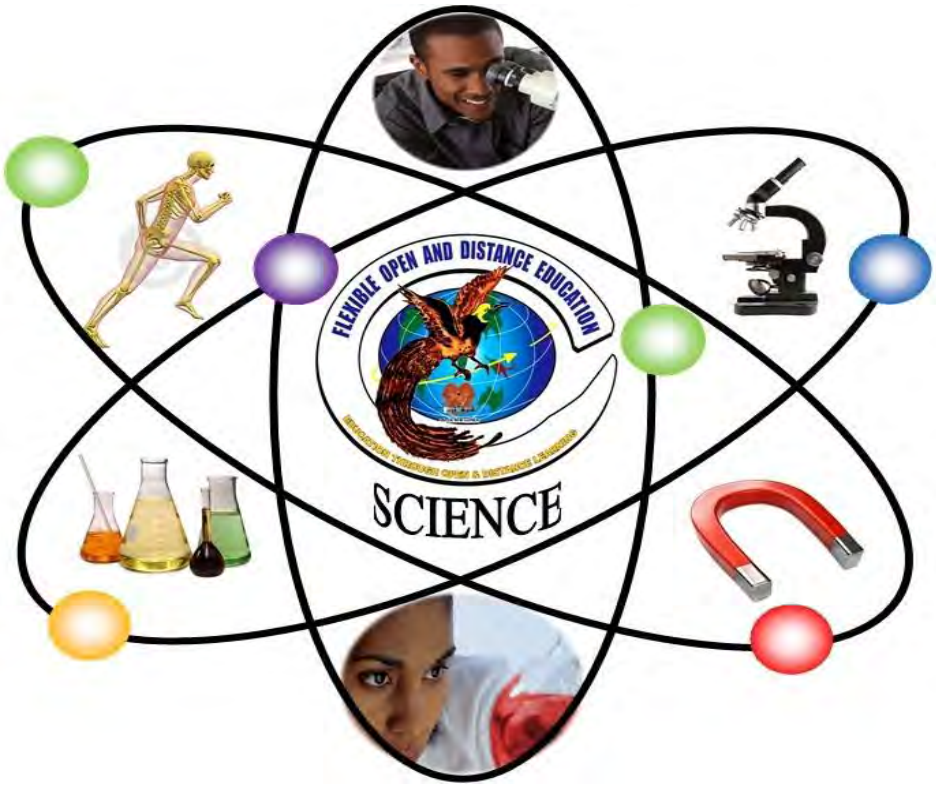
DEPARTMENT OF EDUCATION

GRADE 8

SCIENCE

STRAND 2



LIVING THINGS

FLEXIBLE OPEN AND DISTANCE EDUCATION
PRIVATE MAIL BAG, P.O. WAIGANI, NCD
FOR DEPARTMENT OF EDUCATION
PAPUA NEW GUINEA
2017

Writer
Selected Contract Writers

Content Editors
Science Department
FODE Edit Team
Subject Content Adviser
Science Review Committee

Course Format Editor
Joydee Mabbagu

SCIENCE 8

STRAND 2

LIVING THINGS

SUB STRAND 1: **PLANT REPRODUCTION**

SUB STRAND 2: **ANIMAL REPRODUCTION**

SUB STRAND 3: **RENEWABLE AND NON-RENEWABLE RESOURCES**

SUB STRAND 4: **EFFECTS OF NON-BIODEGRADABLE SUBSTANCES**

Acknowledgement

We acknowledge the contributions of all secondary teachers who in one way or another have helped to develop this Course.

Our profound gratitude goes to the former Principal of FODE, Mr. Demas Tongogo for leading FODE team towards this great achievement.

Special thanks to the staff of the Science Department of FODE who played active roles in coordinating writing workshops, outsourcing lesson writing and the editing processes involving selected teachers of Central Province and NCD.

We also acknowledge the professional guidance provided by Curriculum and Development Assessment Division throughout the processes of writing and the services given by members of the Science Review and Academic Committees.

The development of this book was co-funded by the GoPNG and World Bank.

DIANA TEIT AKIS

PRINCIPAL

Flexible Open and Distance Education
Papua New Guinea

Published in 2017 by Flexible Open and Distance Education
©Copyright 2017, Department of Education, PNG

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means electronic, mechanical, photocopying, recording or any other form of reproduction by any process is allowed without the prior permission of the publisher.

Printed by Flexible Open and Distance Education
ISBN 978-9980-87-323-1
National Library Services of Papua New Guinea

TABLE OF CONTENTS

SECRETARY'S MESSAGE

Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is part and parcel of the new reformed curriculum. The learning outcomes are student-centred with demonstrations and activities that can be assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution and Government Policies. It is developed in line with the National Education Plans and addresses an increase in the number of school leavers as a result of lack of access to secondary and higher educational institutions.

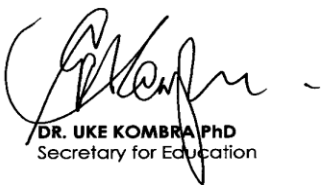
Flexible, Open and Distance Education curriculum is guided by the Department of Education"s Mission which is fivefold:

- To facilitate and promote the integral development of every individual
- To develop and encourage an education system that satisfies the requirements of Papua New Guinea and its people
- To establish, preserve and improve standards of education throughout Papua New Guinea
- To make the benefits of such education available as widely as possible to all of the people
- To make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced through this course to provide alternative and comparable pathways for students and adults to complete their education through a one system, two pathways and same outcomes.

It is our vision that Papua New Guineans" harness all appropriate and affordable technologies to pursue this program.

I commend all the teachers, curriculum writers and instructional designers who have contributed towards the development of this course.



DR. UKE KOMBRA PhD
Secretary for Education

STRAND 2: INTRODUCTION

Dear Student,

Welcome to Strand 2 of your Grade 8 Science Course! I hope that you enjoyed studying the earlier Strand. I also hope that this Strand, Living Things, will be an interesting and enjoyable subject to study too.

In this Strand, there are 21 Lessons on four Sub strands. The four Sub strands are:

- **Plant Reproduction**
- **Animal Reproduction**
- **Renewable and Non-renewable Resources**
- **Effects of Non-biodegradable Substances**

There are five Lessons in the first Sub strand. The lessons will discuss plant reproduction. It will also tackle the various parts of plants, functions of reproductive parts in plants and seed dispersal. You will also learn from this Sub strand about the developmental stages in plants.

The second Sub strand is made of five Lessons and will discuss about animal reproduction. You will also learn in this Sub strand the reproductive organs in animals, the functions of these organs, the growth and development in animals and its different sexual behaviours.

In the third Sub strand, there are five Lessons that will discuss renewable and non-renewable resources. It will also talk about the biodegradable materials, nutrient cycle and non-biodegradable materials.

The last Sub strand has six Lessons. It will talk about the effects of non-biodegradable substances on food webs. You will also learn from this Sub strand the effects of pollution, ozone depletion and global warming in the environment. It will also discuss waste management and man-made activities.

Remember, you have to do all the activities and carry out the Practice Exercises after each lesson. Answers to the Practice Exercises are at the end of each Sub strand.

If you have any problems in understanding any of the lessons in this Strand, please do not hesitate to inform the Science Department at FODE Headquarters. This will help the teacher to revise the lessons for the next edition.

You may study this Strand now following the Study Guide on the next page.

All the Best!

STUDY GUIDE

Follow the steps given below and work through the lessons.

Step 1 Start with Sub strand 1 and work through it in order.

Step 2 When you complete Lesson 1, do Practice Exercise 1.

Step 3 After you have completed the Practice Exercise, correct your work. The answers are given at the end of each Sub strand.

Step 4 Then, revise well and correct your mistakes, if any.

Step 5 When you have completed all of these steps, tick the check box for Lesson 1, on the Contents page, like this:

☑ Lesson 1: Plant Reproduction

Then, go on to the next Lesson. Repeat this process until you complete all the Lessons on a Sub strand. When this is done, revise using the Review Section.

Remember, as you complete each lessons, tick the box for that lesson on the Contents page. This will help you check your progress.

Assignments: Sub strand Tests and Strand Test

When you have completed all the lessons in a Sub strand, do the Sub strand Test for that Sub strand, in your Assignment Book. The Course Book tells you when to do this.

When you have completed the entire Sub strand Tests for the Strand, revise well and do the Strand Test. The Assignment Book tells you when to do the Strand test.

When you have completed the entire Assignment Book, check and revise well before sending it to the Provincial Centre.

If you have any questions, write them on the Student‟s page. Your teachers will advise you when he/she returns your marked Assignment.

The Sub strand Tests and the Strand Test in each Assignment will be marked by your Distance Teacher. The marks you score in each Assignment will count towards the final result. If you score less than 50%, you will repeat that Assignment.

Remember, if you score less than 50% in three Assignments, your enrolment will be cancelled. So, work carefully and ensure that you pass all Assignments.

SUB STRAND 1

PLANT REPRODUCTION

In this sub strand you will learn about:

- **plant reproduction**
- **reproductive parts in plants**
- **functions of reproductive parts in plants**
- **seeds dispersal**
- **development stages in plants**

SUB STRAND 1: PLANT REPRODUCTION

Introduction

If you are an organism, you will need to **reproduce**. Otherwise, there will be no more of your species and the species will die off. You may have heard of endangered animals. There are also endangered plants. These endangered species have very few individuals left and scientists/naturalists are working together to make sure the species don"t become extinct. Reproduction is one of two things:

1. One cell can split into two, giving you two identical cells. That type is asexual reproduction.
2. The second type is when two cells, each with half of the DNA needed, combine and create a living cell. That type is sexual reproduction.

Making more mosses - Sporophytes are the reproductive structures you will find in mosses. They are actually a phase of the moss life cycle that feeds off the green parent plant (the gametophyte). The sporophyte is a stalk that grows after the haploid sperm of one moss plant is able to mix with the haploid egg of a female moss plant. When ready, spores stored in the sporophyte are released and they grow into new moss plants.

Capsules are found on the ends of moss sporophyte stems.

Conifers and their cones - While there are male and female mosses, conifers produce two types of **cones** on the same tree. One of the cone types gives off pollen (the **staminate** cone). The other type of cone catches the pollen if the wind is moving in the right direction. Better yet, the wind blows the pollen to another conifer of the same species, and a cone (called the **ovulate** cone) catches the pollen.

Many conifer species have both male and female cone types.

Flowers and pollen - Plants that rely on **flowers** for reproduction are also very dependent on outside help such as insects and animals. While conifers have the two structures on one tree, flowering plants went one step further and put the devices that make and receive pollen in the same structure.

Angiospems use flowers of all sizes to reproduce.

Some questions will arise such as

- What are the different seed dispersals?
- How do reproductive parts in plants functions?
- What are the different developmental stages in plants?

In this Sub strand, you will find the answers to these questions and other questions relating to plant reproduction.

Lesson 1: Plant Reproduction

Welcome to the first lesson of Strand 2. In this lesson you will learn that organisms can produce new individuals of its own kind in a process called reproduction. In humans and many other organisms reproduction involves two individuals. We call this sexual reproduction. However, some organisms can reproduce on their own without another individual. We call this asexual reproduction.

Plants can reproduce sexually and asexually. Sexual reproduction in plants involves their sexual reproductive structure - the flower. Plant asexual reproduction takes place either by fragmentation or by special asexual structures.

Your Aims:

- differentiate sexual from asexual reproduction
- distinguish between vegetative propagation and artificial propagation
- look at methods by which plants reproduce asexually
- get familiar with plant asexual structures; and
- explain some of the benefits plants can get from asexual reproduction

What Is Sexual And Asexual Reproduction?

Sexual reproduction involves the union of sex cells from two parents producing a new individual. **Asexual reproduction** does not involve fusion (joining) of sex cells. A new individual is produced from a single parent.

Asexual reproduction in plants can either be vegetative artificial. **Vegetative propagation** is a type of asexual reproduction that happens naturally. Parts of simple plants like mosses break off from the parent and grow into new individuals, as do plant cuttings. Other examples are the formation of runners, stem tubers, rhizomes, bulbs and spores.

Methods of vegetative propagation

1. Fragmentation

Microscopic plants, mosses and seaweeds can reproduce by simply dividing or disintegrating. A strong water current or violent wave action can separate a small group of algae.

Seaweed exposed at low tide (left) and a moss growing on a tree trunk (right) can reproduce asexually by fragmentation.

When this cluster of algae finds a suitable environment to inhabit, it can grow into a new colony of algae. Microscopic algae can do cell fragmentation. The cell simply divides.

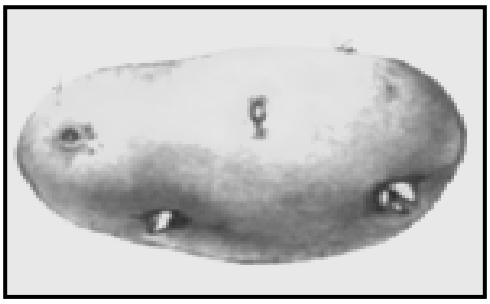
2. Runners

Strawberries and grasses, although flower-bearing can reproduce sexually, they can also reproduce asexually by growing lateral (sideways) shoots or stems called **stolons** or **runners**. A runner can produce a bud and roots which will develop into an independent plant.

Strawberries grow lateral shoots called runners**.**

3. Tubers

A **tuber** is an underground food-storing stem of many plants such as potato, sweet potato (kaukau) and cassava (tapioca), characterised by buds or eyes. Young plants developing from tuber buds are nourished from starch stored in the tubers until mature enough to develop their own root systems.



A potato tuber with buds or „eyes"

Activity 1: Now test yourself by doing this activity.

Examining a potato tuber

Go to your house kitchen or to the nearest food shop and find a piece of potato tuber that you can examine.

You may have heard people talk about the „eyes" of a potato. Examine the eye and see if you can count how many there are in the tuber.

1. The potato has _____ eyes.

   Each eye is a very small bud which is capable of sprouting into a new plant.

2. How many buds will the tuber you are examining likely to produce? _____

If the potato is fresh, you will see little black specks dotted about over its skin. These are little holes called **lenticels** which allow air to get through the skin so that the tuber can breathe.

3. As well as providing means for food storage, sweet potatoes (kaukau) are useful to the plant for another reason. What is this reason?

_____

_____

---

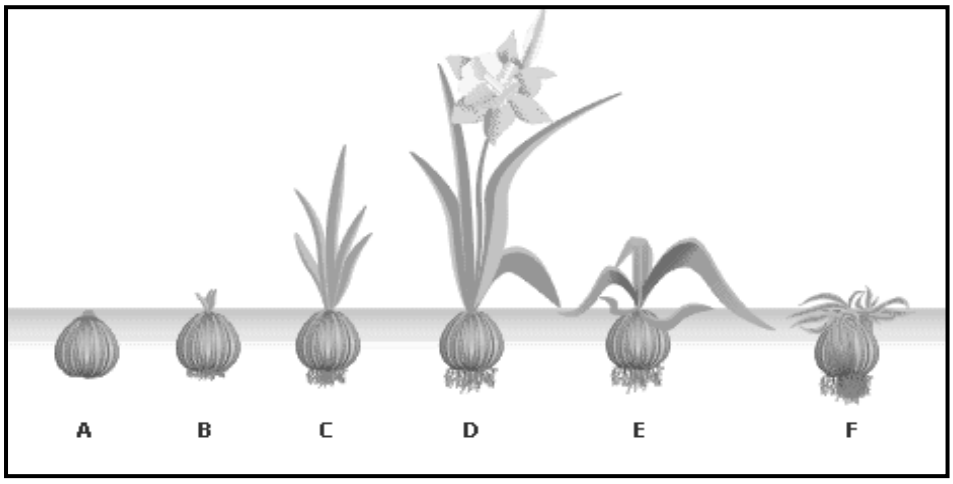
4. Rhizomes

Any fleshy stem that grows horizontally, as a food-storing organ, under the surface of the ground, and enables a plant to reproduce itself is called a **rhizome**. A rhizome is not a root, which is a food-gathering organ; rather, it grows roots on its lower side and shoots from its upper side that produce new plants in the same way as a runner. A rhizome however is different from a stolon or runner because it becomes swollen with food.

A ginger is not a root but a fleshy stem

5. Bulbs

Bulbs are underground shoots with a mass of overlapping, usually fleshy leaves. The outer leaves are usually scaly and dry that protect the inner ones which are thick and fleshy with stored food. Lateral or „daughter" buds can grow at the base of the bulb that will sprout in the growing season.



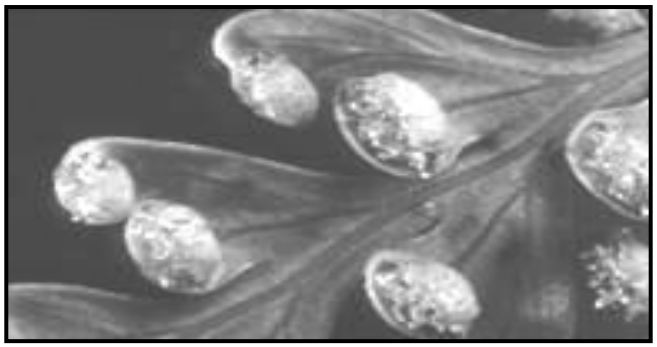
The life Cycle of a Bulb

A. A bulb is planted
B. 3-5 weeks: first leaf tips appear
C. 16-20 weeks: leaves develop
D. 24-26 weeks: flower (daffodil) blooms
E. 32-34 weeks: leaves wither and die
F. 36 weeks: bulb multiplies, to produce daughter bulbs

6. Spores

Spores are special cells produced by simple land plants like mosses and ferns. These plants produce capsules from their shoots or patches underneath the leaves that burst open and release these spores. The spores are like tiny

specks of dusts so light they can float through the air. Spores can grow into new plants when they land in shaded, humid habitats.



Spore capsule

Activity 2: Now test yourself by doing this activity.

To see the spores produced by a fern
Look for a fern with mature leaves. Look at the underside of the leaves. Can you see a series of brown patches on the underside of the leaf? These patches produce and release spores.

1. Draw the under section of the fern leaf below and label the structure that bears the spores.

2. Run a finger through the leaf to allow the spore bearing patches to break. Can you see the spores on your finger?
   _____

3. Give two characteristics of the spores on your fingers.
   _____

4. Why do you think spores have these characteristics?
   _____

Artificial propagation is a form of asexual reproduction that would not occur naturally in plants living in the wild. Grafting, budding, mar cottage (air layering), root and stem cuttings are some of the examples of this type of propagation.

Methods of vegetative propagation

1. Grafting

Grafting is done by inserting the cut shoot of one plant under the bark or stem of another, closely related plant so that they will join. The supporting plant (the one that is rooted) is called the **stock** and the shoot being grafted is called the **scion**.

Grafting is frequently used to combine advantageous characteristics of scion and stock. For example, branches or buds of trees known to produce sweet fruit are grafted to stronger trees that produce fruit of lesser quality. Grafting is also used in propagating seedless fruits, such as seedless oranges and grapes.

Grafting in which the scion is used as a bud is called **budding**.

Twin graft on an apple tree

2. Cutting

A **cutting** is produced by cutting off a short piece of stem just below a point where a leaf joins a stem. The cutting is trimmed so that only two or three leaves remain and is then put into some moist soil or rooting compost. Roots develop from cut end of stem and new leaves grow where old leaves used to be.

A cutting may be covered by a clear plastic to prevent excessive loss of water from the leaves and prevent entry of fungus which might infect the cutting. Gardeners often take cuttings of plants which they particularly like.

Activity 3: **Now test yourself by doing this activity.**

Garden cuttings

1. Visit a flower garden and list down some ornamental plants that can be propagated by cuttings.

   _____

   _____

2. Visit a vegetable garden and list down some edible plants that can be propagated by cuttings.

   _____

   _____

3. Some gardeners put the branch of cuttings in water before sticking them in the soil. What is the advantage of this method?

_____

_____

---

3. Mar cottage or air layering

In **mar cottage** a ring of bark is removed from around the branch to cut off the flow of nutrients to the branch tip. The cut area is then surrounded with moss plants and wrapped in plastic. Eventually, roots grow from the cut region. The branch is cut for potting when sufficient root mass is present and start protruding out of the plastic.

Advantages and disadvantages of asexual reproduction

The most evident advantage of asexual reproduction is that there is no need for the organism to have a partner. When asexual reproduction happens by fragmentation or by formation of spores, it occurs quickly and enables an organism to spread fast over a wide area.

Tubers and bulbs enable the plant to survive winter because they not only serve as organs for asexual reproduction but store food as well.

The main disadvantage is that the offspring is always like the parent. It is therefore impossible to produce new kinds of organisms by this method. In other words asexual reproduction does not give rise to variety.

Importance of vegetative and artificial propagation

Farmers and gardeners make use of their knowledge of asexual reproduction in plants to produce a lot of plants with particular good feature. They can increase stocks of plants by dividing rhizomes and tubers at the end of the growing season.

Cuttings and grafting is often used to cultivate crop and ornamental plants and preserve their useful characteristics as they revert to wild forms if grown from seeds.

All these are important to farmers and market gardeners who produce commercially important plants on a large scale.

Summary

You have come to the end of lesson 1. In this lesson you have learnt that:

- asexual reproduction does not involve two individuals.
- asexual reproduction in plants is divided into two types: vegetative and artificial propagation.
- plants can propagate vegetatively by fragmentation or by growing specialized parts such as bulbs, tubers, rhizomes, runners and spores that can grow into new plants.
- some common artificial propagation methods include cutting, grafting, mar cottage, and rooting cutting.

- the main advantages of sexual reproduction are that it does not require two individuals and it may be rapid and result in wide dispersal.
- the main disadvantage of asexual reproduction is that it does not give rise to variety.
- knowledge of vegetative and artificial propagation methods is important in gardening and farming for mass food production and preservation of plants with good features.

NOW DO PRACTICE EXERCISE 1 ON THE NEXT PAGE.

Practice Exercise 1

Answer the following questions:

1. Eight methods of asexual reproduction are listed below. In each case, write the name of a plant that uses the method.

(i)	Fragmentation	_____	(v)	Runners	_____
(ii)	Bulbs	_____	(vi)	Tubers	_____
(iii)	Rhizomes	_____	(vii)	Spores	_____
(iv)	Grafting	_____	(viii)	Cutting	_____

2. Of the methods listed in Question 1, which ones

   A. enables the organism to survive the winter
   _____

   B. develop stems that can grow horizontally underground
   _____

   C. involve the formation of an underground structure containing food
   _____

   D. is able to combine the advantageous characteristics of two plants
   _____

3. A fern is a plant with two methods of asexual reproduction: it can form numerous spores and it also possesses an underground rhizome from which a new plant grows up each growing season.

   State two advantages which the spores have over the rhizome as a means or reproduction.

   A. _____
   _____

   B. _____
   _____

4. Differentiate

   A. Sexual reproduction
   _____

Asexual reproduction

_____

B. Vegetative propagation

_____

C. Artificial propagation

_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1.

Answers to the Activities

Activity 1

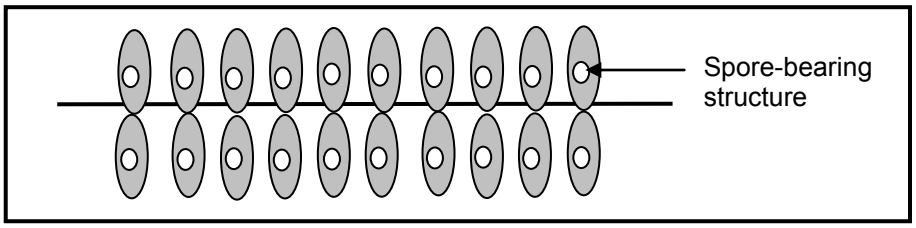
1. The potato has many eyes. (Answer may vary depending on the tuber used)

2. Many (the number of buds will be similar to the number of „eyes" counted in 3)

3. It is an organ for asexual reproduction. It is an organ that allows the potato to produce new potato plants.

Activity 2

1. Draw the under section of the fern leaf below and label the structure that bears the spores.



A diagram showing the spore-bearing structures on the lower section of fern"s leaf.

2. Yes
3. Spores are tiny, light, and sticky.
4. Spores are tiny and light so they can easily float and get scattered by wind, they are sticky so they can easily attach to insects and other passing animals – all these features are needed for spore dispersal.

Activity 3

1. Roses, bougainvillea, exora, crotons, tanget, and most shrubs planted for hedges are obtained from cuttings.

2. Aibika, water crest and kangkong,

3. Water stimulates the development of roots. Cuttings with roots have a higher chance of survival.

Lesson 2: Reproductive Parts in Plants

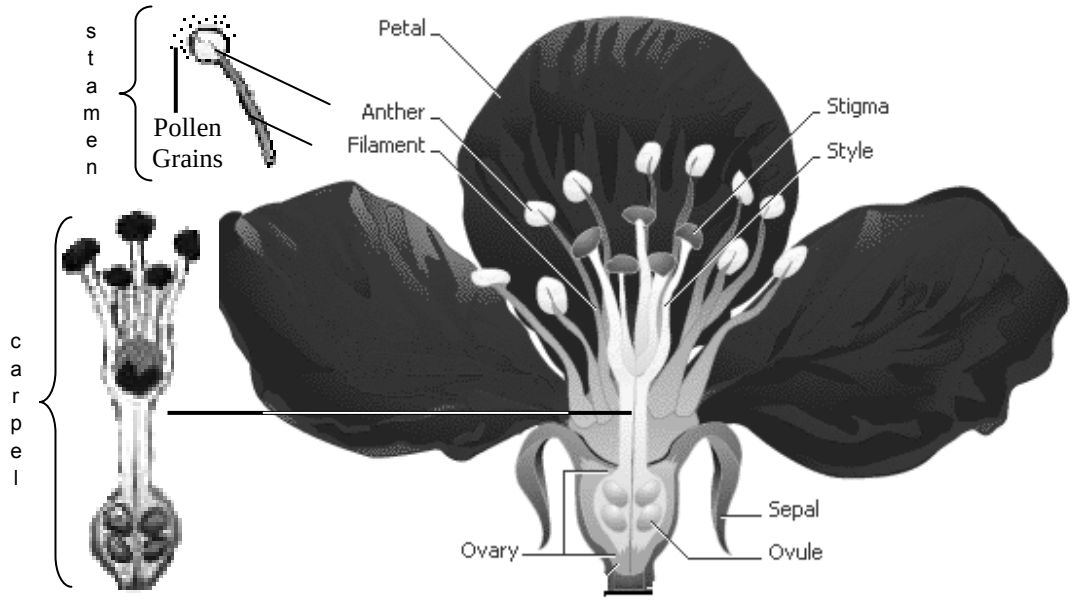
Welcome to Lesson 2 of Strand 2. In the last lesson you have learnt that plants can reproduce asexually, without a partner, using specialized roots, stems and leaves. In this lesson you will learn that sexual reproduction in plants involves two individuals, a male and a female. The male and female reproductive structures are found in the flowers.

Your Aims:

- identify the parts of a typical flower
- distinguish between the flowers‟ male and female parts; and
- examine and draw the structure of an insect-pollinated flower

The Flower

The plant‟s sexual reproductive structures are found in the flowers, which are formed towards the top of the plant. There are many different kinds of flowers, but they are all commonly divided into four parts. These parts in order starting from the outside are sepal, petal, stamen and carpel.



Parts of a flower

The **petal** is usually the brightly coloured and scented part of the flower. The **sepal** is green and small, and used to be part of the bud. The **stamen** or the male part of the flower consists of a **filament** and **anther**. An anther is a swollen structure present on the tip of the filament. The anther produces a powdery substance called the **pollen grains** that contain the male sex cells of a plant.

At the center lies the female part of the flower, the **carpel**. It contains the five short branches of the **stigma** at the top connected to a single **style** in the middle, and the swollen base called the **ovary**. Inside the ovary are the **ovules** that contain the female sex cell of the plant.

What is the major responsibility of a flower?
The flower has an important responsibility of forming sex cells and making sure that these sex cells combine.

Most plants have the male and female sexual parts in the same flower so that the male sex cells in the pollen grains only have to travel a short distance to the female sex cells in the ovules.

Activity: **Now test yourself by doing this activity.**

Looking at a hibiscus flowers

1. Collect a hibiscus flower and count the number of petals and sepals.

   How many petals are there? _____
   How many sepals are there? _____

2. Carefully remove the sepals and the petals to show the inner parts of the flower.

   Draw what you see in the box on the right.

3. Examine the flower. There should be five darkly coloured stigmas held high by the long, thin style. Attached to the style, just below the five stigmas are the numerous very tiny stamens.

   Label the stigma, style, ovary, filament and anther.

   Collect some pollen grains by slightly running your pointer finger at the many tine stamens.

   Give a brief description of the pollen grains.
   _____
   _____
   _____

The male and female parts of the hibiscus.

4. With a scalpel or razor blade, slice open the swollen base lengthwise.
   Can you see the ovules? Describe the ovules based from what you observe.
   _____
   _____

5. Compare the stamen and carpel of the hibiscus with the stamen and carpel of the flower on the diagram in the previous page.
   _____
   _____

6. What can you conclude from your comparison of the two flowers in question 5?

_____

_____

Summary

You have come to the end of lesson 2. In this lesson, you have learnt that:

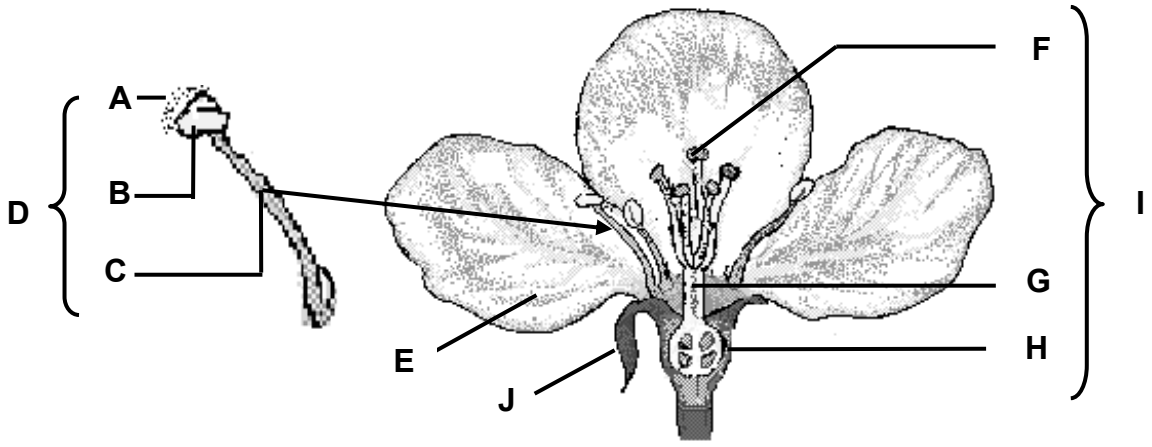
- the flower is the sexual reproductive part of the plant.
- the stamen is the male part of the flower. It contains the filament, anther and pollen.
- the carpel is the female part of the flower. It contains the stigma, style and ovary that carry the ovules.
- the male sex cells are in the pollen while the female sex cells are in the ovules.
- there are many kinds of flowers, but they all have certain features in common.

NOW DO PRACTICE EXERCISE 2 ON THE NEXT PAGE.

Practice Exercise 2

Answer the following questions:

1. Label the parts of the flower.



A _____ **B** _____ **C** _____

D _____ **E** _____ **F** _____

G _____ **H** _____ **I** _____

J _____

2. Use the words in the box to complete the sentence.

carpel	pollen	sepal	anther	petal	stamen	style	filament

The coloured and scented part of the flower is the _____ while the _____ is the green part that used to be part of the bud. The _____ is the male part of the flower. It is made of filament and _____ which bears the _____ or male sex cell. The female part or _____ is made up of _____, style and ovary. Inside the ovary are the _____ or the female sex cells.

3. What are the two main responsibilities of a flower?

A. _____

B. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1.

Answers to the Activity

1. **There are five petals. Number of sepals may vary.**

3. **The pollen grains are very small, light, and sticky, with no fragrance or odour. (The colour may vary.)**

4. **Yes. The ovules are tiny, sticky (or are surrounded by a sticky mucous), plenty, and are all inside the ovary.**

5. **The carpels are the same in number, shape and position. However, there are more ovules in the ovary of the hibiscus while there are only four in the diagram. The stamens on the diagram are attached to the base while the stamens in the hibiscus are attached to the style and are more numerous.**

6. **Different flowers have the same or common parts and features but the positions may be different.**

Lesson 3: Functions of Reproductive Parts in Plants

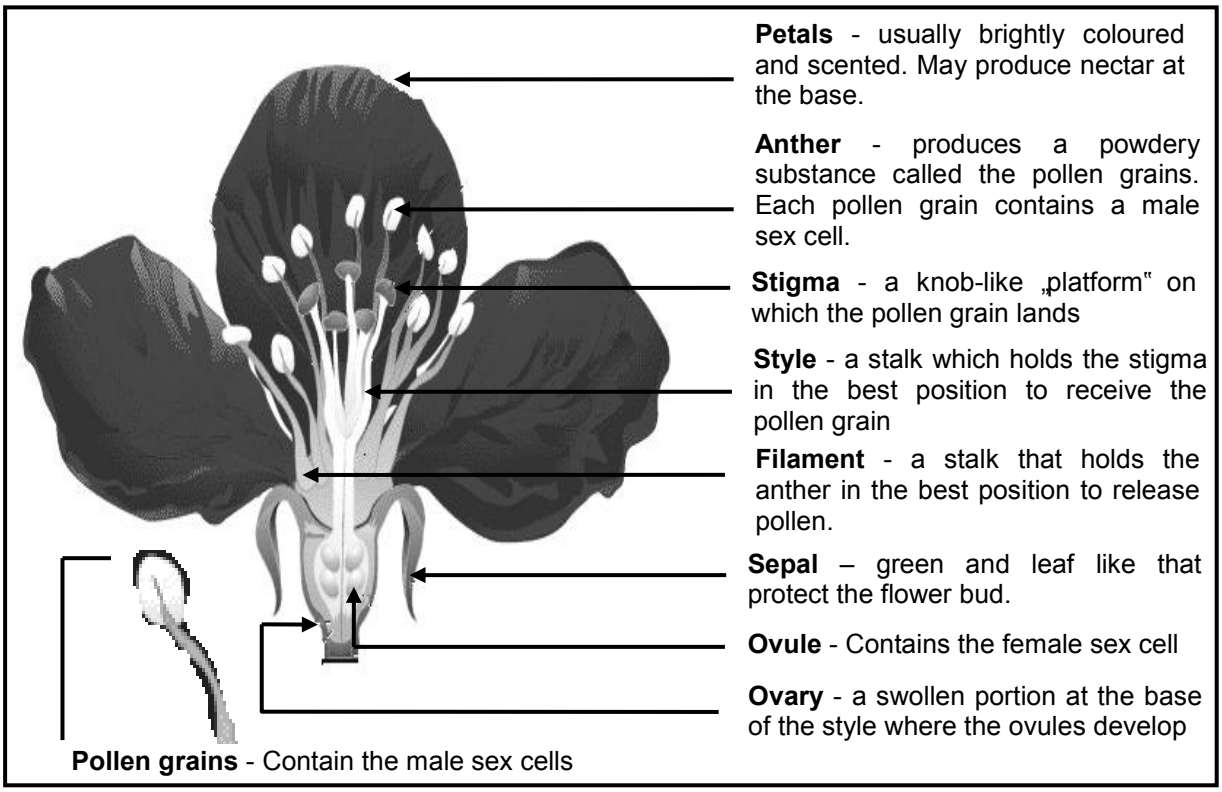
Welcome to Lesson 3 of Strand 2. After completing lesson 2, you will be familiar with the parts of a flower. You may also recall the main function of the flower which is to make male and female sex cells.
In this lesson you will learn about the functions of the reproductive parts in plants.

Your Aims:

- describe how sex cells combine in the flower
- define the process of pollination and fertilization
- explain the functions of the flower parts involved in these processes

Pollination

Pollination is the transfer of pollen grains from the anther to the stigma. Study the diagram below and find out how the flower produces the male and female sex cells and how some parts are well designed for the process of pollination.



The flower is specialized for pollination.

Self pollination occurs when the transfer of pollen grains to the stigma is within the same flower or between flowers of the same plant.

Cross pollination happens when the transfer of pollen grains to the stigma is between flowers from different plants of the same species.

Agents of pollination

Pollination often involves various external agencies or help to carry pollen grains from the male to the female part of the flower. These agents may be air, water, insects or animals. Most flowers are pollinated by insects.

When you visit a garden, you observe many butterflies and bees hovering around the flowers. They are in fact attracted to the colour, scent and nectar of the flower. The **nectar** is a sugary solution release at the base of the petal.

Bumble-bees and other insects perform the important function of cross-pollination as they move from flower to flower.

As this bee pushes between the tightly closed petals of a flower to feed on the nectar within, its furry back picks up pollen from the flower"s anthers. The bee will carry the pollen to the stigma of another flower, depositing pollen collected at its previous stops.

A bumble-bee is a pollinating agent

Insect-pollinated flower

Wind-pollinated flower

Activity 1: Now test yourself by doing this activity.

Have you noticed the flowers pollinated by insects and those by wind? Below are different features of flowers. Try to classify whether the flower feature is designed for wind pollination or insect pollination by ticking in the corresponding boxes.

Flower feature	Wind-pollinated	Insect-pollinated
Large, brightly coloured petals		
Small, dull petals with no scent		
With nectar		
Small quantity of sticky pollen grains		
Large quantities of light, smooth pollen grains		

Insects are attracted to colour, scent and nectary. Sticky grains easily attached to their hairy bodies. A large number of pollen needs to be produced by wind-pollinated flowers to increase their chances of successful pollination.

Fertilization
When pollen grains land on the stigma, the pollen tube begins to develop and move downwards into the style. The **pollen tube** inside the style carries the male sex cell from the stigma to the ovule inside the ovary. **Fertilization** takes place when the male sex cell combines with the female sex cell inside the ovule in the ovary.

Activity 2: Now test yourself by doing this activity.

Investigating the pollen tube inside the Hibiscus flower.

1. Get a mature hibiscus flower.
2. Carefully remove all the sepals and petals.
3. Use a blade to cut the ovary lengthwise. **Be careful when using a blade**
4. Separate the ovary by gently pulling it until the style divides and opens into half.

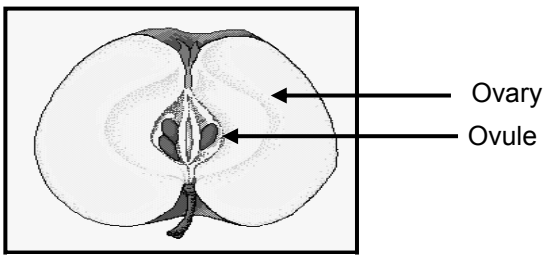
   a. Can you see the long pollen tube inside the style? _____

   b. From where and to where is the tube attached?
   _____

   c. Based from its points of attachments, work out the function of the pollen tube.
   _____

Formation of fruit and seed
After the female sex cells are fertilized, the ovary begins to develop into a fruit and the ovules harden into seeds. In most cases the other parts of the flower dry up and fall. In some cases, like the chilies and tomato, they continue to grow.

Fruit or vegetable?
If you have a tomato and an eggplant, which of the two is a fruit and which is a vegetable? What about a carrot? The answer is very simple. If it is being formed through the process of pollination and fertilization, it‟s a fruit. If there‟s no sex cells involved it‟s a vegetable.



A fruit is a mature swollen ovary. The tiny ovules become seeds.

Summary

You have come to the end of lesson 3. In this lesson you have learnt that:

- **pollination** is the transfer of pollen grains from the anther to the stigma.
- **self-pollination** occurs when the transfer of pollen grains to the stigma is within the same flower or between flowers of the same plant.
- **cross pollination** happens when the transfer of pollen grains to the stigma is between flowers from different plants of the same species.
- transfer of pollen often requires **pollinating agents** such as insects, wind, water and other animals.
- insect-pollinated flowers are usually scented, large, brightly coloured, and with nectar. Their pollens are sticky.
- wind pollinated flowers are smaller, dull, not scented and does not produce any nectar. They produce a lot of small, smooth and very light pollen grains.
- **fertilization** takes place when the male sex cell combines with the female sex cell inside the ovule in the ovary.
- after fertilization the ovary develops into a fruit and the ovules become seeds.

NOW DO PRACTICE EXERCISE 3 ON THE NEXT PAGE.

Practice Exercise 3

Answer the following questions:

1. Which part of the flower

   A. is the ovule? _____

   B. does fertilisation occur? _____

   C. does pollination take place? _____

   D. is the pollen grains produced? _____

2. Name three agents of pollination.

   A. _____

   B. _____

   C. _____

3. What are the male and female sex cells in the flowering plant?

   Male sex cells - _____

   Female sex cells - _____

4. Write whether the following flower adaptation is for wind or insect pollination.

Flower features	Wind or Insect Pollinated
1. Large and bright petals	
2. Smooth, dry pollen grains	
3. Without scent	
4. With nectary	
5. Sticky pollen grains	

5. Define:

   A. Pollination

   _____

   B. Fertilisation

   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1.

Answers to the Activities

Activity 1

Flower feature	Wind-pollinated	Insect-pollinated
Large, brightly coloured petals		√
Small, dull petals with no scent	√	
With nectar		√
Small quantity of sticky pollen grains		√
Large quantities of light, smooth pollen grains	√	

Activity 2

A. Yes

B. From the stigma to the ovary

C. It functions to carry the pollen (male sex cell) from the stigma to the ovule (female sex cell) inside the ovary.

Lesson 4: Seed Dispersal

Welcome to Lesson 4 of Strand 2. In the last lesson, you learnt about the process of fertilisation in flowering plants. To recall, fertilization is the union of the male and female sex cells in the ovary of the flower. The ovary develops into a fruit while the tiny ovules inside harden to seeds. After fertilisation, the seeds are attached to the parent plant. In this lesson you will learn that before a seed can develop into a new young plant, it must be separated from its parent plant. The seed must be dispersed away from its parent.

Your Aims:

- define the term dispersal
- identify agents for seed dispersal and
- distinguish angiosperms from gymnosperms

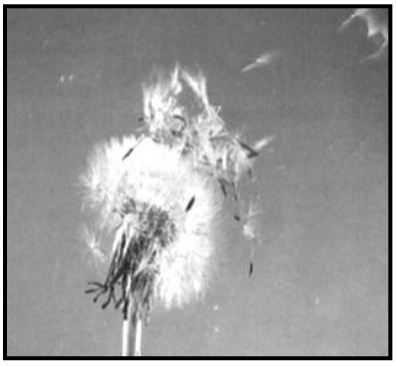
Seeds Need To Be Dispersed Away From The Parent Plant

When flowering is over and the seeds are mature, the whole ovary containing the seeds fall from the parent plant to the ground. If the conditions are suitable germination will take place.
If the young plant remains close to its parent, it would need to compete with its parents for resources such as light energy, water and nutrients from the soil.
In many plants, the fruits and seeds are adapted in such a way that they are distributed away from the parent plant.

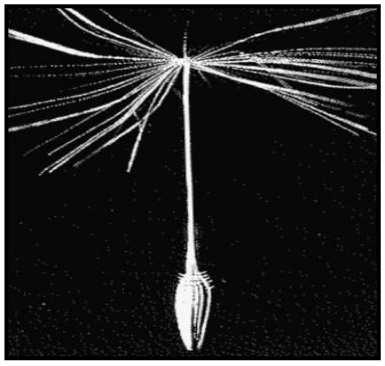
Dispersal is a plant adaptation where fruits and seeds are distributed away from the parent plant to help reduce overcrowding and competition.
Competition for limited resources is reduced by a range of methods of fruit and seed dispersal. Agents that disperse fruits and seeds include wind, water and animals.

Wind Dispersal
Some fruits have wings or hairs. These slow their fall allowing them to be carried away by the wind. Sycamore trees have winged fruits, and the dandelions have hairy parachutes.

The sycamore fruit has two extended wings formed from the fused carpels



Dandelion fruits are dispersed by wind.



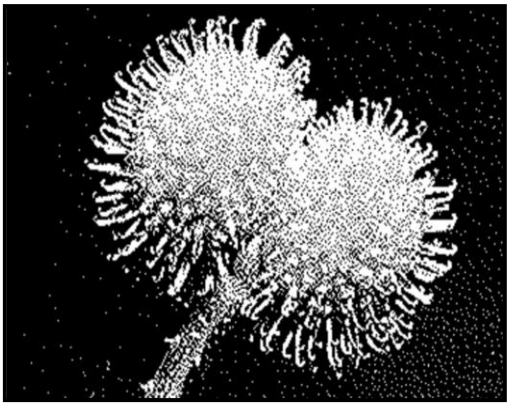
The seed of a dandelions hanging from its hairy fruit

Animal dispersal

Some fruits are eaten by animals such as birds. The seeds are not digested but pass out with the bird‟s droppings, often a long way where the bird ate them.

Fleshy fruits often look and taste nice so animals are attracted to them. The seeds with their hard testa are resistant to the digestive juices of the animals, and pass out in the faeces.

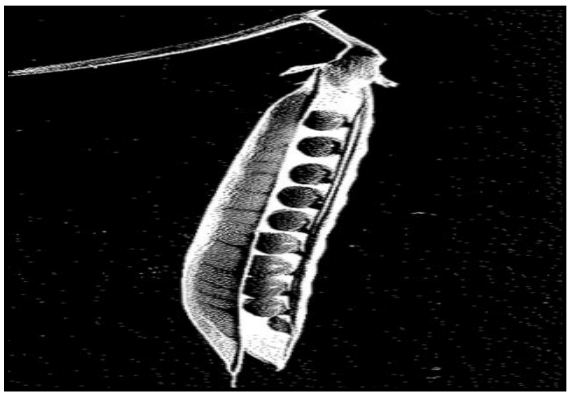
Some fruits are covered with little hooks. The hooks enable the fruit to cling to feathers and furs of animals. A well-known example is the fruit of the local grass that clings to your clothes.



Tiny hooks in the goosegrass fruit

Tiny hooks of cleaver fruits clinging to the fur of a passing animal.

Melons have sweet, juicy flesh that attracts a lot of animals. Their seeds cannot be digested.



Beans and pod have an explosive mechanism. The pod or bean simply splits and twists, ejecting the seeds.

Water dispersal and self-dispersal

Some fruits like the coconuts have a fibrous ovary wall that allows the fruits to float and be easily carried away by the water. Other fruits disperse their seeds by splitting open. This may occur with such force that seeds are scattered quite a long way from the parent plant. The bean family has fruits of this sort: The „pod‟ is the fruit and the „beans‟ are the seeds.

Angiosperms and gymnosperms
Flowering plants are called **angiosperms**. They bear flowers and their seeds are „enclosed" or inside their fruits.

Gymnosperms or conifers are plants that bear cones instead of flowers. The cones have pollens and ovules. After pollination a fertilized ovule develops into a seed. The seed is said to be „naked" because it is not inside a fruit as in the flowering plants.

Pines and firs are conifers. They have needle-like leaves and dominate the landscape in colder habitats.

Ripe cones open their scales to expose and release their seeds.

Summary

You have come to the end of lesson 4. In this lesson you have learnt that:

- dispersal is a plant adaptation where fruits and seeds are distributed away from the parent plant. It helps to reduce overcrowding and competition for light, water, space and minerals from the soil.
- parent plants developed some means of dispersing seeds and fruits.
- agents that disperse fruits and seeds include wind, water and animals.
- angiosperms are flower-bearing plants while gymnosperms are cone-bearing plants.

NOW DO PRACTICE EXERCISE 4 ON THE NEXT PAGE.

Practice Exercise 4

Answer the following questions:

1. What is seed dispersal?

   _____

2. Give three kinds of competition that is likely to take place between seedlings if they are not properly dispersed?

   A. _____
   B. _____
   C. _____

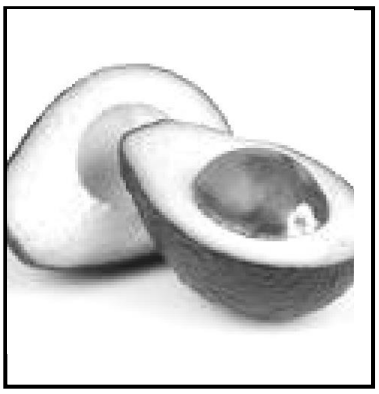
3. Differentiate dispersal from pollination.

   _____

4. Study the following plant reproductive structures and identify the agent that each uses for seed dispersal.

Sycamore

_____



Avocado

_____

Kunai

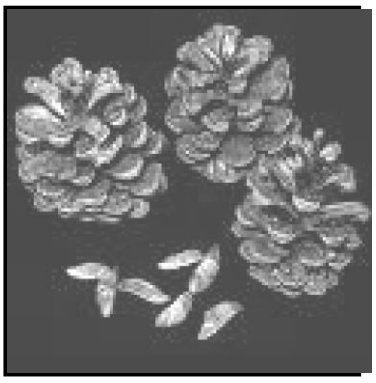
_____

Buai

_____

Coconut

_____



Cones

_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1.

Lesson 5: Development Stages in Plants

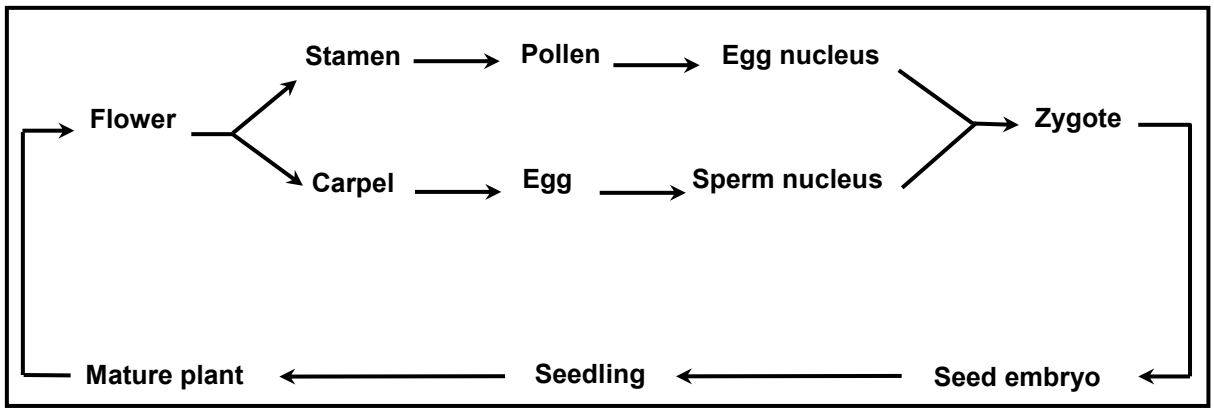
Welcome to Lesson 5 of Strand 2. Flowering plants, as their name suggests, are able to reproduce sexually using highly adapted structures called flowers. In the previous lesson you saw how sexual reproduction in plants results in the formation of seeds. You have also learnt that seeds need to be dispersed before they grow. This lesson will explain what happens to seeds after they are dispersed.

Your Aims:

- identify stages of development in flowering plants
- define the term germination
- describe the life cycle of flowering plants and
- differentiate annual from perennial plants

The Life Cycle Of Flowering Plants

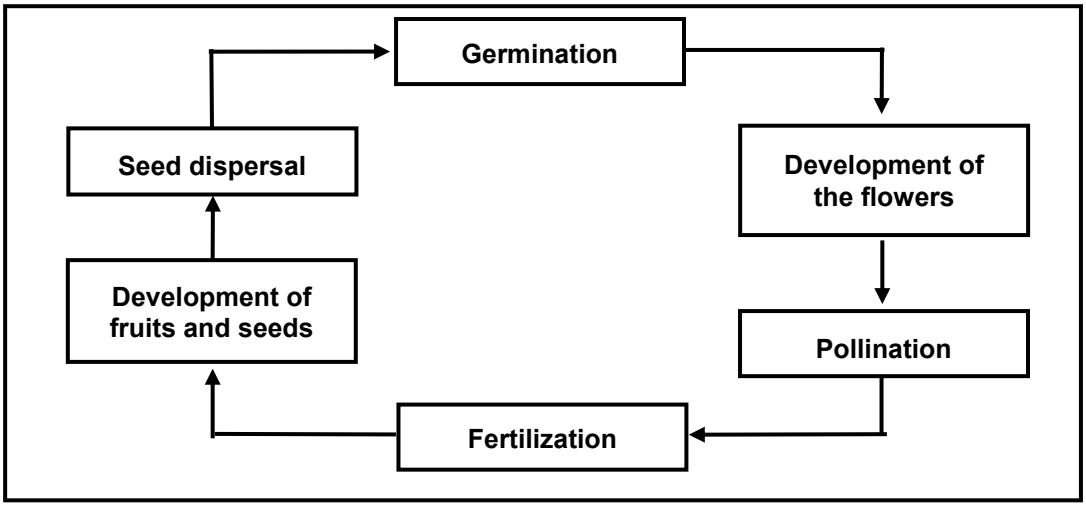
The sexual reproduction highlighted in lesson 2 and the growth and development in this lesson together make up the flowering plants' **life cycle**.



The life cycle of a flowering plant

Stages of development in flowering plants

Flowering plants reproduce sexually. The following diagram shows the stages that can be recognised in the reproduction of flowering plants.



Germination
A seed is a hard structure found inside a fruit. It is made up of an embryo, one or two cotyledons or food store and a protective seed coat. The development of a seed embryo to a new young plant is called **germination**.

What do seeds need to germinate?
What do you think a seed might need in order to germinate? List them in your writing pad. Think of an experiment which could be done to test each of your suggestions.

One of your suggestions is probably water. We will now do an experiment to discover if water is indeed needed for germination.

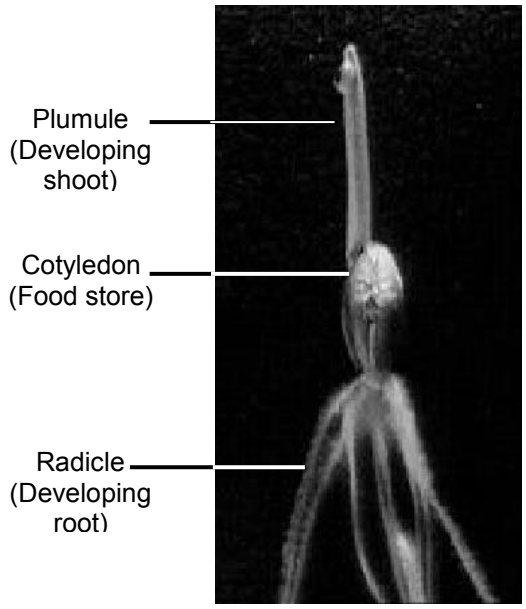
How does a seed germinate?
Water enters the seed through the hole in the seed coat called **micropyle**. As a result, the seed swells up and the seed coat or **testa** becomes soft.

The water also helps enzymes present in the seed to become active. The enzymes digest the food stored in the seed cotyledon.

Oxygen burns the digested food to release the energy needed for the growth of the seed. This process is called respiration.

The **radicle** or developing root first comes out of the seed coat and forms the root system.

The **plumule** or developing shoot too comes out of the seed coat or testa and forms the first leaf.



A germinating seed

Activity 1: Now test yourself by doing this activity.

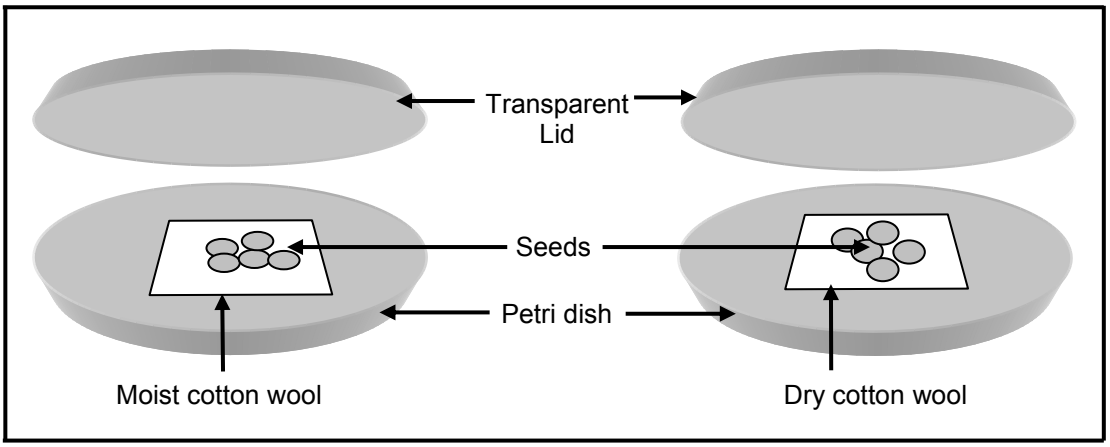
Is water needed for germination?

For this experiment use the seeds of mustard or peanuts.

1. Set up two Petri dishes side by side. Place a moist cotton wool in one of them, and a dry cotton wool in the other.

   (Two small plastic plates or wide mouthed transparent glass jars may take the place of the Petri dish. A tissue paper, rag or wet newspaper may be used instead of a cotton wool).

2. Put the seeds on the cotton wool in each dish. Cover the dishes, and place them in a warm, well lit place.



3. Observe the seeds at intervals during the next few days.

   A. Do your results support the suggestion that water is needed for seeds to germinate? _____

   B. Why was it necessary to set up a dish with a dry cotton wool as well as the one with moist cotton wool?

   _____

   _____

Conditions needed for the growth and development of a seed
The following conditions have been found to be needed for the germination of seeds:

- a supply of water
- oxygen
- a temperature of between 10^0C to 30^0C

If these conditions are not met, the seed will undergo a resting state called **dormancy**.

How is the seedling nourished?
At first the young seedling gets all the food it needs from starch stored in the cotyledon. Later on, the shoot develops green leaves, and the seedling starts making its own food by photosynthesis. It is fun to plant seeds and watch the young seedlings grow up into adult plants. The young plant matures, and under the correct light and temperature conditions gradually develop into four rings of specialized leaves called the flowers

Annual and perennial plants
Some flowering plants grow to full size, produce seed and die within one year. We call these **annual plants**. Other plants go on growing year after year. We call these **perennial plants**. Some perennials that appear from the above ground to may have died during dry seasons but are actually alive supported by their underground bulbs, tubers, runners or rhizomes.

Activity 2: **Now test yourself by doing this activity.**

Annual or perennial.

Based from the pattern of growth that you have observed from the following local plants, classify whether they are annuals or perennials.

Plant	Annual or perennial?	Plant	Annual or perennial?
1. Corn		6. Capsicum	
2. Grass		7. Banana	
3. Potato		8. Cabbage	
4. Sunflower		9. Tapioca	
5. Tomato		10. Mango	

Summary

You have come to the end of lesson 5. In this lesson you have learnt that:

- germination is the development of a seed embryo to a new young plant.
- for a seed to germinate, it has to have a supply of water, oxygen for respiration and a suitable temperature.
- when the seed‟s requirements for germination are not met, it becomes dormant.
- germination begins when water enters the hole in the seed.
- the developing root is called a radicle while a developing shoot is called a plumule.
- the developing seed is nourished by the food stored in the seed cotyledon.
- the life cycle of a flowering plant involves the development of the flower, the germination of the seed and the development of the seedling into a mature plant.
- plants that grow, bear seeds and die within a year are called annuals.
- perennials are plants that keep on growing year after year.

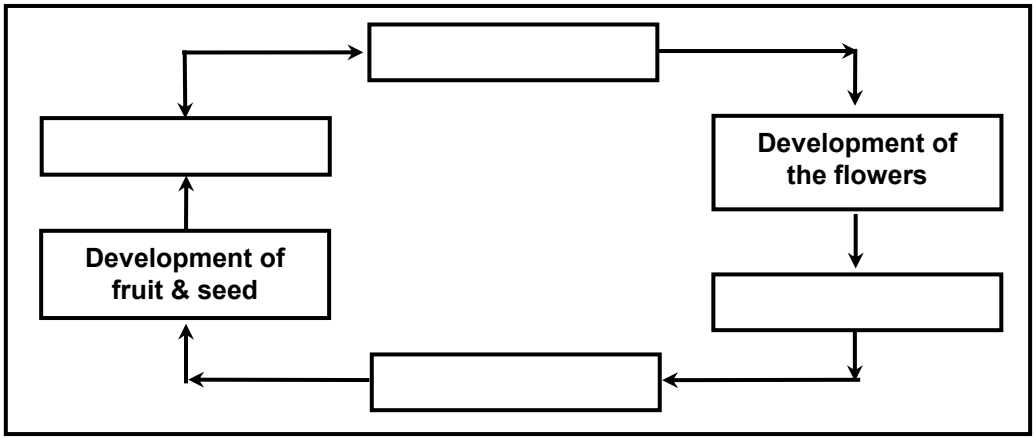
NOW DO PRACTICE EXERCISE 5 ON THE NEXT PAGE.

Practice Exercise 5

Answer the following questions:

1. Use the words in the box to fill in the given processes.

fertilization	pollination	germination	seed dispersal



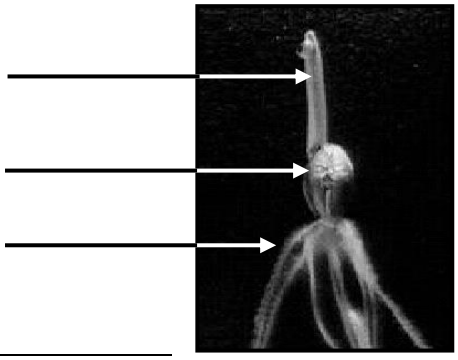
2. Complete the following paragraph.

The life cycle of a flowering plant has a number of stages. A young plant develops when a seed (i) _____. The plant matures until it produces (ii) _____ which is a collection of leaves specialised for reproduction. Male sex cells are transferred to the female part of the flower by (iii) _____ and fuse with female sex cells at (iv) _____. Following this process, the ovary develops into a (v) _____ which contains a seed and a structure to help it move away from the parent plant. This process which is called (vi) _____ requires some agent or vector to remove the seed form the parent plant.

3. Explain what happens to a seed when it does not have any contact with water.

_____

4. Label the following parts of the seedling.



(i) _____
(ii) _____
(iii) _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 1.

Answers to the Activities

Activity 1

A. Yes

B. To prove that seeds can only germinate if water or moisture is available. To show that the seeds cannot develop in dry conditions.

Activity 2

Plant	Annual or perennial?	Plant	Annual or perennial?
1. Corn	annual	6. Capsicum	annual
2. Grass	perennial	7. Banana	perennial
3. Potato	perennial	8. Cabbage	annual
4. Sunflower	annual	9. Tapioca	perennial
5. Tomato	annual	10. Mango	perennial

REVIEW OF SUB STRAND 1: PLANT REPRODUCTION

Revise all the Lessons in this Sub Strand and then do **ASSIGNMENT 2.**
Here are the main points to help you revise.

Lesson 1: Plant Reproduction

- Asexual reproduction does not involve two individuals.
- Asexual reproduction in plants is divided into two types: vegetative and artificial propagation.
- Plants can propagate vegetatively by fragmentation or by growing specialized parts such as bulbs, tubers, rhizomes, runners and spores that can grow into new plants.
- Some common artificial propagation methods include cutting, grafting, mar cottage, and rooting cutting.
- The main advantages of sexual reproduction are that it does not require two individuals and it may be rapid and result in wide dispersal.
- The main disadvantage of asexual reproduction is that it does not give rise to variety.
- Knowledge of vegetative and artificial propagation methods is important in gardening and farming for mass food production and preservation of plants with good features.

Lesson 2: Reproductive Parts in Plants

- The flower is the sexual reproductive part of the plant.
- Stamen is the male part of the flower. It contains the filament, anther and pollen.
- Carpel is the female part of the flower. It contains the stigma, style and ovary that carry the ovules.
- The male sex cells are in the pollen while the female sex cells are in the ovules.
- There are many kinds of flowers, but they all have certain features in common.

Lesson 3: Functions of Reproductive Parts in Plants

- **Pollination** is the transfer of pollen grains from the anther to the stigma.
- **Self-pollination** occurs when the transfer of pollen grains to the stigma is within the same flower or between flowers of the same plant.
- **Cross pollination** happens when the transfer of pollen grains to the stigma is between flowers from different plants of the same species.
- Transfer of pollen often requires **pollinating agents** such as insects, wind, water and other animals.
- Insect-pollinated flowers are usually scented, large, brightly coloured, and with nectar. Their pollens are sticky.
- Wind pollinated flowers are smaller, dull, not scented and does not produce any nectar. They produce a lot of small, smooth and very light pollen grains.
- **Fertilization** takes place when the male sex cell combines with the female sex cell inside the ovule in the ovary.
-

- After fertilization the ovary develops into a fruit and the ovules become seed.

Lesson 4: Seed Dispersal

- Dispersal is a plant adaptation where fruits and seeds are distributed away from the parent plant. It helps to reduce overcrowding and competition for light, water, space and minerals from the soil.
- Parent plants developed some means of dispersing seeds and fruits.
- Agents that disperse fruits and seeds include wind, water and animals.
- Angiosperms are flower-bearing plants while gymnosperms are cone-bearing plants.

Lesson 5: Development Stages in Plants

- Germination is the development of a seed embryo to a new young plant.
- For a seed to germinate, it has to have a supply of water, oxygen for respiration and a suitable temperature.
- When the seed‟s requirements for germination are not met, it undergoes a state of rest and becomes dormant.
- Germination begins when water enters the hole in the seed.
- The developing root is called a radicle while a developing shoot is called a plumule.
- The developing seed is nourished by the food stored in the seed cotyledon.
- The life cycle of a flowering plant involves the development of the flower, the germination of the seed and the development of the seedling into a mature plant.
- Plants that grow, bear seeds and die within a year are called annuals.
- Perennials are plants that keep on growing year after year.

REVISE WELL AND THEN DO SUB STRAND TEST 1 IN YOUR ASSIGNMENT 2.

Answers to Practice Exercises 1- 5

Practice Exercise 1

1. (i) **algae, mosses**
   (ii) **onions**
   (iii) **ferns, ginger**
   (iv) **apples, grapes, oranges**
   (v) **grasses**
   (vi) **potato, kaukau**
   (vii) **ferns, mosses**
   (viii) **roses, aibika**

2. A. **Tubers, bulbs**
   B. **Runners, rhizomes**
   C. **Tubers, bulbs, rhizomes**
   D. **Grafting**

3. A. **Spores allow the fern to reproduce more quickly.**
   B. **Spores cover a wider area.**

4. A. **Sexual reproduction is reproduction that involves two individuals. Asexual reproduction does not involve two individuals.**
   B. **Vegetative propagation occurs naturally**
   C. **Artificial propagation will not occur naturally to plants growing in the wild.**

Practice Exercise 2

1. **A – Pollen** **B – Anther** **C – Filament**
   D – Stamen **E – Petal** **F – Stigma**
   G – Style **H – Ovary** **I – Carpel**
   J – Sepal

2. The coloured and scented part of the flower is the **petal** while the **sepal** is the green part that used to be part of the bud. The **stamen** is the male part of the flower. It is made of filament and **anther** which bears the **pollen** or male sex cell. The female part or **carpel** is made up of **stigma**, style and ovary. Inside the ovary are the **ovules** or the female sex cells.

3. A. **To produce sex cells**
   B. **To make sure that these sex cells combine**

Practice Exercise 3

1. A. **Ovary**

   B. **Ovary**

   C. **Stigma**

   D. **Anther**

2. A. **wind**

   B. **insect / animals**

   C. **water**

3. Male sex cells - **Pollen grains**

   Female sex cells - **Ovules**

4. State whether the following flower adaptation is for the wind or the insect pollination.

Flower features	Wind or Insect Pollinated
1. large and bright petals	**insect**
2. smooth, dry pollen grains	**wind**
3. without scent	**wind**
4. with nectary	**insect**
5. sticky pollen grains	**insect**

5. A. **Pollination is the transfer of pollen from the anther to the stigma of the flower.**

   B. **Fertilisation is the fusion or combination of the male and female sex cell in the ovary of the flower.**

Practice Exercise 4

1. **Dispersal is a plant adaptation where fruits and seeds are distributed away from the parent plant to help reduce overcrowding and competition.**

2. **Competition for space, mineral nutrients, water and light.**

3. **Dispersal is the scattering and distribution of seeds while pollination is the transfer of pollen from the anther to the stigma of the flower.**

4.

Sycamore

Wind

Avocado

Animal

Kunai

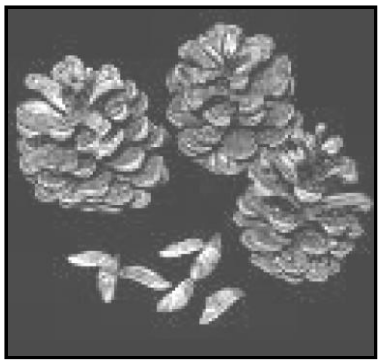
Wind

Buai

Animal/water

Coconut

Animal/water

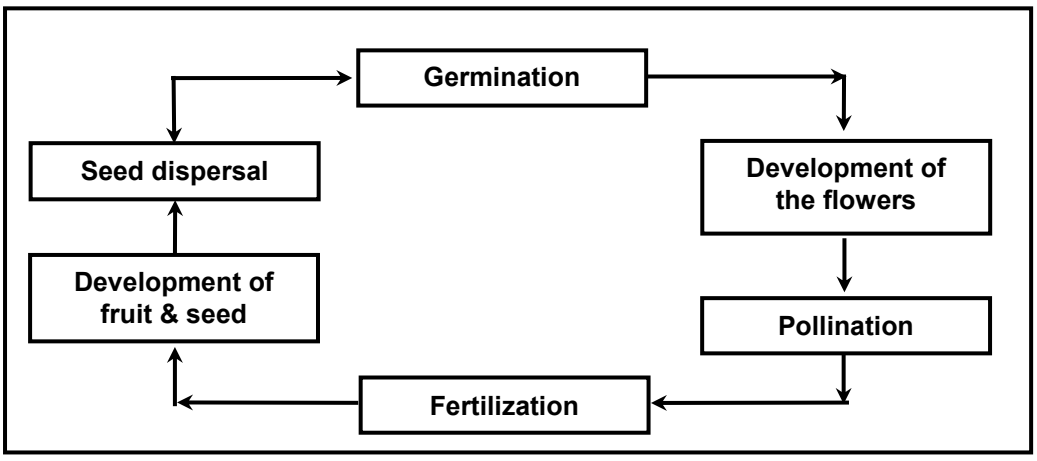


Cones

Wind

Practice Exercise 5

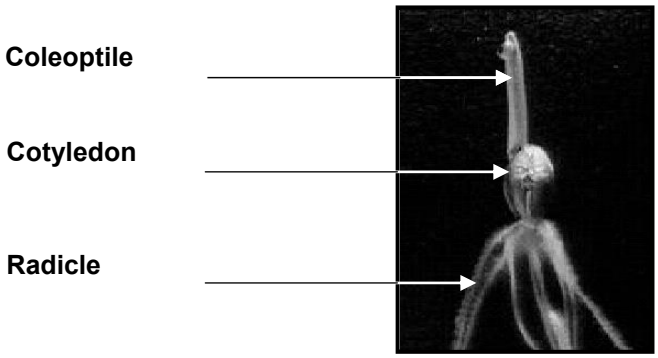
1.



2. The life cycle of a flowering plant has a number of stages. A young plant develops when a seed **germinates**. The plant matures until it produces a **flower** which is a collection of leaves specialized for reproduction. Male sex cells are transferred to the female part of the flower by **pollination** and fuse with female sex cells at **fertilization**. Following this process, the ovary develops into a **fruit** which contains a seed and a structure to help it move away from the parent plant. This process which is called **dispersal** requires some agent or vector to remove the seed form the parent plant.

3. **It undergoes a period of inactivity or dormancy.**

4.



SUB STRAND 2

ANIMAL REPRODUCTION

In this sub strand you will learn about:

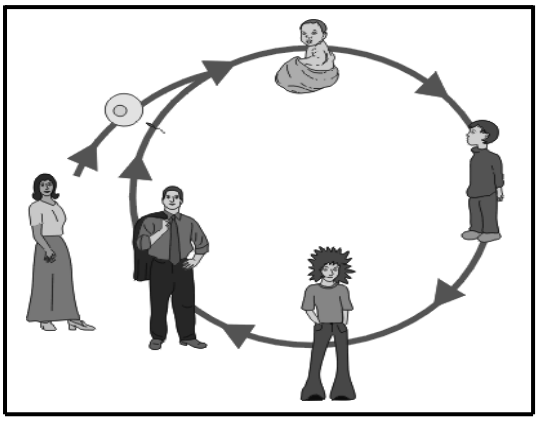
- **animal reproduction**
- **reproductive organs in animals**
- **functions of the reproductive organs**
- **growth and development in animals**
- **the environment and the sexual behaviours of animals**

SUB STRAND 2: ANIMAL REPRODUCTION

Introduction

Animals can live happily all their lives, growing, eating and moving around, but if they don't reproduce (make babies) they won't have anything to show for themselves in the future - their species will quickly die out.

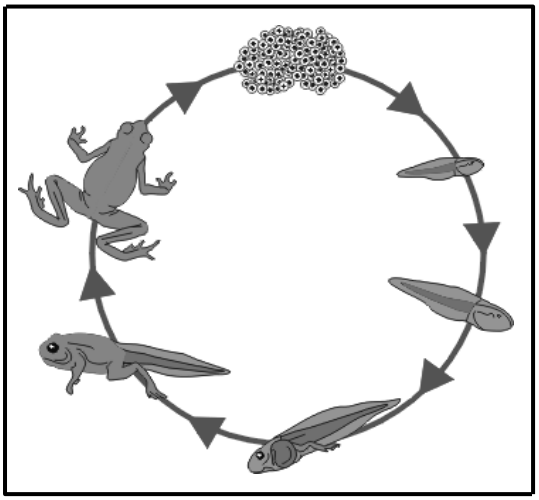
All animals reproduce. Human babies develop within their mother for nine months before they are born. They grow into children, adolescents, and eventually, adults. The human life cycle is pretty simple.



Look at the pictures on the right, where do you fit in?

But not all animals reproduce in this way. Birds lay hard-shelled eggs that hatch and produce helpless chicks. Marsupial mammals, like kangaroos give birth to tiny babies (about the size of jelly babies) that spend a long time in their mother's pouch before they are able to face the big wide world.

What about frogs? Probably one of the most amazing ways of reproducing - and you can see it in your garden pond every year. Have a look at the frog's life cycle. But if you think the frog's way of doing things is a bit strange, imagine this: not all animals need two parents to reproduce.



Amazingly, some animals like sponges and the fresh water jelly fish Hydra can sprout babies like buds growing out of the body of the parent. This is a type of asexual reproduction.

Now, you may want to know:

- What are the different reproductive organs of animals?
- How do reproductive organs of animals‟ functions?
- How does environment affect the sexual behaviours of animals?

In this Sub strand, you will find the answers to these questions and other questions relating to animal reproduction.

Lesson 6: Animal Reproduction

Welcome to Lesson 6 of strand 2. In the last lessons we learnt that all living organisms reproduce. And we studied how plants reproduce. Reproduction is one of the most important characteristics of living organisms. It means creating new life – producing young ones of their own kind. In this lesson we will study how animals reproduce.

Your Aims:

- state the difference between sexual and asexual reproduction and
- describe some methods by which animals reproduce asexually

Types of reproduction

Living organisms display several different types of reproduction. In lesson 1 we broadly grouped these into two types - asexual and sexual. Let us review their meaning.

Sexual reproduction is characterized by the fusion (joining) of two sex cells or gametes usually coming from two parents.

Asexual reproduction, is any type of reproduction that does not involve the joining of sex cells or gametes. This type of reproduction occurs mainly in micro-organisms (microbes). Microbes are the tiniest living organisms that can only be seen with a microscope.

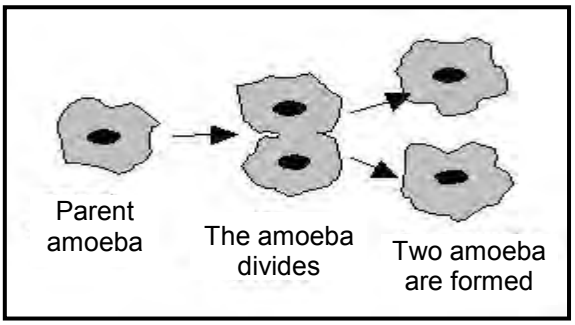
The obvious advantage of asexual reproduction is that there is no need for an organism to have a partner. This method is also fast allowing an organism to multiply quickly and easily.

Methods of asexual reproduction in microorganism

A. Binary fission

Amoeba is a single-celled animal which lives in ponds and lakes. It reproduces by splitting in two. We call this **binary fission** (fission means „splitting" and binary means „two").

First the nucleus divides into two, and then the cell splits across the middle. The two new amoebas then grow, and after a day or so each of them may split again.



Binary fission in amoeba

Activity: Now Test yourself by doing this activity.

When it is warm and plenty of food is available, Amoeba may split once every 24 hours. Dividing at this rate, complete the following table to work out how many amoeba can be formed from a single amoeba after seven days?

Day	1	2	3	4	5	6	7
Number of bacteria	2	4	8				

A Paramecium is another single-celled animal that multiply by cell division but do so much faster than amoeba. In good conditions the paramecium may divide by binary fission every 30 minutes.
At this rate, how many cells would be formed 2 paramecium cell after 4 hours?

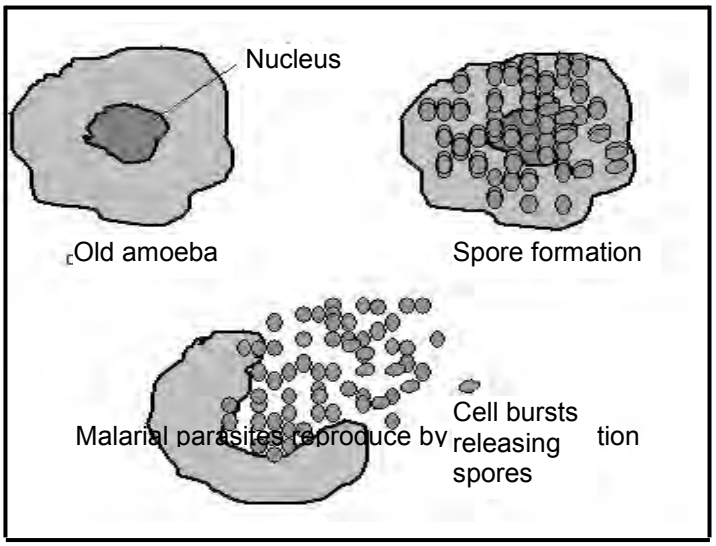
Hours	0.5	1	1.5	2	2.5	3	3.5	4
Minutes	30	60	90	120	150	180	210	240
Number of bacteria	4	8	16					

B. Spore formation

Reproduction by this method commonly takes place during unfavourable conditions. In Amoeba, for example, the nucleus gets divided into a number of small fragments. Each nuclear fragment gets surrounded by a portion of cytoplasm and thus, a number of **spores** are formed.

When the parent cell breaks down, each spore, under favourable conditions, will form a large number of daughter amoeba.

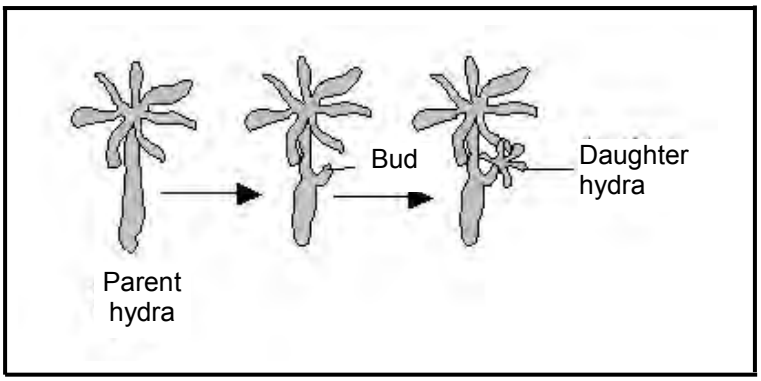
The single-celled **Plasmodium** parasites that cause malaria are known to reproduce by spore-formation inside our red blood cells.



C. Budding

Some simple animals reproduce by **budding**. Their cells or tissues send out a small outgrowth which gets larger and eventually breaks away from the parent cell.

Hydra, an aquatic animal whose adult form is attached to a rock reproduces by budding. The young bud detaches itself from the parent hydra and free-floats until it can find a new rock it can attach and colonize.



Budding in Hydra

D. Fragmentation

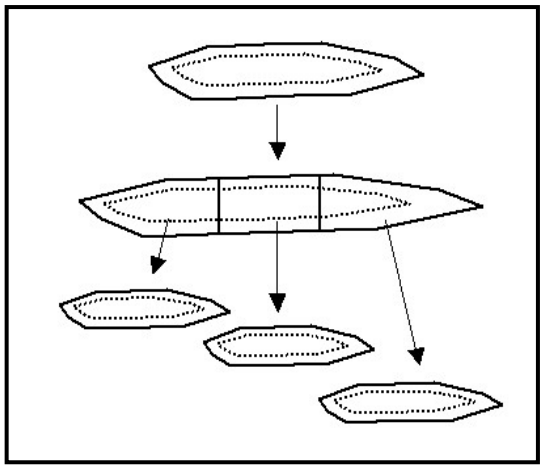
Among the animals, invertebrates such as sponges and flatworms show fragmentation. Their soft bodies simply fragment into several smaller pieces and develop into new individuals.

E. Regeneration

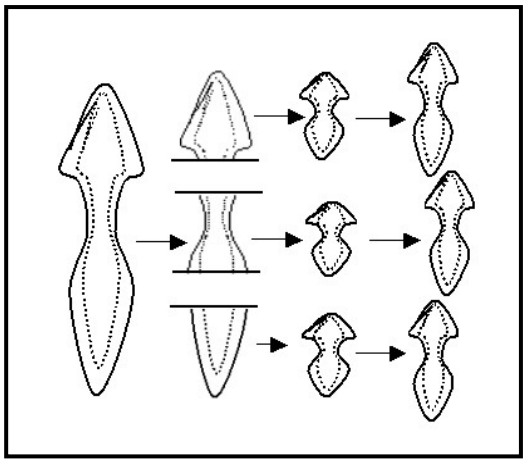
You probably have observed that if you cut your finger, it heals. Likewise a lizard that breaks off its tail when it escapes from its enemies can regrow it.

In animals, the capacity of regeneration varies but it is noted that simple animals have more power of regeneration than complicated ones.
A starfish is a simple animal. It usually has five arms. If one arm is cut off along with a part from the centre, a whole new animal will grow from the arm.

Regeneration in complex organisms like mammals is very limited. They cannot regenerate whole parts such as an arm or a leg but can only regenerate skin, hair, nails and other tissues.



Fragmentation in a flatworm



Regeneration in a flatworm

Summary

You have come to the end of lesson 6. In this lesson you have learnt that:

- sexual reproduction is characterised by the fusion of two sex cells or gametes usually coming from two parents.
- asexual reproduction does not involve the union of sex cells or gametes. A new individual is produced from a single parent.
- methods of asexual reproduction in animals include binary fission, spore formation, budding, fragmentation and regeneration.
- binary fission occurs when a single-celled animal splits to form two new daughter cells.
- spore formation happens when the nucleus of a single-celled animal divides into multiple fragments each capable of growing into a new organism when the parent cell bursts open.
- some simple animals reproduce by budding. Their cells or tissues send out a small outgrowth or bud which eventually breaks away from the parent cell.
- some soft bodied invertebrates can undergo fragmentation by breaking down into new individuals and regenerating by growing body parts into a new individuals.

NOW DO PRACTICE EXERCISE 6 ON THE NEXT PAGE.

Practice Exercise 6

Answer the following questions:

1. Which method of reproduction is observed in the following animals?

   Amoeba _____
   Flatworms _____
   Hydra _____
   Plasmodium parasites _____

2. Draw the asexual method of reproduction for the following animals:

   a. Amoeba

   b. Hydra

   c. Plasmodium parasite

3. State one advantage of asexual reproduction.

   _____
   _____

4. Which of the asexual methods in animals will produce the largest number of offspring and give the fastest rate of reproduction?

   _____

5. A single-celled organism divides by binary fission every 12 hours. How many of this organism could be formed if it splits for 3 consecutive days?

   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2.

Answers to the Activity

1. When it is warm and plenty of food is available, Amoeba may split once every 24 hours. Dividing at this rate, complete the following table to work out how many amoeba can be formed from a single amoeba after seven days?

Day	1	2	3	4	5	6	7
Number of bacteria	2	4	8	16	32	64	**128**

The simple equation in maths will be $1 \times 2^7 = 128$ (This means, if 1 bacterium divides into two seven times, 128 bacteria will be produced.)

2. A Paramecium is another single-celled animal that multiply by cell division but do so much faster than amoeba. In good conditions the paramecium may divide by binary fission every 30 minutes.

   At this rate, how many cells would be formed 2 paramecium cell after 4 hours? There are eight 30 minute periods in 4 hours. The simple math‟s equation will be $2 \times 2^8 = 512$. (This means that a total of 512 bacteria will be produced if two bacteria divide into two, eight times.)

Hours	0.5	1	1.5	2	2.5	3	3.5	4
Minutes	30	60	90	120	150	180	210	240
Number of bacteria	4	8	16	32	64	128	256	**512**

Lesson 7: Reproductive organs in animals

Welcome to Lesson 7 of Strand 2. In the last lesson you learnt about simple animals such as the, microbes and how they reproduce. However there are higher order animals like human beings that can produce offspring only by means of sexual reproduction. This requires the joining together of two sex cells inside or outside the females body. In this lesson you will learn about the human male and female reproductive organs.

Your Aims:

- list down the changes in males and females during puberty
- identify and describe the organs that make up the male and female reproductive systems

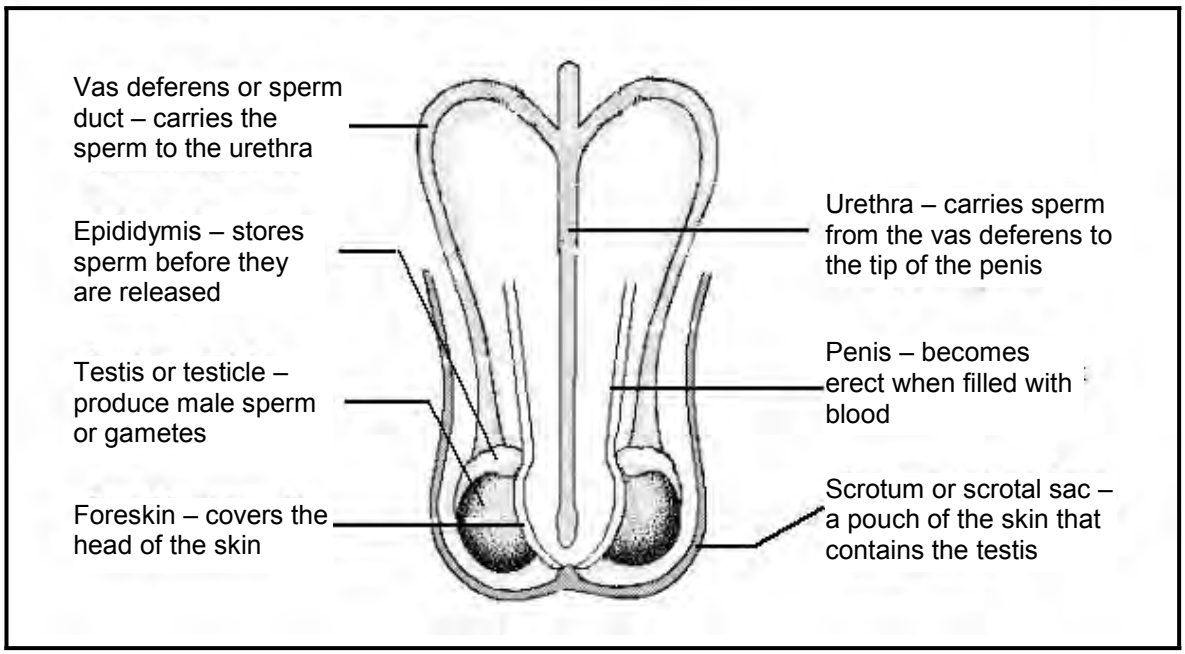
Changes During Puberty

The reproductive organs in humans only work when the organs have fully developed. **Puberty** is the stage when males and females become capable of sexual reproduction.

Males reach their sexual maturity at the age of 14-16 years when they begin to release the male sex cells or **sperms**. The other changes that also take place in males voice becomes deeper, hair on the face, pubic parts begin to grow and the muscles start developing.

While females reach their sexual maturity between the ages of 11-12 years when they start producing their sex cells or **eggs**. Some bodily changes also occur like the development of breast, widening of the hips and the voice becomes high pitched.

The Male's Reproductive Organs



There are two **testes** and they function to produce sperm. The testes lie side by side in a bag called the **scrotal sac**. The testes hang outside the main body cavity where the temperature is slightly lower than the general body temperature; sperm cells develop best at this lower temperature.

Sperm is temporarily stored in the **epididymis** but is carried by the **sperm duct** to the **urethra** when the sperm is released in the process called **ejaculation**, when the sperm cells are released from the tip of the penis.

The **penis** is used to release the sperm inside the body of the female. The head is very sensitive and is protected by the sheath-like **foreskin**.

The foreskin may be removed early on in life by an operation called **circumcision**. This may be done because the foreskin is too tight or because of a cultural or religious reason.

The **urethra** is connected to the bladder as well as the sperm ducts; it carries urine as well as sperms, but never at the same time.

The male sex cells

The male sex cells or gametes are also called sperm or **spermatozoa** (singular - spermatozoon). The male produces millions of sperm cells in his testes each day.

A fluid containing sperm cells may be released from the penis early on in puberty. This process is called **ejaculation**.

The fluid builds up in the tubes leading from the testes and it has to be released. This may occur at night, during sleep, and is called „wet dream". Not everyone experiences this, but it is quite normal and nothing to worry about.

The sperm cell contains a small capsule-shaped and a whip-like tail which helps it to propel towards the egg.

Activity: Now test yourself by doing this activity.

The human male reproductive organs

1. Where are the sperm cells stored?

   _____

2. Why do the testes hang outside the body cavity?

   _____

3. From where and to where does the sperm duct carry the sperm.

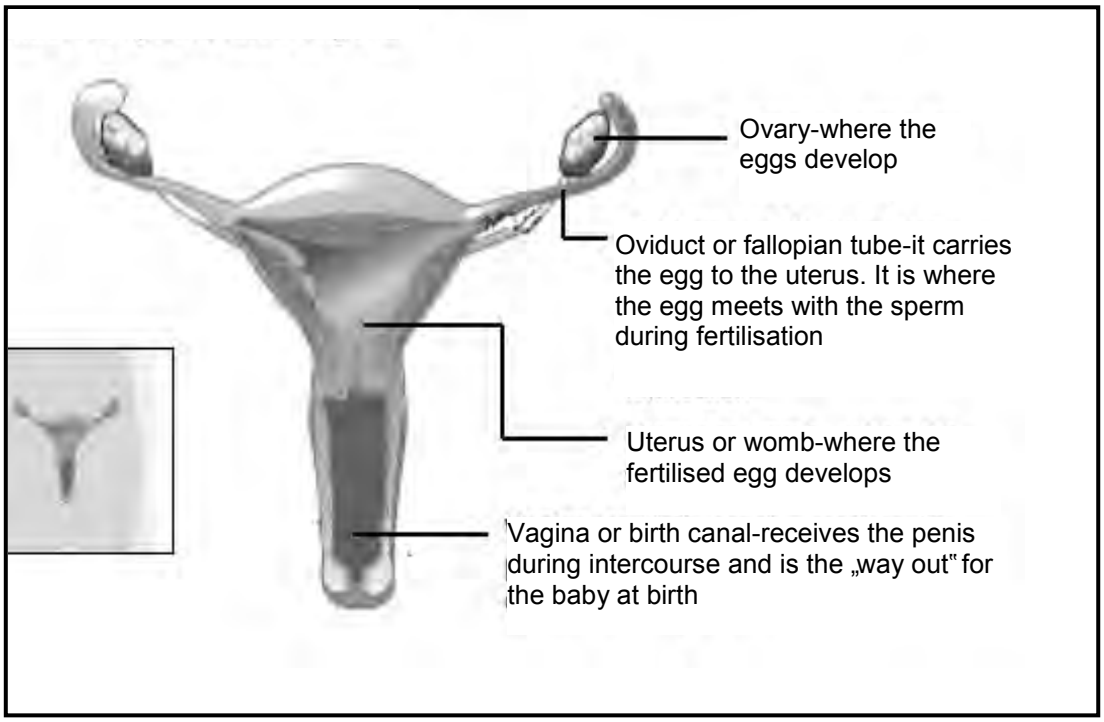
   _____

The female's reproductive organs

It is in the pair of **ovaries** where the female egg cells or **ova** are produced and developed. A tube, called the **oviduct** or the **fallopian tube**, leads from each ovary.

The oviducts open into a chamber called the **uterus** or „womb". The uterus has a soft inner lining surrounded by a thick muscular wall. It is here where the baby develops. From the uterus, a tube called the vagina leads to the outside.

The Female's Reproductive Organs

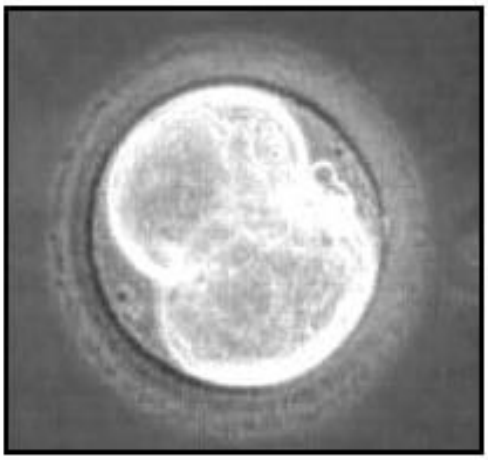


The female sex cells

The female sex cells or gametes are called egg cells or **ova** (singular - ovum). One egg cell develops and is released from one of the ovaries approximately every 28 days.

If the egg is not fertilised by a sperm, the soft inner lining of the uterus or womb will not be used for the development of a baby and is removed through menstruation.

A bleeding occurs from the uterus and a small amount of blood passes out of the vagina. This is described as a „period" or **menstruation**. This happens usually every 28 days and is a natural part of a female"s monthly cycle.



The female gamete, also known as the ovum is one of the largest cells in humans.

Summary

You have come to the end of lesson 7. In this lesson you have learnt that:

- puberty is a stage when males and females undergo some physical changes and become capable of sexual reproduction.
- when puberty is reached the testes starts releasing sperms and the male starts to ejaculate. The ovaries start releasing eggs and the females begin to have a „monthly period" and menstruate.
- the main sexual organs of the males are the testes, sperm ducts and penis.
- the main reproductive organs of the females are the ovaries, oviducts,

---

NOW DO PRACTICE EXERCISE 7 ON THE NEXT PAGE.

Practice Exercise 7

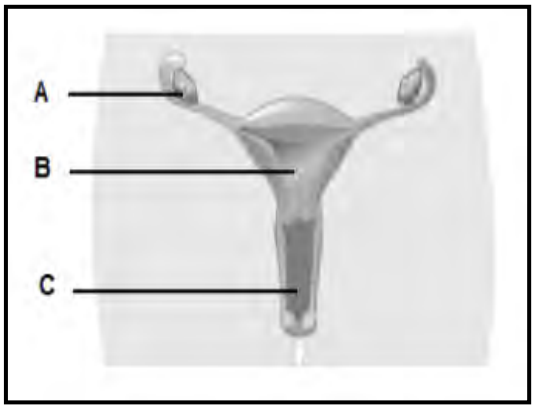
Answer the following questions:

1. Match the organs in Column A with their names in Column B.

	Column A
	Female sex cell
	Oviduct
	Birth canal
	Sperm duct
	Womb

	Column B
A	Uterus
B	Ovum
C	Vas deferens
D	Vagina
E	Fallopian tube

2. Name the parts labeled **A**, **B** and **C**.



A. _____

B. _____

C. _____

3. What is the function of the structure labeled **A**?

_____

4. In which structure, **A**, **B** or **C**, does the fertilized egg develop into a baby?

_____

5. Write the changes in the male and female body during puberty.

Male	Female
1.	1.
2.	2.
3.	3.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2.

Answers to the Activity

1. In the epididymis.

2. To keep the temperature of the testes slightly lower than the temperature of the body so sperm cells can be best produced.

3. From the epididymis to the urethra.

Lesson 8: Functions of the Reproductive Organs

Welcome to Lesson 8 of Strand 2. In the last lesson you learnt about the human male and female reproductive organs. In this lesson you will learn about the functions of the reproductive organs. Your new sexual feelings begin because your reproductive system is maturing. The rate of physical and sexual development will be different for everyone, although the process is usually complete about the age of 15 for girls and 17 for boys. Generally girls will mature about two years before the boys.

Your Aims:

- recall the parts and functions of the male and female reproductive organs
- define the process of fertilization
- describe the various steps leading to the process of fertilization
- differentiate between internal and external fertilization

Testes

The testes are the main reproductive organs in males. The function of the testes is to produce the male sex cells or the **sperm.** Releasing of a chemical called **hormone** into the blood stream is another function of the testes. This chemical goes around the body and brings about the physical changes in males at puberty.

Physical changes in males

During puberty when the body changes from that of a child to that of an adult, the testes of the males begin to produce the hormone. This hormone which is very active during puberty controls the development of the reproductive system and other sexual characteristics of a male.

Some sexual characteristics developed in males controlled by this hormone are:

- growing of the sex organs
- development of the muscles
- shoulders widen
- growth of hair on the face and pubic areas
- deepening of the voice. The teenage boy"s voice also begins to deepen occasionally „breaking" in mid-sentence. Changes at puberty are caused by a male hormone.

Facial hair of a male

Boy flexing his muscles

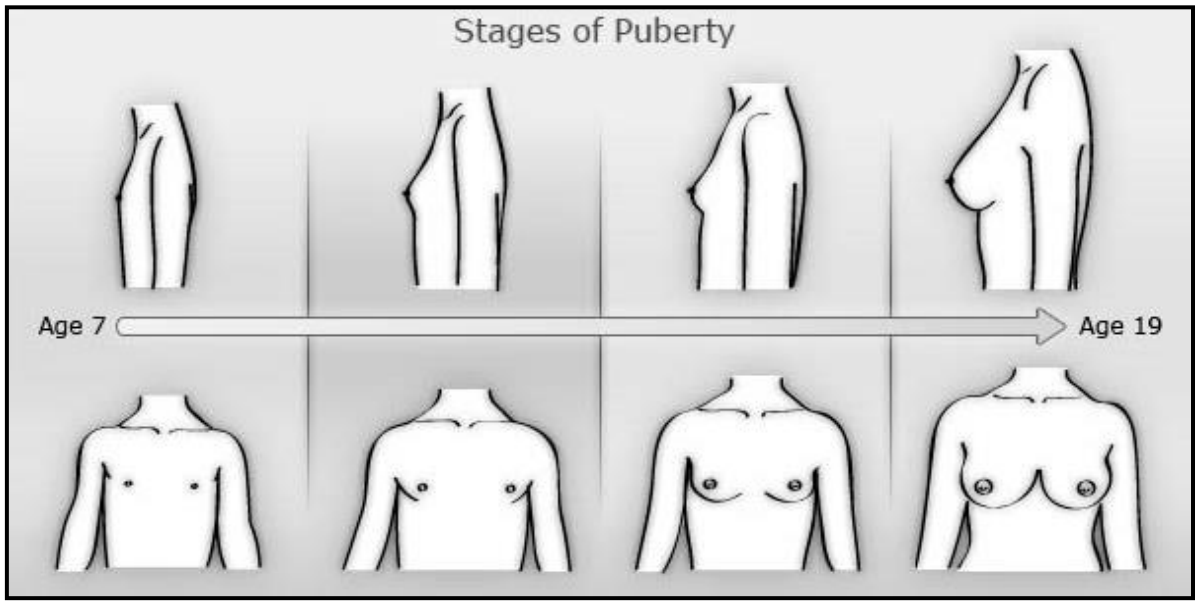
Ovaries

In females, the reproductive organs are the ovaries. If you can remember they function to release female sex cells or ova. The ovaries also function to release hormones in the blood of the female. These hormones travel around the body and are responsible for the bodily changes that take place in females at puberty.

Physical changes in females

The breasts and external genital area develop. There is a growth of hair in the pubic regions and their voice also become deeper. The girl"s hips begin to widen and her body begins to take in a more womanly shape.

At puberty, a girl will menstruate or have her first period. Changes at puberty are caused by a female hormone.



The diagram shows the girls physical development

Activity: **Now test yourself by doing this activity.**

Physical changes in males and females

1. What changes associated with puberty do males and females have in common?

   _____
   _____

2. Which changes do you think cause the most problems and/or embarrassment for many teenagers?

   _____
   _____

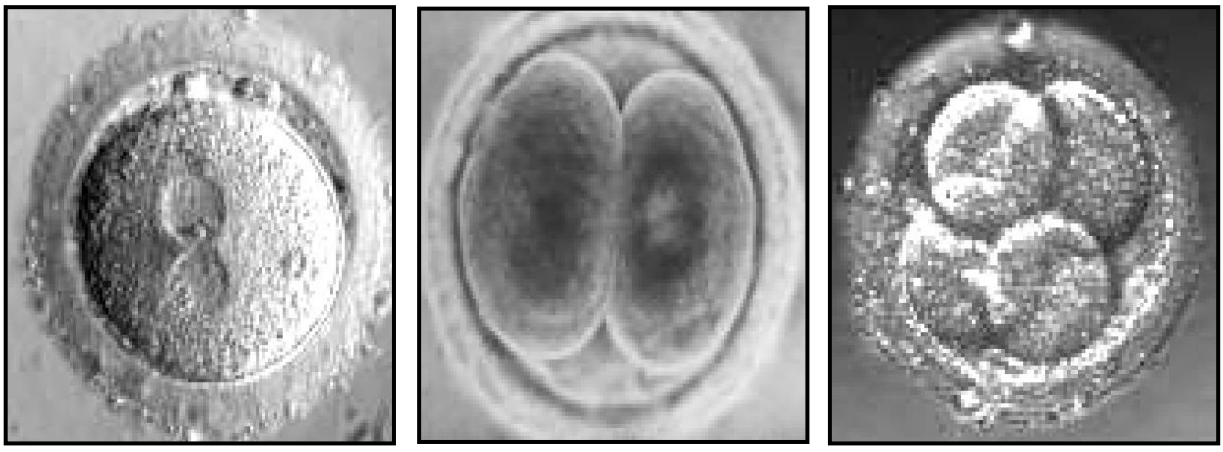
The penis and vagina as organs for sexual intercourse
The development of the sex organs during puberty prepares the young man and woman for reproduction. The male begins to produce sperms and the female starts releasing a mature egg.

In order to fertilise an egg, the sperms must be placed inside the female‟s body. This is achieved by **sexual intercourse** or **copulation**. The male organ for copulation is the **penis** while the female organ for copulation is the **vagina**.

Sexual stimulation causes blood to flow into the male‟s penis causing it to become hard. This is called **erection**. This is important because it makes sure that the sperm is deposited into the female vagina.

Fertilisation in the oviduct
Once inside the female, the sperm swim through the uterus and into the oviducts. If an egg is present in an oviduct, one of the sperms may fertilise it: the head of the sperm penetrates the egg and its nucleus combine with the egg‟s nucleus. **Fertilisation** is the joining together of an egg and a sperm nuclei. The fertilised egg is now called a **zygote**.

The uterus or womb
The zygote divides into a ball of cells called an **embryo** which moves down the oviduct to the uterus. Once in the uterus, the embryo sinks into its soft inner lining. The female is now **pregnant**.



A fertilised egg developing into an embryo

Internal and external fertilisation
In fishes and amphibians, the male and female individuals release their sex cells in water, and fertilisation takes place in water. This type of fertilisation that occurs outside the body of animals is called **external fertilisation**.

In reptiles, birds and mammals, the male discharges the male sex cells inside the body of the female. This type of fertilisation that occurs inside the body of the female is called **internal fertilisation**.

Summary

You have come to the end of lesson 8. In this lesson you have learnt that:

- the two main functions of testes is to produce sperm and release a chemical called hormone into the blood stream.
- changes caused by the male hormone during puberty include the deepening of the voice, growth of facial and pubic hairs and muscle development.
- the two functions of the ovaries in female is to release eggs and produce female hormones into the blood stream.
- the effect of female hormones is shown in the development of the breast, a high- pitched voice, growth of hairs in the pubic region and the widening of the hips.
- in order for the sperm to fertilise an egg, it must be placed inside the female‟s body in a process called sexual intercourse or copulation.
- fertilisation is the joining together of an egg and a sperm in the oviduct.
- the fertilised egg is called a zygote.
- pregnancy occurs when a dividing zygote called an embryo sticks to the wall of the uterus.
- external fertilisation is the type of fertilisation that occurs outside the body of a female. Internal fertilisation, as the name suggests, is the type of fertilisation that takes place inside the body of the female.

NOW DO PRACTICE EXERCISE 8 ON THE NEXT PAGE.

Practice Exercise 8

Answer the following questions:

1. Name the organ that:

   A. produces the egg cells. _____

   B. produces the male hormone. _____

   C. houses the developing embryo. _____

2. List down three changes that may happen to the male body under the influence of the male hormone?

   A. _____
   _____

   B. _____
   _____

   C. _____
   _____

3. List down three changes that may happen to the female body under the influence of the female hormone?

   A. _____
   _____

   B. _____
   _____

   C. _____
   _____

4. Why can humans produce babies only after both partners have reached puberty?

   _____
   _____
   _____

5. Differentiate external fertilisation from internal fertilisation.

   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2.

Answers to Activity

1. Their sex organs begin to develop, growth of pubic hair, deepening of the voice.

2. In boys, the development of pubic hair, the „breaking‟ of the voice. In females, the development of the breast, menstruation.

Lesson 9: Growth and development in animals

Welcome to Lesson 9 of Strand 2. In the last lesson you learnt about the functions of the reproductive organs. In this lesson you will learn that it takes about nine months, or 40 weeks for a fertilised egg in humans to develop and become a fully formed baby. This progress involves two linked processes - growth and development.

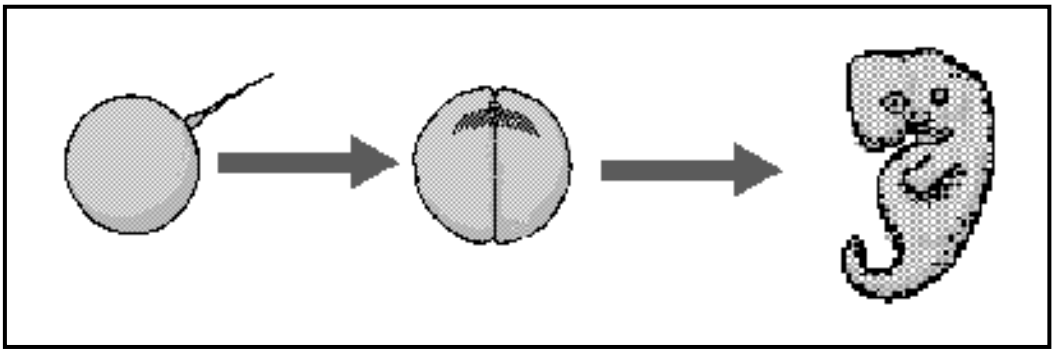
Your Aims:

- define zygote, embryo and fetus
- distinguish growth from development
- understand some sequence of events in the development of a baby

Growth

When an egg has been fertilised, it splits into two; two parts into four; four into eight; and so on. Can you recall this type of cell division? Yes, it is called binary fission. This division turns a fertilised egg into an embryo.

Growth is defined as the increase in **size** of an organism. It is the most obvious change that can be observed in a fertilised egg or **zygote** as it divides and grows into an **embryo** and into a fully grown organism.



Growth of an Embryo

Development

If you observe the growth of an embryo, you will begin to see new changes which cannot be explained by growth and an increase in the number of cells alone.

The round shape of an early embryo begins to change into a sausage shape of the foetus. If you look carefully you will see new features start to appear on the surface.

Inside the body, the heart and blood are forming. These changes, which we refer to as development, also begin soon after the egg is fertilised.

Development is defined as the change in form of an organism. This change is clearly shown when identical cells in an embryo form tissues (i.e. blood) and organs (i.e. heart). The complete period of development from fertilisation to birth is called **gestation period** or **pregnancy**.

Although it takes **nine months** for the fertilised egg to become a fully formed baby, the foetus has a recognizable human form by the 12th week of development. The vital organs are not adequately developed to support life outside the uterus (womb) until the seventh month. While in the womb, the foetus is very sensitive to the effects of drugs, alcohol, and X-rays.

Growth and development of the embryo

As the embryo grows and develops inside the mother's uterus or womb, it becomes surrounded by a bag of watery fluid.

The bag is called **amniotic sac**, and the fluid inside is called **amniotic fluid**. This bag of watery fluid helps to protect the developing embryo from damage.

By the end of the third month, the embryo is about 10 cm long, and it looks like a small human being. It is called a **foetus**.

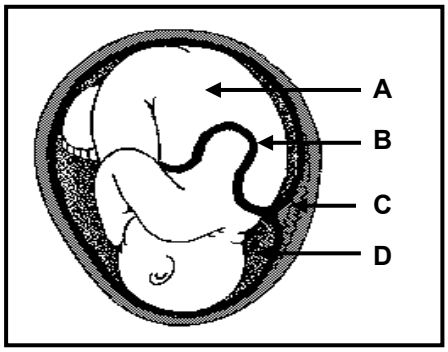
The human foetus

The foetus is nourished by a structure called **placenta**. This is shaped like a plate and is attached to the lining of the uterus. The placenta is connected to the foetus by the **umbilical cord** which contains blood vessels from the foetus.

Activity: **Now test yourself by doing this activity.**

The human foetus in the uterus

The diagram shows the human foetus inside the uterus around three months after the egg was fertilised.



1. Name **A**, **B** and **C**.

   A. _____

   B. _____

   C. _____

2. What can be found inside the structure **B**?

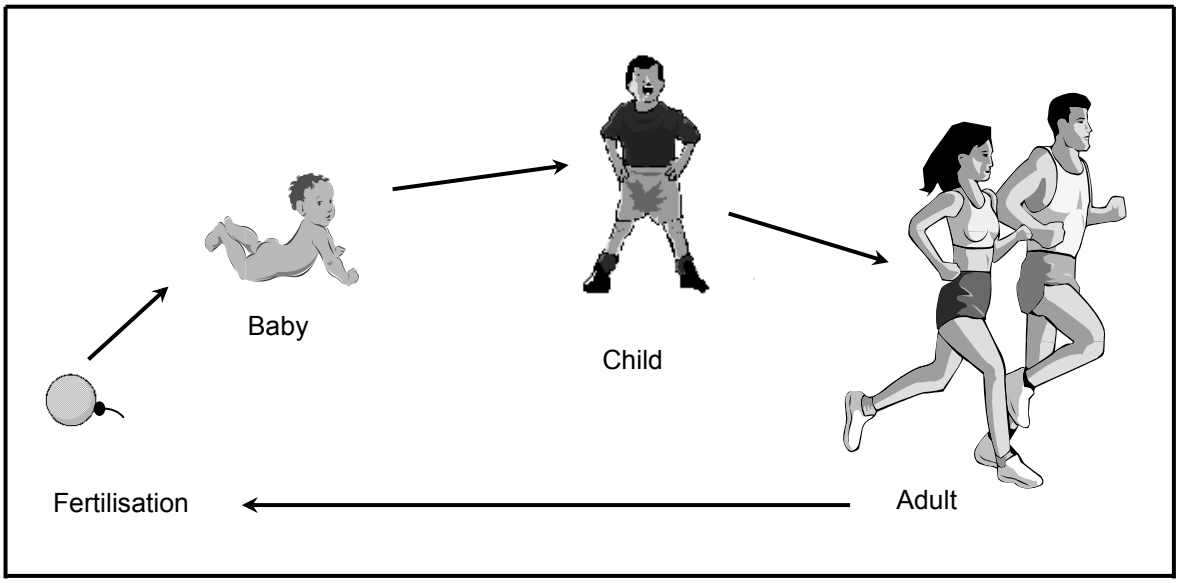
   _____

3. Label **D** is the amniotic fluid. Give its function.

   _____

Development in other animals

Some organisms are like humans. They develop gradually towards adult shape, size and structure. For example, a puppy or a kitten has most of the features of an adult dog or cat long before it is born.

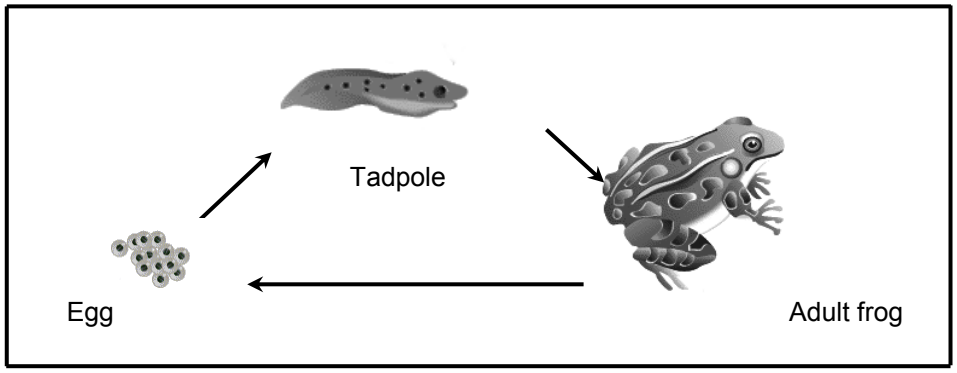


Human Life Cycle

However, a tadpole looks very different from the frog into which it will develop. We call the tadpole a **larva**. Caterpillars and maggots are examples of larval stage of insects, but they do not turn directly into adults. Instead, the change from larva to adult takes place inside a protective case. This stage is called the **pupa**.

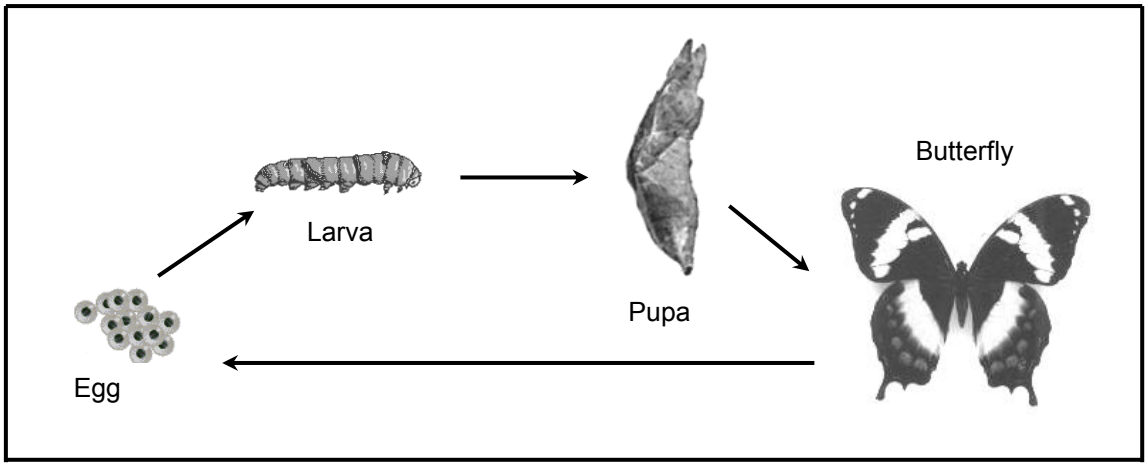
If you closely follow the development of tadpoles for 2 - 3 months, you will probably see the tremendous change which takes place as the tadpole turns into a frog or toad.

A sudden change during development is called **metamorphosis**. The tadpole structures are broken down and replaced by the adult structures. Different types of development in frogs are shown in the form of a **life cycle** below. Butterflies also has a similar metamorphosis.



The Life Cycle of a Frog

During the early stages of their lives, frogs go through a process of metamorphosis changing from eggs to larva (tadpoles) to adult frogs.



The Life Cycle of a Butterfly

The images above show butterfly eggs, a larva (caterpillar), a pupa (chrysalis) and an adult butterfly. When it is inside the pupa, the larva body mostly break up. A new butterfly body is then created inside the pupa. The caterpillar is a leaf eater while a butterfly is a nectar collector. This metamorphosis illustrates that the two forms do not compete for food.

Summary

You have come to the end of lesson 9. In this lesson you have learnt that:

- growth is the increase in size of an organism.
- development is defined as the change in form of an organism.
- a zygote is a fertilised egg. A developing zygote is an embryo.
- a foetus is an embryo that has an appearance of a fully-developed human.
- it takes nine months for a fertilised egg to become a fully formed baby.
- structures such as amniotic sac, amniotic fluid, placenta and umbilical cord help support the baby as it develops inside the uterus.
- the complete period of development from fertilisation to birth is called gestation period or pregnancy.
- the gestation period in humans lasts for nine months.
- humans and most mammals go through a slow process of development towards their adult stage.
- insects and amphibians undergo a sudden change in development in a process called metamorphosis.

NOW DO PRACTICE EXERCISE 9 ON THE NEXT PAGE.

Practice Exercise 9

Answer the following questions:

A. Multiple Choice.

Circle the letter of the correct answer.

1. An egg can develop into an adult after _____.

   A. gestation B. pollination

   C. copulation D. fertilisation

2. The change from larva to adult is called _____.

   A. growth B. pregnancy

   C. development D. metamorphosis

3. The foetus is protected from mechanical damage by the _____.

   A. vagina B. placenta

   C. amniotic fluid D. umbilical cord

4. The placenta is connected to the foetus by the _____.

   A. uterus B. oviduct

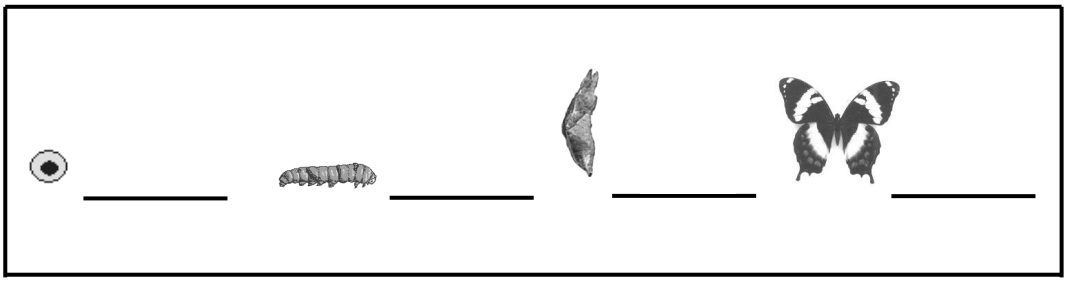
   C. fallopian tube D. umbilical cord

5. The pregnancy or gestation period of human beings is about _____ days.

   A. 4 B. 28

   C. 280 D. 365

B. Write the stages in the life cycle of a butterfly.



C. Where does the foetus or unborn baby develop?

_____

D. Briefly explain how the foetus gets its nourishment.

_____

_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB

Answers to the Activity

1. A. **Foetus**

   B. **Umbilical cord**

   C. **Placenta**

2. **Blood vessels from the foetus**

3. **D. Helps protect the developing embryo from damage.**

Lesson 10: The environment and the sexual behaviors of animals

Welcome to Lesson 10 of Strand 2. We have learnt that animals produce young by sexual reproduction. In this lesson we will learn about certain things that happen before males and females come to mate or reproduce. This is where the environment and the animal"s sexual behaviour plays an important role in reproduction.

Your Aims:

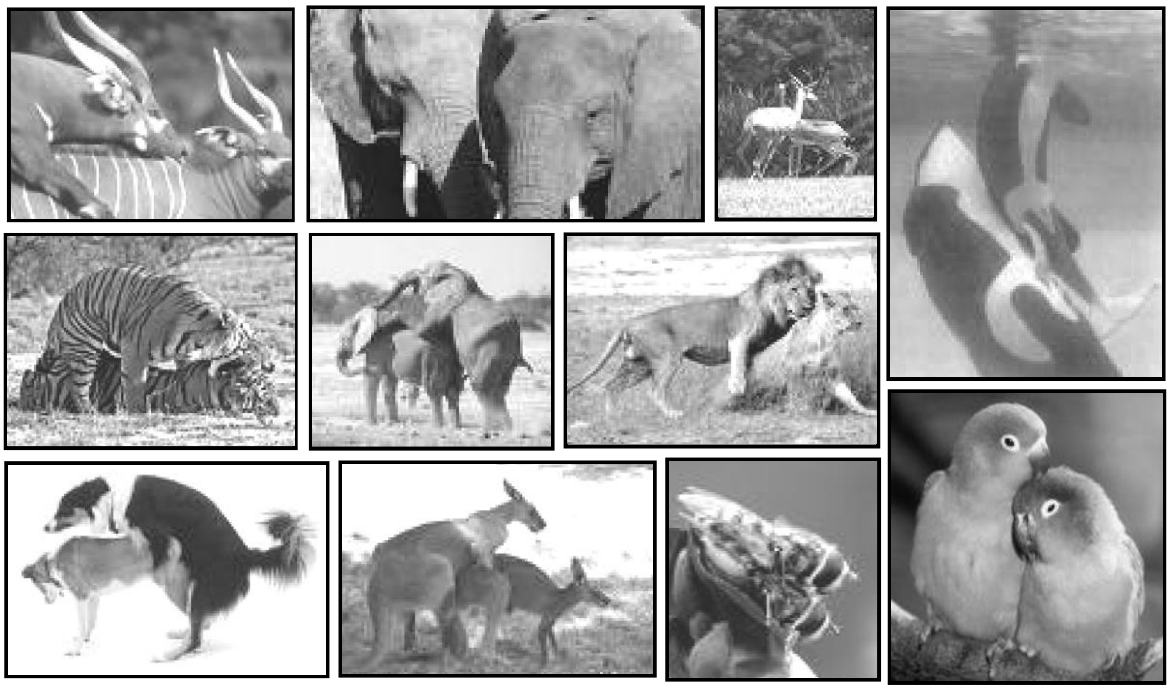
- define courtship and mating
- identify some methods used by animals in finding a partner
- list some courtship rituals observed in animals; and
- describe what happens when animals mate

Adaptations To Attract A Partner

Adaptation is a way an animal"s structure or behaviour helps it to find food, escape an enemy and finds a partner.

Males and females will have a greater chance of finding a partner and mate if they possess characteristics that can attract. To **mate** means to come in sexual union and reproduce.

Before mating takes place, many animals perform complicated series of actions referred to as **courtship**. Often the male establishes a territory to live in before finding a suitable partner to share it with.



Courtship and mating rituals in some animals

Activity: Now test yourself by doing this activity.

Watching animals mate

If it just rained and you have a pond near your house, you may be lucky enough to see common frogs or toads mating. You take a walk in the bush and perhaps you may have butterflies or grasshoppers in the vegetation. In your house you may see lizards and mosquitoes, while outside there might be cats, dogs, pigs or chickens.

Under the right conditions they will mate at any time of the year. Cats and dogs mate at least twice a year. Watch the mating animals carefully without disturbing them. Write a clear description of mating, including details of the positions of the two animals.

Questions
Observe some courtship and mating rituals of some animals. Note some differences between the male and the female. Record movements, sounds or responses that you observe before and during mating. Can you explain why they occurred?

Two examples are already given.

Animal pair	Notable differences between the pair, courtship and mating rituals
Scorpions	The male is smaller than the female. The male and female lock claws and move in circles for about an hour. The male then digs a mating chamber on the soil and they retreat into it. The smaller male moves on top of the bigger female and transfers his sex cells. After mating the female eats the male.
Giant frogs	The female is much bigger than the male. The male frog digs a sandy basin surrounded by water. He then sits and sings inside a basin until a female arrives. She makes the basin larger and swims around laying eggs while the male fertilises them behind her.

2. What passed between the two animals while they were mating? Could you see any sign of this transfer taking place?

   _____

   _____

Adaptations and strategies to attract a partner
In the animal world, males will do whatever it takes to win the mating game. They display their best body covering; they sing, dance, fight a rival, build a house, give a gift or spray a chemical in the air or on vegetation to attract a female. In the end, it‟s usually the females who do the choosing.

Below are examples of ways developed by some animals to attract a sexual partner.

1. Visual Signals

One of the best strategies to catch the attention of a mate is by visual signal. As what the famous saying say, “the eyes can see at a glance what may take many words to explain‟.

i. Light in Fireflies

Fireflies may be the most famous insects that flirt using visual signals. The female flashes her light in a specific code that tells passing males that she is interested in mating. An interested male will reply with his own signal. Both male and female continue to flash their lights until they have found each other.

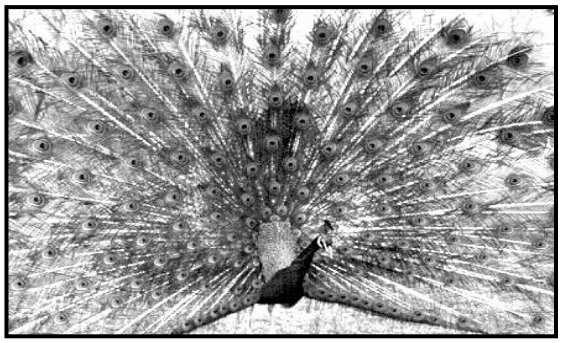
ii. Colourful Plumage in Birds

The feathers of birds, collectively called **plumage**, play several roles but are often influential in attracting a mate. The display of such plumage is also used with equal frequency by males to try to intimidate or frighten other males competing for females or for territory.

The peacock has greatly elongated upper tail feathers. The male‟s brilliant colours are used to attract females during courtship.

It is easy to spot a male peacock, ostrich and bird of paradise from their female counterpart because their plumage is more colourful and attractive looking. Females generally have a monotonous, non-attractive plumage.

The firefly generates a chemically created cold light which is known to attract a partner.



The plumage of a male peacock is used to attract a female for mating.

iii. Courtship Dance

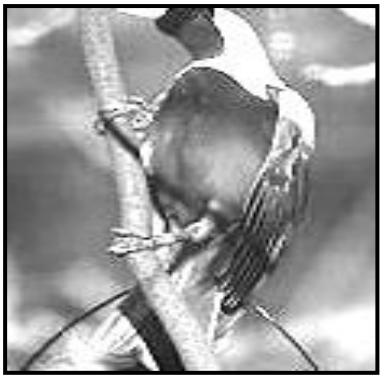
Beside their colourful plumage male peacocks, ostriches and birds of paradise also perform carefully orchestrated courtship dances to their respective females to catch and win their attention.

During the breeding season these birds choose special places visible to the females to perform their courtship dances.

Other males may be doing the same thing close by and the females will „window-shop‟ - the bird with the best display wins. The male birds of paradise lure the females to the dancing area by loud mating calls.

Their dance is enacted on a branch, with the males sometimes hanging upside- down. The female chooses the male with the most impressive dance.

The male and female ostrich perform a ritual dance before mating.

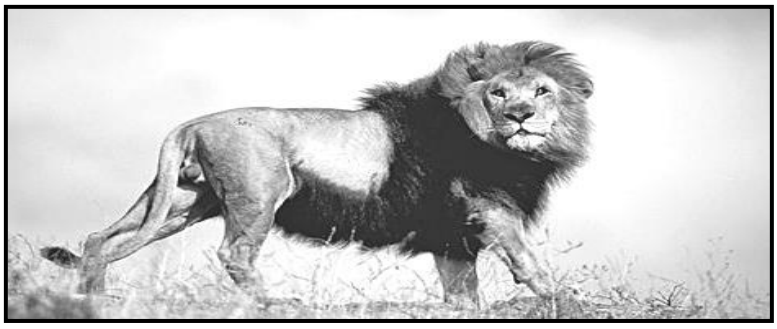


A male bird of paradise has a colourful plumage. It can also sing and dance to attract.

iv. A Show of Strength

Strength is used by some animals to attract and get females. Male cats, dogs, deer's and antelopes often resort to a battle or a fight to show off their strength and to test who is the superior male in the group.

Lions are polygamous. They have more than one mate. The strongest usually get all the female. The strongest male, or the **alpha male**, then marks his territory with his signature smell.



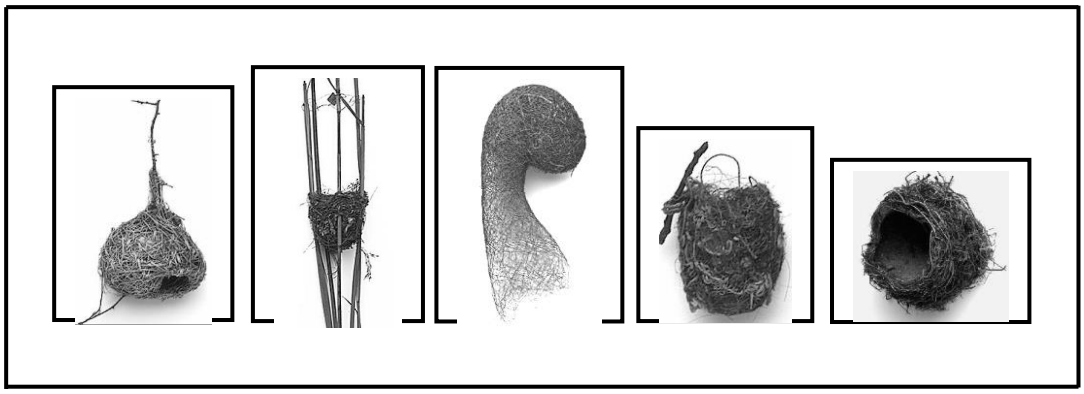
The strongest male lion in the pride or group of lions owns all the female lions. Other male lions have to challenge him over a fight and win to have the chance to mate with females. The mane (the thick hair which covers the head and neck, sometimes or to the shoulders and belly) of the strongest male is longer and fuller.

Male antelopes and deer's use length of their antlers or horns and their strength to exhibit supremacy over the other males in the territory.

v. A Gift or Present

Male bowerbirds in the outback build elaborate showgrounds of dried grasses. They decorated these arenas with piles of animals‟ bones, shiny aluminium foils, and shards of broken glasses, colourful stones and strips of coloured plastics.

If the male designed and constructed a good bower, then he wins a very good prize - a female who chooses him as a mate. Other male birds have to build a nest to entice a female. The female agrees to mate and lay eggs after she approves of the best nest.



Examples of Intricately Designed Nests Built by Some Species of Birds

2. Courtship Calls

If you have heard the chirp of a cricket, you‟ve listened to an insect calling for a mate. Most insects that make sound do so for the purpose of mating. These calls are called **mating** or **courtship calls.**

Sounds to attract a female can be produced in different ways. Some rub their forewings, a few underground insects construct entrance tunnels from which they amplify their calls, and others simply tap on a hard surface to produce their love calls.

Birds communicate among themselves by voice in many ways, often recognising their mates or young by sound rather than sight. The songs of birds are not always the beautiful sounds of nightingales or canaries, but they are important to all birds, particularly males, in communicating.

Male birds sing to attract a mate and define its territory to other birds. In many species, the more complex the song, the more likely the male bird is to find a mate. The very basic elements of a birdsong are inborn but the more elaborate songs are learned.

Male frogs cry out to advertise their virility or „maleness‟. Female frogs squeak just before they release their eggs to announce their fertility.

This male frog makes a bell-like sound. Hundreds of males may sing together in a nocturnal mating chorus.

The field cricket is popular with its chirping call. It is nocturnal, active only at night.

3.

Some female animals leave a special scent trail in the air or in the vegetation when they are ready to mate with a male. Female cats, dogs and insects are able to do this behaviour when they are „on heat" and about to produce an egg.

The strongest male dog or cat in a group uses his signature odour to mark his territory so that rival males will be alarmed of his presence. His scent is also transferred to the family members for recognition.

This male moth"s feather-like antennae are very receptive to the chemicals that the female moth sprays in the air. It can be used to tract a female even in the dark.

Female moths and butterflies can spray and leave their trail in the air. The males spend much of their afternoon patrolling for receptive females.

The scents produced by these animals can be very powerful it can attract males from miles around.

Some animals have a facial gland, in front of each eye, which contains a strongly scented substance used to mark its home range. The strongest scent can be used to attract females and warn other males.

Eggs and sperm

Eggs and sperm are single cells. **Eggs** are rather large because they often contain a store food called **yolk**.

Sperm are very small and have a long tail which lashes from side to side, enabling them to swing to the egg. Millions of sperms are released for each egg even if only one is needed to fertilise it. This increases the chances of successful fertilisation.

When animals are mating, it is quite difficult to see anything passing between them. This is because their bodies are very close together to make sure that the eggs and sperms meet.

Summary

You have come to the end of lesson 10. In this lesson you have learnt that:

- an adaptation is a way an animal"s structure or behaviour helps it to find food, escape an enemy and finds a partner.
- mating occurs when the male and female body come together in sexual union in order to reproduce;
- before mating takes place, many animals perform complicated series of actions referred to as courtship.
- in the animal world males are the ones that usually show off their assets. They display their best body covering; they sing, dance, fight a rival, build a house, give a gift or spray a chemical in the air or on vegetation to attract a female.
- to attract the attention of sexual partners, animals often send visual or chemical signals, or send out a mating call.
- eggs are rather large because they often contain a store food called yolk.
- sperms are very small and have a long tail which flicks from side to side, enabling them to swing to the egg.

NOW DO PRACTICE EXERCISE 10 ON THE NEXT PAGE.

Practice Exercise 10

Answer the following questions:

1. The following are some strategies used by some animals to attract a partner. Classify if they are a **visual signal**, **chemical signal** or a **courtship call**.

Strategy	Type of Signal
1. The wild boar walks round and round the female, sometimes for hours until she decides she is ready to mate.	
2. Female dogs that are ready to mate leave a special odour in their urine to attract other male dogs. The male dogs trace this smell by sniffing.	
3. The crane birds start with a long duet. Then they take turns in bowing, crouching and leaping in the air, flapping their wings furiously.	
4. Male monkeys generate a series of cantankerous sounds in order to keep other males away while at the same time attracting females.	
5. A male rat sprays its urine in the area. Females that smell his urine begins to produce eggs and become very friendly to him.	

2. Give the importance of the two processes in animal reproduction.

   Courtship- _____
   _____

   Mating- _____
   _____

3. What is passed between the two animals while they are mating?
   _____

4. Why is it difficult to see the process of fertilisation?
   _____
   _____

5. Briefly describe the sperm and explain how it is adapted to carry out its function.
   _____
   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 2.

Answers to Activity

1. Answers may vary depending on the pair of animals chosen to be observed.

2. The male sex cell is passed on to the females. Yes, because the partners are positioned so close together so that the sex cells can easily meet.

REVIEW OF SUB STRAND 2: ANIMAL REPRODUCTION

Revise all the Lessons in this Sub Strand and then do **ASSIGNMENT 2.**
Here are the main points to help you revise.

Lesson 6: Animal Reproduction

- Sexual reproduction is characterised by the fusion of two sex cells or gametes usually coming from two parents.
- Asexual reproduction does not involve the union of sex cells or gametes. New individual is produced from a single parent.
- Methods of asexual reproduction in animals include binary fission, spore formation, budding, fragmentation and regeneration.
- Binary fission occurs when a single-celled animal splits to form two new daughter cells.
- Spore formation happens when the nucleus of a single-celled animal divides into multiple fragments each capable of growing into a new organism when the parent cell bursts open.
- Some simple animals reproduce by budding. Their cells or tissues send out a small outgrowth or bud which eventually breaks away from the parent cell.
- Some soft bodied invertebrates can undergo fragmentation by breaking down into new individuals and regeneration by growing body parts into a new individuals.

Lesson 7: Reproductive Organs in Animals

- Puberty is a stage when males and females undergo some physical changes and become capable of sexual reproduction.
- When puberty is reached the testes starts releasing sperms and the male starts to ejaculate. The ovaries start releasing eggs and the females begin to have a „monthly period" and menstruate.
- The main sexual organs of the males are the testes, sperm ducts and penis.
- The main reproductive organs of the females are the ovaries, oviducts, uterus and vagina.

Lesson 8: Functions of the Reproductive Organs

- The testes functions to produce sperm and release a chemical called hormone.
- The male hormone is released into the bloodstream and causes changes in the male body during puberty.
- Changes caused by the male hormone during puberty include the deepening of the voice, growth of facial and pubic hairs, and muscle development.
- Ovaries in female function to release eggs. They also produce female hormones.
- Female hormones are released into the bloodstream and cause bodily changes in females at puberty.

- The effect of female hormones is shown in the development of the breast, a high- pitched voice, growth of hairs in the pubic region, and the widening of the hips.
- In order for the sperm to fertilise an egg, it must be placed inside the female‟s body in a process called sexual intercourse or copulation.
- Fertilisation is the joining together of an egg and a sperm in the oviduct.
- The fertilised egg is called a zygote.
- Pregnancy occurs when a dividing zygote called an embryo sticks to the wall of the uterus.
- External fertilisation is the type of fertilisation that occurs outside the body of a female. Internal fertilisation, as the name suggests, is the type of fertilisation that takes place inside the body of the female.

Lesson 9: Growth and development in Animals

- Growth is the increase in size of an organism.
- Development is defined as the change in form of an organism.
- A zygote is a fertilised egg. A developing zygote is an embryo.
- A foetus is an embryo that has an appearance of a fully-developed human.
- It takes nine months for a fertilised egg to become a fully formed baby.
- Structures such as amniotic sac, amniotic fluid, placenta and umbilical cord help support the baby as it develops inside the uterus.
- The complete period of development from fertilisation to birth is called gestation period or pregnancy.
- The gestation period in humans lasts for nine months.
- Humans and most mammals go through a slow process of development towards their adult stage.
- Insects and amphibians undergo a sudden change in development in a process called metamorphosis.

Lesson 10: The Environment and the Sexual Behaviours of Animals

- An adaptation is a way an animal‟s structure or behaviour helps it to find food, escape an enemy and finds a partner.
- Mating occurs when the male and female body come together in sexual union in order to reproduce.
- Before mating takes place, many animals perform complicated series of actions referred to as courtship.
- In the animal world males are the ones that usually show off their assets. They display their best body covering; they sing, dance, fight a rival, build a house, give a gift or spray a chemical in the air or on vegetation to attract a female.
- To attract the attention of sexual partners, animals often send visual or chemical signals, or send out a mating call.
- Eggs are rather large because they often contain a store food called yolk.
- Sperms are very small and have a long tail which flicks from side to side, enabling them to swing to the egg.

REVISE WELL AND THEN DO SUB STRAND TEST 2 IN YOUR ASSIGNMENT 2.

Answers to Practice Exercises 6- 10

Practice Exercises 6

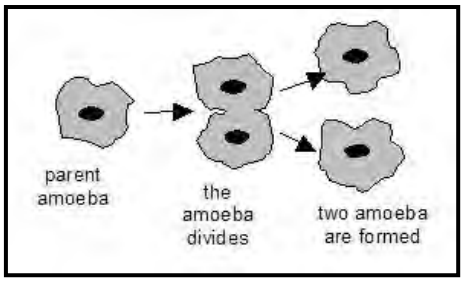
1. Amoeba **binary fission or spore formation**

   Flatworm **fragmentation or regeneration**

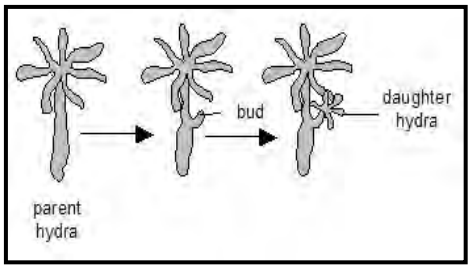
   Hydra **budding**

   Plasmodium parasites **spore formation**

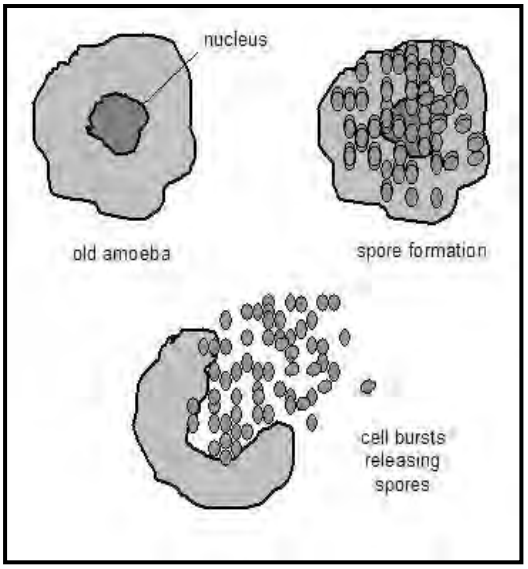
2. A. Amoeba



B. Hydra



C. Plasmodium parasite



3. **There is no need for an organism to have a partner. / This method is also fast allowing an organism to multiply quickly and easily.**

4. **Spore formation**

5.

Hours	12	24	36	48	60	72
Day	$^1/_2$	1	$1\ ^1/_2$	2	$2\ ^1/_2$	3
Number of bacteria	2	4	8	16	32	**64**

Or **$1 \times 2^6 = 64$**

Practice Exercise 7

1.

	Column A
B	Female sex cell
E	Oviduct
D	Birth canal
C	Sperm duct
A	Womb

	Column B
A	Uterus
B	Ovum
C	Vas deferens
D	Vagina
E	Fallopian tube

2. A. **Ovary**

   B. **Uterus/ Womb**

   C. **Vagina**

3. **To develop and release the eggs or ova**

4. **The baby develops inside the structure labeled B, the uterus.**

5.

Male	Female
1. **growth of facial hairs**	1. **the breasts develop**
2. **the voice deepens**	2. **the voice becomes high-pitched**
3. **the muscles develop**	3. **the hips widen**

Practice Exercise 8

1.

   A. **Ovaries**

   B. **Ovaries**

   C. **Uterus or Womb**

2. A. **Development of the muscles**

   B. **Deepening of the voice**

   C. **Growth of facial hairs/ growth of hairs in the pubic regions**

3. A. **The breasts and external genital area develops.**

B. **There is a growth of hair in the pubic regions and their voice also become deeper.**

C. **The girl's hips begin to widen and have her first period or menstruation.**

4. **Because it is only when the male and female partners reach puberty that their sex organs begin to develop and start producing sex cells needed for making babies.**

5. **External fertilisation occurs when the egg cell is fertilised by the sperm outside the female body while internal fertilisation takes place when the egg cell is fertilised by the sperm inside the female body.**

Practice Exercise 9

1. **D**

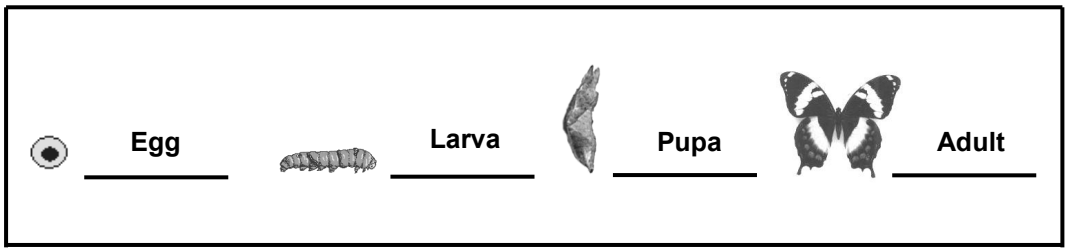
2. **D**

3. **C**

4. **D**

5. **C**

B.



C. **In the uterus or womb**

D. **From the mother's placenta through the umbilical cord**

Practice Exercise 10

1.

Strategy	Type of Signal
1. The wild boar walks round and round the female, sometimes for hours until she decides she is ready to mate.	**visual**
2. Female dogs that are ready to mate leave a special odour in their urine to attract other male dogs. The male dogs trace this smell by sniffing.	**chemical**

3. The crane birds start with a long duet. Then they take turns in bowing, crouching and leaping in the air, flapping their wings furiously.	**courtship call/ visual**
4. Male monkeys generate a series of cantankerous sounds in order to keep other males away while at the same time attracting females.	**Courtship call**
5. A rat sprays its urine in the area, Females that smell his urine begins to produce eggs and become very friendly to him.	**chemical**

2. Courtship- **This complicated series of action helps animals find their sexual partner.**

   Mating- **This process brings the body of the male and female closer so that the sperm can easily be transferred to the female.**

3. **The male sex cells/ the sperms are passed to the female.**

4. **Because the male and the female body are joined together. Because the male and female sex cells are very tiny**

5. **The sperms are very small and have a long tail which flicks from side to side, enabling them to swing to the egg.**

SUB STRAND 3

RENEWABLE AND NON-RENEWABLE RESOURCES

In this sub strand you will learn about:

- **renewable resources**
- **non-renewable resources**
- **biodegradable materials**
- **nutrient cycle**
- **non- biodegradable materials**

SUB STRAND 3: RENEWABLE AND NON-RENEWABLE RESOURCES

Introduction

A renewable resource is something that is being continually replaced faster than we use it up.

- Solar energy is considered a renewable source of energy because the sun's energy is continuous. (Note that the rest of these lists are all forms of solar power.)
- Wind Power
- Water Power (Hydro-electricity from dammed rivers, tidal streams and ocean waves)
- Thermal Power from the earth (Geothermal: Using the earth's heat to generate electricity)
- Thermal Power from the ocean
- Biomass, the burning of plant material, is a renewable resource. Even though the burning puts carbon dioxide into the atmosphere, it also prevents a much greater amount of methane being released by the decomposing vegetation, so it is rated as positive.
- Trees are renewable because we can replant them.

A non-renewable resource is something that is not being replaced as we consume it. Oil is a good example of a non-renewable resource. It is used to make gasoline and other fuels, as well as plastics, such as grocery bags. We are using billions of gallons of oil every year, but it takes millions of years to be replaced. We are using up oil much faster than it is being produced. Once we use up oil from the earth, it's gone. We can't wait millions of years for some more. Coal, Peat and Uranium are non-renewable.

Now, you may want to know

- How can we replace the renewable resources?
- How does nutrient cycle affect the environment?
- What are the biodegradable and non-biodegradable materials?

In this Sub strand, you will find the answers to these questions and other questions relating to renewable and non-renewable resources.

Lesson 11: Renewable Resources

Welcome to Lesson 11 of Strand 2. In this lesson you will learn that the earth consist of some resources that living things simply cannot live without. These naturally occurring resources are often taken for granted especially by man because they exist in abundance. These resources have been greatly reduced by our actions.

Your Aims:

- define what a natural resource is and give examples
- differentiate the two types of resources: renewable and non-renewable
- explain what a renewable resource is and give examples
- state what contributes to the depletion of natural resources
- suggest ways of conserving natural resources

Natural Resources

Any natural source that living things use can be considered as **natural resources**. Natural resources include such things as sunlight, wind, water, soil, minerals, plants, animals, forests and fossil fuels.

Types of natural resources

Some natural resources cannot be replaced. These are called **non-renewable** resources and will be discussed in the next lesson.

Other resources are continually being replaced, even as they are being used. These are called **renewable resources**.

Renewable resources

1. Sunlight

   Almost all of the energy on Earth can be traced back to the sun. Energy from the Sun heats up the land, the water and the air, causing wind, rain, waves and sea currents.

   The sun is the original source of energy for all life on Earth. Green plants are able to trap light energy and convert it to chemical energy that they can store or transfer to other organisms.

By using solar panels, such as in this home, the energy from the Sun's rays can be converted directly into a usable form of energy**.** The sun is a renewable resource.

Activity 1: Now test yourself by doing this activity.

Uses of **sunlight**

List 4 ways in which living things use sunlight.

A. _____
B. _____
C. _____
D. _____

---

2. Air and wind

Air contains oxygen that plants and animals use for respiration. It also contains carbon dioxide needed for food production in plants.

Wind or moving air is used to sail boats, or turn the blades of a wind machine.

Wind turbine generators are increasingly used as alternative sources of electricity generation.

The use of wind as a source of electrical energy is increasing world-wide. They are much less harmful to the environment than other sources of energy, but can only work in places that are constantly windy.

3. Water

Water is needed by plants and animals. It is an important chemical that makes up the cells of all living things. It dissolves a lot of substances, transports them, breaks them down and even combines them. It serves a lot of functions in the body of all organisms.

About 70 percent of the Earth‟s surface is water. It is found in the oceans, lakes and rivers where it evaporates. It falls as rain and snow over high ground and flows back to the ocean as the cycle continues.

If it is divided evenly, each person is estimated to get about 1 trillion gallon each. It would seem concern in the planet.

Moving water can power machinery like this water-powered mill.

Activity 2: **Now test yourself by doing this activity.**

Uses of air and water

List 5 ways in which living things use air and water.

Air or wind:

A. _____

B. _____

C. _____

D. _____

E. _____

Water:

A. _____

B. _____

C. _____

D. _____

E. _____

---

4. Resources from living things

Plants are the primary source of food on Earth. They provide energy directly or indirectly to all animals by feeding. Trees that are cut down to be used for housing, furniture or firewood, and fruits and vegetable that are picked can be replaced by replanting.

Animals are an important source of protein. Cows, chickens and fishes reproduce and can be harvested each year.

Plants and animals are renewable resources because they can be replaced.

5. Soil

Soil is a resource because it is used by most organisms. Plants use it for growth and anchorage. Burrowing animals and decomposers use it for shelter. Humans use it for growing crops.

It is renewable because under normal conditions it can replenish its nutrients, and retain its moisture as it is being used.

Some renewable resources are inexhaustible

Renewable resources such as the wind and sunlight are so abundant that they are considered to be inexhaustible. They cannot all be used up.

No matter how much solar energy we use, sunlight will continue to stream toward the Earth as long as the sun shines.

Other renewable resources can be depleted

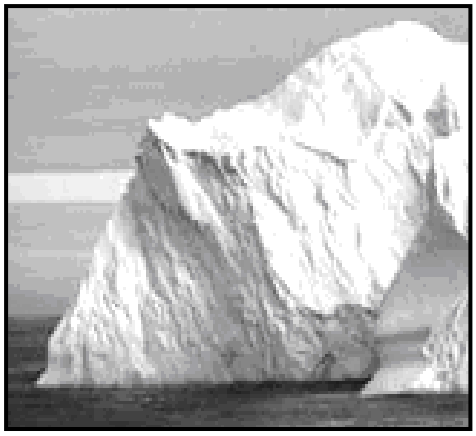
Renewable resources can be depleted. **Resource depletion** takes place when a large part of a natural resource has been used up faster than it can be replaced.

Causes of the depletion of renewable resources

As the human population increases, the demand for freshwater use in drinking and agriculture also increases.

There is a lot of water but most is saltwater and not suitable for plant and animal use. Only 3% of the earth‟s water is fresh and most of this is permanently frozen in the polar icecaps.

If trees are cut down faster than new ones are grown, we will run out of trees.



Most freshwater are permanently frozen.

If the soil is over-used because of farming, it can no longer be of use to plants as it looses its fertility. It deteriorates and becomes desert-like.

It is hard for a rainforest to recover after it is denuded. This deforested valley erodes away and may soon resemble a desert.

An irrigation canal turns uncultivated valleys into rich farm lands but it also uses a lot of water.

Caring for renewable resources

Correct farming and fishing techniques, soil and water conservation, forest protection and management, and reforestation and family planning programs to help control the population are just some of the ways we can do to protect and care for our renewable resources.

We must be careful about how we use renewable resources, and we must learn to use them at a rate that allows them to renew themselves.

If we eat these fishes no faster than nature replaces them, there may be enough of these resources in the future.

Water

Water is an important substance that makes up all living things. It is used by plants as a means of transporting food and minerals. It is a material needed for photosynthesis. Animals need water to quench their thirst. It is the major component of the blood. It is used to break down food in digestion. It is used for washing and cooling down the body. Water is used for agriculture and can be an alternative source of electrical energy.

Summary

You have come to the end of lesson 11. In this lesson you have learnt that:

- any natural sources that living things uses are called Natural resources.
- natural resources include sunlight, wind, water, soil, minerals, plants, animals, forests, and fossil fuels.
- renewable resources are those resources that are continually produced.
- sunlight, wind, water, soil, plants and animals are renewable resources.
- sunlight and wind are inexhaustible renewable resources. They cannot be all used up or depleted.
- resource depletion occurs when water, soil, plants and animals are used up faster than they can be replaced.
- care must be taken so that renewable resources are not depleted faster than they can be replaced.

NOW DO PRACTICE EXERCISE 11 ON THE NEXT PAGE.

Practice Exercise 11

Answer the following questions:

A. Multiple Choice Questions.

Circle the letter of the correct answer.

1. Which of the following renewable resource cannot all be used up?

   A. Soil B. Water

   C. Sunlight D. Fishes

2. The following would be considered resource depletion **except**

   A. plants not growing in overused gardens.
   B. water supply in Port Moresby running out.
   C. the Birds of paradise hunted to extinction for their feathers.
   D. solar energy not reaching the Earth‟s surface because of a fog.

3. Choose one resource that cannot be used as an alternative source of electricity.

   A. Soil B. Water

   C. Wind D. Sunlight

4. The depletion of renewable resources is:

   A. impossible to solve.
   B. caused by competition for the same resource.
   C. partly a result of increased human population.
   D. enough a reason to increase funding for the discovery of a new planet to inhibit.

5. When a renewable resource cannot all be used up, it is said to be _____.

   A. inexhaustible B. indefatigable

   C. insurmountable D. indistinguishable

B. Short Answer

1. Seventy percent of the earth‟s surface is water yet the supply is sometimes depleted. Give two reasons for this.

   _____
   _____
   _____
   _____

2. Are wallabies renewable resources? Explain your answer.

   _____
   _____

3. Why should you care for your local plants and animal resources?

   _____
   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 3.

Answers to the Activities

Activity 1

A. Living things use sunlight as a source of heat energy.

B. Plants use sunlight for photosynthesis.

C. Animals use sunlight as a vitamin D source.

D. It is converted and used as an alternative source of electricity.

Activity 2

Living things use air to breathe. Carbon dioxide in air is used by plants to photosynthesise while oxygen is used by plants, animals and bacteria when they respire. Plants use the moving air or wind as an agent for pollination and seed dispersal. The wind is used for sailing and to help lift animals in flight. The wind can be an alternative source of electricity.

Lesson 12: Non-renewable resources

Welcome to Lesson 12 of Strand 2. In your last lesson you learnt about renewable resources. Maybe you have heard of the LNG project in PNG. LNG or Liquefied Natural Gas is a natural gas that has been converted temporarily to liquid form so it can be stored and transported easily. As a **combustion fuel** it will be taken to towns and cities and will be used to warm houses, cook food and heat water. It is a non-renewable resource. In this lesson you will learn more about non-renewable resources.

Your Aims:

- define non-renewable resource and give some examples of these
- state the importance of non-renewable resources; and
- suggest ways of conserving this resource

What Is A Non-Renewable Resource?

A **non-renewable resource** is a natural resource that cannot be replaced or produced. These resources often exist in a fixed amount and are consumed or used up faster than nature can recreate them. Fossil fuels, metals and nuclear power are examples of non- renewable resources.

Fossil fuels
These are formed from remains of organisms (living things) that have been buried in the earth over millions of years. The organisms decayed (rotted) and became fossilised to form fossil fuels such as coal, petroleum and natural gas.

1. Coal
   Coal is a solid, black fossil fuel formed from plants that grew over millions of years. It is mainly made up of the element carbon. Coal was formed millions of years ago, when most of the Earth was covered with plants growing in swamps. These organisms died and sunk under water, where they gradually decomposed.
   As time passed, layers of sand and mud settled over the remains. The pressure of these overlying layers, movements of the earth's crust and sometimes volcanic heat acted on these to compress and harden the deposits. As a result coal is produced.

   When coal burns, it releases a large amount of **energy** as heat. In the past, houses were kept warm by burning coal fires. Today, coal is used to fuel power plants that produce electricity.

A miner cutting out coal from a mine shaft.

Black coal from the mine.

Coal miners go as deep as 1500 metres below the surface into mine shafts to cut or drill out coal. They face many dangers including dangerous gases, explosive coal dusts, flooding and possible roof collapse. Geologists believe that most of the world‟s coal has already been discovered. This coal is rapidly being used. This means that if we are not careful, it may soon run out.

2. Oil and Natural Gas

Petroleum or crude oil is formed under the Earth‟s surface by the rotting of marine organisms. The remains of tiny organisms that live in the sea as well as those of land organisms that are carried down to the sea in rivers, and of plants that grow on the ocean bottoms - mixed with the fine sands and mud at the bottom.

Millions of years of squashing and heating due to the pressure of burial changed the animal and plant remains into **crude oil** or **petroleum**. The oil seeped into the spaces between the sand and the mud and hardened into limestone. When heated long enough, some of the oil changed into **natural gas**. Petroleum is formed deep within the earth engineers need to drill deep down to reach it. Once the pressure is released the petroleum flows freely to the surface.

Drilling under the sea is even more complicated than drilling for petroleum and natural gas on the land.

Unwanted gases that accompany petroleum flares up in this oil field in Iran.

Excess natural gas is being flared up from an offshore drilling rig in the Java Sea.

What happens to petroleum in a refinery?
First petroleum is refined to petrol and aircraft fuel. This is used as energy sources for transportation. Next kerosene, diesel, bitumen or „asphalt, industrial fuels, waxes lubricants and greases are removed from petroleum. Finally the by products are used to make other products such as manufacturing of medicines and fertilizers, foodstuffs, plastic ware, building materials, paints, cloth, and to generate electricity.

A maintenance crew attends to an oil pipeline in the Persian Gulf.

Combustion of petrol is what makes a car move.

Metals
Can you imagine a world without metal? From cars to computers, bridges to cutlery, most of us rely on metal. Metals are found as minerals or ore. **Minerals** are naturally occurring substances often found in the earth‟s crust. Sand is an example of a mineral.

An **ore** is a naturally occurring mineral from which metal can be extracted. Bauxite is an ore. It contains the metal aluminium and a number of other chemicals, including oxygen. A few metals, such as copper, gold and silver, are found as pure metals in the Earth.

Metals are found all over the world. There is more aluminium in the earth‟s crust than any other metal. Iron is the Earth‟s second most abundant metal. It is thought that there are over 10 billion tonnes of iron ore reserves in the former Soviet Union alone.
Of all the metals, iron is the most important to us. Iron is made into the metal alloy steel. Steel is an alloy of carbon and iron. It is much more flexible than cast iron. We use steel in a huge variety of ways.

This world's first bridge made entirely of cast iron was built about 230 years ago in Britain.

Aluminium cans are being bundled into large bales at a collection point for recycling.

As only a limited supply of metal exists on Earth, it is important to **recycle** so that scrap metal can be melted and used again to make new products. Once metals are mined and used, the Earth can no longer make new ones. We must use them wisely and recycle whenever possible.

Activity 1: **Now test yourself by doing this activity**

Answer the following questions:

A. List ten (10) materials in your house that are made of metals.

1. _____ 6. _____
2. _____ 7. _____
3. _____ 8. _____
4. _____ 9. _____
5. _____ 10. _____

B. Explain why metals need to be recycled.

_____
_____
_____
_____

3. Nuclear power

It is an electrical power produced from energy released by a nuclear reactor. A nuclear reactor works by introducing an extra neutron into the nucleus of an atom (usually a **uranium** atom). This makes the atom unstable and it splits into two, releasing spare neutrons at the same time.

Each of these uranium fuel pellets contains the energy equivalence of about 1 metric tonne of coal.

These neutrons can go on to split more uranium atoms, which will also release neutrons that go on to split more atoms, and so on. This is known as a **chain reaction**. Every time an atom splits it releases a huge amount of **energy**.

A nuclear reactor can produce much greater amounts of energy than chemical processes such as the burning of coal or oil. The nuclear power stations also produce very low carbon dioxide emissions. Nuclear energy is not widely used because the nuclear fuel or uranium is in relatively short supply and nuclear power plants are very expensive to build.

Effects of using non-renewable resources

The use of fossil fuels and nuclear power can cause damage to the environment in the following ways:

- release of poisonous gas into the atmosphere and environment from industries, power stations and vehicles.
- Oil spills can pollute oceans and river systems.
- Destroying natural habitats for living things.

When coal, oil or petrol are burned they release the harmful gases sulphur dioxide and nitrogen dioxide into the air. These gases dissolve in the moisture that is always present in the air and form weak acids that may be carried over huge distances. Eventually they return to the ground as acid rain, hail, snow, sleet or even fog.

These smokes billowing from industrial smoke-stacks are caused by the combustion of fossil fuels. The contaminants contribute largely to the world"s atmospheric pollution.

Acid rain chemically burns the leaves of plants. It also poisons lake water which kills the aquatic organisms

The large amounts of carbon dioxide released when fossil fuels are burned have a worldwide impact by changing the Earth"s climate. The nuclear power stations produce radioactive wastes which are very dangerous and very difficult to dispose.

A massive explosion in Chernobyl nuclear plant in the former Soviet Union released tonnes of radioactive material into the air and contaminated thousands of square kilometres of land. Hundreds of fire fighters and other workers died from radiation exposure, and thousands more may contract cancers as a result of their high exposure to radiation.

Empty buildings line the streets of the Ukrainian town of Chernobyl. Settlements around the Chernobyl nuclear power plant were abandoned after it exploded in 1986.

Conservation

Our non-renewable resources are decreasing, while our need to use them is increasing. We cannot afford to be careless with our resources anymore. What comes to mind when you hear the word **conservation**? Conservation means using less resources and using them wisely.

Summary

You have come to the end of lesson 12. In this lesson you have learnt that:

- non-renewable resources are natural resources that cannot be replaced or produced.
- non-renewable resources often exist in fixed amounts, or are consumed or used up faster than nature can recreate them.
- fossil fuels are formed from remains of organisms (living things) that have been buried in the Earth for millions of years.
- metals are non-renewable but they can be recycled.
- fossil fuels, metals and nuclear power are non-renewable resources. They provide energy for transport and electricity, as well as energy to run machineries that make our standard of living very easy.
- conservation means using less resources and using them wisely.

.

NOW DO PRACTICE EXERCISE 12 ON THE NEXT PAGE.

Practice Exercise 12

Answer the following questions:

A. Multiple Choice Questions.

Circle the letter of the correct answer.

1. Pick one that does not observe an efficient use of natural resource?

   A. Walk or ride a bicycle for short trips.
   B. Take short showers instead of baths.
   C. Use natural lighting whenever possible.
   D. Buy more home appliance to increase living standards.

2. Which metal is considered as the most important to man in terms of its usage?

   A. Iron B. Gold
   C. Copper D. Aluminium

3. Fossil fuels are used widely because

   A. they contain a great deal of energy.
   B. they are a renewable energy source.
   C. they are not harmful to the environment.
   D. their carbon emission is less than nuclear fuels.

4. Which natural resource produces the least carbon dioxide emission when used?

   A. Coal B. Diesel
   C. Petroleum D. Radioactive fuel

5. A natural gas is a non-renewable resource because

   A. it cannot be recycled.
   B. it is not made from plants or animals.
   C. when it is depleted, the earth can no longer replace it.
   D. it is easily converted into other forms of energy that man can use.

B. Short Answer Questions.

6. Define fossil fuels.

_____

_____

7. State two advantages and disadvantages of using nuclear power.

Advantages**:**

a. _____

b. _____

Disadvantages:

a. _____

b. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 3.

Answers to the Activity

Suggested answers

1. Car bodies, security bars, pins, needles, hair clips, bedsprings, cans, can opener, scissors, knives, jewelleries, batteries, electrical wires, fridge, TV, radio, mobile phone, computer, stove, roof, door handles, hangers, clothes line, fly wire, hammer, pliers, spade, fork, spoon, fertiliser, cast iron, nails, keys, and pots – the list seems endless.

2. Metals need to be recycled because they are a non-renewable resource. When we dig them up, no new metals will form to replace them.

Lesson 13: Biodegradable Materials

Welcome to Lesson 13 of Strand 2. In the last lesson you learnt about materials that cannot be replaced. In this lesson you will learn about materials that decay or decompose. Sometimes when you prepare food, you peel the kaukau and banana and remove the parts of the meat or fish that you will not include in your cooking. Later you throw these food scraps in the rubbish pit and wonder how they easily disappear just hours or days after you dump them. These scraps of food can be called biodegradable materials and you will more about these in this lesson.

Your Aims:

- define biodegradable, biodegradability and biodegradation
- identify and list examples of biodegradable materials
- recognize the role played by detritivores and bacteria in breaking down materials
- suggest conditions that contribute to the biodegradability of some materials; and
- state the importance of biodegradable materials in the environment

What Is Biodegradable Material?

A **biodegradable material** is a material that decay or decompose. They are broken down into simpler materials that can be used by living things.

Biodegradable materials are made from **natural materials** or materials that exist naturally on earth. Examples of biodegradable materials from plants include food scraps, newspapers, paper bags, cotton fibres, and leather.

Biodegradability is the ability of complex materials to be broken down by micro-organisms to form simple end-products. **Biodegradation** is the process where these complex natural materials break down into simpler form.

Book

Cotton fibres

Timber

Leather

Why Materials Need to Decay, Decompose or 'Biodegrade'
What do you think will happen if materials that come naturally from plants and animals don"t break down and decompose?

If material from living organisms stay forever and never decay, the earth will be covered to our knees with dead plants and animals. This is because a group of living organisms specialises in feeding on these dead plants and animals and other other natural materials.

The Earth is not littered with dead plants and animals or of materials derived from them. This is because a group of living organisms specialises in feeding dead organisms and natural materials.

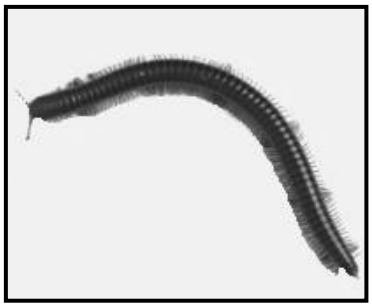
Detritivores
Dead remains or parts of plants and animals are called **detritus**.
Animals that feed on the dead remains of plants and animals are called **detritivores**.

Common detritus feeders or detritivores include beetles and flies (and their larvae or maggots), together with earthworms, millipedes, slugs, snails and woodlice. They break the waste materials down into smaller pieces that they expel in their droppings. These then rot away.

Detritivores are commonly found in rotting wood or woodpiles, or under the loose bark of old stumps or fallen trees. Detritivores are important in our environment because they feed on decaying plant matter (dead leaves and animals and rotting wood) and then break the waste materials down into smaller pieces. These smaller pieces are then broken down even further by **fungi** and **bacteria**.

Some examples of detritivores

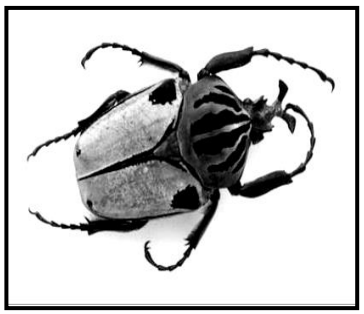
Wood lice



Millipede

Fly

Earth worm



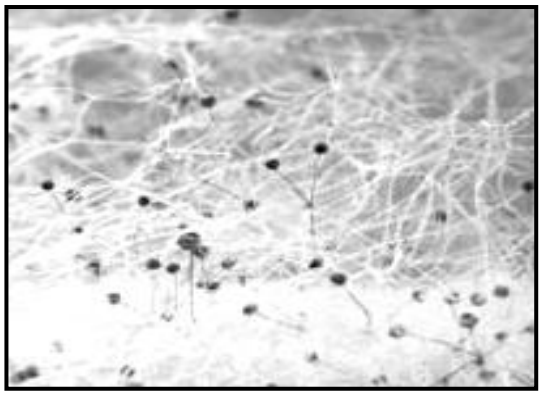
Beetle

Snail

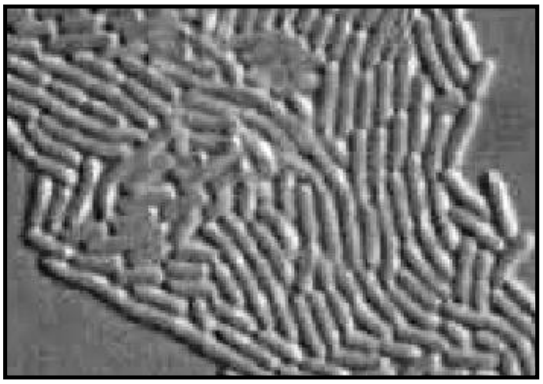
Decomposers

Bacteria and fungi are the main agents of decomposition and are both known as **decomposers**. They feed on dead plant materials, waste products and dead animals that are not fully broken down by detritivores.

Decomposers break down plants and animals material into chemical nutrients that plants and other living things can use. Warm, moist and dark conditions allow bacteria and fungi to break down plant and animal materials quickly.



Bread mould



Bacteria

Mushrooms

Humus

Every naturally occurring material can be decomposed, either by single bacteria, or by different groups of bacteria and fungi working in combination. Some materials in plants and animals are more resistant to decomposition than others and build up in the soil.

This slow decaying matter known as **humus** is the major component of soil. Humus is important for soil fertility because it affects drainage, increases the ability of the soil to retain moisture and allows oxygen penetration into the soil.

In areas where cultivated plants are grown, humus is constantly being depleted or used up from the soil by the succession of crops, and the organic balance is restored by adding humus in the form of compost or manure.

Activity 1: Now test yourself by doing this activity.

Mulching

Do you have a garden or a collection of pot plants? If you notice that the plants are dry-looking, then the soil must be **infertile**. An infertile soil is dry, lacking in moisture and light in colour.

One way of helping your plant roots grow well in this poor soil condition is by mulching. **Mulch** refers to substances that spread on the ground to protect the roots of plants from extreme temperature and moisture changes.

1. Suggest some biodegradable materials that can be used to make mulch.
   _____

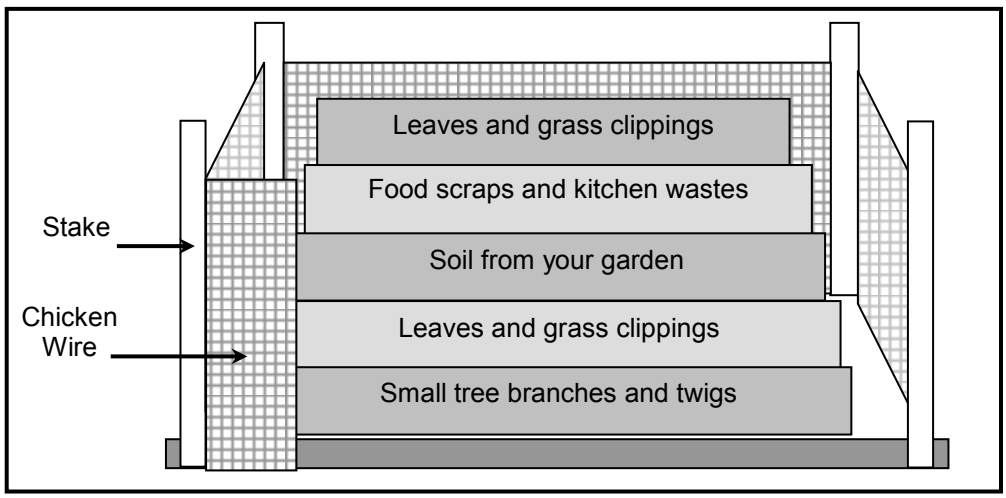
2. Apart from protecting the roots from high temperature and allowing the soil to retain moisture, what other benefits can plants get from the mulch?
   _____
   _____

Activity 2: Now test yourself by doing this activity.

Making a compost heap

What do you normally do with the bunch of garbage in your garden? You burn it? You let it rot? Crazy as it may sound; making your garbage rot is actually a very good idea because the clippings, cuttings and fallen leaves are biodegradable. **Compost** is a dark brown, crumbly material made from the decomposed vegetable and animal materials. It is rich in nutrients that help plants grow. Make a **compost heap** anywhere in your yard - either a sunny or shady spot, on a concrete slab or a grassy area, so long as it is out of the way of normal activity.

Diagram showing how a compost heap is made



You can contain your compost pile by putting four recycled metal or wooden stakes and chicken wire around it. You will be able to add more biodegradable materials in a smaller area. The **warm**, **moist**, **dark** conditions inside the pile or biodegradable material allow decomposers to grow and break down the waste rapidly.

Your compost heap must contain a mixture of many organic (natural) materials like leaves, small tree branches and twigs and grass clippings. You can also add coffee grounds, tea bags, cotton, saw dusts, discarded plants and weeds. If you add uncooked food scraps remember to cover them with leaves.

It‟s a good idea to shovel a couple of scoops of soil from your yard into the heap. Once the organic matter has broken down, to the point that no single item is recognizable, it‟s ready to work into your gardens soil.

1. Why is it necessary to:

   A. cover the food scraps in the compost heap with leaves?

   _____

   B. shoves soil from the yard into the heap?

   _____

2. What benefit can a garden soil get from the compost?

   _____

Importance Biodegradable Materials

Biodegradable materials are important because when they break down or decay, they are not lost but are converted into very simple materials that plants can use.

Biodegradation ensures that important elements such as carbon, oxygen, hydrogen and nitrogen are not all used up by plants and animals but are recycled when they die. This natural cycle of elements aided by the process of decomposition is called **nutrient cycle.**

Summary

You have come to the end of lesson 13. In this lesson you have learnt that:

- a **biodegradable material** is a material that decay or decompose.
- **detritivores** are animals that feed on dead remains or fragments of plants and animals. **Decomposers** break down the plant and animals material into chemicals that plants and other living things can use.
- **humus** is decaying organic matter found in soil or from dead animal and plant material
- **mulch** refers to biodegradable substances that spread on the ground to protect the roots of plants from extreme temperature and moisture changes. **Compost** is a dark brown, crumbly material made from the decomposed vegetable and animal materials.

NOW DO PRACTICE EXERCISE 13 ON THE NEXT PAGE.

Practice Exercise 13

Answer the following questions:

A. Multiple Choice Questions. Circle the letter of the correct answer.

1. A mushroom is a _____.

   A. plant B. bacteria

   C. decomposer D. detritivore

2. Composting

   A. is a process of adding animal manure to a plant.
   B. increases the amount of rubbish materials collected.
   C. is a natural way to decompose biodegradable materials.
   D. is a method of putting biodegradable materials in the soil to protect plant roots.

3. Humus is

   A. a bone in the arm.
   B. destroyed by light.
   C. found in a fertile soil.
   D. important in photosynthesis.

4. Which is not a decomposer?

   A. Mould B. Bacteria

   C. Earthworm D. Mushroom

5. Biodegradable waste includes all of the following except

   A. coke can and bottles.
   B. newspaper and junk mails.
   C. cotton towels and milk cartons
   D. food scraps and grass clippings.

B. Short Answer Questions.

1. Name two ways that can help you manage your biodegradable wastes.

   _____
   _____
   _____

2. Refer to the diagram below.

   A. What biodegradable materials make up X?

   _____

   B. List three conditions that increase the rate of decomposition of materials inside the compost.

   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 3.

Answers to the Activities

Activity 1

1. Manure, sawdust, leaves and grass, cereal chaff, peat moss, straw

2. The materials used for mulching decay in time and enrich or fertilise the soil as humus. The mulch also prevents the growth of unwanted weeds.

Activity 2

1. A. The grass will prevent an unpleasant odour and keep away flies and other animals.

   B. The detritivores and decomposers in the soil will begin to break down the items in the heap.

2. The garden soil will be enriched with nutrients that will help plants grow.

Lesson 14: Nutrient Cycles

Welcome to Lesson 14 of Strand 2. In the last lesson you learnt that complex natural materials can be broken into simpler materials and be used by living things. Nitrogen and carbon are very important elements that are needed by all living things. These elements are taken into the body through the food we eat. They are found in food as **nutrients** or nutritious ingredients or substances in food. But do you know that there could be nutrients in your body which were also in your ancestor's body, which you are using now. What makes this possible? In this lesson you will learn that it is because nutrients in our environment are used again and again; otherwise, they would soon be gone once used, and life could no longer exist.

Your Aims:

- identify two nutrient cycles that allow materials to be reused - the carbon cycle and the nitrogen cycle
- state the importance of the nutrient cycles
- explain the natural processes involved in the cycle of nutrients

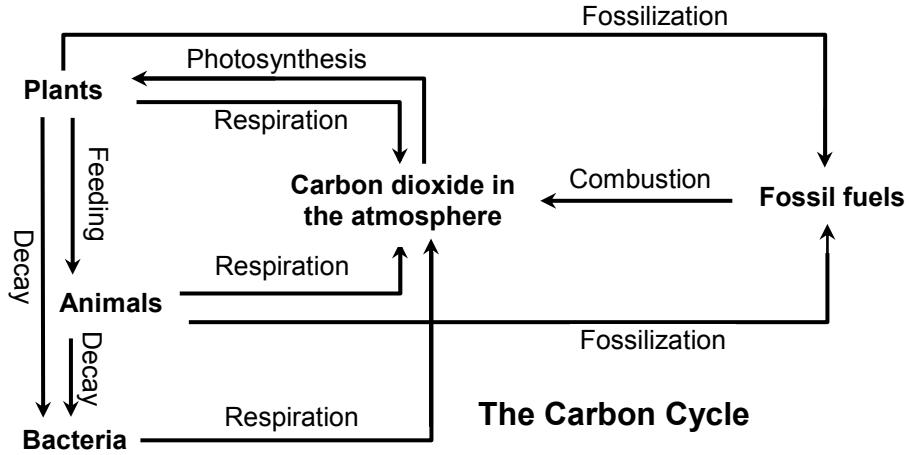
The Carbon Cycle

Carbon is an important element that makes proteins, fats and carbohydrates which provide energy needed for life. Carbon enters the plants when they take in carbon dioxide from the atmosphere when they make their food during **photosynthesis**.

When animals eat the plants, they obtain carbon. Carbon is passed from one organism to the next by **feeding**. As animals and plants break down food during **respiration**, the carbon is released back into the atmosphere as carbon dioxide.

Carbon compounds, trapped in the bodies of dead plants and animals go into the soil for **decomposition**. Carbon can also be trapped in the animal wastes and goes into the soil by **excretion**.

Fungi and bacteria are responsible for decomposition. When the decomposers feed on these dead organisms and wastes it releases the carbon in them back into the atmosphere as carbon dioxide. Below is a simplified version of the carbon cycle.



The Carbon Cycle

Activity 1: Now test yourself by doing this activity.

The carbon cycle

Examine the diagram of the carbon cycle above and answer the following questions.

1. How is carbon passed from one organism to the next?

   _____

2. Name three chemical compounds found in plants and animals that contains carbon.

   _____

3. Explain what will happen to the level of carbon dioxide in the atmosphere if a lot of plants on earth die.

   _____

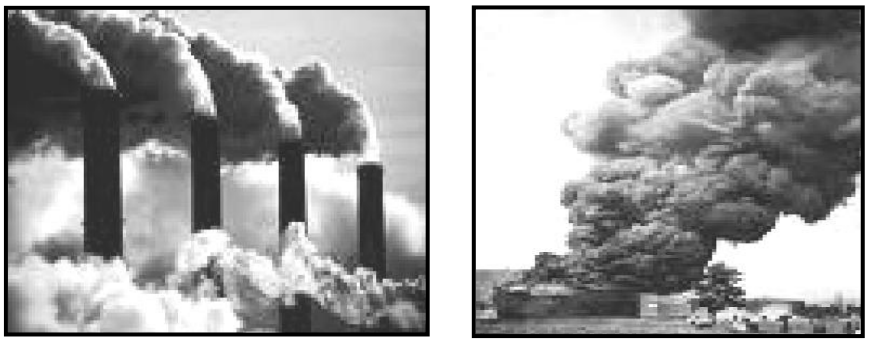
4. Aside from cutting down trees, how else are humans overloading the atmosphere with carbon?

   _____

How humans are affecting the carbon cycle

Fossil fuels such as coals, oil, and natural gas are essentially stored carbon left over from the bodies of plants and animals that died millions of years ago and were trapped underground. This process is called **fossilization**.

When we burn fossil fuels, in cars, lawn mowers and generator sets for example, we release this carbon into the atmosphere as carbon dioxide.



Combustion

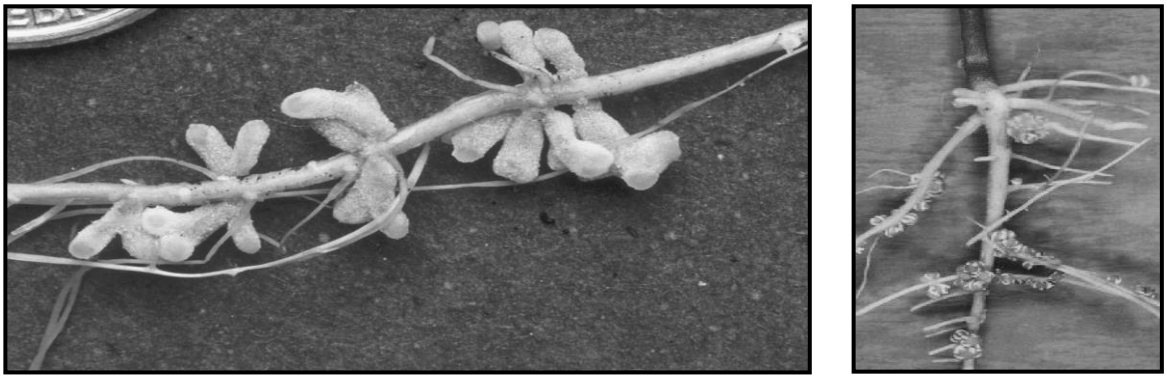
The problem is that we are burning such large quantities of fossil fuels that the concentration (the amount) of carbon dioxide in the atmosphere is increasing. In lesson 20, you will read about the relationship between the increased levels of carbon dioxide and global warming.

The nitrogen cycle
All organisms need nitrogen to build proteins. Proteins are important because they help organisms build new tissues and replace old ones.

Nitrogen is around in vast quantities; nitrogen gas makes up 78% of the atmosphere. Plants and animals cannot use nitrogen directly from the atmosphere. Plants, however, can take nitrogen as **nitrate** from the soil. Nitrates are soluble in water and easily get absorbed in plant roots.

Nitrogen fixation
The removal of nitrogen from the atmosphere and the adding of it to the soil are called **nitrogen-fixation**. The only organisms that remove and use nitrogen gas directly from the atmosphere are a few groups of bacteria known as **nitrogen-fixing bacteria**.

Some nitrogen-fixing bacteria live in the soil while others live within the roots of a few plants such as beans, peas and nuts. These plants are generally called **legumes**. A peanut is a legume.

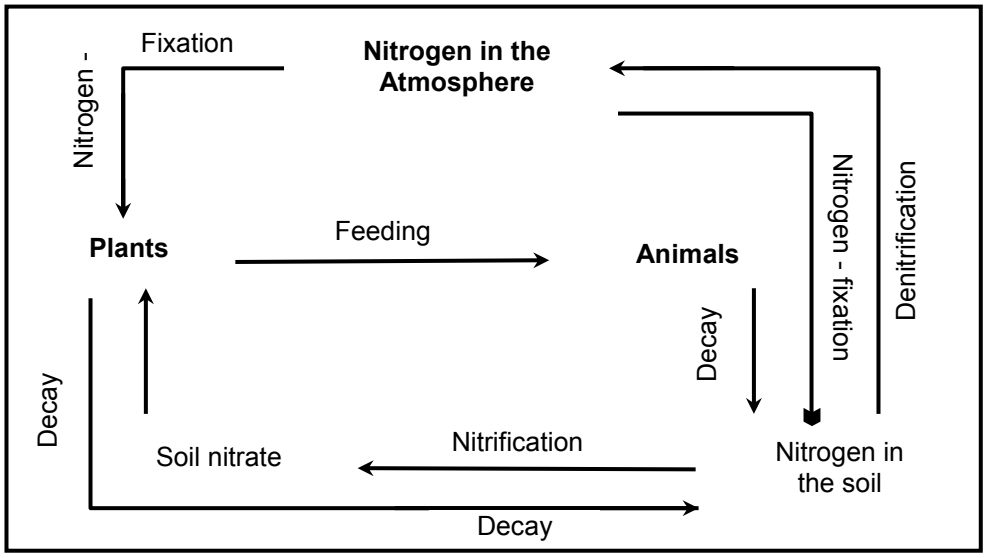


Root Nodules

The legumes and nitrogen-fixing bacteria have a relationship in which both organisms benefit from the association. The bacteria receive food from the plant for energy. The bacteria then use the energy to fix nitrogen gas from air and convert it to a form that legumes can use to make proteins.

Plants that don‟t have nitrogen-fixing bacteria make protein using nitrogen from the soil.

Animals get nitrogen by eating plants or other animals, both of which are sources of usable nitrogen.



The Nitrogen Cycle

Activity 2: **Now test yourself by doing this activity.**

The nitrogen cycle

1. Where does the nitrogen from the atmosphere come from?

   _____

2. Name the process that enriches the atmosphere with nitrogen.

   _____

3. Give two processes that return nitrogen to the soil.

   _____

4. Predict what will happen if all the bacteria in the soil will be gone.

   _____

Nitrification
Some bacteria can combine nitrogen and oxygen in the soil to produce a protein compound called **nitrate.** Nitrate is nitrogen compound absorbed by plants. This process that increases the amount of nitrate in the soil is called **nitrification** and the bacteria involved are the **nitrifying bacteria**.

Denitrification
Other bacteria called **denitrifying bacteria** can transform nitrogen in the soil into nitrogen gas, which then returns to the atmosphere and completes the nitrogen cycle. The conversion of nitrogen in the soil into gaseous nitrogen is called **denitrification**.

Decomposition

Bacteria and **fungi** are essential to the nitrogen cycle. These decomposers break down wastes (urine, dung, leaves, and other plant parts) and dead organisms, returning the nitrogen compounds they contain to the soil. This process is called

decomposition. If it were not for decomposers, much of the nitrogen compounds in the environment would be locked away in wastes, corpses, and castoff plant parts.

Summary

You have come to the end of lesson 14. In this lesson you have learnt that:

- carbon is an important component of the proteins, fats and carbohydrates needed for life. Nitrogen is an important component to build proteins.
- carbon and nitrogen cycles are examples of nutrient cycles. The circulation of nutrients in the environment enables organisms to use them again and again.
- carbon enters plants by photosynthesis. Carbon from plants is passed to animals by feeding.
- other processes involved in the carbon cycle include respiration, decomposition, combustion, excretion, and fossilisation.
- plants take in nitrogen as nitrate in the soil. Nitrate is formed by two sets of processes carried out by bacteria - nitrogen fixation and nitrification.
- the removal of nitrogen from the atmosphere and the adding of it to the soil are called nitrogen-fixation.
- nitrification is the conversion of nitrogen in the soil into a form that plants can use.
- denitrification is the conversion of nitrogen in the soil into atmospheric nitrogen.

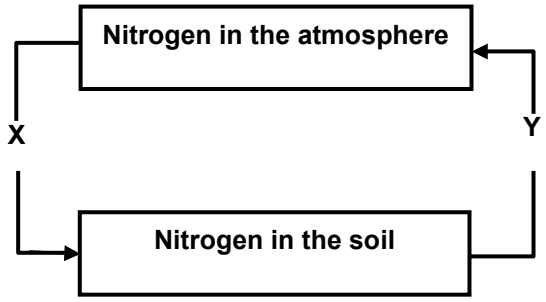
NOW DO PRACTICE EXERCISE 14 ON THE NEXT PAGE.

Practice Exercise 14

Answer the following questions:

1. Use the words in the box and study the diagram below to answer the questions.

nitrogen fixation	**denitrification**	**nitrogen-fixing bacteria**	
nitrates	**decomposers**	**denitrifying bacteria**	**nitrification**



A. What is the name of the process represented by letter X?

_____

B. Name the bacteria in the roots or soil that allow X to take place.

_____

C. What form of nitrogen in the soil are most plants able to absorb?

_____

2. Describe how animals obtain nitrogen.

_____

_____

3. (i) In what form of food nutrient would nitrogen be present in plants and animals?

_____

(ii) What is the importance of this nutrient?

_____

_____

4. Why is nutrient cycle important?

_____

_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 3.

Answers to Activities

Activity 1

1. By feeding.

2. Carbohydrates, fats and proteins.

3. The level of carbon dioxide in the atmosphere will increase.

4. By combustion or use of fossil fuels.

Activity 2

1. It comes from the soil.

2. Denitrification

3. Nitrogen-fixation, decomposition, excretion

4. If all the bacteria in the soil are gone, nitrogen in the soil and the atmosphere can no longer cycle. Nitrogen cycle will stop.

Lesson 15: Non-Biodegradable Substances

Welcome to Lesson 15 of Strand 2. Look at the biro you have right now! What is it made of? Where will it end up if its ink runs out? Will it be reduced? Having different answers to this questions now lead us to think about the importance of different substances and whether they can be broken down easily or not. In lesson 13, you studied that some materials can be broken down by microorganisms into simpler materials that can be used by other living things. These materials are called biodegradable materials. In this lesson you will learn about materials that cannot be broken down into simpler forms.

Your Aims:

- identify and describe materials that cannot be broken down into simpler forms
- give examples of these materials
- briefly explain why these materials cannot be broken down

Non-Biodegradable Materials

A **non-biodegradable** or man-made material is one that cannot be broken down easily by decomposers and remain in the environment for a very long time. Many products from **synthetic** or man-made materials are non-biodegradable. These materials do not exist in nature. Plastics are solid wastes and are the major cause of land and water pollution.

Examples of non-biodegradable materials
Some examples of these non-biodegradable synthetic materials are plastic, nylon and polyester.

Plastics
The first synthetic plastic was invented in 1907 by Belgian-American chemist Leo Hendrik Baekeland. Plastics are everywhere and every day of your life you will probably come into contact with an item made of plastic: cups, pens and rulers, toothbrushes, shopping bags and much more.

Plastics are not natural materials, such as wood or cotton. They are **synthetic**, which means that they are man-made from substances in the natural world.

Plastics are popular because they can be easily moulded and shaped.

Characteristics of plastics
Plastics are characterised by their ability to be easily formed into desired shapes, their high strength, their ability to prevent heat and electricity to pass through, and their high resistance to acids and bases.

Activity: **Now test yourself by doing this activity.**

Products made of plastics

The most popular usage of plastics is in packaging (plastic bags and containers) and construction (PVC pipes, building sheets, cable insulation, roofing, door and window frames).

1. Give other examples where plastic is used apart from packaging and construction.
   _____
   _____

Why do we use plastics?
Plastics are widely used because they are strong and light and can be made cheaply and quickly in great quantities.

Before plastics were first made, items both in everyday lives and in industry were made from natural materials, such as wood, cotton, glass, metal and parts of animals such as skin (leather) and bone.

These materials are more expensive than plastics as they are not widely available and they take longer to put together into finished goods. Items, such as cutlery, shoes, sports equipment, toys and suitcases that were once made from natural materials can now be made from plastics.

It is safe to use plastic in making goods that have many electrical parts, such as televisions, PlayStations and CD players.

Because of its versatility, plastic is used in many products

Nylon

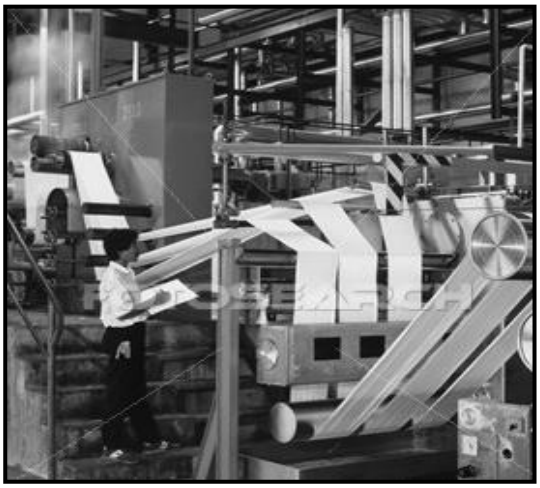
Nylon, was first invented in the 1930s, by Wallace Carothers. Nylon is made from products derived from coal tar or oil. It is used in the manufacture of clothing. Nylon fabrics are water-resistant; they dry quickly when laundered and usually require little or no ironing. It is strong and has a high shine or lustre.

Nylon fibres are also used for parachutes, strings for tennis rackets, brush bristles, rope, and fishing nets and line. Moulded nylon is used for insulating material, combs, kitchen utensils, and machinery parts.

Examples of materials made from nylon.

Polyester

Polyester, discovered in the 1940s, is a form of plastic used in textiles to make fabrics. It absorbs little moisture and can be washed or dry-cleaned. Polyester is also used to make bottles as containers for soft drinks.



Polyester spinning plant for production

Plastics, nylons and polyesters are non-biodegradable materials

Plastics and other synthetic materials are non-biodegradable materials and can cause problems.

Over millions of years, bacteria have evolved ways to breakdown nearly all natural chemicals. However, bacteria have not developed ways to break down the chemical components of synthetic materials. Thus, when we throw these materials, they may last for hundreds of years.

Summary

You have come to the end of lesson 15. In this lesson you have learnt that:

- non-biodegradable or “refractory” materials are synthetic or man-made materials that resist decomposition and persist in the environment for a long period of time
- some examples of these non-biodegradable synthetic materials are polyester, nylon and plastic.
- plastics are characterised by their ability to be easily formed into desired shapes, their high strength, their ability to prevent heat and electricity to pass through, and their high resistance to acids and bases.
- nylon is a strong synthetic fabric used in the manufacture of articles as sleepwear, underwear, blouses, shirts, parachutes, raincoats, medical sutures, strings for tennis rackets, rope, and fishing nets and line.
- polyester is a form of plastic fabrics that absorb little moisture and can be washed or dry-cleaned. Polyester is also used to make bottles as containers for soft drinks.
- plastics and other synthetic materials are non-biodegradable and can stay on earth for hundreds of years.

NOW DO PRACTICE EXERCISE 15 ON THE NEXT PAGE.

Practice Exercise 15

Answer the following questions:

A. Multiple Choice Questions.

Circle the letter of the correct answer.

1. Which is not an example of a non-biodegradable material?

   A. Nylon B. Cotton

   C. Plastic D. Polyester

2. Synthetic materials are

   A. normal materials that are found in nature.
   B. materials that are easily decomposed by bacteria.
   C. man-made and do not exist in the environment.
   D. difficult and very expensive to produce.

3. Pick one that does not correctly describe nylons.

   A. They have a very high melting point.
   B. Nylons are strong, light and have lustre.
   C. They do not allow water to pass through.
   D. Nylons dry up quickly and do not require ironing.

4. Which of the following is not likely made of nylon fibres?

   A. Rope B. Fish net

   C. Parachute D. Soft drink bottle

5. Micro-organisms such as bacteria are unable to break down plastics because they are

   A. too abundant.
   B. made from oil.
   C. does not occur in nature.
   D. not found in any other substances.

B. Short Answer Questions

1. Give five characteristics of plastics that are reasons why they are widely used.

   A. _____

   B. _____

   C. _____

   D. _____

   E. _____

2. If plastics are useful, why are they posing a danger to the environment?

   A. _____

   _____

   B. _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 3.

Answer to the Activity

1. Other popular uses of plastics would be in motor vehicle manufacturing (fuel pumps, emission canisters, interior panelling, seats, and the car body), electronic devices (computers, play stations, mp3 players), tools, and other consumer goods ranging from sports, office and school equipment to luggage and toys.

REVIEW OF SUB STRAND 3: RENEWABLE AND NON RENEWABLE RESOURCES

Revise all the Lessons in this Sub Strand and then do **ASSIGNMENT 2.**
Here are the main points to help you revise.

Lesson 11: Renewable Resources

- Any natural sources that living things uses are called Natural resources.
- Natural resources include sunlight, wind, water, soil, minerals, plants, animals, forests, and fossil fuels.
- Renewable resources are those resources that are continually produced.
- Sunlight, wind, water, soil, plants and animals are renewable resources.
- Sunlight and wind are inexhaustible renewable resources. They cannot be all used up or depleted.
- Resource depletion occurs when water, soil, plants and animals are used up faster than they can be replaced.
- Care must be taken so that renewable resources are not depleted faster than they can be replaced.

Lesson 12: Non- Renewable Resources

- Non-renewable resources are natural resources that cannot be replaced or produced.
- Non-renewable resources often exist in fixed amounts, or are consumed or used up faster than nature can recreate them.
- Fossil fuels are formed from remains of organisms (living things) that have been buried in the Earth for millions of years.
- Metals are non-renewable but they can be recycled.
- Fossil fuels, metals and nuclear power are non-renewable resources. They provide energy for transport and electricity, as well as energy to run machineries that make our standard of living very easy.
- Conservation is the practice of decreasing the amount of resources used which is achieved by efficient energy use.

Lesson 13: Biodegradable Materials

- A biodegradable material is a material that decay or decompose.
- Detritivores are animals that feed on dead remains or fragments of plants and animals. Decomposers break down the plant and animals material into chemicals that plants and other living things can use.
- Humus is decaying organic matter found in soil and derived from dead animal and plant material while.
- Mulch refers to biodegradable substances that spread on the ground to protect the roots of plants from extreme temperature and moisture changes. Compost is a dark brown, crumbly material made from the decomposed vegetable and animal materials.

Lesson 14: Nutrient Cycle

- Carbon is an important component of the proteins, fats and carbohydrates needed for life. Nitrogen is an important component to build proteins.
- Carbon and nitrogen cycles are examples of nutrient cycles. The circulation of nutrients in the environment enables organisms to use them again and again.
- Carbon enters plants by photosynthesis. Carbon from plants is passed to animals by feeding.
- Other processes involved in the carbon cycle include respiration, decomposition, combustion, excretion, and fossilisation.
- Plants take in nitrogen as nitrate in the soil. Nitrate is formed by two sets of processes carried out by bacteria - nitrogen fixation and nitrification.
- The removal of nitrogen from the atmosphere and the adding of it to the soil are called nitrogen-fixation.
- Nitrification is the conversion of nitrogen in the soil into a form that plants can use.
- Denitrification is the conversion of nitrogen in the soil into atmospheric nitrogen.

Lesson 15: Non- Biodegradable Materials

- Non-biodegradable or “refractory” materials are synthetic or man-made materials that resist decomposition and persist in the environment for a long period of time.
- Some examples of these non-biodegradable synthetic materials are polyester, nylon and plastic.
- Plastics are characterised by their ability to be easily formed into desired shapes, their high strength, their ability to prevent heat and electricity to pass through, and their high resistance to acids and bases.
- Nylon is a strong synthetic fabric used in the manufacture of articles as sleepwear, underwear, blouses, shirts, parachutes, raincoats, medical sutures, strings for tennis rackets, rope, and fishing nets and line.
- Polyester is a form of plastic fabrics that absorb little moisture and can be washed or dry-cleaned. Polyester is also used to make bottles as containers for soft drinks.
- Plastics and other synthetic materials are non-biodegradable and can stay on earth for hundreds of years.

REVISE WELL AND THEN DO SUB STRAND TEST 3 IN YOUR ASSIGNMENT 2.

Answers to Practice Exercises 11-15

Practice Exercise 11

A. Multiple Choice

1. **C**

2. **C**

3. **A**

4. **C**

5. **A**

B. Short Answer

1. **Because most of the water are saltwater and cannot be used for drinking and agriculture / Most freshwater are permanently frozen and are not available / A lot of freshwater are misused or are used in agricultural lands.**

2. **Yes. As it is used by humans and other predatory animals for food, it is continually replaced as they reproduce.**

3. **They are our renewable resource. If we do not care for them, their number will be depleted.**

Practice Exercise 12

A. Multiple Choice

1. **D**

2. **A**

3. **A**

4. **D**

5. **C**

B. Short Answer Questions.

6. **Fossil fuels are formed from remains of organisms that have been buried in the Earth for millions of years.**

7. **Advantages:**
   A. It releases a lot of energy.

B. Produce very low carbon dioxide emissions.

Disadvantages:

A. Relatively short supply and expensive to generate.

B. Produces radioactive wastes and is highly dangerous.

Practice Exercise 13

A. Multiple Choice Questions.

1. C
2. C
3. C
4. C
5. A

B. Short Answer Questions.

1. **Mulching and Composting**
2. Refer to the diagram below.

A. **Leaves and Grass clippings**

B. **Warm, dark and moist conditions**

Practice Exercise 14

1. A. **Nitrogen fixation**

   B. **Nitrogen-fixing bacteria**

   C. **Nitrates**

2. **Animals obtain nitrogen by the process of feeding.**

3. **Protein**

   It helps build new cells and repair or replace old ones.

4. **It replaces the elements that permanently stay in the bodies of dead plants and animals.**

Practice Exercise 15

A. Multiple Choice Questions.

1. B
2. C
3. A
4. D
5. C

B. Short Answer Questions

1. a. **Plastics are light and strong.**

   b. **They are easily formed and shaped.**

   c. **They can be made cheaply and quickly in great quantities.**

   d. **They are poor conductors of heat and electricity.**

   e. **They have a high resistance to acids and bases.**

2. a. **Plastics are non-biodegradable. They can stay in the soil for hundreds of years.**

   b. **Plastics are solid wastes and are the major cause of land and water pollution.**

SUB STRAND 4

EFFECTS OF NON-BIODEGRADABLE SUBSTANCES

In this sub strand you will learn about:

- **man-made activities**
- **effects of non-biodegradable substances**
- **pollution**
- **ozone depletion**
- **global warming**
- **waste management**

SUB STRAND 4: EFFECTS OF NON-BIODEGRADABLE SUBSTANCES

Introduction

Items that break down over time naturally, like food scraps or paper, are biodegradable. Most biodegradable items are made from animals or plants, but some artificial materials designed to mimic these organic substances can also degrade over time. When the environment--air, sunlight, water or ground soil substances--cannot break down the waste, it is considered non-biodegradable. These products have a longer-lasting effect on the environment.

Just because an item is biodegradable does not mean that it will break down quickly. According to research, a banana peel degrades in two months, while notebook paper will break down in three months. Harder substances take longer. Soda cans, can take up to 350 years, while the plastic rings that hold together a six-pack of those cans can take up to 450 years. Glass bottles and Styrofoam products might never biodegrade.

The danger is that products that do not biodegrade will continue to pile up over time, requiring more and more land devoted to holding waste.

Long-term exposure to air, light and water can cause synthetic materials like plastic to emit toxic pollutants. Plastics contain toxins that can leach into water supplies. It can also pollute the air. Constant exposure to heat melts plastic, emitting gases into the atmosphere in a process known as outgassing.

Now, you may want to know

- What are the effects of ozone depletion?
- How does global warming affect the environment?
- Why do we need good waste management?
- What are the different man-made activities that contribute to the formation of non-biodegradable substances?

In this Sub strand, you will find the answers to these questions and other questions relating to the effects of non-biodegradable substances.

Lesson 16: Man-made Activities

Welcome to Lesson 16 of Strand 2. In the last lesson you learnt that some materials cannot decay and stay in the environment for a long period of time. In this lesson you will learn about how human activities can affect our environment. Trees are cut down in the forest and insects and tree-dwellers become endangered, slopes of mountains are „sculpted" for mining, the fishes in the nearby river die, a mangrove swamp is cleared to improve the view from a beach-front property and soil from the property begins to cover and kill a coral reef are all examples that show how human activities can affect our environment.

Your Aims:

- identify some man-made activities that affect the environment
- describe how these human activities can have an impact on our natural world; and
- suggests ways to manage and reduce these problems

Our Environment

Life exists only on planet earth apart from other planets in the solar system. There is scarcely a place on our planet that is not home to some living organism

Our **environment**, or surroundings, is where different species of plants and animals exist. It includes the air, water, soil and all the living things that share our planet.

Many things affect the plants and animals that live in our surroundings. These include changes in the seasons, drought, fire and flood.

Organisms often develop ways of adapting or coping to these natural changes and are able to survive. The land eventually recovers from this natural changes and returns to its original condition. Humans also can cause different changes to the environment that organisms may not be able to cope with.

Harvesting trees

Trees are harvested to provide products we use every day, such as paper, furniture, and lumber and plywood for our homes. We all use large amounts of wood.

Harvested trees also provide firewood for many people. In fact, about 1.5 billion people in developing countries depend on firewood as their major source of fuel.

Timber industries provide resources that are important in construction and manufacturing.

In some places, it‟s not trees but the forest land that is valuable - the trees are removed to make way for farming and building of roads. This benefits people but on the other end it brings destruction to the natural habitat of living things.

The effects of harvesting trees - deforestation
Today forests around the world are being cleared at an alarming rate, and deforestation has become a serious environmental problem. **Deforestation** involves clearing from an area without replacing them.

This situation is especially serious in tropical rainforests, which exist primarily in developing countries where population are growing rapidly.

The island of Madagascar was once covered with forests. In recent years it had been stripped of trees that have been cut down to be used as fuel, building materials and timber exports, as well as to make space for agriculture and grazing

There are many different methods of harvesting trees. Most methods cause damage to the forest, and some are more destructive than others. **Clear-cutting**, for example, is a process that involves removing all the trees from a land area. Clear-cutting destroys wildlife habitats, increases soil erosion, and diminishes the beauty of forests. It is popular because it is the least expensive for timber companies to harvest trees.
A good alternative to clear-cutting is **selective cutting** which involves cutting only middle-aged or mature trees.

Reforestation
When trees die or are removed from a forest, reforestation helps restore the area to its original condition. **Reforestation** is the process of replacing trees that have died or been cut down. This can happen naturally when seeds fall from nearby trees, or it can happen when humans plant seeds or seedlings.

Activity 1: Now test yourself by doing this activity.

Harvesting trees

1. List six reasons why humans cut down trees.

   A. _____ D. _____

   B. _____ E. _____

   C. _____ F. _____

2. State the difference between deforestation and reforestation.

   _____

   _____

3. What effects do the cutting down of trees have on the environment?

   _____

   _____

Ranching

Rangelands support grasses and shrubs that are used by ranchers for grazing animals such as cattle, sheep, and goats. Along with farmland, rangeland is essential for maintaining the world‟s food supply.

Over-grazing animals can pose a danger to perennial grasses and herbs. Over-grazed ranches cause land to erode and become more desert-like.

Effects of ranching

Grasses in the rangelands are remarkably adaptable plants - they can live through droughts, very cold temperatures, fires and years of animal grazing. This is because of their under- ground stems and roots that enable the grass to grow back. The roots also hold the soil together and prevent soil erosion.

Even though grass is adaptable, it does have limits. When too many animals graze in an area for too long, they damage the grass beyond its ability to recover and much of it dies. This is called **overgrazing**.

When an area is overgrazed, much of the grass is destroyed and the roots decay. The grass becomes less efficient in protecting the soil from wind and water erosion. Prolonged drought leads to the land becoming degraded that it cannot recover. This process, called **desertification**, changes rangeland to wasteland.

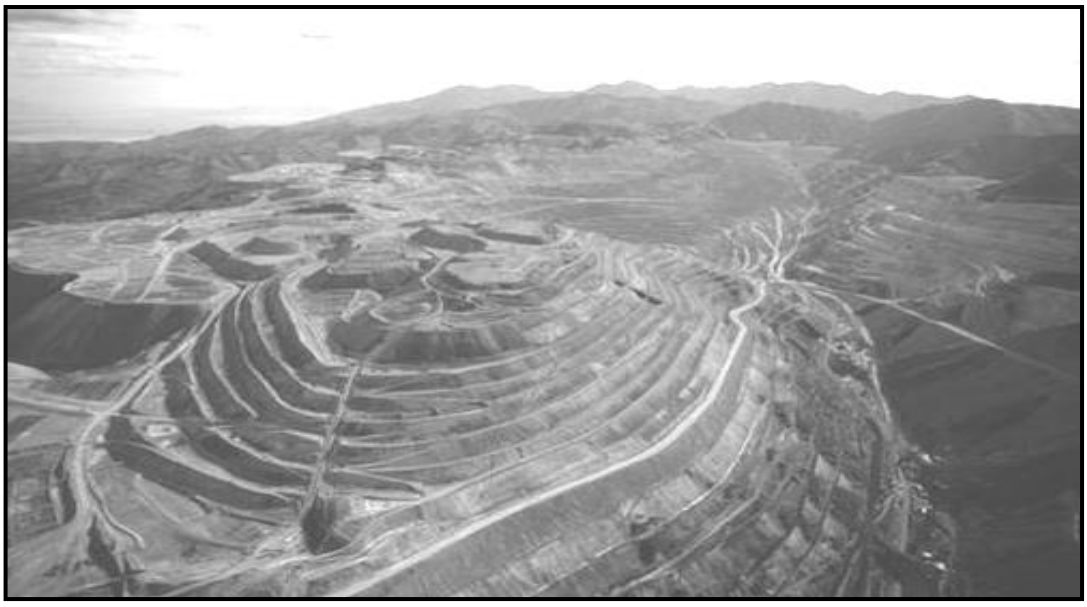
Maintaining the range

In order to protect the range from the posing danger of desertification, grazing must be managed and the ranged must be improved.

Grazing is managed by limiting the animal herds to sizes the land can support. Range management include planting vegetation where soil is bare, fencing areas that need to recover from overgrazing and putting enough water holes to keep grazing animals from concentrating around a single watering area.

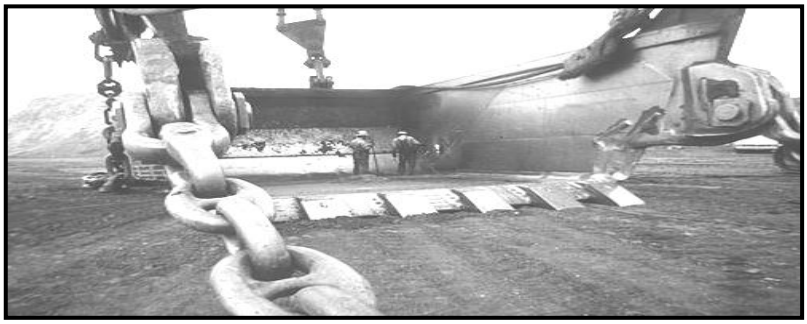
Mining

A surprising amount of land is used for mining minerals. Two common methods of removing minerals from the Earth are open-pit mining and strip mining. In **open-pit mining**, machines are used to dig large holes in the ground and remove the **ore**, which is the mineral-containing rock.



An open-pit copper mine damages the land surface, destroys natural habitat and disrupts the natural environment of organisms.

In **strip mining**, huge bulldozers, buckets, and other machines are used to level or move land, or clear away large strips of Earth‟s surface. The buckets have sharp, slanted teeth on the front edge and are dragged along the surface of the ground by powerful machines.



Strip miners often use extremely large buckets to level or move land. This bucket, used in a coal mine in Ohio, is the size of a small house.

The effects of mining

As you might imagine, extracting minerals from the Earth causes environmental damage. The most obvious damage is the disruption of the land surface and the ugly piles of waste materials left behind. When large areas of natural vegetation are cleared, natural habitat is lost and the natural environment is disrupted.

The large-scale removal of vegetation and rocks can cause land erosion and even landslides. In addition, poisonous substances left behind at a mining site can pollute the air and water. It also requires a lot of energy to remove and process minerals.

Responsible mining

One way to reduce damage from mining is to require mining companies to restore mined land to the condition it was in before mining began. This process is known as **reclamation**.

Another way to reduce the destructive effects of mining is to reduce the need for more minerals. By **recycling** (reusing discarded materials) existing products made from minerals such as iron, copper, and aluminum, we not only save energy and money, but also reduce the pollution caused by additional mining and processing operations.

Activity 2: Now test yourself by doing this activity

Mining

Answer the following questions:

1. What are the disadvantages of mining?

_____

_____

2. Name and describe two ways to decrease the bad effects of mining on the land.

_____

_____

Other man-made activities

Other man-made activities that are harmful to the environment such as manufacturing of plastics, over-use of fossil fuels, and production of solid, liquid, and gaseous wastes leading to pollution, are featured in the other lessons.

Summary

You have come to the end of lesson 16. In this lesson you have learnt that:

- many natural occurrences affect our environment but the organisms have developed ways of adapting or coping to these natural changes and are able to survive. The environment usually recovers and returns to its original condition.
- man can cause different changes to his environment that organisms and the environment itself may not be able to cope.
- trees are harvested to provide products man use every day, such as paper, furniture, lumber and plywood, and firewood.
- deforestation is the process of clearing trees from an area without replacing them.
- removal of trees destroys wildlife habitats, increases soil erosion, and diminishes the beauty of forests.
- reforestation is a process of replacing trees that have died or been cut down.
- overgrazing is the damage to grassland caused by too many animals eating in a limited area; often so harmful that the grass cannot recover.
- when an area is overgrazed, much of the grass is destroyed and becomes less efficient in protecting the soil from wind and water erosion.

NOW DO PRACTICE EXERCISE 16 ON THE NEXT PAGE.

Practice Exercise 16

Answer the following questions:

A. Multiple Choice Questions.

Circle the letter of the correct answer.

1. One advantage of clear-cutting is that it

   A. aerates the soil, allowing it to regenerate.
   B. is the cheapest way for companies to harvest trees.
   C. enables the environment to return rapidly to normal.
   D. brings light to the heavily shaded plants of the forest floor.

2. It is the process where mining companies reduce the effect of mining by restoring the mined land to the condition it was in before mining began.

   A. Recycling
   B. Reclamation
   C. Reforestation
   D. Regeneration

3. The picture shows large holes in the ground where very large machines bore to remove mineral-containing rocks.

   This way of removing minerals is called

   A. ore mining
   B. strip mining.
   C. open-pit mining.
   D. selective mining.

4. Selective cutting involves

   A. cutting all the trees in a forest then reseeding.
   B. cutting the young trees in a forest and leaving the rest.
   C. cutting the mature trees in a forest and leaving the rest.
   D. cutting all the trees that belong to the same group and leaving the rest.

B. Short Answer Questions

1. Write down three ways in which humans can affect the ecosystem?

   a. _____

   b. _____

   c. _____

2. Of these three, which one do you think is the most common in PNG?
   _____

3. Why is it important to recycle materials?
   _____
   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 4.

Answers to the Activities

Activity 1

1. A. make papers D. make way for farming and ranching

   B. make furniture E. used as firewood

   C. materials for housing F. clear an area for housing

2. The clearing of trees from an area without replacing them is deforestation and reforestation - process of replacing trees that have died or been cut down.

3. Removal of trees destroys wildlife habitats, increases soil erosion, and diminishes the beauty of forests.

Activity 2

1. Mining damages the land, destroys the vegetation and habitat, causes erosion and landslides, and pollutes the air and water.

2. The effect of mining can be reduced by reclamation and recycling.
   Reclamation is the process of restoring the land to the condition it was in before mining operations began. Recycling is reusing discarded materials.

Lesson 17: Effects of non-biodegradable substances on food webs

Welcome to Lesson 17 of Strand 2. In the last lesson you learnt about how human activities can affect the environment. In this lesson you will learn about how chemicals in pesticides can build up in food chains and become very poisonous. Now study this simple food chain found in a garden.

aibika → caterpillar → frog → snake

The owner of the garden is not able to harvest all his aibika leaves. And so, out of frustration, he adds a chemical to remove the uninvited guests to his aibika leaf. To his surprise the number of frogs and snakes also decreased which was not his intention. What caused the decrease in the number of frogs and snakes in the garden?

Your Aims:

- define food chains and food webs
- state the uses of fungicides, insecticides and herbicides
- explain why these chemicals are non-biodegradable
- describe how these chemicals affect the organisms in the food web

Food Chain And Food Web

The illustration in the introduction shows a food chain. Sadly, the food chain contains a chemical that removed the caterpillar right up to the snake. And so, a series of organisms in which each organism is eaten by the next in the chain is called a **food chain.**

Organisms usually eat more than one type of food. All the food chains linked in a natural environment is called **food web.**

Pests

Did you know that 90 per cent of the world is dependent for food supplies on just 15 major crop and 7 animal species? Worldwide, pests destroy 35 per cent of these potential world‟s harvest.

A **pest** is an organism that occurs in large numbers to cause damage. Many kinds of organisms can be pests for example caterpillars in an aibika leaf, wasp on a grape, weeds in a lettuce garden, pod borer on a cocoa fruit, a worm eating a green tomato, fungus on mangos, fruit flies and rats in the kitchen.

Wild plants have more protection from pests than do crop plants. Wild plants grow scattered throughout the landscape, so pets have a harder time finding plants they can eat. Crop plants, however, are usually grown together in large fields, providing pests with a one stop source of nutritious food.

Pest Control refers to any of a wide range of environmental methods that aims to reduce the incidence of insect pests, plant fungus, and weed populations, to enable maximum production of high-quality food and other crops. **Pesticide** is the name applied to all types of chemicals used in pest control. Below are examples of pesticides.

1. Fungicides

Fungicides are toxic (poisonous) substances applied either to prevent the growth of or to kill fungi harmful to plants, animals, or humans. Most agricultural fungicides are sprayed or dusted onto seeds, leaves, or fruit to prevent the spread of rusts, smuts, moulds, or mildew.

2. Herbicides

A **weed** is a plant growing where human beings do not want it to grow. Removing competing weeds by hand or by cultivation or tilling, however, is time-consuming and expensive, and thus limits the area that can be farmed. **Herbicides** are chemicals that kill target weeds.

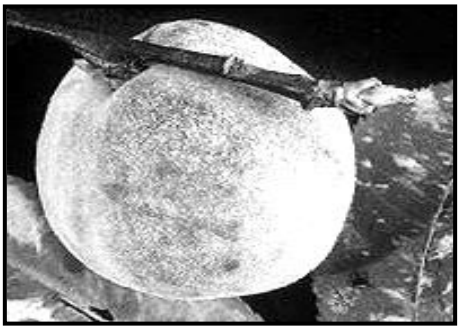
These chemicals, which are relatively inexpensive and effective, have revolutionized weed-control methods and have helped reduce the labour required to produce large quantities of food crops.

Most types of plant-related disease are caused by fungi. The leaves of this plant have been infected by a fungus. Fungi can

3. Insecticides

Insecticides are not as widely produced as fungicides and herbicides but they are often the most controversial because of the negative environmental effects on wildlife.

The public has raised concerns about how insecticides harm non-targets such as bees and other insects needed for pollination.



A plant virus like this one that infects the peach can be transmitted by insects. The virus itself is very difficult to treat, and the best method of treatment is to control the insects that carry the disease.

Drawbacks of pesticides in the food webs

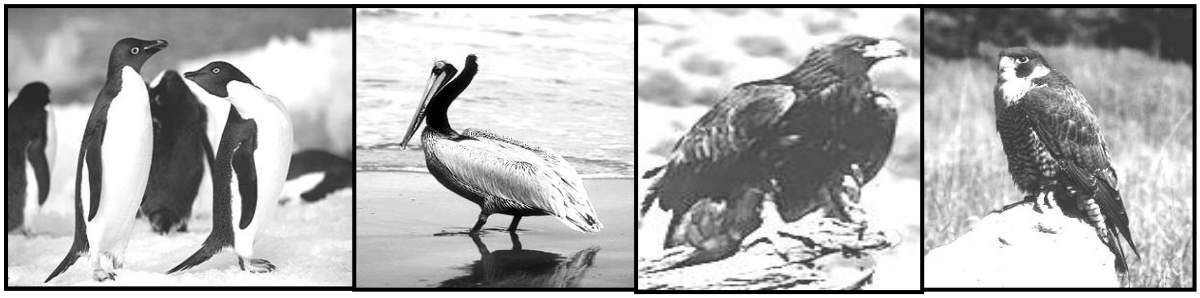
Pesticides affect a lot more than just the pests that they were designed to kill. They can also harm people and wildlife. Many pesticides are non-biodegradable. **Non-biodegradable pesticides** do not break down rapidly into harmless chemicals when they enter the environment.

Pest control has become a difficult issue for farmers because of its potential environmental impact. Although the insecticide being sprayed on this potato field will eliminate a generation of potato beetles, it may also contaminate local food and water sources.

The reason why some pesticides are non-biodegradable is because they are **synthetic** or man-made chemicals. Because they don"t exist naturally, decomposers cannot easily break them down. Pesticides are difficult to remove from the tissues of organisms because unlike most other chemicals that easily dissolve in water, pesticides are insoluble (cannot dissolve in water) and cannot go out as waste.
Harmful chemicals from pesticides accumulate in the soil, water and bodies of organisms.

One of the best known and most persistent pesticides is **DDT**. This pesticide was used in the 1940s to kill the mosquitoes that caused malaria and the lice that spread typhus (a disease that causes fever), saving millions of lives. DDT leaked into the soil, got washed into the water systems and gradually gathered in bodies of water.

It was then absorbed by plants and got transferred in the food chain by feeding. Organisms high on the food chain, like fish-eating birds, are likely to have high levels of DDT in their bodies as they eat many smaller organisms whose bodies contain low levels of DDT. Poisons can become more concentrated as they move up a food chain in a process called **biological magnification** or **bio magnifications**.



Penguins Pelican Eagle Falcon

Poisons from pesticides can transfer from smaller fishes to these birds of prey. Pesticides cannot easily be removed from the tissues of animals because they don"t easily dissolve and break down.

Pesticide Resistance

You might think that the most effective way to get rid of pests is to spray often with large amounts of pesticide. However, in the long run this approach usually makes the pests problems worse. Pest populations develop an ability to tolerate a particular pesticide. This ability of pests to tolerate a pesticide is called **tolerance**.

Summary

You have come to the end of lesson 17. In this lesson you have learnt that:

- a food chain is the transfer of energy from the producers to a series of consumers.
- a food web is an interlocking food chain.
- chemicals from pesticides can also transfer and accumulate in concentration in each step in the food chain.
- a pest is an organism that occurs in large numbers to cause damage.
- pest Control refers to any of a wide range of environmental intervention that aims to reduce the incidence of pests.
- pesticide is the name applied to all types of chemicals used in pest control.
- herbicides control weeds, insecticides control insect pests, and fungicides prevent the growth of fungi.
- persistent pesticides do not break down rapidly into harmless chemicals when they enter the environment.
- poisons can biomagnify or increase in concentration in the tissues of organisms at each step in the food chain.
- pests are often able to develop resistance to pesticides.

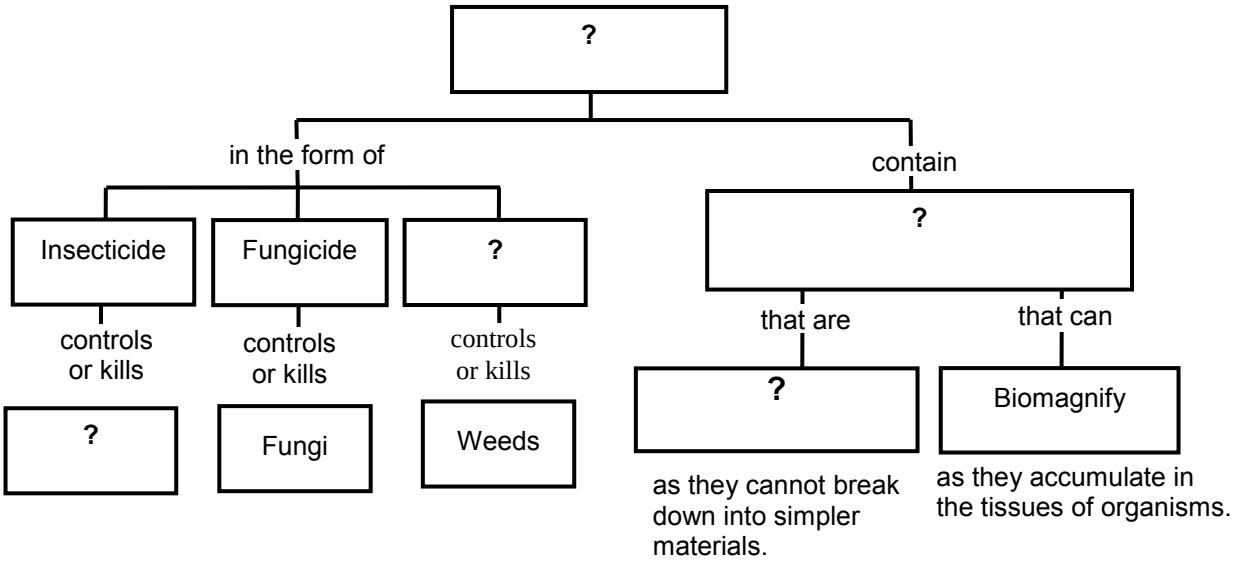
NOW DO PRACTICE EXERCISE 17 ON THE NEXT PAGE.

Practice Exercise 17

Answer the following questions:

A. Relating Concepts

Complete the concept map by writing the correct word/s in each box containing a question mark.



B. Short Answer Questions.

1. Which plants, wild or crop, are better protected from pests? Why?

_____

_____

_____

2. Explain why chemicals from pesticides

   i. do not easily break down in the soil.

   _____

   _____

   ii. cannot simply be removed from the body of organisms.

   _____

   _____

3. Which organisms in the food web are greatly affected by the use of pesticides?

   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 4.

Lesson 18: Pollution

Welcome to Lesson 18 of Strand 2. In the last lesson you learnt that chemicals in pesticides can transfer and build up in concentration in each step in the food chain. In this lesson we will learn about pollution. There are more than six billion people in the world at present. Every person on Earth contributes to the state of our planet, because we all use its natural resources and produce waste materials. The more we populate the world, the more damage we do through pollution.

Your Aims:

- define and list down the different types of pollution
- identify the causes and effects of pollution; and
- suggest ways to control and reduce pollution in the environment

Pollution

It is the contamination of the environment by man-made substances, and a **pollutant** is any man-made product that has a harmful effect in the environment.
Pollution can be grouped according to the medium in which it occurs: **atmospheric pollution** (air pollution), **freshwater and sea pollution** (water pollution), or **land pollution** (solid waste disposal). However, transfers can take place in both directions between the atmosphere, water, and the land. For example, the emission of sulphur dioxide caused by the combustion of fossil fuels such as gas, petroleum, and coal into the air can fall has acid rain and can pollute the soils and lakes.

Over one-third of our pollution comes from gasoline burned in motor vehicles.

Gases such as carbon dioxide, sulphur dioxide and other types of contaminants are seen here pouring from industrial smoke-stacks.

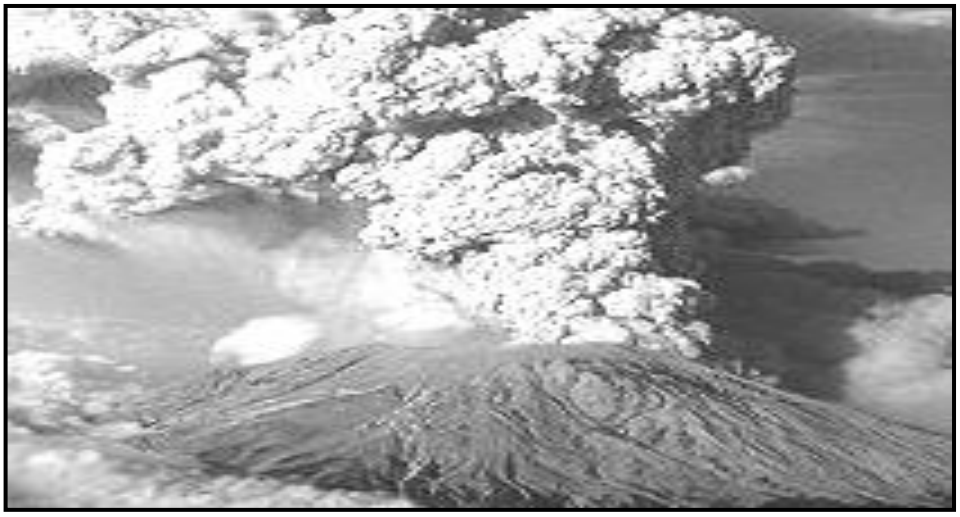
Air pollution

One of the most precious things in our planet is air. Without it we would quickly die. Clean air consists mostly of nitrogen and oxygen gases, along with very small amounts of argon, carbon dioxide, and water vapour.

When harmful substances end up in the air at unhealthy levels, the result is **air pollution**. Substances that pollute the air can be in the form of solids, liquids, or gases.

The most common air pollutants are carbon monoxide, nitrogen oxides, lead, ozone, and sulphur oxides from vehicles, industrial and power plants that burn fossil fuels.

Most air pollution is the result of human activities, but pollutants can come from natural sources as well. A volcano, for example can spew clouds of particles and sulphur dioxide that can harm animals. Natural pollutants also include dust, pollen, and spores.



A violent volcanic blast can send clouds of ash and other volcanic debris into the atmosphere.

Smog

When air pollution hangs over the skies and reduces visibility, it is called **smog**, a term combining the words *smoke* and *fog*. Smog results from chemical reactions involving sunlight and some air pollutants released by automobiles and industries.

Continued exposure to smog can result in respiratory problems, eye irritation, and even death.

Effects of air pollution

In some countries the air is clean and pure but in big cities or industrial countries air is much more polluted. Factories, power stations, aircraft and motor vehicles send smoke and harmful gases into the air. These pollute the atmosphere and cause many thousands of deaths worldwide each year.

Air pollution can cause serious health problems. People who are very young or very old and those with lung and heart problems are particularly prone to the effects of air pollutants. Emphysema, asthma, lung cancer, chronic bronchitis and other respiratory diseases can be worsen by air pollution. Lead compounds released into the atmosphere from the combustion of leaded petrol are absorbed into the body and may cause slow mental development and can damage the liver.

Thick smoke allows less light to penetrate the air and its deposits can cover leaves of plants. Both these effects lead to reduced photosynthesis and so reduce crop harvesting.

Particles of smoke can also irritate eyes, nose and lungs in animals. Smoke from burnt plastics can be very poisonous when inhaled.

Controlling air pollution

The Clean Air Act observed in most countries aims to regulate automobile emissions. It required the gradual elimination of lead in gasoline and as a result, lead pollution has dropped. In addition, vehicle converters clean exhaust gases of other pollutants before they exit a car"s exhaust pipe.

One effective way to reduce air pollution is to drive less. Cars that can run using solar power, electricity, hydrogen or natural gas are also being developed. Toxic materials like plastics and foams should never be burned in the open.

Activity: **Now test yourself by doing this activity.**

Air pollution

Answer the following questions:

1. Name two major sources of air pollution.

   _____
   _____

2. What harmful effects could air pollution have on plants?

   _____
   _____

3. Suggest one way to reduce air pollution from motor vehicles.

   _____
   _____

Acid rain

Acid rain is a highly acidic precipitation that results from the burning of fossil fuels. Acid rain is a kind of air pollution. When coal, oil and petrol are burned, they release the harmful gases sulphur dioxide and nitrogen dioxide into the air. When these gases combine with water in the atmosphere, they form sulphuric acid and nitric acid. Eventually they return to the ground as acid rain, hail, snow, sleet and fog.

Effects of acid rain

When acid rain gets into lakes and streams it kills the fish and other animals and plants living there. It also damages all kinds of land plants, including farm crops and forests.

In 1984, at Germany almost half of the trees in Black Forest had been damaged or killed by acid rain. Even the drinking water was affected by it.

Acid rain corrodes or wears away the outside surfaces of stone buildings and monuments as well as metal work such as steel bridges and railings. Some of the world‟s greatest cathedrals and most famous monuments show signs of the damage caused by acid rain.

Forests throughout the world are being severely damaged by the effects of acid rain. Acid rain chemically burns the leaves of plants.

Reducing acid rain

Most of the acid gases that produce acid rain come from power stations and factories. The exhaust fumes produced by motor vehicles also contain acid gases. Power stations and factory chimneys can be fitted with devices that remove the sulphur dioxide gas, while cars can be fitted with converters, which reduce the nitrogen oxides in exhaust fumes.

Water pollution

Water pollution is the introduction of harmful chemicals or micro-organisms into water that degrades or spoils the quality of the water and affects the organisms that depend on it.

Water pollutants include biodegradable remains of plants and animals including animal faeces, disease causing organisms such as bacteria, pesticides, nitrates from fertilizers, plastics, detergents, gasoline and oil, industrial wastes like mercury, cadmium and lead and radioactive wastes.

The pollution of rivers and streams with chemical contaminants is one of the world's most critical environmental problems.

How the water gets polluted

Many towns and factories are built near lakes and rivers so that they can use the water. But some towns and factories do not clean the water they use they damp their wastes back into the rivers and lakes.

Tanker spills are an increasing environmental problem because once oil has spilled, it is virtually impossible to remove or contain it completely. Even small amounts spread rapidly across large areas of water. Fertilizers and pesticides used on farms, as well as animal manures, can be washed into rivers and lakes.

Workers use special nets to clean up a beach following an oil tanker spill.

Effects of water pollution

Water pollution affects all living things including human health. Nitrates in drinking water can cause a disease in infants that sometimes results in death. Cadmium in fertilizer can be absorbed by crops if ingested in sufficient amounts, the metal can cause diarrhoea, liver and kidney damage. Some industrial wastes such as mercury, arsenic, and lead are extremely poisonous. Poisonous chemicals can get into the food chain and increase their concentration in the tissues of organisms thereby harming them.

On the other hand, oil spills can devastate the lives of plants and animals in the water. Plants cannot photosynthesise because the oil that floats on the surface blocks the light. Floating plants cannot perform gas exchange since the oil covers their stomata. Whereas as in animals the oil sticks to the bird's feathers making it hard to move and fly. They can also take in oil through their beaks.

All these forms of pollution make rivers and lakes to become smelly, kill water plants, animals, and make the water unfit for people to use.

This seabird is being washed after a spillage from an oil tanker. Only a few "oil-dirty" birds can ever be saved.

Eutrophication (decrease of oxygen in water)

Eutrophication is the process by which water becomes rich in dissolved nutrients from fertilizers, sewage and dead algae which causes an increase in the number of bacteria‟s. The bacteria‟s then use up all the dissolved oxygen in the water thereby resulting in harm to other organisms. For example fish suffocate and die in the oxygen-depleted water.

What can we do?

Different types of pollution evidently have negative effect on us and in our environment. We cannot eliminate pollution in our environment but we can reduce it to a minimum and constantly check their effect on living organisms.

Summary

You have come to the end of lesson 18. In this lesson you have learnt that:

- pollution is the contamination of the environment by man-made substances, and a pollutant is any man-made product that has a harmful effect in the environment.
- air pollution results when harmful substances end up in the air.
- when air pollution hangs over urban areas and reduces visibility, it is called smog, a term combining the words *smoke* and *fog*.
- acid rain is a highly acidic precipitation that results from the burning of fossil fuels.
- water pollution is the introduction of harmful chemicals or micro-organisms into water that affects the organisms that depend on it.
- eutrophication occurs when lake water becomes artificially enriched with nutrients causing abnormal plant growth.

NOW DO PRACTICE EXERCISE 18 ON THE NEXT PAGE.

Practice Exercise 18

Answer the following questions:

A. Multiple Choice Questions.

Circle the letter of the correct answer.

1. Which is not a component of clean air?

   A. Oxygen
   B. Nitrogen
   C. Water vapour
   D. Carbon monoxide

2. Which of the following diseases is not linked to air pollution?

   A. Asthma B. Diabetes

   C. Lung cancer D. Bronchitis

3. Which of the following causes acid rain?

   A. Carbon dioxide
   B. Sulphur dioxide
   C. Hydrogen oxide
   D. Carbon monoxide

4. The component of car exhaust fumes that is known to cause brain damage in young children is _____.

   A. Lead B. Argon

   C. Arsenic D. Mercury

5. Sewage outfall in rivers and lakes causes eutrophication. Which of the following is a correct description of the sequence of events in this process?

   A. sewage → less animals → more respiration → less oxygen
   B. sewage → increase in algae → more respiration → less oxygen
   C. sewage → increase in algae → less photosynthesis → less oxygen
   D. sewage → decrease in algae → more photosynthesis → less oxygen

B. Short answer Questions

1. Define pollution

_____

_____

2. What is the major human activity that contributes to acid rain?

_____

3. One major problem faced by cocoa plantations in the New Guinea islands is the outbreak of the pod borer that infects the cocoa. Describe the effect to the environment if a pesticide is used to eliminate this problem.

_____

_____

_____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 4.

Answers to Activity

1. Motor vehicles, industrial plants, power plants

2. Thick smoke reduces light availability; smoke particles can cover plant leaves; both contribute to reduced rate of photosynthesis in plants.

3. By not using lead in gasoline, use converters to filter exhausts, drive less, and develop bio-fuels and other cleaner sources of energy

Lesson 19: Ozone Depletion

Welcome to Lesson 19 of Strand 2. In the last lesson you learnt about the types of pollution, their causes and effects and how you can control and reduce pollution. In this lesson you will learn about how we are protected from the harmful rays of the sun. The atmosphere consists of five layers of gas that surrounds our planet. However in the stratosphere there is a very special layer of gas contained in there which is called the ozone layer. The ozone layer acts as a blanket preventing us from receiving too much heat and sunlight.

Your Aims:

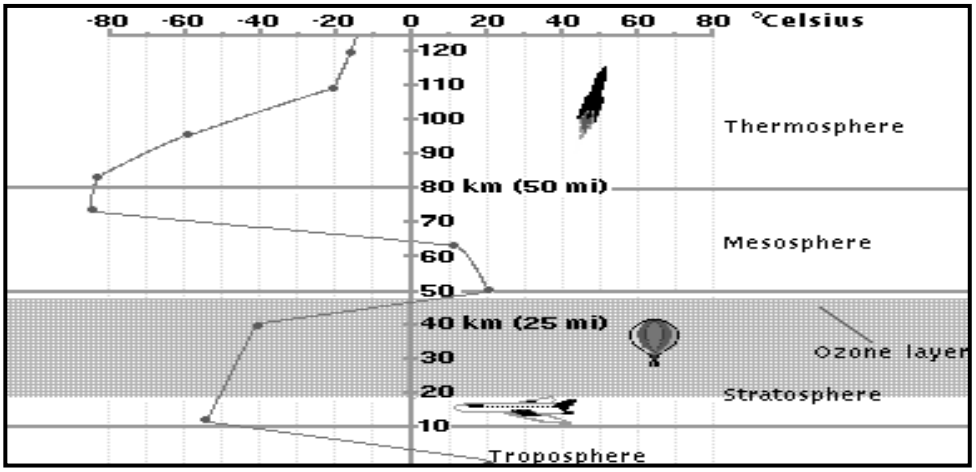
- state the composition of the ozone gas
- explain the importance of the ozone layer in the atmosphere
- list some reasons that contributes to the depletion of the ozone layer
- describe the damaging effects of ozone depletion and
- suggest ways to reduce ozone depletion

Ozone Layer

The ozone layer consists of the highest concentrations of ozone gas (O_3) which is made up of three oxygen atoms. These gas is situated about 20 to 25 kilometres in the stratosphere above the earth‟s surface.

The function of Ozone layer

The **ozone layer** absorbs harmful ultraviolet radiation from the sun and turns its energy into heat. In this way, the ozone layer shields the earth‟s surface against ultraviolet rays from the Sun and protects plants and animals, including people, from its harmful effects.



The illustration shows the position of the ozone layer in the atmosphere. The temperature changes associated with the various layers are also shown.

The hole in the ozone layer

The ozone layer around the earth had been stable for millions of years. It is thinnest near the equator and thickest at the North and South poles.

In 1985, scientists from the British Antarctic Survey discovered that the ozone layer over the Antarctic gets thinner during the southern winter and spring. The “hole” is about the size of the United States and as deep as Mount Everest.

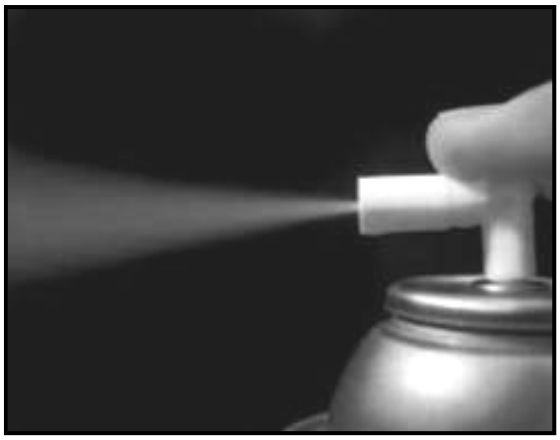
Similar, but smaller, “holes” occur from time to time in the ozone layer over the North Pole, and there is also a general thinning of the ozone layer over the rest of the world. As a result of these changes to the ozone layer, more ultraviolet rays are reaching the Earth.

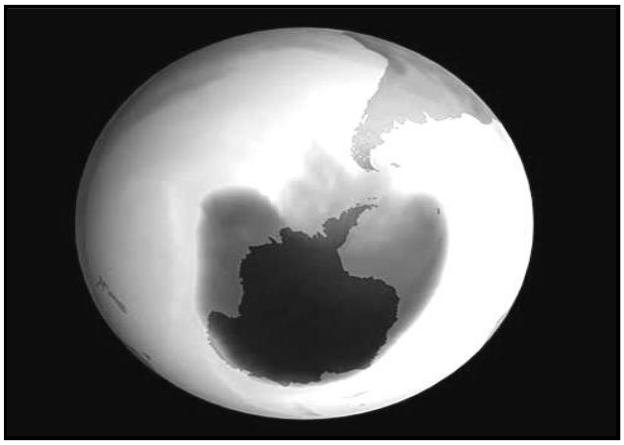
Chlorofluorocarbons (ozone eaters)

Scientists studying the ozone holes believe the cause is a group of chemicals known as chlorofluorocarbons, or CFCs for short.

For many years after CFCs were discovered in 1930, they were widely used in aerosol sprays. In aerosol cans, CFCs were used as propellants to force the contents of the cans out as a fine spray. Most aerosols now use other propellants and the cans are labelled “CFC-free” or “ozone friendly”.

CFCs were also widely used as coolants in refrigerators and air-conditioning units, dry cleaning and the plastic foam used to make cartons for eggs and Styrofoam in lunch packs.





The hole in the ozone layer over the South Pole can be seen in this image sent by Nimbus 7 weather satellite in October 1999.

Aerosol sprays may contain CFCs

Ozone depletion
CFCs rise from the Earth and gradually collect in the stratosphere. There they are broken down by the Sun‟s ultraviolet light, and the gas chlorine is released. The chlorine attacks the ozone, and one chlorine atom can destroy 100,000 ozone molecules.

When the chlorine from CFCs has destroyed the ozone, more of the Sun‟s ultraviolet rays can then reach the earth‟s surface.

Activity: **Now test yourself by doing this activity.**

To spray or not to spray?

Answer the following questions

1. Name five canned products that use a propellant to spray? (A visit to your nearest grocery store may help.)

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

2. Why do you think most aerosol spray cans are now labelled “CFC-free” or “ozone friendly?
   _____
   _____
   _____

Ozone from combustion of fossil fuels
You read in the previous lesson that ozone is being produced near the ground as air pollution from motor vehicles so you may be wondering why this ozone doesn‟t just float up to the stratosphere and repair the ozone hole.

The answer is that ozone is very chemically reactive. Ozone produced by pollution breaks down or combines with other substances long before it can reach the stratosphere to replace the ozone that is being destroyed.

This ozone produced close to the earth‟s surface is poisonous and is a health hazard, as it is one of the major constituents of photochemical smog.

The effects of ozone depletion

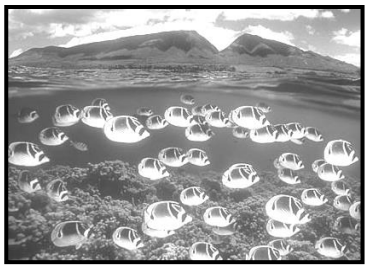
As the amount of ozone in the stratosphere decreases, more ultraviolet light is able to pass through the stratosphere and reach the earth‟s surface.

UV or ultraviolet light is dangerous to living things. It is the major cause of skin cancer and eye disease in humans.

High levels of UV light can kill one-celled organisms that live near the surface of the ocean. Their loss could disturb ocean food chains and reduce fish harvests. In addition, a reduction in the number of microscopic photo synthesizers would further increase the amount of carbon dioxide in the atmosphere.

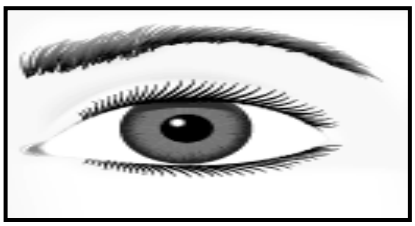
Other damaging effects of excessive UV light are shown in the figure below.

Crops
Interference with photosynthesis, results to lower crop yields

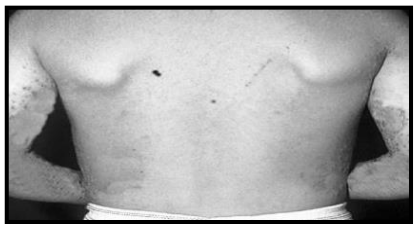


Marine Life
Kills microscopic plants near the surface, disrupts ocean food chain

Immune System
Weaker immune response, making body more susceptible to most diseases



Eyes
Cataracts or eye disease can develop, closing lens to cloud up. This leads to blurred vision or blindness



Skin
Faster aging, wrinkling, Skin cancer

Some of the adverse effects of increased exposure to UV light as a result of ozone

Banning CFCs – a way to reduce ozone depletion

Most countries have now stopped making and using CFCs. But CFCs do not react easily with other chemicals and there is no natural way to get rid of them from the atmosphere.

Scientists are launching a balloon from a research base in Antarctica. The balloon will be used to study the ozone layer, which is thinning rapidly in an area over the Antarctic.

As a result, even if everyone stopped making and using them today, scientists think it will take at least 50 years for the ozone layer **to repair itself. This is because CFCs can stay** in the atmosphere from 50 to 100 years, and takes 5 to 10 years to reach the upper atmosphere where they are broken down.

The hydro-chlorofluorocarbons (HCFC‟s) were developed to replace CFCs. These gases can still damage ozone if they reach the stratosphere, but they are less likely to since their extra hydrogen atom allows them to be destroyed in the lower layers of the atmosphere.

Summary

You have come to the end of lesson 19. In this lesson you have learnt that:

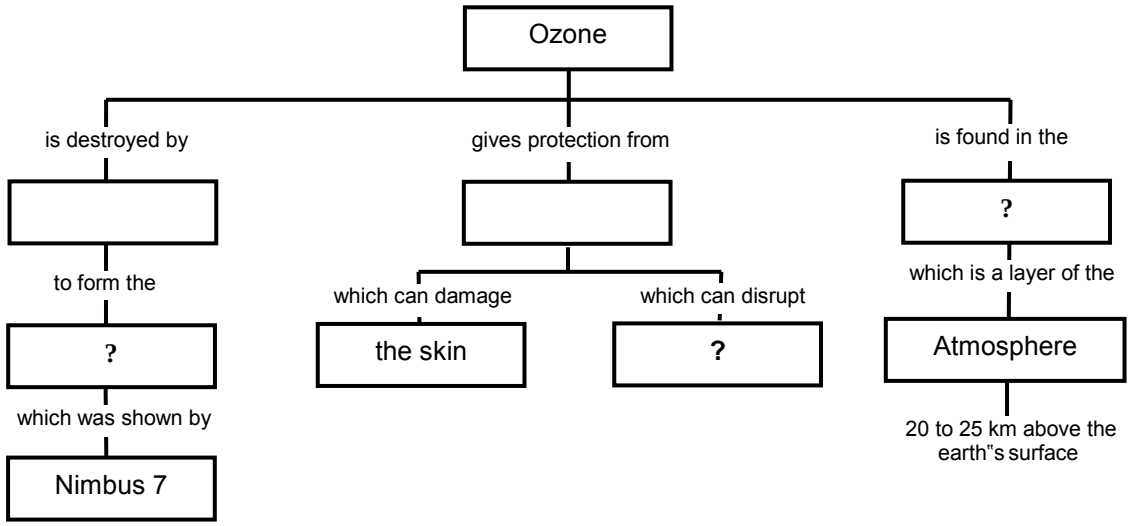
- ozone is a form of oxygen with molecules made of three oxygen atoms (O_3).
- the ozone layer absorbs harmful ultraviolet radiation from the sun and turns its energy into heat.
- ozone is destroyed by chlorine atoms released when chlorofluorocarbons (CFCs) are broken down.
- CFC‟s are human-made chemicals found in coolants and aerosols. These chemicals are restricted in use because they destroy ozone.

NOW DO PRACTICE EXERCISE 19 ON THE NEXT PAGE.

Practice Exercise 19

Answer the following questions:

A. Relating Concepts. Write the correct word or phrase in each box containing a question mark.



B. Short Answers

1. What does the initials CFC stands for?

   _____

2. Name the major sources of CFCs in our atmosphere?

   _____

   _____

3. Name the particular element in CFCs that destroys the ozone layer.

   _____

4. How does UV light damage plants? Briefly describe the consequence of this.

   _____

   _____

5. If the ozone layer gets thinner and thinner during your lifetime, what changes might you need to make to your lifestyle?

   _____

   _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 4.

Answers to Activity

1. Insecticide (mortein), deodorant (axe, rexona), paints (spray paints), air spray (air wick, glade), whipped creams cans and cooking spray, ashma inhalers

2. Because they are already aware of the dangerous effect CFC has on the ozone layer.

Lesson 20: Global Warming

Welcome to Lesson 20 of Strand 2. In the last lesson you learnt that the ozone layer acts as a blanket preventing us from receiving too much heat from the sun. In this lesson we will learn about why our Earth is becoming warmer.

Your Aims:

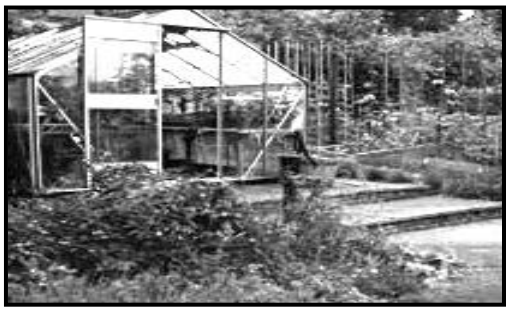
- explain why the earth and its atmosphere are a like a greenhouse
- define greenhouse effect and global warming
- name the greenhouse gases and explain why their levels in the atmosphere are rising
- describe the effects of global warming and
- suggest ways of reducing the effects of global warming

Greenhouse Effect

The atmosphere is like a car or a greenhouse. It is largely transparent to incoming **ultraviolet solar radiation**, which is absorbed by the Earth's surface. Much of this radiation is then re-emitted as heat energy.

Some of this energy escapes back into space, but much of it is absorbed and trapped by gases in the atmosphere. Without these gases, our Earth would be a much colder place. Many parts of the world would be too cold for people to live in.

The warming effect on the air caused by heat rising from the surface of the Earth and being trapped by the gases in the atmosphere is called the **greenhouse effect**.

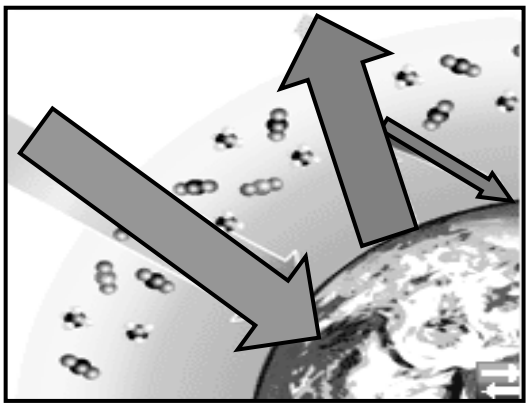


How is the earth like a greenhouse?

Not every gas in the atmosphere absorbs and traps heat. The gases that do trap and radiate heat and so keep the surface of the Earth warm are called **greenhouse gases**.
The major greenhouse gases are water vapour, carbon dioxide, chlorofluorocarbons (CFCs) methane, and nitrous oxide. After water vapour, carbon dioxide is the most important of the greenhouse gases.

How the greenhouse effect works?

Sunlight streams through the atmosphere and heats the Earth.



Greenhouse gases trap some of the heat near the Earth"s surface.

Too much carbon dioxide
Under normal conditions the level of carbon dioxide in the atmosphere remains constant, and trees absorb the same amount of carbon dioxide that people produce. But in recent decades, our planet has supported more people and fewer trees, leaving an excess of carbon dioxide in the atmosphere.

We are putting more and more carbon dioxide into the atmosphere by burning more and more fossil fuels (coal, oil and natural gas), and by clearing huge areas of forest. Forests are important to us because trees, like other green plants, take carbon dioxide from the air when they make their food by the process called **photosynthesis.**

In the last 150 years the amount of carbon dioxide in the atmosphere has increased by 25 per cent and scientists believe that this is causing our atmosphere to warm up.

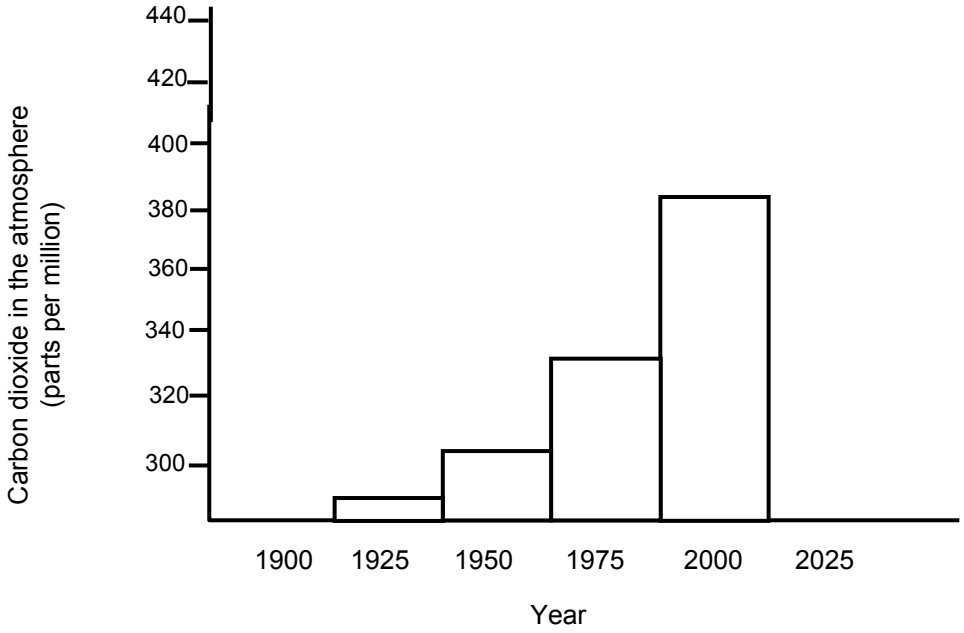
Other greenhouse gases
Increasing amounts of several other greenhouse gases are also being released into the atmosphere, besides carbon dioxide and water vapour. They include methane, nitrous oxide and substances called **CFC, or chlorofluorocarbons.**

The methane comes from animal wastes, rotting rubbish heaps, rice paddy fields and oil and gas drilling rigs. Much of the nitrous oxide comes from car exhausts and chemical fertilizers, while the CFCs were used in the past in refrigerators, aerosol sprays and foam packaging.

The carbon dioxide released from the burning of the forest and the vehicle exhaust fumes contribute significantly to global warming.

Activity 1: Now test yourself by doing this activity.

Greenhouse effect



1. The figure above shows the increase in carbon dioxide in the atmosphere since 1900. List some factors that contributed to the sudden increase of carbon dioxide level in the atmosphere.

   _____

   _____

   _____

2. How much carbon dioxide was in the atmosphere (parts per million) in 1950?

   _____

3. Predict, by adding another bar, the concentration of carbon dioxide in the atmosphere in 2025 assuming the pattern of increase does not change.

   _____

Global warming

As a result of all this extra pollution, our Earth is warming up. The problem began more than 100 years ago when people began to use fuels such as petrol and oil on a large scale.

By 1990, average world temperatures had risen by about a half a degree Celsius. Many scientists now believe that the average global temperature will be at least 1 degree Celsius (^{o}C) warmer by the year 2030 and at least 2 degree Celsius by 2050.

A 1 or 2 degree rise in 40 years does not sound very much, but it is much faster than any climate change in the past 10,000 years. This predicted increase in temperature brought about by the increasing level of greenhouse gases in the atmosphere is called **global warming**.

The effects of global warming

1. **Rising sea levels and flooding**. As the temperatures rise, the **polar ice caps and glaciers will melt**; there is evidence that this has already begun. As the ice melts, the sea level will rise and low-lying areas such as the Maldives islands in the Indian Ocean, Bangladesh and many coastal areas around the world will be covered by sea. In addition, because the oceans and seas are warmer, the water in them will expand and take up more space which may cause floods.

   More water will probably evaporate from the oceans, producing more rain and causing flooding in coastal areas.

Some scientists are concerned that a rise in sea level due to global warming could put the low-lying Maldives under water in less than 100 years.

2. **Desertification**. More water will evaporate from the land. The soil will be desert-like causing droughts and food shortages in some areas, mostly in the tropics.

3. **Change in weather patterns**. The oceans will heat up more significantly which will make more hurricanes stronger and more common. The oceans‟ current patterns will change causing some regions to have more rain than normal, while others might have less. Severe flooding will occur in some regions at the same time droughts devastate other regions.

4. **More animals and plants will become endangered**.There have been natural climate changes in the past, but these were very slow and plants and animals were able to adapt to them. Today‟s global warming is happening much more quickly.
   It could wipe out many plant and animal species that cannot adapt in time. The golden toad of Costa Rica became extinct in 1989, probably because of climate change. At the same time, other species, some of them regarded as **pests,** may spread to new areas.

Global warming in PNG

The Carteret Islands became well known all over the world for their rising water level due to global warming. It is predicted that by 2015 there will be no life on these islands as the islands will be under the sea.

Some of the islanders moved to the mainland of Bougainville. These islanders have become the **world's first refugees** as a result of global warming. The residents of the islands never use electricity, gas or vehicle, and never contributed to the world carbon emission at all.

American climate scientist Michael Prentice warned that more unknown species of plants and animals in PNG may die out before they are identified because of climate change. Research has shown that global warming is happening in the country 20 times faster than previously thought.

Many unidentified organisms hiding in this lush rainforest in the Southern Highlands of PNG may not adapt to the global warming that is happening much quickly.

Reducing global warming

What can be done to slow down global warming? You and I can help in the reduction of global warming by:

- Using less fossil fuel so that less carbon dioxide is released into the atmosphere.
- Walking or cycling instead of driving
- Travelling by train or bus instead of many cars.

Additionally, the Earth‟s existing forests could be preserved, and more trees could be planted so that more carbon dioxide is removed from the atmosphere.

Insulating our homes, using less electricity and recycling rubbish, particularly glass, paper and metals, will slow down the production of greenhouse gases.

On a more specialized level, we can reduce the quantities of fossil fuels we use by developing engines and heating systems that use fuel more efficiently.

Governments can encourage the use of sources of power that do not burn fuel and release carbon dioxide. These include using wind, wave, tidal, hydroelectric and geothermal power.

Taking action on a global scale - The Kyoto Protocol

The act of planting trees or taking public transport is not enough to address global warming. In December 1997, representatives from 150 nations met in Kyoto, Japan to debate international limits on greenhouse gas emissions. The developed nations including the United States, agreed to cut down greenhouse-gas emissions by an average of 5 per cent below 1990 levels.

Summary

You have come to the end of lesson 20. In this lesson you have learnt that:

- certain gases trap heat in the atmosphere. This process is called greenhouse effect which keeps the earth warm enough for life to exist.
- the gases that do trap and radiate heat and so keep the surface of the Earth warm are called greenhouse gases.
- the major greenhouse gases are water vapour, carbon dioxide, chlorofluoro-carbons (CFCs) methane, and nitrous oxide.
- the burning of fossil fuels and the clearing of the forests are causing a rapid rise in the carbon dioxide levels in the atmosphere.
- some scientists predict that the increase in the intensity of greenhouse effect will cause global warming.
- global warming poses serious threat to organisms and the environment.

NOW DO PRACTICE EXERCISE 20 ON THE NEXT PAGE.

Practice Exercise 20

Answer the following questions:

A. Multiple Choice Questions. Circle the letter of the correct answer.

1. Which is **not** a greenhouse gas?

   A. Nitrogen
   B. Methane
   C. Water vapour
   D. Carbon dioxide

2. Which one is not a harmful result of high carbon dioxide level in the atmosphere?

   A. Heavier rainfall
   B. Melting of polar ice
   C. Change in weather patterns
   D. Increased cases of skin cancer

3. Greenhouse gases are important in the atmosphere because without them

   A. nutrients will not cycle.
   B. plants cannot photosynthesise.
   C. the planet would be too cold for people to live in.
   D. all of the solar radiation will stay in the atmosphere.

4. Which greenhouse gas also has the potential to destroy the ozone layer?

   A. Methane
   B. Water vapour
   C. Nitrous oxide
   D. Chlorofluorocarbon

5. Which effect of global warming is said to be the major threat to some species of plants and animals in Papua New Guinea?

   A. Flooding
   B. Climate change
   C. Rising of the sea level
   D. Spreading of pests to new areas

B. Short Answer Questions.

1. Why is the air warmer inside a greenhouse than outside it?

_____
_____

2. Describe three human activities that contribute to the increase in greenhouse gases in the atmosphere?

_____
_____
_____

3. What evidence do scientists have that global warming is occurring?

_____
_____
_____

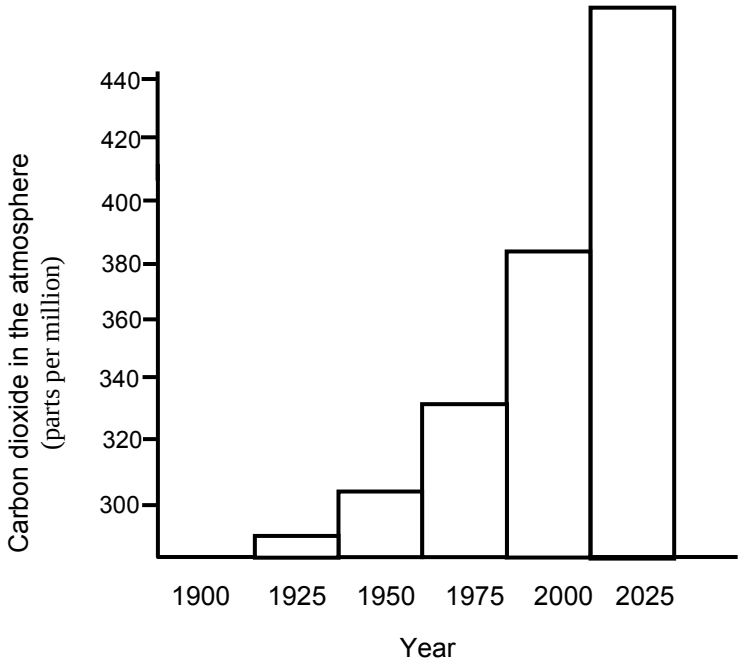
CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 4.

Answers to Activity

1. We are putting more and more carbon dioxide into the atmosphere by burning more and more fossil fuels (coal, oil and natural gas), and by clearing huge areas of forest.

2. About 300 parts per million

3. If the trend of increase does not change, the concentration of carbon dioxide in the atmosphere will be more than 440 parts per million.



Lesson 21: Waste Management

Welcome to Lesson 21 of Strand 2. In the last lesson you learnt about global warming. In this lesson you will learn about how you can produce less waste and help reduce waste problems.
It‟s lunchtime. You stop at a *kai*-bar and buy a rice stew and a can of drink. Within minutes, the food is eaten, and you throw your trash into the nearest rubbish bin. The figure below shows what might be in your trash: plastic cups and containers, Styrofoam cups and container, and empty cans of drinks.

Your Aims:

- define solid waste disposal
- classify the different types of wastes
- describe some ways of disposing wastes
- identify some strategies of waste management

Different Types Of Solid Wastes

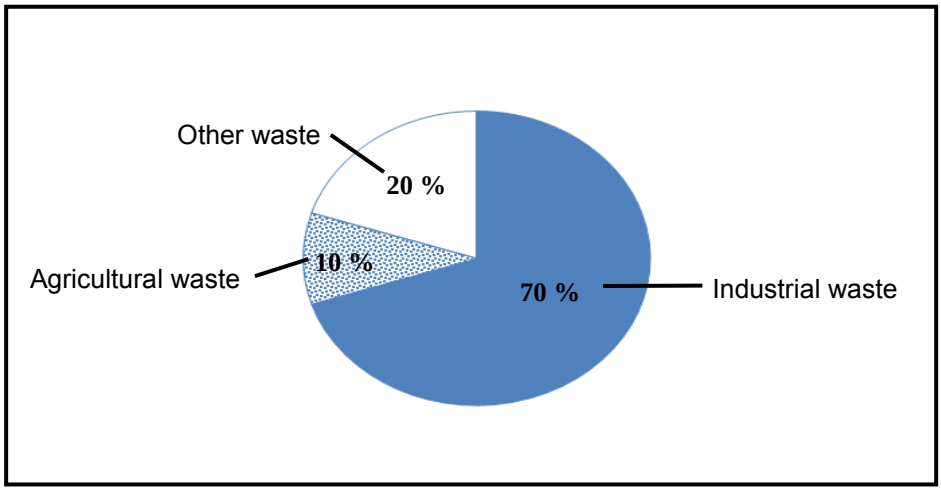
Less than ten per cent of the world‟s waste is the **municipal waste** from households and businesses. It includes garbage and rubbish. **Garbage** is composed of biodegradable wastes from food. **Rubbish** is made of non-biodegradable wastes, either combustible (such as paper, wood, and cloth) or non-combustible (such as metal, glass, and ceramics).

Municipal waste can be an ugly site. They are filthy and smelly, and provide a breeding ground for disease-carrying organisms such as rodents and mosquitos.

Paper and plastic make up the largest amount of our municipal wastes. This is because almost everything we buy are packaged in paper or plastic.

More than half of the world‟s waste is **industrial waste** that comes from manufacturing and mining. It includes such materials as chemicals, paints, and sand, slag heaps and coal refuse piles, ash residues of the combustion of solid fuels, demolition and construction debris and trees.

About ten per cent is **agricultural waste** from farms which includes animal manure and crop residues.



Where our trash go

Solid waste disposal is the throwing away of normally solid or semi-solid materials from human and animal activities that are useless, unwanted or hazardous. These are either just thrown away carelessly, brought to landfills or burnt in incinerators.

Landfills are the most common method of disposal. **Incineration** accounts for most of the remainder, whereas better management of solid wastes accounts for only an insignificant amount. But these methods are sometimes costly people often just throw them away carelessly.

1. **Landfills**. Disposal of wastes on land is the most common method used around the world. A **landfill** is a waste-disposal facility where wastes are put on the ground and covered each day with a layer of dirt, plastic or both.

   In a **modern landfill**, refuse or trash is spread in thin layers, each of which is compacted by a bulldozer before the next is spread. When about 3 m (10 ft) of trash has been laid down, it is covered by a thin layer of clean earth, which also is compacted.

An overflowing landfill

Landfills are safer than the open dumps which produce unbearable smells and provide breeding grounds for flies and rats which is a health hazard.

A modern landfill

One problem with landfills is leachate. **Leachate** is water that contains poisonous or toxic chemicals dissolved from wastes in a landfill. These harmful chemicals come from paints, pesticides, cleansers, cans, batteries, and appliances.
Leachate sometimes flows into groundwater supplies, making water from nearby well unfit to drink.

Another problem with landfills is methane. **Methane** is a gas produced when organic wastes decompose without oxygen. Methane is a highly flammable gas and may seep through the ground into basements of homes up to 300 metres from a landfill. If the methane is ignited by spark, it can cause deadly explosions.

An average town dweller may produce a tonne of refuse (waste) in a year, a volume that rapidly overflows local dumps. Local authorities running out of space for landfill often turn to incinerating their waste or transporting it to other areas.

2. Incinerators

Wastes are often burnt in incinerators so that the amount that is sent to the landfills are reduced. Some incinerators have special equipment that uses the heat from the burning waste to produce steam. The steam can be used to generate electricity.
However, waste that is burned does not disappear. Some of it ends up in the air as polluting gases, and the rest is converted into ash that must be disposed of in a landfill.
The amount of space needed in the landfill is reduced, but the material to be buried is more toxic.

An incinerator plant generates electricity from domestic wastes.

Activity 1: Now test yourself by doing this activity.

Solid wastes

1. Why do non-biodegradable wastes cause waste-management problems?

   _____

   _____

2. What is the difference between industrial waste and municipal solid waste?

   _____

   _____

3. Write one advantage and disadvantage of incinerating solid waste.

   _____

   _____

4. Name a biodegradable product that you could use instead of using a non-biodegradable product

   _____

   _____

Better waste management

If landfills and incinerators are expensive and polluting, what are some other options? There are four: producing less waste, recycling, composting, and changing materials used in products.

1. **Producing less waste**. If we produce less waste, we will reduce the expense and difficulty of collecting and disposing of it. Many ideas of reducing waste are simple common sense, like using both sides of a sheet of paper and using used bags.
   You can also reduce the amount of trash by refusing to buy products with unnecessary packaging. This will help influence manufacturers to create products that don‟t require a lot of packaging.
   Families with babies can reduce the amount of solid waste they produce by using washable cloth diapers instead of disposable ones.
   Beverage manufacturers could also be influenced to stick to refillable glass bottles instead of buying plastic bottles or cups.

2. **Recycling**. Think of all the things you throw away: plastic bottles, drinks cans, sweet wrappers. Most of this rubbish gets buried in big holes in the ground called landfills. A lot of these things can be **recycled**, or turned back into something useful. Most materials can be recycled. The main things we recycle today are made from metal, paper, glass or plastic.
   People recycle for many reasons. One of the main reasons is to conserve resources. Making new aluminium cans out of old ones means less aluminium is needed for new cans.

Recycling aluminium cans

Paper is sorted by type

Sorting plastics

Separating glass by colour

The second reason for recycling is to save energy. Recycling old aluminium cans takes a lot less energy than making new aluminium. To make new aluminium, you need to mine metal ore from the ground, remove the impurities and refine it into a finished metal.
Recycling also conserves valuable land. By recycling, we produce less waste. That means fewer landfills are needed for dumping our rubbish.

3. **Composting**. Yard waste and biodegradable household waste are examples of municipal solid waste. None of these wastes really has to go to a landfill because they can decompose. They can be allowed to decompose naturally in a compost pile.
   Composting can also be an effective way of handling waste from food-processing plants and restaurants, manure from animal farms and food scraps from the vegetable markets. If all such biodegradable waste were composted, the amount of solid waste going to landfills could be greatly reduced.

Residential organic waste Collection

Restaurant organic waste collection

School organic waste collection

Organic waste collection truck

Organic waste is unloaded

Composting system

Screen separates the compost

Mixing a custom blend of compost

Compost – The finished product

Compost being spread in a Vineyard

COMPOSTING STAGES

4. **Changing the materials we use**. We can help reduce waste by changing the materials used to package products.
   More of our waste could be recycled if such products were simply eliminated and all drinks came in recyclable glass or aluminium containers. Manufacturing products that are more durable could reduce waste and conserve resources.

Biodegradable plastics

Several companies have developed new kinds of plastics that they call „degradable". One type, called photodegradable plastic, is made so that when it is left in the sun for many weeks, it becomes weak and brittle and eventually breaks into pieces.

Another type, usually called biodegradable by the manufacturers, is made by blending cornstarch and a special chemical agent into ordinary plastic. When this plastic is buried, the bacteria in the soil eat the cornstarch, leaving the plastic weakened because it is full of microscopic holes. The weakened plastic then falls apart.

The problem is that these „degradable" plastics do not entirely break down but are merely reduced into smaller pieces.

Summary

You have come to the end of lesson 21. In this lesson you have learnt that:

- Each year, people generate a lot of solid waste that must be disposed of in one way or another.
- Non-biodegradable materials such as plastics are a major cause of disposal problem.
- The solid waste comes in three types: industrial, agricultural and municipal waste.
- Waste can be stored in landfills or incinerated.
- To reduce waste problems, we can begin by producing less waste, recycling used products, making compost, and developing more biodegradable materials.

NOW DO PRACTICE EXERCISE 21 ON THE NEXT PAGE.

Practice Exercise 21

A. Multiple choice questions.

Circle the letter of the correct answer.

1. Solid waste includes all of the following except

   A. ozone and carbon dioxide.
   B. beer cans and milk cartons.
   C. newspaper and drink bottles.
   D. food scraps and yard clippings.

2. Municipal wastes comes from

   A. manufacturing and mining.
   B. manure and crop residues.
   C. households and businesses.
   D. poultry and other farm produce.

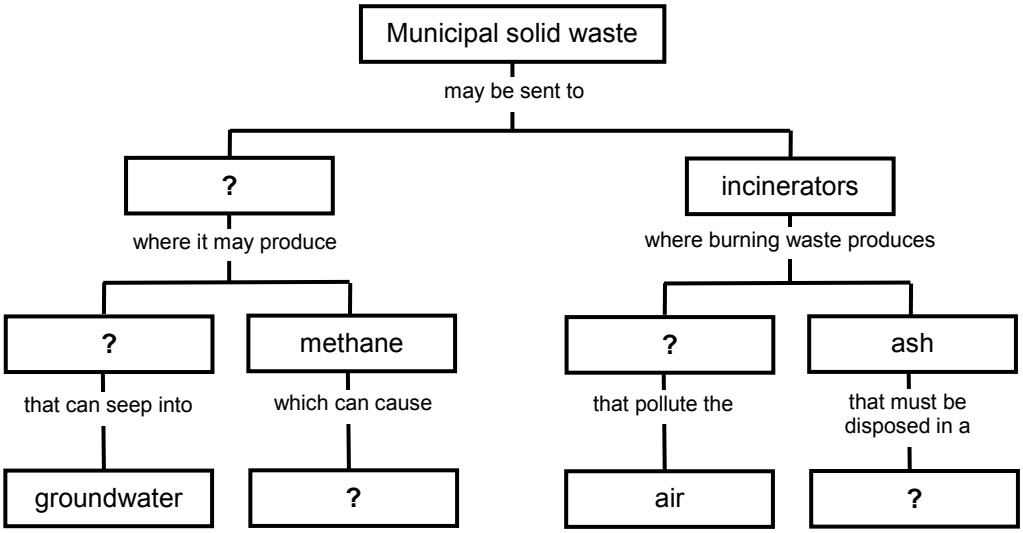
3. Leachate is a substance that

   A. leeches have for dinner.
   B. is produced in a compost pile.
   C. contains dissolved toxic chemicals.
   D. is a product of bacterial decomposition.

4. Which is **not** a benefit of incinerating waste?

   A. It reduces the amount of material sent to the landfill.
   B. It produces energy in the form of heat.
   C. It destroys all the toxic materials in the waste.
   D. It can be used to generate electricity.

B. Relating concepts
Write the correct word or phrase in each box containing a question mark.



CHECK YOUR WORK. ANSWERS ARE AT THE END OF SUB STRAND 4.

Answers to Activity

1. Because they don‟t breakdown and may last for hundreds of years filling up and overcrowding the Earth with rubbish.

2. Industrial waste comes from manufacturing and mining while municipal waste comes from households and businesses.

3. An incinerator reduces the amount of waste that goes to landfills and can be used to generate electricity.

4. The material left after burning is usually toxic.

5. Plastic bag. It can be substituted with a paper bag or a bag made of fabric maybe. Plastic cups/Styrofoam cups. They can be substituted with glasses or china cups or mugs that can be repeatedly used.

REVIEW OF SUB STRAND 4: EFFECTS OF NON-BIODAGRADABLE SUBSTANCES

Revise all the Lessons in this Sub Strand and then do **ASSIGNMENT 2.**
Here are the main points to help you revise.

Lesson 16: Man- made Activities

- Many natural occurrences affect our environment but the organisms have developed ways of adapting or coping to these natural changes and are able to survive. The environment usually recovers and returns to its original condition.
- Man can cause different changes to his environment that organisms and the environment itself may not be able to cope.
- Trees are harvested to provide products man use every day, such as paper, furniture, lumber and plywood, and firewood.
- Deforestation is the process of clearing trees from an area without replacing them
- Removal of trees destroys wildlife habitats, increases soil erosion, and diminishes the beauty of forests.
- Reforestation is a process of replacing trees that have died or been cut down.
- Overgrazing is the damage to grassland caused by too may animals eating in a limited area; often so harmful that the grass cannot recover.
- When an area is overgrazed, much of the grass is destroyed and becomes less efficient in protecting the soil from wind and water erosion.
- Desertification is the deterioration of the land to the point that it becomes desert like.
- Mining damages the land, destroys the vegetation and habitat, causes erosion and landslides, and pollutes the air and water.
- One way to reduce damage from mining is to require mining companies to restore mined land to the condition it was in before mining began. This process is known as reclamation. Another way is by recycling or reusing discarded materials.

Lesson 17: Effects of Non- Biodegradable Substances on Food Webs

- A food chain is the transfer of energy from the producers to a series of consumers.
- A food web is an interlocking food chain.
- Chemicals from pesticides can also transfer and accumulate in concentration each step in the food chain.
- A pest is any organism that occurs where you don‟t want it or in large enough numbers to cause damage.
- Pest Control refers to any of a wide range of environmental intervention that aims to reduce the incidence of pests.
- Pesticide is the name applied to all types of chemicals used in pest control.
- Herbicides control weeds, insecticides control insect pests, and fungicides prevent the growth of fungi

- Persistent pesticides do not break down rapidly into harmless chemicals when they enter the environment.
- Poisons can biomagnify or increase in concentration in the tissues of organisms at each step in the food chain.
- Pests are often able to develop resistance to pesticides.

Lesson 18: Pollution

- Pollution is the contamination of the environment by man-made substances, and a pollutant is any man-made product that has a harmful effect in the environment.
- Air pollution results when harmful substances end up in the air.
- When air pollution hangs over urban areas and reduces visibility, it is called smog, a term combining the words *smoke* and *fog*.
- Acid rain is a highly acidic precipitation that results from the burning of fossil fuels.
- Water pollution is the introduction of harmful chemicals or micro-organisms into water that affects the organisms that depend on it.
- Eutrophication occurs when lake water becomes artificially enriched with nutrients causing abnormal plant growth.

Lesson 19: Ozone Depletion

- Ozone is a form of oxygen with molecules made of three oxygen atoms (O_3).
- The ozone layer absorbs harmful ultraviolet radiation from the sun and turns its energy into heat.
- Ozone is destroyed by chlorine atoms released when chlorofluorocarbons (CFCs) are broken down.
- CFC‟s are human-made chemicals found in coolants and aerosols. These chemicals are restricted in use because they destroy ozone.

Lesson 20: Global Warming

- Certain gases trap heat in the atmosphere. This process, called greenhouse effect, keeps the Earth warm enough for life to exist.
- The gases that do trap and radiate heat and so keep the surface of the Earth warm are called greenhouse gases.
- The major greenhouse gases are water vapour, carbon dioxide, chlorofluoro-carbons (CFCs) methane, and nitrous oxide.
- The burning of fossil fuels and the clearing of the forests are causing a rapid rise in the carbon dioxide levels in the atmosphere. Some scientists predict that this will increase the intensity of greenhouse effect, causing global warming.
- Global warming poses serious threat to organisms and the environment.

Lesson 21: Waste Management

- Each year, people generate a lot of solid waste that must be disposed of in one way or another.
- Non-biodegradable materials, which include plastics, are a major cause of disposal problem.
- The solid waste comes in three types: industrial, agricultural and municipal waste.

-
- Waste can be stored in landfills or incinerated.

- To reduce waste problems, we can begin by producing less waste, recycling used products, making compost, and developing more biodegradable materials.

REVISE WELL AND THEN DO SUB STRAND TEST 4 IN YOUR ASSIGNMENT 2.

Answers to Practice Exercises 16- 21

A. Multiple Choice Questions.

1. A

2. B

3. C

4. C

B. Short Answer Questions

1. A. **By cutting down trees (deforestation)**

   B. **Ranching (allowing farm animals to overgraze)**

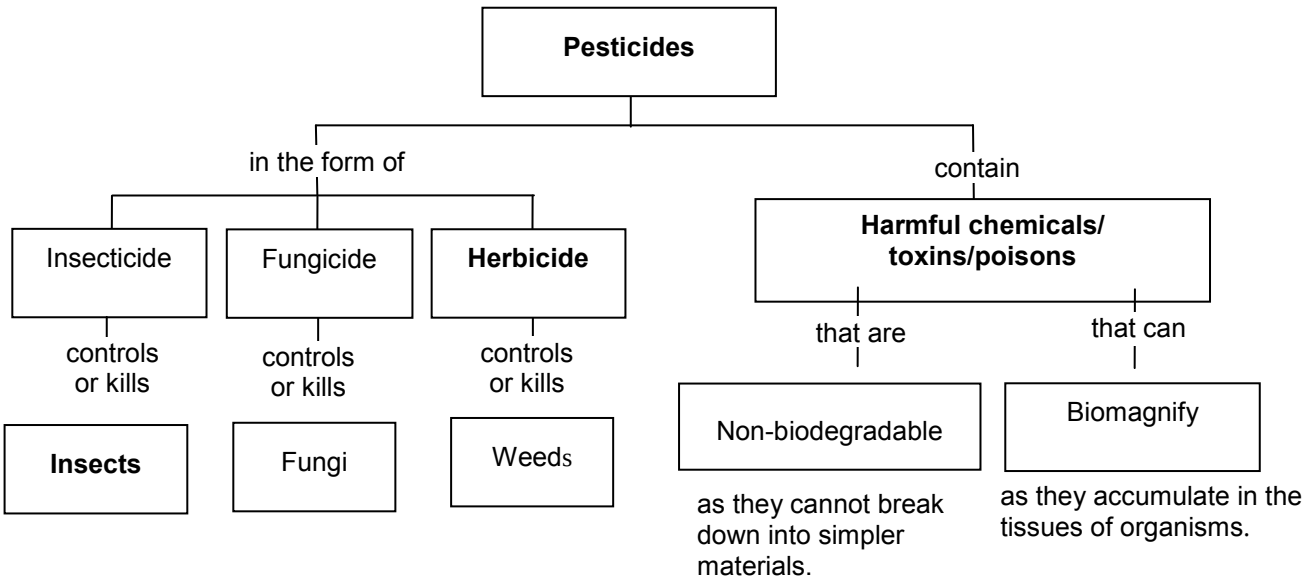
   C. **Mining**

2. **Deforestation**

3. **Recycling saves energy and money. It also reduces the pollution caused by additional mining and processing operations.**

Practice Exercise 17

A. Relating Concepts



B. Short Answer Questions.

1. **Wild plants are more protected from pests because they grow scattered throughout the landscape, so pets have a harder time finding them.**

2. i. **Because they are synthetic or man-made chemicals. They don't exist naturally so decomposers cannot easily break them down.**

   ii. **Because they are insoluble in water and cannot easily go out as waste.**

3. **The top carnivores**

Practice Exercise 18

A. Multiple Choice Questions.

1. D

2. B

3. B

4. A

5. B

B. Short answer Questions

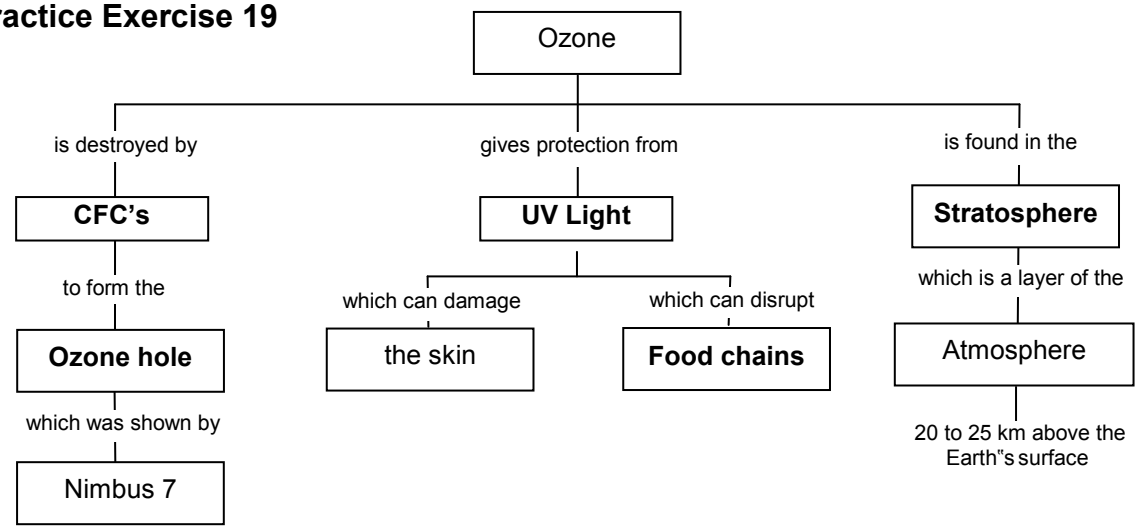
1. **Pollution is the contamination of the environment by harmful man-made materials.**

2. **Combustion of fossil fuels**

3. **Poisonous chemicals can get into the food chain and increase the concentration in the tissues of organisms thereby harming them.**

Practice Exercise 19

A.



B. Short Answers

1. **Chlorofluorocarbon**

2. **Coolants in fridges and air conditioners, aerosol propellants in spray cans, combustion of fossil fuels**

3. **Chlorine**

4. **It kills microscopic plants. This affects the food chain as microscopic plants are the primary producers in aquatic environments.**

   Increase in CO_2 level in the atmosphere.

5. **Most of my activity will be done indoors to reduce the risk of skin cancer and cataract from high exposure to UV light.**

Practice Exercise 20

A.

1. A

2. D

3. C

4. D

5. B

B. Short Answer Questions.

1. **Because the transparent glass that allows the sun's energy to get in entraps and prevents it from moving out. The heat builds up inside the car.**

2. **The Burning of fossil fuels release CO_2. Cutting down or burning of the forests also contributes to CO_2 rise. Farming and agriculture add methane. Use of aerosol sprays and coolants give CFCs.**

3. **Changing weather patterns, rising sea level, desertification, drought, flooding, melting of the polar ice caps, spreading of pests to new areas.**

Practice Exercise 21

A. Multiple Choice Questions.

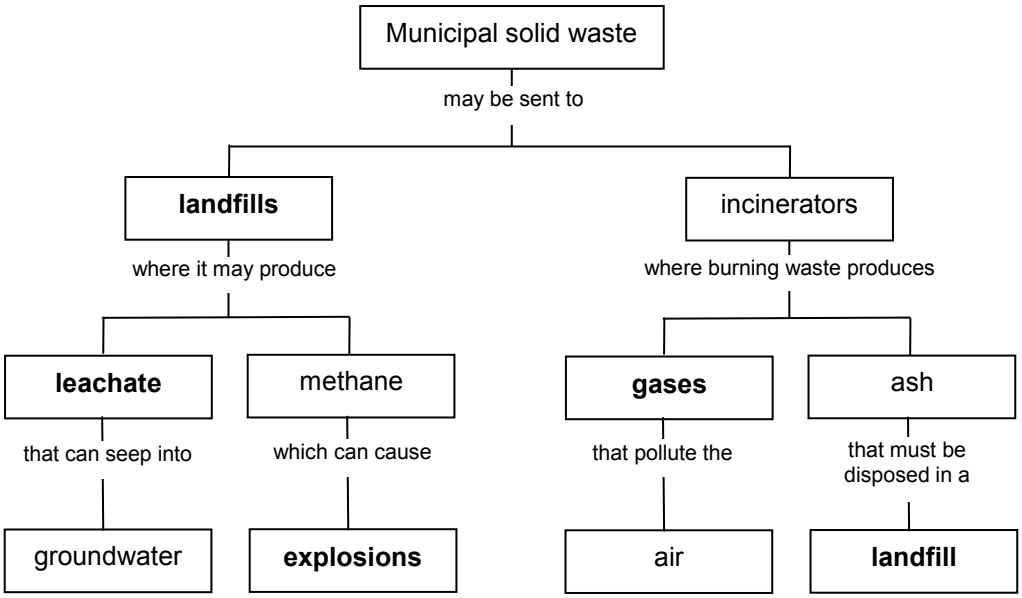
1. A

2. C

3. C

4. C

B. Relating Concepts



GLOSSARY

Adaptation	is a way an animal"s structure or behaviour that helps it to find food, escape an enemy and finds a partner.
Amoeba	is a single-celled animal which lives in ponds and lakes. It reproduces by splitting in two. We call this binary fission (*fission* means „splitting" and *binary* means „two").
Annuals	Plants that grow bear seeds and die within a year.
Anther	is a swollen structure present on the tip of the filament. The anther produces a powdery substance called the pollen grains that contain the male sex cells of a plant.
Artificial Propagation	is a form of asexual reproduction that would not occur naturally in plants living in the wild.
Asexual Reproduction	is reproduction that does not involve fusion of sex cells. New individual is produced from a single parent.
Biodegradable	material is a material that decay or decompose.
Bulbs	are underground shoots with a mass of overlapping, usually fleshy leaves. The outer leaves are usually scaly and dry and protect the inner ones which are thick and fleshy with stored food.
Compost	is a dark brown, crumbly material made from the decomposed vegetable and animal materials.
Conservation	is the practice of decreasing the amount of resources used which is achieved by efficient energy use.
Decomposers	break down the plant and animals material into chemicals that plants and other living things can use.
Deforestation	is the process of clearing trees from an area without replacing them.
Desertification	is the deterioration of the land to the point that it becomes desert like.
Detritivores	are animals that feed on dead remains or fragments of plants and animals.
Development	is defined as the change in form of an organism.
Dispersal	is a plant adaptation where fruits and seeds are distributed away from the parent plant to help reduce overcrowding and competition.
Fertilisation	is the joining together of an egg and a sperm in the oviduct.
Foetus	is an embryo that has an appearance of a fully-developed human.
Fossil fuels	are formed from remains of organisms (living things) that have been buried in the Earth for millions of years.

Flowering plants	are called angiosperms. They bear flowers and their seeds are „enclosed" or inside their fruits.
Germination	is the development of a seed embryo to a new young plant.
Grafting	is done by inserting the cut shoot of one plant under the bark or stem of another, closely related plant so that they will join. The supporting plant (the one that is rooted) is called the stock and the shoot being grafted is called the scion.
Growth	is defined as the increase in size of an organism.
Gymnosperms or Conifers	are plants that bear cones instead of flowers. The cones have pollens and ovules. After pollination a fertilized ovule develops into a seed. The seed is said to be „naked" because it is not inside a fruit as in the flowering plants.
Humus	is decaying organic matter found in soil and derived from dead animal and plant material while.
Hydra	an aquatic animal whose adult form is attached to a rock reproduces by budding.
Mulch	refers to biodegradable substances that spread on the ground to protect the roots of plants from extreme temperature and moisture changes.
Natural	
Nectar	is a sugary solution release at the base of the petal.
Resources	Any natural sources that living things uses.
Overgrazing	is the damage to grassland caused by too may animals eating in a limited area; often so harmful that the grass cannot recover.
Paramecium	is another single-celled animal that multiply by cell division but do so much faster than amoeba.
Perennials	are plants that keep on growing year after year.
Petal	is usually the brightly coloured and scented part of the flower.
Pollination	is the transfer of pollen grains from the anther to the stigma.
Reclamation	is the process of restoring the land to the condition it was in before mining operations began.
Recycling	is reusing discarded materials.
Reforestation	is a process of replacing trees that have died or been cut down.
Renewable Resources	are those resources that are continually produced.
Rhizomes	any fleshy stem that grows horizontally, as a food-storing organ, under the surface of the ground, and enables a plant to reproduce itself.
Sepal	is green and small, and used to be part of the bud.

Sexual Reproduction	is reproduction that involves union sex cells from two parents.
Sperms	are very small and have a long tail which flicks from side to side, enabling them to swing to the egg.
Spores	are special cells produced by primitive land plants like mosses and ferns. These plants produce capsules from their shoots or patches underneath the leaves that burst open and release these spores.
Stamen	or the male part of the flower consists of a filament and anther.
Testes	are the main reproductive organs in males. It functions to produce the male sex cells or the sperm cells.
Tuber	is an underground food-storing stem of many plants such as potato, sweet potato (*kaukau*), and cassava (*tapioca*), characterized by buds, or eyes.
Vegetative Propagation	is a type of asexual reproduction that happens naturally.
Zygote	is a fertilised egg. A developing zygote is an embryo.

References

1. Anderton, John, and the Papua New Guinea Department of Education. Fundamental Science For Melanesia Book 1, South Melbourne, Addison Wesley Longman Australia Pte Limited, 1988

2. Stannard, Peter, and Williamson Ken. *Science World 7*. South Yarra: Macmillan Education Australia PTY LTD, 2006

3. Watson, Christine. *Heinemann Interactive Science 1*. Port Melbourne: Reed International Books Australia Pty Ltd. 1998

4. Watson, Geoff. *Science Works 2*. New York: Oxford University Press, 2001.

FODE PROVINCIAL CENTRES CONTACTS

PC NO.	FODE PROVINCIAL CENTRE	ADDRESS	PHONE/FAX	CUG PHONE (COORDINATOR)	CUG PHONE (SENIOR CLERK)
1	ALOTAU	P. O. Box 822, Alotau	6411343/6419195	72228130	72229051
2	BUKA	P. O. Box 154, Buka	9739838	72228108	72229073
3	CENTRAL	C/- FODE HQ	3419228	72228110	72229050
4	DARU	P. O. Box 68, Daru	6459033	72228146	72229047
5	GOROKA	P. O. Box 990, Goroka	5322085/5322321	72228116	72229054
6	HELA	P. O. Box 63, Tari	73197115	72228141	72229083
7	JIWAKA	c/- FODE Hagen		72228143	72229085
8	KAVIENG	P. O. Box 284, Kavieng	9842183	72228136	72229069
9	KEREMA	P. O. Box 86, Kerema	6481303	72228124	72229049
10	KIMBE	P. O. Box 328, Kimbe	9835110	72228150	72229065
11	KUNDIAWA	P. O. Box 95, Kundiawa	5351612	72228144	72229056
12	LAE	P. O. Box 4969, Lae	4725508/4721162	72228132	72229064
13	MADANG	P. O. Box 2071, Madang	4222418	72228126	72229063
14	MANUS	P. O. Box 41, Lorengau	9709251	72228128	72229080
15	MENDI	P. O. Box 237, Mendi	5491264/72895095	72228142	72229053
16	MT HAGEN	P. O. Box 418, Mt. Hagen	5421194/5423332	72228148	72229057
17	NCD	C/- FODE HQ	3230299 ext 26	72228134	72229081
18	POPONDETTA	P. O. Box 71, Popondetta	6297160/6297678	72228138	72229052
19	RABAUL	P. O. Box 83, Kokopo	9400314	72228118	72229067
20	VANIMO	P. O. Box 38, Vanimo	4571175/4571438	72228140	72229060
21	WABAG	P. O. Box 259, Wabag	5471114	72228120	72229082
22	WEWAK	P. O. Box 583, Wewak	4562231/4561114	72228122	72229062

FODE SUBJECTS AND COURSE PROGRAMMES

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language& Literature
	2. Mathematics - Mathematics A / Mathematics B
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

REMEMBER:

- For Grades 7 and 8, you are required to do all six (6) subjects.
- For Grades 9 and 10, you must complete five (5) subjects and one (1) optional to be certified. Business Studies and Design & Technology – Computing are optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) subjects to be certified.

Your Provincial Coordinator or Supervisor will give you more information regarding each subject and course.

Notes: You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

GRADES 11 & 12 COURSE PROGRAMMES			
No	**Science**	**Humanities**	**Business**
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics A/B	Mathematics A/B	Mathematics A/B
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT

CERTIFICATE IN MATRICULATION STUDIES		
No	**Compulsory Courses**	**Optional Courses**
1	English 1	**Science Stream:** Biology, Chemistry and Physics
2	English 2	**Social Science Stream:** Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

REMEMBER:

You must successfully complete 8 courses: 5 compulsory and 3 optional.