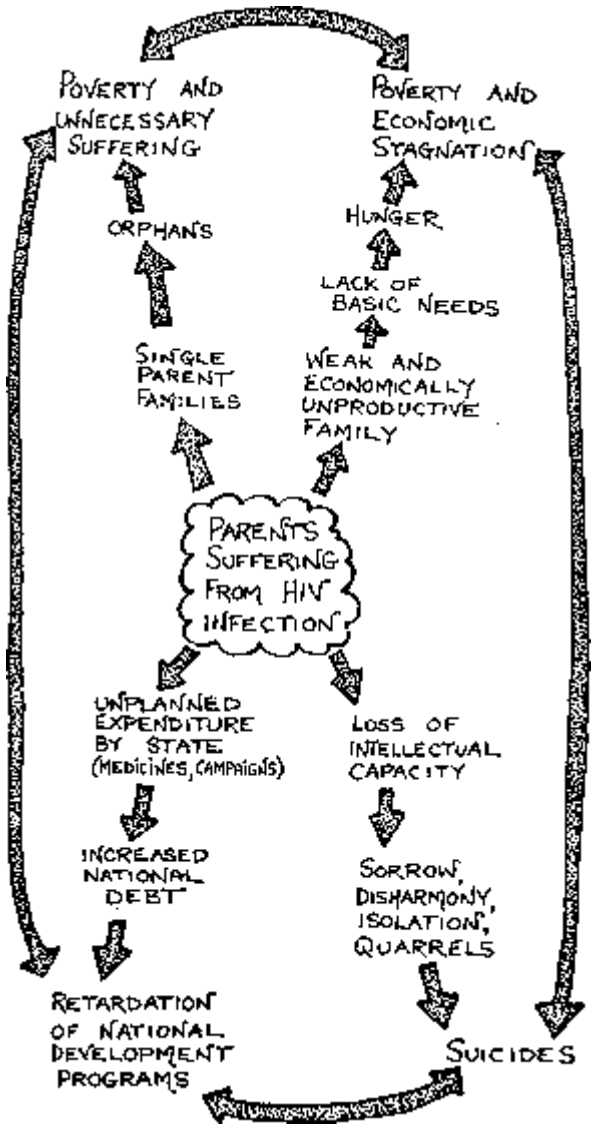
vi) How might HIV/AIDS enter their lives, or the lives of their families, neighbours or friends if they are engaged in the above activites?

vi) Will they know and be prepared to help anyone who is HIV positive or has AIDS?

c) Stop the exercise. Discuss their responses.

2. Futurity Cycle

Let the students consider a family whose parents or guardiain have been diagnosed HIV positive. Help students develop a futurity cycle depicting the consequences (social, economical, psychological outcomes resulting from this situation using the following diagram



Topic 13 Values Clarification of Issues Surrounding Sexuality and AIDS

Objective

To enable students to explore their personal values and become comfortable with listerning and understanding opinions different from their own.

Teaching approach

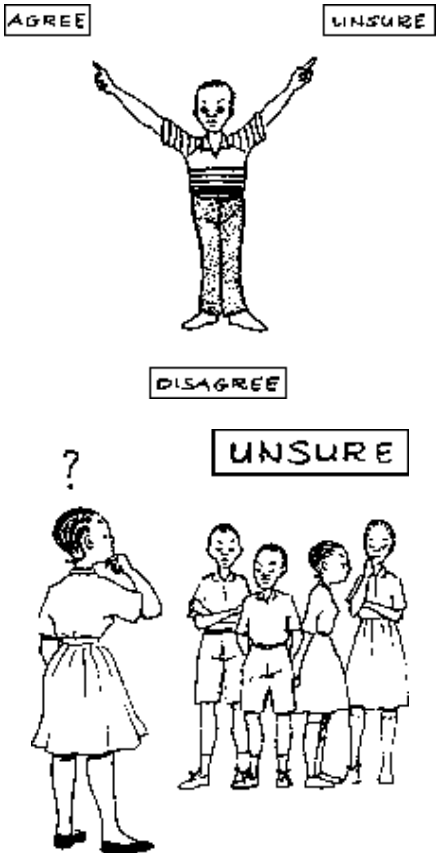
1. Explain to the students that in this activity they will be asked to express their feelings about particular values.

2. Designate three areas of the room to be called. 'Agree' 'Unsure' 'Disagree'.

3. Explain to the students that you are going to read several value statements; as you read each one you may want them to think very carefully about how they feel about each statement and then move to the section of the room depending on whether they 'agree' 'disagree' or 'unsure'.

4. Let them know that you will be asking for volunteers to describe their feelings about the statement

5. Emphasize that there are no right or wrong answers only opinions. Everyone has the right to express his/her opinion. Let them know they can change their voting at anytime.



Here is a list of value statements to read or choose from.

1. The AIDS epidemic has changed my life.

2. I am worried that, I or someone I love, will get AIDS.

3. I think sexual intercourse is appropriate only between married people.

4. I think that prostitutes (teenagers and sugardaddies) are responsible for the AIDS epidemic

5. I think it should be a crime for anyone infected with HIV to have sexual intercourse without telling their partner

6. I think that it is important to educate youth about low-risk alternatives condoms abstinence to sexual intercourse

7. Believing that condoms are 100 percent effective in preventing HIV infection gives people a false sense of security

8. Parents should not teach their children about AIDS and Sexuality.

Vocabulary List

Abstinence - No sexual intercourse, no IV drug use.

Acquired Immune Deficiency Syndrome - A disease caused by a virus which breaks down the body's immune system, making it vulnerable to opportunitic infections and cancer.

Addiction - Habitual use of a substance (like IV drugs) and inability of stop the craving for such a substance.

AIDS - The initials for the disease "Acquired Immune Deficiency Syndrome".

A disease caused by a virus which breaks down the body's immune system, making it vulnerable to opportunistic infections and cancer.

AIDS virus (HIV) test - A test used to detect antibodies against the AIDS virus (HIV) in blood samples. This test does not detect AIDS but rather the presence of the virus that can cause AIDS.

Antibodies - Substances in the blood produced by the body's immune system to fight against invading organisms.

Antigen - A substance that stimulates the production of antibodies.

ARC - AIDS Related Complex. A condition caused by the HIV in which an individual tests positive for HIV and has a specific set of clinical symptoms that are often less severe than those of AIDS.

Asymptomatic - No apparent symptoms of illness even though the individual tests positive for HIV.

Birth - The act or process of being born.

Bisexual - A person who has sexual preference for both males and females.

Blood transfer - The act of transmitting blood from one individual to another. In pregnancy it would occur between the mother and unborn baby through maternal/fetal circulation.

Carrier - A person who harbors a specific infectious agent, in the absence of clinical disease, and serves as a potential source of infection.

Casual contact - The usual daily interaction between people at work, in school, or in social situations.

Communicable disease - A disease that is transmitted directly or indirectly from one person to another. It is caused by bacteria, viruses, and other organisms or their toxic products.

Condom - A sheath used to cover the penis. Condoms come in a variety of materials. Rubber is a material that prevents penetration of HIV and does not break as easily as other substances. Used during sexual intercourse to prevent the transmission of semen, blood, or vaginal secretions and to protect against the AIDS virus (HIV).

Contaminated needle/works - A needle or works that has been previously used, with infected blood or blood particles left on the needle/works to be passed on to the next user.

Droplet spray - Organisms that are projected in droplets of water when an infected person coughs or sneezes and are received in the eyes, nose, or mouth of a nearby person.

Fetus - Unborn baby developing in the uterus after the end of the second month of pregnancy. Before eight weeks it is called an embryo.

Heterosexual - A person who has sexual preference for a person of the opposite sex.

HIV - The Human Immunodeficiency Virus. It causes AIDS by attacking the body's immune system, making infected people vulnerable to fatal infections, cancer, and neurological disorders.

Homosexual - A person in whom an infectious agent can live and multiply.

Illegal drugs - Drugs that are not obtained through legal means or for legitimate medical purposes.

Immune system - A body system that helped fight off invading organisms and disease.

Immunization - A method of producing resistance to an infectious disease, usually by vaccination or inoculation.

Incubation period - The time interval between invasion by an infectious agent and appearance of first sign or symptom of the disease in question.

Infected partner - Individual in a sexual relationship who is carrying the AIDS virus (HIV) in his/her body.

Infectious agent - An organism (virus, bacterium, etc.) that is capable of producing infection or infectious disease.

Intravenous drugs - Drugs that are administered through a needle and syringe and injected directly into a vein and thus into the bloodstream.

Kaposti's sarcoma - A cancer or tumor of the blood and/or lymphatic vessel walls. It usually appears as blue-violet to brownish skin blotches or bumps.

Lymphocyte - A type of white blood cell that is produced in the bone marrow. Some of these cells migrate to the thymus, where they develop as T-cells. Other lymphocytes that mature in the bone marrow or in organs other than the thymus are called B-cells. The B-cells manufacture antibodies, and the T-cells regulate antibody production. In healthy people about 60 percent of circulating lymphocytes are helper T-cells. With AIDS, only about two percent of the lymphocytes are helper T-cells. With fewer helper T-cells, the body is unable to recognize and attack invading organisms.

Method of entry - Manner in which organisms enter the host's body:

Method of escape - Manner in which organisms leave the host's body.

Mode of transmission - Manner in which an infectious agent is transmitted from one person to another.

Needles and works - Devices used to prepare and inject drugs directly into the vein and thus into the bloodstream.

Noncommunicable disease - A disease that is *not* transmitted from person to person.

Opportunistic infection - An infection caused by a microorganism that rarely causes disease in persons with a normal immune system.

Organism - Any living thing, such as a virus, a bacterium, etc.

Pneumcystic carinii pneumonia - The most common life-threatening opportunistic infection diagnosed in AIDS patients. It is caused by a parasite, Pneumocystic carinii.

Pregnancy - The condition of having a developing embryo or fetus in the body.

Risk factor - Activity that makes a person more susceptible or more likely to be exposed to the AIDS virus (HIV).

Semen - The fluid that is expelled from the penis during sexual activity.

Sexual abstinence - Not having sexual intercourse with another person.

Sexual intercourse - Physical sexual contact between individuals that involves the genitalia of at least one person. Includes vaginal intercourse, oral intercourse, and anal intercourse.

Spectrum - A range of factors associated with HIV infection or a range outcomes.

Susceptible host - A person not possessing sufficient resistance against a particular organism to prevent contracting the infection when exposed to the organism.

T-cells - A class of lymphocytes that play a major role in carrying out the activities of the immune system. Some T- cells are called helper T-cells.

Transmission - The passing of infectious agents from one person to another.

Uterus (womb) - Hollow, muscular, pear-shaped organ in females in which the unborn baby develops.

Vaginal secretions - Fluids within the vaginal tract.

Virus - A microscopic organism that cause infections.

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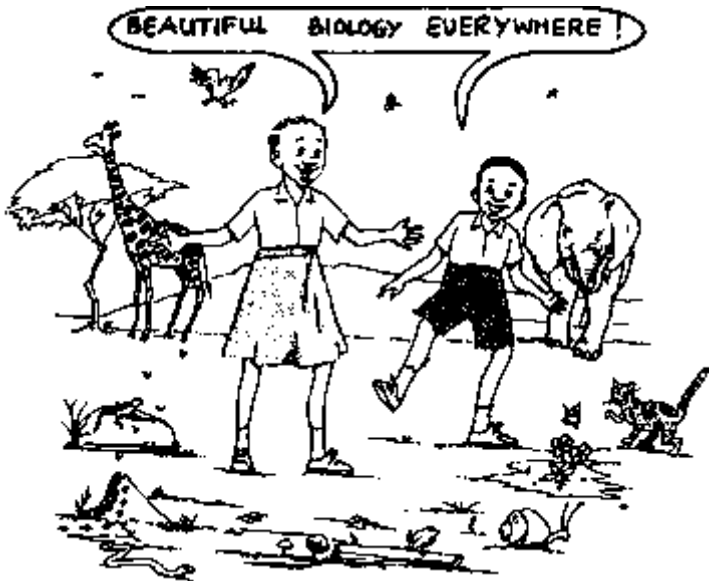
• explains how to make some basic items of equipment.

• includes many ideas for low cost but effective visual aids.

• provides an easy to understand source of ideas to encourage enquiry and investigation.

• attempts to make teachers and students aware of the resources available in their environment, which may be used for the teaching and learning of the science of Biology.



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