



DEPARTMENT OF EDUCATION

GRADE 9

SCIENCE

UNIT 2



ECOLOGY



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GRADE 9

SCIENCE

UNIT 2

ECOLOGY

IN THIS UNIT YOU WILL LEARN ABOUT:

TOPIC 1: ECOLOGY

TOPIC 2: HOW ECOSYSTEMS WORK

TOPIC 3: ECOLOGICAL ISSUES

TOPIC 4: MAINTAINING BALANCE

Acknowledgement

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

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DIANA TEIT AKIS

PRINCIPAL



Flexible Open and Distance Education
Papua New Guinea

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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 of the new Flexible, Open and Distance Education curriculum. The learning outcomes are student-centred and allows for them to be demonstrated and 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 and Reports. It is developed in line with the National Education Plan (2005 – 2014) and addresses an increase in the number of school leavers affected by the 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, university lecturers and many others who have contributed in developing this course.



UKE KOMBRA, PhD
Secretary for Education

UNIT INTRODUCTION



Dear Student,

Welcome to Unit 2 of your Grade 9 Science Course. I hope that you have learnt a lot and enjoyed studying the earlier Units. This Unit on Ecology will be an interesting and enjoyable subject to study too.

There are four (4) topics and twenty (20) Lessons in this unit. The topics are:

- **Ecology**
- **How Ecosystems Work**
- **Ecological Issues**
- **Maintaining Balance**

There are five lessons in the first topic. The lessons are all about the major parts of the environment. This topic will also discuss the levels of biotic organisation, an organism's habitat and the different roles that different organisms play. You will also learn how living things are affected by the actions of other living things.

The second topic is composed of six lessons and is all about the different roles that all living things within an ecosystem have, photosynthesis and respiration, feeding relationships of living things and how energy is transferred from organism to organism. You will also learn about how the nutrients carbon and nitrogen are recycled.

There are five lessons in topic 3. These lessons focus on the causes and effects of an unhealthy environment and the impacts of mining and logging. You will also learn about the importance of protecting the natural species from harm.

Topic four lessons are all about conditions that affect the survival of an organism and how ecosystems change overtime. You will learn from this Topic that some natural resources can be replaced while others cannot therefore, they have to be properly managed to prevent their destruction now and in the future.

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

If you have any problems in understanding any of the lessons in this unit, 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 Unit 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 Topic 1 and work through it in order.
- Step 2 When you study lesson 1, do the given Activities. When you complete the Activities, check your work. The answers are given at the end of the Lesson. (Note: Short lessons may not have an Activity.)
- Step 3 You will also do a Practice Exercise at the end of each lesson. After you have completed the Practice Exercise, correct your work. The answers are given at the end of each Topic.
- Step 4 Then, revise and correct any mistakes.
- 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: Biotic Factors in the Ecosystem

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

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

Assignments: Topic Tests and Unit Test

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

When you have completed the entire Topic Tests for the Unit, revise well and do the Unit Test. The Assignment Book tells you when to do the Unit 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. You will receive a response and advice from your teacher when he/she returns your marked assignment.

The Topic Tests and the Unit 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 the same Assignment.

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

TOPIC 1

ECOLOGY

In this topic you will learn about:

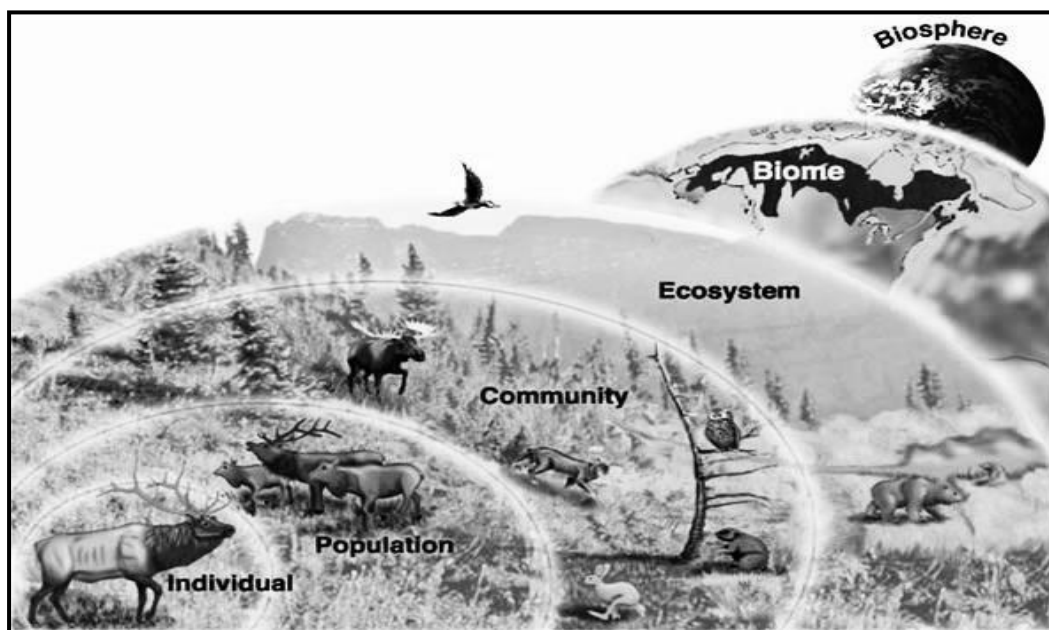
- **biotic factors in the ecosystems**
- **abiotic factors in ecosystems**
- **levels of organization in ecosystems**
- **ecological niches and habitats**

INTRODUCTION TO TOPIC 1: ECOLOGY

Living things are usually well suited to the place and the way in which they live. In other words living things are adapted to their own particular way of life. Every living thing is linked to other living things for their survival.

Living things are also linked to the non-living things like sunlight, rocks, soil, water and air. They depend on them for energy, support, shelter and the basic raw materials of life. As you can see, living things interact with each other and with the non-living surroundings.

When we study ecology, we will be looking at how living things interact with each other and with their non-living surroundings.



You should know all about ecology and how living things are adapted to their way of life. The questions you should ask yourself are

- What is ecology?
- What are the major parts of an ecosystem?
- How do organisms interact with each other and the non-living surroundings?
- How are living things organized in the ecosystem?
- How have living things adapted to their way of life?

In this Topic, you will find the answers to these questions and all other questions relating to ecology.

Lesson 1: Biotic Factors in the Ecosystem



Welcome to Lesson 1. In this lesson, you will be introduced to ecology. There are many reasons why we should study ecology. Better understanding of ecology will help us not to destroy the environment in which we live in, and also its resources but conserve them for future generations.



Your Aims:

- define ecology and ecosystem
- identify and describe the different parts of an ecosystem
- explain what happens when one part of the ecosystem does not function well

Introduction to Ecology

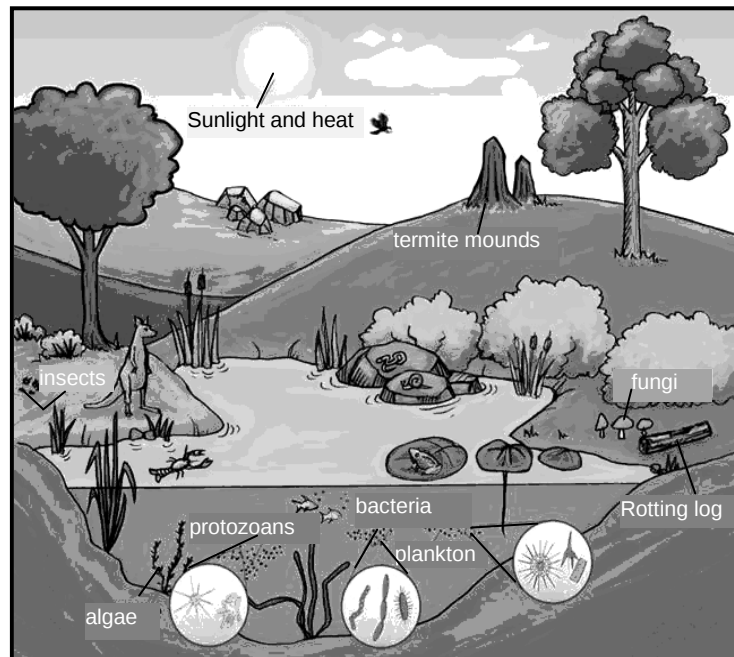
The word ecology comes from a Greek word meaning 'home' and it means studying plants and animals in their home. Thus, a definition for **ecology** is the study of how living things interact with each other and with their environment.

To most people, the word 'environment' means their surroundings. In ecology, however, the environment of an organism is its surroundings composed of abiotic and biotic factors.

Abiotic factors are non-living things in the environment such as sunlight, water, temperature, wind and soil types. Living things depend on the abiotic factors for their growth and nutrition.

Organisms recycle material to the environment by releasing wastes that return some of the nutrients.

The **biotic** factors of the environment include all the living things and their interactions that affect it. That includes food supply and ways of feeding such as predation, symbiosis, parasitism and competition.



Some factors that can affect an organism's survival

All the abiotic (non-living) and biotic (living) factors in an environment will affect where an organism is found.

The place where a plant or an animal lives in its natural environment is called a habitat. An **ecological niche** is the role and position a species has in its environment; how it meets its needs for food and shelter, how it survives, and how it

reproduces. A species' **niche** includes all of its interactions with the biotic and abiotic factors of its environment.

All the factors around an organism, which affects its chances of survival, make up the environment of the organism. To survive in their environment organisms must be able to tolerate or withstand the range of physical conditions and other organisms living in the same area.

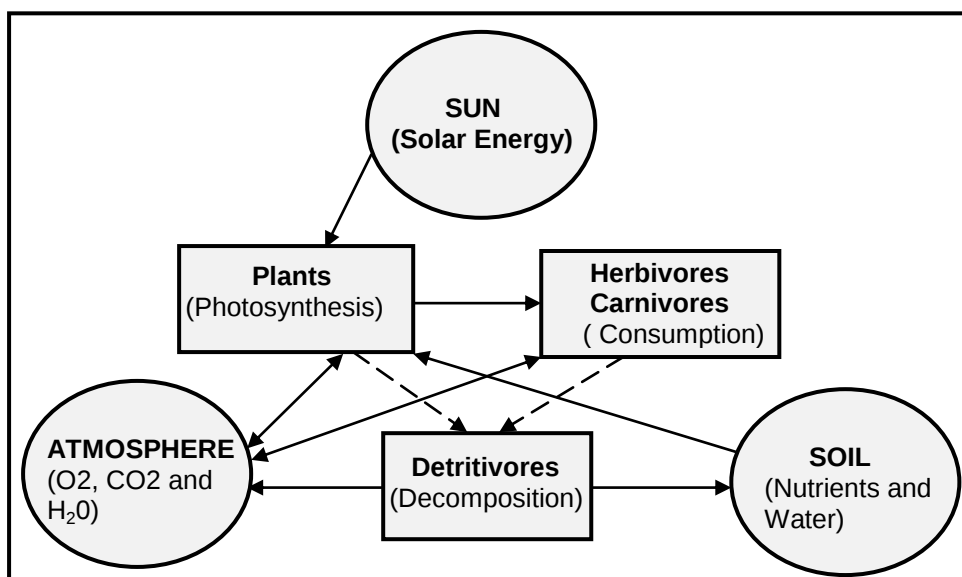
Ecosystem

The basic unit of study in ecology is an **ecosystem**. Scientists use the term ecosystem to describe a particular environment and all the living things that are supported by it. It can also be described as a collection of living and non-living parts of the environment, which interact with each other to function as a whole. Other parts of the ecosystem are affected when one part of the ecosystem changes or does not function well.

Another way of thinking of an ecosystem is all the biotic and abiotic factors in an area. Examples of ecosystems are a swamp, a pond, an ocean or a forest.

Let us take a look at a pond. A pond ecosystem is more than just water and fish. Plants grow in and around the water and animals feed on these plants. A variety of tiny micro-organisms in the water are food for the fish. These are just a few of the living parts, or biotic factors, of a pond ecosystem. The non-living parts, or abiotic factors, includes the air that supplies oxygen and carbon dioxide, the soil that provides nutrients, the water in the pond and the sunlight that plants need to grow.

The main parts of an ecosystem are the producers (green plants), consumers (herbivores and carnivores), the decomposers (fungi and bacteria), and the non-living or abiotic component, consisting of dead organic matter and nutrients in the soil and water. Large quantities of nutrients are added to ecosystems from the atmosphere and are known as atmospheric inputs. Inputs into the ecosystem are solar energy, water, oxygen, carbon dioxide, nutrient losses and the heat released during respiration, or heat of respiration. The major driving force of all these is solar energy.



Some components of an ecosystem

The particular place where an organism can be found is its **distribution**. For an organism to live in an area, all the resources it requires must be present. The relationships between living things and their surroundings are often complicated and the people who study them are called **ecologists**.

REMEMBER: In an ecosystem, all organisms interact with each other and also with their non-living (physical) environment.

Biotic Factors

Biotic means living and so biotic factors are living parts of the ecosystem in which an organism must interact depending on whether it is a producer, a consumer, or a decomposer.

Biotic factors are the living things in an ecosystem that affect the survival of an organism in that ecosystem. It includes all the ways in which the organisms in a certain area or in an ecosystem affect each other. All living organisms are affected by the activities of other living things. How the other organisms affect an individual organism depends on what type of organism it is.

They can be classified as:

- 1) **Predators** – These are carnivorous animals that hunt, kill, and eat other animals in order to survive.
- 2) **Parasites** - Plants or animals that live on or in another, usually larger, host organism in a way that harms or is of no advantage to the host.
- 3) **Prey** - An animal or animals caught, killed, and eaten by another animal as food.
- 4) **Symbionts** - An animal or plant living in close relationship with another of a different species.
- 5) **Competitors** - Plants or animals who are affected by those having the same living requirements such as food, water or space.

Many interactions between living things are the result of the need for living things to feed. All living things must have a source of food.

Food is made by organisms called **producers**. All green plants are producers. We all know that plants do not eat food. Plants make their own food by photosynthesis. Plants take in carbon dioxide and water from their environment, producing a sugar called glucose. This glucose serves as food for the plant. Organisms take in food and use it for energy, growth and repair.

Living things also interact in providing shelter for other living things. For example, birds and cuscus shelter in trees.

Animals affect plants in several ways. Insects **pollinate** flowers. They transfer pollen grains from the male part of a plant to the female part of a plant and fertilize it. Termites and worms **aerate** the soil to help create humus. Aerate means to allow circulating air to reach or penetrate the soil and many animals take part in seed **dispersal**. Dispersal is the scattering of plant seeds over a wide area by different methods.

Humans are also biotic factors and they are the most powerful in most ecosystems on Earth. Other organisms are affected by human actions and often in ways that can be harmful. We compete with some organisms for resources, prey on other organisms, and alter the environment of many other organisms. Humans dig up trees

and burn away bush to clear land for farming, they build roads, cities, and reservoirs, hunt animals for food and pleasure, and they pollute (poison) the environment with the wastes of modern civilisation.



Activity: Now test yourself by doing these activities.

Answer all questions according to the given instructions.

1. Define these terms.

(a) Ecology

(b) Environment

(c) Ecosystem

2. Answer the following questions.

(a) Name the two factors that make up the environment.

(i) _____ (ii) _____

(b) Which factor of the environment determines the kind of organism which can live in a certain area?

(c) Name the main parts of an ecosystem.



Summary

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

- ecology is the study of how living things interact with each other and with their environment.
- the living organisms and the non-living surroundings in an area are called an ecosystem.
- the environment is all the biotic and abiotic factors in the surroundings of organisms that directly or indirectly have an effect on the organism.
- all the parts of an ecosystem work together to function as a whole.
- the place where an animal or plant lives is its habitat.
- an **ecological niche** is the role and position a species has in its environment.

NOW DO PRACTICE EXERCISE 1 ON THE NEXT PAGE.



Practice Exercise 1

Part A: Multiple Choice – Choose from the alternatives A, B or C as your correct answer.

1. From what Greek word does the word ecology come from?
A. House B. Shelter C. Home
 2. What is the physical environment made up of?
A. Living things B. Non-living things C. Invisible things
 3. What is the biological environment made up of?
A. Visible things B. Living things C. Non-living things
 4. The most powerful biotic factors in any ecosystem are the _____.
A. decomposers B. humans C. plants
-

Part B: Answer these questions on the space provided.

1. What are the three groups that organisms in an ecosystem can be classified into?
a) _____
b) _____
c) _____
 2. Name the physical factors that can determine the kind of organism that can live in a certain area.
a) _____
b) _____
c) _____
d) _____
e) _____
-

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.
--

Answers to Activity

1.
 - a) Ecology is the study of how living things interact with each other and their environment.
 - b) The environment is an organism's surroundings and is made up of the abiotic and biotic factors.
 - c) The organisms and their non-living surroundings make up the ecosystem.
2.
 - a) The two factors that make up the environment are the
(i) biotic and (ii) abiotic factors.
 - b) It is the abiotic (physical) component which determines the kind of organisms that can live in a certain area.
 - c) The main parts of an ecosystem are the producers, consumers and decomposers.

Lesson 2: Abiotic Factors in Ecosystems



Welcome to Lesson 2. In the last lesson, we identified some examples of the abiotic components in the ecosystem. In this lesson, you will learn more on how these abiotic factors affect the functions of living organisms. They also determine the kind of organism that can live in an ecosystem.



Your Aims:

- describe the physical factors that make up the environment
- discuss how physical factors affect the functions of living organisms
- identify the things that an organism needs to survive

Physical Factors in the Environment

In Lesson 1, you learned about abiotic factors are non-living factors that affect living organisms. Environmental factors such as light, water, minerals, temperature, wind and soil are abiotic (physical) factors. The physical (non-living) factors in the environment determine the kind of organism that can survive in an area. The plant life in an area determines which animals can survive in that area. All the abiotic factors are interrelated and each one affects the other.

Abiotic factors have large effects on living things and often determine the kinds of living things that will survive in a given area

Let us now look at how these physical factors affect the functions of living organisms.

1. Light

Light is an important ecological factor. Without light plants would not be able to make food and this would affect the feeding relationship of organisms in that particular area.

You can easily understand how abiotic factors work together when you think about sunlight and temperature. Sunlight warms the Earth's surface and the atmosphere. In addition, energy from sunlight supports all life on Earth. The sun provides the energy that plants absorb and use to produce food in a process called photosynthesis. The food produced by plants and other photosynthetic organisms, feeds almost all other living things found on Earth.



Sunlight - essential for photosynthesis

Light from the sun is the main source of energy for living things.

In Papua New Guinea, most of our people are subsistence farmers and know that some plants will only grow well in certain places. If they have a shady spot in their garden, they will plant taro, pineapple and wild ginger which are examples of plants which grow well in shade.

Animals, too, are adapted to the amount of light. Soil dwellers such as earthworms and moles, and cave dwellers such as bats live in the absence of light. Some animals are **nocturnal**, meaning that they are active only at night. **Diurnal** animals are active during the day.

2. Temperature

The temperature in an area limits the types of plants that can grow in the area, which in turn determines the kinds of animals that feed off the plants. All plants have a thermal minimum and maximum. The **thermal minimum** is the lowest temperature at which the plant can survive. The **thermal maximum** is the highest temperature at which the plant can survive.

Heat affects the speed of chemical reactions in the cells of organisms. The effect of temperature on chemical reactions can be seen in many cold-blooded animals. The body temperature of these animals depends on the temperature of their surroundings. Some of these animals are reptiles, amphibians and fish.



A lizard lying on a warm rock

Lizards are very slow moving in the morning and in cold weather because the chemical reactions in their muscles are much slower. These animals can influence their body temperature in some ways, such as lying on warm rocks in the sun to heat up, or hiding in a burrow if they are too hot. A burrow is a hole or tunnel dug by a small animal to live in.

Naturally, plants develop more rapidly in warmer temperatures and so do animals like reptiles, amphibians and fish. Migrations also occur with favourable temperatures. When temperatures are low, animals migrate to warmer areas where food is plentiful.

Birds and mammals are warm-blooded. Their body temperature is automatically constant. If it is cold outside their bodies, more chemical reactions occur in their cells so that more heat is produced. If they are too hot, they can cool down in different ways. For example, some can sweat to lose heat.

Plants grow more rapidly at higher temperatures, as long as all other conditions are suitable. An example of this is the sweet potato, which in the lowlands is ready for harvesting in six months but in the highlands it takes a year.

Spring in southern Australia and other temperate parts of the world is a time of rapid growth and flowering. The temperatures are higher than in winter, and there is adequate moisture.

3. Water

The amount of water available to support life is another important abiotic factor in land ecosystems. All organisms need water. Water enables or helps chemical reactions in the body to take place. Plants need water as well as sunlight to carry out the process of photosynthesis. Animals need water to digest food and release the energy stored in the food. Trees cannot survive without enough supply of water.

Some ecosystems have a lot of water. These ecosystems can support a large number of different types of plants. The different types of plants will support a large number of different types of animals. This is called **biodiversity**.

Our country is in the tropics and we have big tropical rainforests. The wettest of all ecosystems on land are the tropical rainforests and they are also the most diverse meaning they have many different types of plants and animals. We do not have deserts here, but deserts are the driest land ecosystems and have far fewer types of plants and animals. The types and number of living things in a land ecosystem will always be related to the amount of fresh water available for the organisms living in that area.

Water in an area determines the distribution of the types of plants and animals in the area. About 97% of the earth's water is found in the oceans, and the remaining 3% is fresh water.

Plants and animals that live in fresh water cannot survive in the ocean. For example, elodea, a plant that grows in water, dies if placed in the ocean. Tuna fish, which live in the ocean, dies if they are put in fresh water.

Plants absorb water through their roots. Different plants need different amount of water.



Nipa palm growing in a lagoon

The sago and nipa palm are found throughout Papua New Guinea. They will grow only in swampy or wet places where there is plenty of water.

There are also many different plants that grow in very dry places such as the eucalyptus, an evergreen tree.

Water plants usually absorb water through their body surfaces. They do not have much problem in obtaining water as land plants. However, freshwater plants can lose water if the water in which they are growing becomes very salty.

Most animals need to drink water. They usually do not move very far away from permanent water supplies. In drought years, large number of animals may migrate towards water sources. A few animals, such as the desert mouse of Australia, do not need to drink water. They seem to survive on the water from dews in the night or morning. They do not move a lot to respire which is a way to keep water in their bodies.



A giant African snail

The giant African snail needs water to reproduce and lay eggs. During the dry season it hides under stones and seals itself inside its shell to prevent water loss. When the rain starts again the snail becomes active.

4. Soil

The main physical features of the soil are the amounts of water, air and humus present, the pH (acidity and alkalinity) of the soil water, and the types of particles of which the soil is made up of. All these features determine which particular plants can grow in the soil, and what animals live there. They are known as **edaphic factors**.

Land plants grow in soil. Plants absorb water, minerals and air from the soil, which they need to help make their food. Not all soils are the same. They differ in particle size (texture), mineral composition, nutrient content, water holding ability, acidity, amount of humus and air spaces.



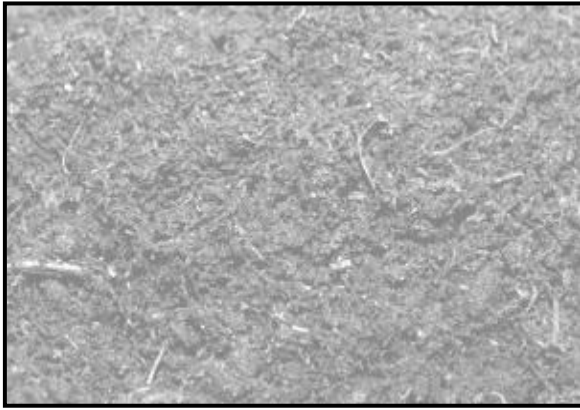
Sandy soil, loamy soil and clay soil

One way to classify soil is by its texture. Sandy soil contains large particles, is looser and more easily penetrated by air and water. Clay soil has small particles and holds on to water better than sand, thus making it sticky and helping to hold together the rest of the soil. Good soil consists of a mixture of the two and is called

Soil acidity and alkalinity are also important for plants. Most plants grow best in soil which is about neutral. However some plants like alkaline soil and others like acidic soil. Some plants, such as pineapples, need acidic soils. High alkalinity will prevent them growing well or even kill them. Other plants, including most vegetables, grow better in alkaline soils. The acidity or alkalinity affects plants mainly through the types of minerals available in the soil.

Dissolved in the soil water are various mineral salts. Mineral salts provide plants with important elements such as nitrogen, phosphorus and potassium which are essential for growth.

Some mineral salts come from the rock which formed the soil. They may give the soil a particular colour: for example some soils are red because they contain a lot of iron salts. Other minerals, such as nitrogen salts, are formed when humus breaks down. This is why humus is so good for plants.



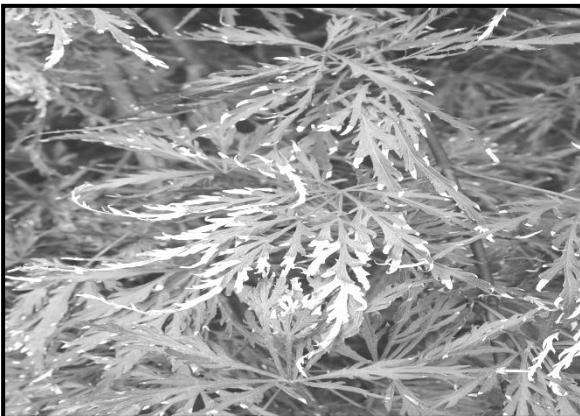
Humus makes the soil rich in nutrients

The soil contains a wide variety of small animals such as mites, insects and worms. There are also a large number of micro-organisms, such as fungi and bacteria, present in soil. When animals and plants die in the soil, their dead bodies gradually decay into a sticky-jam like liquid called **humus**. The bacteria and fungi decay plant and animal material forming humus.

Humus makes the soil rich in nutrients which are needed for plant growth. It also forms a sticky coating round the soil particles, helping them to clump together into soil crumbs. Humus stores water and prevents valuable nutrients and minerals being washed out of the soil against extreme heat and cold.

5. Winds

The difference in temperature between areas causes winds. Wind can greatly affect an area.



An example of windburn

Winds are important because they control cloud movement and, thereby, the distribution of rainfall. For example, a lack of rainfall in an area will only allow plants and animals that are not affected by drought to survive.

If drought continues, then the total amount of plants in the area will be reduced and this will then reduce the number of plant eating animals that could survive in the area.

Wind can greatly affect an area. Wind can dry plants out and turn them brown. This is called **windburn** and is particularly noticeable around Port Moresby in the dry season.

Wind also affects temperature. Wind and breezes also speed up the rate at which water evaporates from the surfaces of animals and plants. These factors affect the type of plant life which can grow on land exposed to strong winds. In some parts of the Highlands the wind changes the shape of trees and makes the branches grow away from the wind.

In many coastal areas of Papua New Guinea salt spray blown by the wind is a problem. As well as drying out the plants, additional salt in the soil affects the type of vegetation that can grow. Winds can also cause serious erosion, and alter the physical structure of an area.

The speed and direction of the wind are important in pollination and in the dispersal of seeds, fruits and spores.



Activity: Test yourself by doing the following activities.

Part A. Circle the letter of the correct answer.

1. Light, temperature and climate are examples of

- | | |
|------------------------|-----------------------------------|
| A. biotic factors | B. abiotic factors |
| C. renewable resources | D. resources that can be recycled |
-

2. Soil that has large particles and is not able to retain water is called _____.

- | | |
|----------|----------|
| A. clay | B. loam |
| C. sandy | D. humus |
-

3. Which group of organisms break down dead plant and animal tissue, returning minerals and nutrients to the soil?

- | | |
|--------------|----------------|
| A. Consumers | B. Scavengers |
| C. Omnivores | D. Decomposers |
-

4. Which physical factor is essential for photosynthesis?

- | | |
|----------------|----------|
| A. Water | B. Light |
| C. Temperature | D. Wind |
-

5. The highest temperature at which a plant can survive is called the _____.

- | | |
|------------------------|------------------------|
| A. minimum temperature | B. lowest temperature |
| C. relative humidity | D. maximum temperature |
-

Part B. Write true if the statement is correct and false if the statement is incorrect on the space provided.

1. A factor that is needed by organisms but is in short supply is called a limiting factor. _____
2. Climate is the day to day change in the atmosphere and is concerned with light, temperature and precipitation in a given location. _____
3. Light from the sun is the main source of energy for all living things.

4. The body temperature of birds and mammals is automatically constant and this means that if they are too hot, they move to a shady place to cool off.
- _____

5. Wind is an important factor in the dispersal of fruits, seeds and spores.
- _____



Summary

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

- the physical factors in an environment determine the kind of organisms that can survive in an area.
- some physical factors that can affect organisms are climate, light, water, temperature, wind and soil.
- sunlight is the main source of energy for living things and is essential for photosynthesis.
- water is another important factor that supports life .
- the main physical factors of the soil are known as edaphic factors and they determine which particular plants can grow in the soil and what animals live there.
- winds are important because they control cloud movement and the distribution of rainfall.

NOW DO PRACTICE EXERCISE 2 ON THE NEXT PAGE.



Practice Exercise 2

Answer these questions on the spaces provided.

1. Explain the importance of water as a physical factor in the environment.

2. Why are there no plants in the ocean depths?

3. Describe the differences between the three main types of soil and how each affects the growth of plants?

(i)

(ii)

(iii)

4. Describe the importance of physical factors of the environment for living things.

5. How does light affect plants?

6. Explain what would happen if there was no difference in temperature.

7. What would happen to a fresh water plant if it was placed in salt water?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity**Part A. Multiple Choice**

1. (B) 2. (C) 3. (D) 4. (B) 5. (D)

Part B. True or False

1. True 2. False 3. True 4. False 5. True

Lesson 3: Levels of Organisation in Ecosystems



Welcome to Lesson 3. In your last lesson, you learnt that the physical factors determine the kind of organisms that can survive in an area. In this lesson, you will learn about the levels of organisation in ecosystems. After studying this lesson, you will understand the structure and function of living things as individuals and as a whole.



Your Aims:

- define species, population and community
- describe the different levels of ecological organization of individual organism to the entire biosphere

Species

A **species** is the smallest group of living things. Members of the same species are so much alike that male and female organisms can mate and produce young like themselves. We can say that male and female organisms of the same species or “kind” breed. The result of such breeding is a **population**.

Population

A population consists of a number of individuals of the same species that live together in the same place at a particular time. So we can talk about the population of human beings living and breeding together.

Let us look at another example. In a swamp, you would find tadpoles. There will probably be many tadpoles in the swamp forming a population of tadpoles. A population can be defined as the number of organisms of one kind or species in an area at a particular time. Members of a population usually occupy or live in similar places.

Community

A **community** is all the populations of different organisms living in the same area. The tadpoles living in the swamp will not be the only organisms living in the swamp. There will be many other kinds of plants and animals making up the swamp community. Most communities consist of hundreds or thousands of different populations.

In ecology, community does not usually refer to a single species but refers to all the many different interacting plants and animals in the area.

Ecosystem

An ecosystem includes both the living organisms in a biological community as well as the non-living factors present in their physical environment. The living organisms in the water, the water itself and the sand and stones at the bottom, make up an ecosystem. In other words, an ecosystem consists of a community and its environment.



A river ecosystem

An ecosystem can be made up of two parts – the biotic and the abiotic components.

Naming Communities

Communities are usually named after an obvious feature in the area in which they live. The most obvious thing may be a living thing such as the most common plant. For example, we may call the community a 'kunai' community. The most obvious feature in the non-living surroundings can also be used to name the community. For example, there are 'limestone cliff' and 'freshwater lake' communities.

In a freshwater lake community, only the living organisms are called the community. The water is not part of the community.

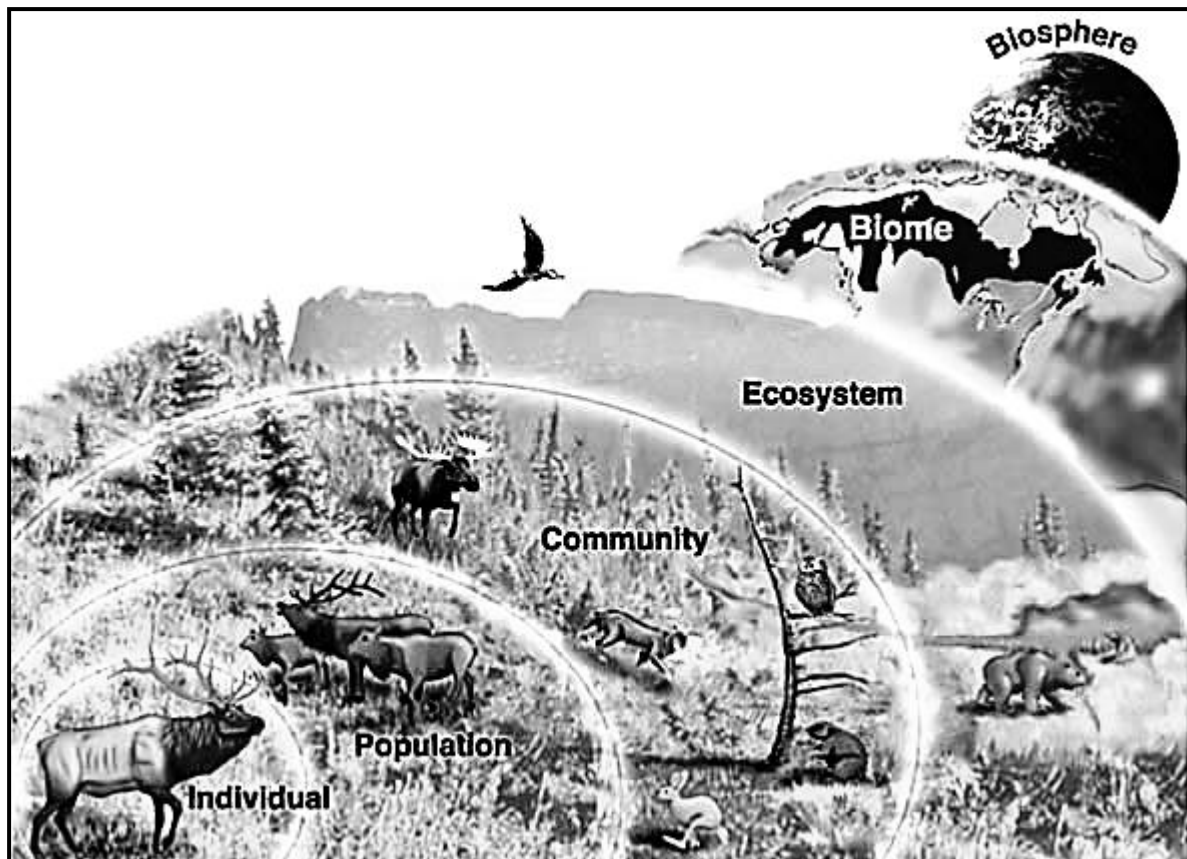
Living organisms in an area are called the community.

When studying a specific ecosystem, it is convenient to name it. For example, the ecosystem that is composed of the coral reef community and its abiotic environment can be called the coral reef ecosystem.

Naming ecosystems and communities is useful because it allows a biologist to communicate something about an environment simply with a name.

Ecological Levels

The living factors in the environment interact with each other and with the abiotic factors. The environment has a level of biotic organisation, beginning with the individual or the species (the smallest category) and ending with biosphere (the largest category).



Level of ecological organization of individual organism to the entire biosphere

Ecology can be studied at different levels of organization with different factors at each. The picture above is a good example of the different levels of ecological organisation.

Levels of Organisation

1. An **organism** is an individual living thing that includes a plant or an animal. For example, a deer
2. A **population** includes all the members of a species in a given area at a particular time. For example, all the white tail deer is a population.
3. A **community** refers to all the populations in a given area. For example, all the organisms in a fish pond: fish, tadpoles, worms, plants, algae.
4. An **ecosystem** is made up of the living (biotic) community and the non-living (abiotic) environment functioning together. For example, the forest ecosystem is made up of the biotic community and the abiotic factors such as weather, rocks, water and soil.
5. The **biosphere** is the portion of the Earth in which life exists. It is made up of all the ecosystems.

Difference between community of an ecosystem and the community of humans

A community of an ecosystem consists of populations that live together in a defined area at a particular time and a human community refers to a group of people having common interests and living together within a larger society.

All the ecosystems combined make up the biosphere.



Activity: Now test yourself by doing this activity.

Answer all questions according to the given instructions.

1. Define the following:

a) Species

b) Population

c) Community:

2. List the levels of ecological organisation beginning with the smallest category and ending with the largest category.

(i) _____

(ii) _____

(iii) _____

(iv) _____

(v) _____



Summary

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

- species refers to organisms that can mate and produce young like themselves.
- population refers to organisms of the same species that live together in a given area at a particular time.
- a community is made up of different populations living together in a given area.
- An ecological organisation begins with the smallest category and ends with the largest category and they are individual or species, population, community, ecosystem and biosphere.

NOW DO PRACTICE EXERCISE 3 ON THE NEXT PAGE.



Practice Exercise 3

Multiple Choice Questions

Select the best answer.

1. All the grass, trees, insects, birds and squirrels living together in a park represent a _____.
A. species
B. population
C. community
D. ecosystem
2. Which of the following best describes a population?
A. All the mice living in a warehouse.
B. Ants capable of reproducing with each other.
C. All the grass, grasshoppers and frogs in a location.
D. All the trees, birds, cats, soil and water in a location.
3. What is the largest level of organisation from the choices below?
A. Ecosystem
B. Organisation
C. Population
D. Community
4. Which of the following levels of organisation includes abiotic factors?
A. Population
B. Organisation
C. Ecosystem
D. Community
5. What level of organisation is represented by a herd of cattle?
A. Organism
B. Population
C. Community
D. Ecosystem

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.
--

Answers to Activity

1.
 - a) A species is the smallest group of organisms that are much alike and can breed with each other and produce young like themselves.
 - b) Group of organisms of the same species that live in the same area.
 - c) Populations of organisms that live together in a defined area.
2.
 - i) Individual organism or species
 - ii) Population
 - iii) Community
 - iv) Ecosystem
 - v) Biosphere

Lesson 4: Ecological Niches and Habitats



Welcome to Lesson 4. In Lessons 1 and 2, we learnt that the different factors in the environment affect the functions of other living organisms. In this lesson, we will look at what enables a species to occupy a certain place within a community.



Your Aims:

- define habitat and ecological niche
- describe some major types of habitat
- classify organisms according to their habitat

Living things are usually well suited to the place and the way in which they live. Over many millions of years, animals and plants have developed special features to help them cope with the conditions in which they live. They have become adapted to their environment.

Habitats

Every organism lives in a particular place called its **habitat**. A habitat can be defined as the actual place in an ecosystem where an organism lives and can satisfy its needs.

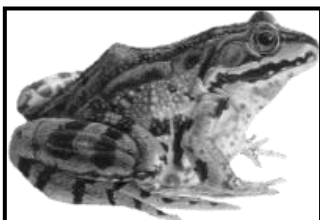


A crocodile in its swampy habitat

A habitat is that special place where a plant or animal calls home. Just like you and I have a home or a place to live, so do animals and plants. When we talk about an animal or a plant's home, it is more like a neighbourhood than a "house". A habitat is like an organism's address. It is usually shared with other plants and animals. The animals and plants that live together form a **community**. The community of living things interact with the non-living world around it to form the **ecosystem**.

An animal needs four things to survive in its habitat - food, water, shelter and a place to raise its young. Just like you have to go to the store to get food, an animal leaves its "shelter" to get the things it needs to live. If its needs are not met, it will move to a better habitat.

Would you expect to see a cuscus in the sea or a fish in a tree? That would be impossible. This is because organisms have **adaptations** that allow them to survive in their particular habitat. Adaptation is a feature of an organism which improves its chances of surviving in a particular environment.

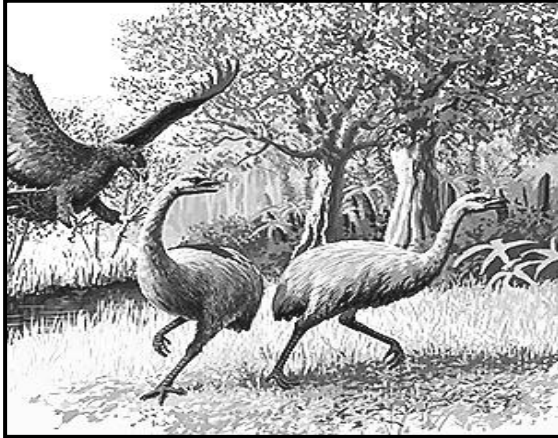


The habitat of the frog that is shown on the left would be in and around a pond, where it is wet and shady. The frog needs these conditions to stop its skin drying out.

There are lots of different types of habitat on Earth. Some examples are lakes, streams, forests, or even a drop of water. All habitats on the Earth are part of the biosphere. Because the Earth is always changing, habitats are constantly changing. Habitats that have similar climate and plants are called **biomes**.

Niche

Within the habitat, organisms occupy different **niches**. A niche is a way of life which enables a species to occupy a certain place within a community. This 'way of life' includes all the things a species does to survive, such as the type of food it eats, how it finds its food, how it has babies, avoids predators and survives the drought. A niche can also be seen as a functional role of a species in a community that is its occupation, or how it earns its living.



An eagle is a carnivore- that is its niche



Organisms have different niches in a habitat

Because resources like water and food may be limited, plant and animal species often compete with each other for food and water. The only way that they can all live together is if they occupy slightly different **niches** or hold different "jobs" in the community. No two species can occupy exactly the same niche. They all have their own jobs or niche in the community.

A niche can also be seen as the smallest unit of a habitat that is occupied by a plant or animal. The **habitat niche** is the physical space occupied by the plant or animal. The **ecological niche** is the role the plant or animal plays in the community found in the habitat.

The ecological niche of an organism depends not only on where it lives but also on what it does.

In ecology, if we compare habitat and niche, it may be said that the habitat is the organism's "address" and the niche is its profession.

Here are few examples to help you understand what ecologists mean when they use the term ecological niche.

We all know that rain trees live in the rainforests. The rainforest is the habitat. If you are going to write a letter to a rain tree, this is how you would address your letter.

Sir Evergreen Rain tree,
The Rainforest,
East Sepik Province,
P. N. G.



A rain tree near a pond habitat

What do rain trees do? If you can answer that question, you know the rain tree's "profession" or its ecological niche. Perhaps you think that rain trees just stand there looking pretty and not doing very much, but think about it.

Rain trees:

1. absorb sunlight by photosynthesis;
2. absorb water and mineral salts from the soil;
3. provide shelter for many animals and other plants;
4. act as a support for creeping plants;
5. serve as a source of food for animals;
6. add nitrates to the soil because it is a legume plant;

These six things are the "profession" or the ecological niche of the rain tree; you can think of it as being a kind of job description. If the rain trees were cut down or destroyed by fire or storms they would no longer be doing their job and this would have a very bad effect on all the other organisms living in the same habitat.

To survive in a niche, a species must be very good at many different tasks. But there must be opportunities for it to use its skills. An insect eating bird must have plenty of insects to catch, sheltered places to nest, and less number of predators. When we destroy habitats we remove these opportunities and thereby remove niches. This can lead to the extinction of species.



So the idea of an ecological niche is very simple. You just need to know where the plant or animal lives and what it does.

Major Types of Habitat

Habitats can be **terrestrial** or **aquatic**. Terrestrial habitats are located on land surfaces, examples, deserts, forests and grasslands. Aquatic habitats are located in water which includes lakes, ponds, rivers, seas and oceans.

Aquatic organisms are any organism that breeds, breathes, grows, lives and eats in, on or near the water.

On land, animals live in many different habitats and at different altitudes (heights above the sea level). Many mammals dig burrows as refuges or as places to raise their young. Some mammals as well as some other animals have developed a largely **subterranean** lifestyle, feeding on small animals or plant roots beneath the soil surface.

Some species of organisms live in trees and they are called the **arboreal** species. Arboreal species are ones that spend most of their lives in trees and they include monkeys, and a number of marsupials including opossums and tree kangaroos.

Some invertebrates live in the air. They can be found in the air above our heads and are called the **aerial** species. Some are powerful fliers, using wings to propel themselves, but others, particularly the smallest invertebrates float on the slightest breeze. These tiny invertebrates form clouds of **aerial plankton** that drift unseen through the skies. Aerial plankton are tiny life forms that float and drift in the air, carried by the current of the wind.

Effects of the Non-living Environment on Organisms in a Garden Habitat

The non-living environment has a major influence on the lives of all other living and non-living things that form the habitat. There are many non-living (or abiotic) factors that influence where an organism can live.

The non-living environment in a garden habitat comprises the soil, water supply, climate and weather which may include humidity, sunlight, temperature and other weather influences. The survival of any organism will depend on how well it has adapted to these factors and how well it fits into the area. All organisms need to be in harmony with their environment in order to maintain stable conditions in their bodies.

1. Soil

The soil in a garden habitat provides a home for many living things such as micro-organisms, worms, mice, rabbits, snakes, bacteria, fungi and so on. What the soil contains, its physical structure, its mineral salts, trace elements and its fertility depend on the amount of decayed animal and plant material in it as well as the inorganic content. The inorganic content varies from region to region depending on the type of rocks and other materials found in the area. Where a plant lives is determined by the nutrients that are available in the soil.

The acidity of the soil also affects the life of an organism. Plants, in particular have a preferred acidity in which they like to live. Some organisms prefer acid soil.

2. Sunlight

Sunlight affects the living conditions of all organisms to a great extent. The existence of plants and all other organisms would cease without the sun. Light provides plants with the energy they need to carry out photosynthesis. This production of food inside plant bodies initiates the chain of life and would not take place if there was no light. In places under big plants like taros and bananas there is little light, plants have had to adapt to these conditions.

3. Temperature and Humidity

Sunlight also affects temperature and humidity and is dependent on temperature. Temperature and humidity greatly influence the lives of organisms. When living things get too hot or too cold, their bodies do not function properly. Processes such as digestion, respiration, excretion and reproduction take place at an optimum (most favourable or best) temperature range. That is why many animals sleep during the

day when it is hot and emerge in the cool of the night to feed and engage in courtship. In a garden habitat you will find evidences of animals visiting the garden in the night only.

Humidity is the amount of water vapour in the air. Humidity determines the amount of water an organism loses into the air. In areas where there is high humidity like in Papua New Guinea located in the tropics, organisms will lose very little water.

Water

Water exists in the body of all organisms and in the air. All organisms require water in order to carry out many functions that are critical to life. Plants in a garden will only grow well if there is enough water.

Weather

Some organisms may also need to adapt to other weather conditions such as wind, air currents and storms. Plants that live in regions that are frequently hit by strong winds need to develop strong root systems that enable them to stay alive. Similarly, organisms that live in areas that experience frequent floods or wild storms need to adapt to the changing conditions.

An organism can usually survive the weather if it has adequate shelter and protection. Different plants and animals require different types of shelter or protection to survive. Rocks, hollow logs, trees and burrows can all provide shelter for different organisms. There are times, however, when natural disasters such as fire, cyclones, severe floods and volcanic eruptions can des an ecosystem. In these cases, the organisms have no time to adapt and will often not survive.

troy

The effects of the non-living environment greatly influences where an organism can live. The organism that adapts best to the environment will be able to survive and flourish.



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

Part A. Answer the following questions.

1. How is a habitat different from a niche?

2. What do plant and animal species do when resources are limited?

3. What are the four things that an animal needs to survive in its habitat?

4. Why is it that you cannot find a fish on the land?

5. What is a biome?

Part B. Write true if the statement is correct and false if it is incorrect.

1. The habitat is like an organism's address. _____
 2. Terrestrial habitats are located in the trees. _____
 3. Arboreal species are the ones that spend most of their lives in trees. _____
 4. An organism's niche is more like its profession. _____
 5. A rainforest is an example of an aquatic environment. _____
-

**Summary**

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

- a habitat is the actual place in the ecosystem where an organism lives and can satisfy its needs.
 - the ecological niche is the role the plant or animal plays in the community found in the habitat.
 - an adaptation is a feature of an organism which improves its chances of surviving in a particular environment.
 - terrestrial habitats are located on land surfaces.
 - aquatic habitats are located in water.
 - the term arboreal refers to animals that live in or among trees. Arboreal creatures are usually highly adapted for living and moving about in trees.
-

NOW DO PRACTICE EXERCISE 4 ON THE NEXT PAGE.



Practice Exercise 4

Answer the following questions on the spaces provided.

1. Define the following.

(a) Habitat

(b) Ecological niche

(c) Adaptation

2. What is the difference between terrestrial and aquatic habitats?

3. In a forest ecosystem, the following four bird species feed by day on insects:

- White-throated tree creepers move *up* the tree trunks, locating insects in crevices.
- Varied sitellas move *down* the tree trunks locating insects in crevices.
- Crested shrikes locate insects by tearing barks off tree trunks.
- Bell miners locate insects on leaves.

a) Given that all these birds are insect eating birds or insectivores, are they in direct competition for food?

b) How is competition minimised in the case of these four bird species that live in the same forest ecosystem?

4. Describe the consequences of destroying the niche of a cuscus.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity**Part A. Short Answer Questions**

1. Habitat is where an organism lives in its environment. Niche is the job or the role that the organism has.
2. Plants and animals often compete when resources like food and water are limited.
3. Food, shelter, water and a place to raise its young.
4. This is because fish has adaptations that allow it to survive in its particular Habitat, which is in the water.
5. Habitats that have similar climate and plants are called biomes.

Part B. True or False

1. True
2. False
3. True
4. True
5. False

Lesson 5: Interactions



Welcome to Lesson 5. In the last lesson you learnt how different species occupy certain places within a community. All living things are affected by activities of other living things, so in this lesson you will learn about how species of organisms interact with each other.



Your Aims:

- define the words associated with species interaction
- identify the different types of species interaction

The Different Types of Species Interaction

All living things are affected by the activities of other living things. A situation in which two different organisms affect each other is called an **interaction**. Relationships are formed in nature when organisms interact with each other.

Some common biotic interrelationships between organisms are competition, predation and symbiosis.

- 1. Competition** occurs when a limited or shared resource like food, light and water is in short supply and there is a struggle between organisms for that resource. A **resource** is some feature of the environment that an individual organism needs for survival. Other resources that animals compete for include air, space, shelter, nesting materials and mate. Those that are more successful survive a competition. Two types of competition exist: intraspecific competition and interspecific competition.

(a) Competition for resources is most likely to occur between organisms of the same species, because all the individuals have the same requirements. This type of competition is called **intraspecific competition** and occurs between members of the same species for territory, food, water and for mating. Such competition is reduced in many species by **territorial behaviour**. This is a behavioural adaptation where organisms map out and defend a territory. **Territory** is a space or area organisms fight for and defend against others. Territory is important because it can provide food and mating opportunities. Consider the following example: A male lion must have his own territory to hunt and to attract females for mating.

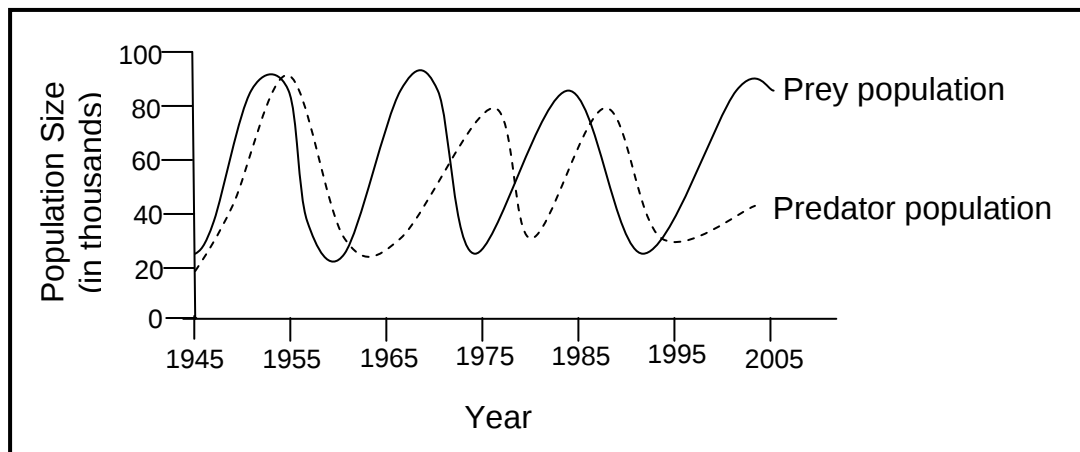
(b) Interspecific competition is competition between members of different species for territory, food and water. The amount of competition between organisms of different species is generally reduced because its species has its own specific requirements. While many live with each other in the same environment, most do not compete for exactly the same resource.

You learnt in the previous lesson that a habitat is where an organism lives in its environment. Think of habitat as the organism's address and niche is the role or job that the organism has in its environment. The organism's niche is closely related to what it eats. As a rule, two organisms cannot occupy the same habitat if they have the same niche. This is true because it places the organisms in competition with each other. Birds in a tree's branch in Africa and a lion in the shade of the tree have the same habitat, but they do not compete because their niches are different. However,

the lion and a cheetah compete because they have the same niche: Both are predators and hunt the same kinds of animals. **Competition exclusion principle** applies when two organisms fight for the same resource and both are excluded or die out.

2. Predation which is also known as predator-prey relationship is one where one organism hunts another. A **predator** is an animal that hunts for food. An example of a predator is a cat. **Preys** are organisms that are hunted by predators. An example is a rat. The search for food and avoiding predators are some of the major concerns in the daily lives of animals. When food is plentiful for the prey population, its numbers increase. After a time this results in an increase in the predator population. As the predator population increases, the prey population decreases. The two populations are linked to each other, and both depend on the other. The following graph illustrates the predator-prey relationship between foxes and rabbits in a certain part of mainland Australia.

PREDATOR-PREY RELATIONSHIP

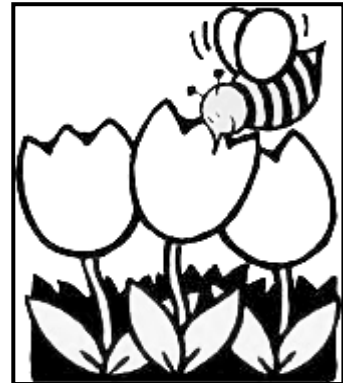


The patterns of the graphs can be explained this way: The predator hunts the prey. When the prey population increases, there is plenty food for the predator resulting in an increase in the predator population. As the predator population increases, plenty prey is consumed. The predator population falls again when there is less food, and the cycle repeats. This causes the population of both organisms to fluctuate in the same pattern. In the graphs above, both the predator and the prey graphs have a similar shape or pattern. The change in the predator population always lags behind that of the prey. The predator population is usually less than the prey population.

A predator population keeps the prey population from increasing to the point where its numbers are so high that the prey organisms begin to die because of a lack of food. When this happens, the prey population has exceeded the **carrying capacity** of the land. The carrying capacity refers to a land's capability to supply enough food to feed a population. When the number of individuals in a population exceeds the carrying capacity of the land, some members of the population must migrate to a new location or some will die of starvation. Predators usually kill the old, diseased and some young in a prey population. When the carrying capacity is exceeded, there is a population crash where the population suddenly drops.

3. **Symbiosis** is a relationship between two organisms that live together where at least one of the organisms benefits from the association. There are three kinds of symbiotic relationships and they are mutualism, commensalism and parasitism.

- (a) **Mutualism** is a close relationship between two organisms of different species that benefits both and harms neither. The organisms are adapted to live with each other. Both organisms benefit by living together, and usually one of the pair cannot live successfully on its own.

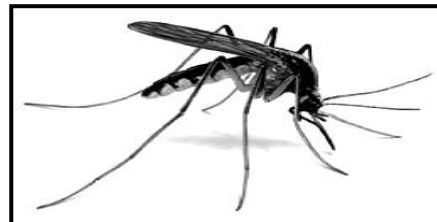


Bee gathering nectar

For example, the bee and the flower. Bees fly from flower to flower gathering nectar, which they make into food, benefiting the bees. When they land in a flower, the bees get some pollens on their hairy bodies, and when they land in the next flower, some of the pollen from the first one rubs off pollinating the plant. This benefits the plants. In this mutualistic relationship, the bees get to eat, and the flowering plants get to reproduce.

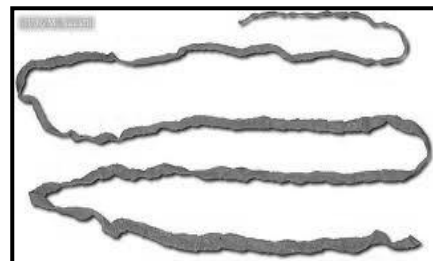
- (b) **Parasitism** describes the close relationship between two organisms which benefits only one organism and the other is harmed. The organism that benefits is the parasite, and the one that is harmed is the host. The parasite obtains its food by taking it from the host or by eating parts of the host itself. So you can see that the parasite always benefits at the expense of the host.

- i. **External parasites**, such as mosquitoes, ticks and fleas, live on the exterior of the host.



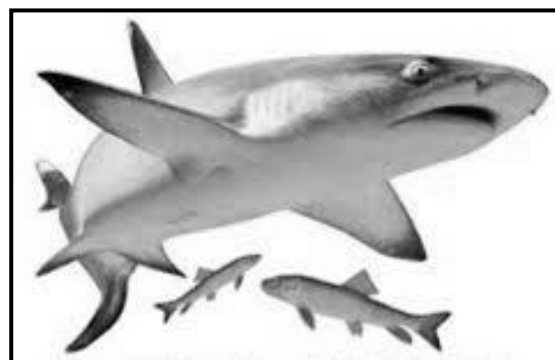
A mosquito

- ii. **Internal parasites** live inside the host. The parasite lives on or in the host. For example, tapeworms are parasites that live inside the digestive tract of an organism. The tapeworm benefits by getting food and a place to live but harms the host by causing pain, weight loss, and diarrhoea.



A tapeworm

4. **Commensalism** is a relationship between two different species where one species benefits from the association and the other is neither helped nor harmed or is not affected at all.

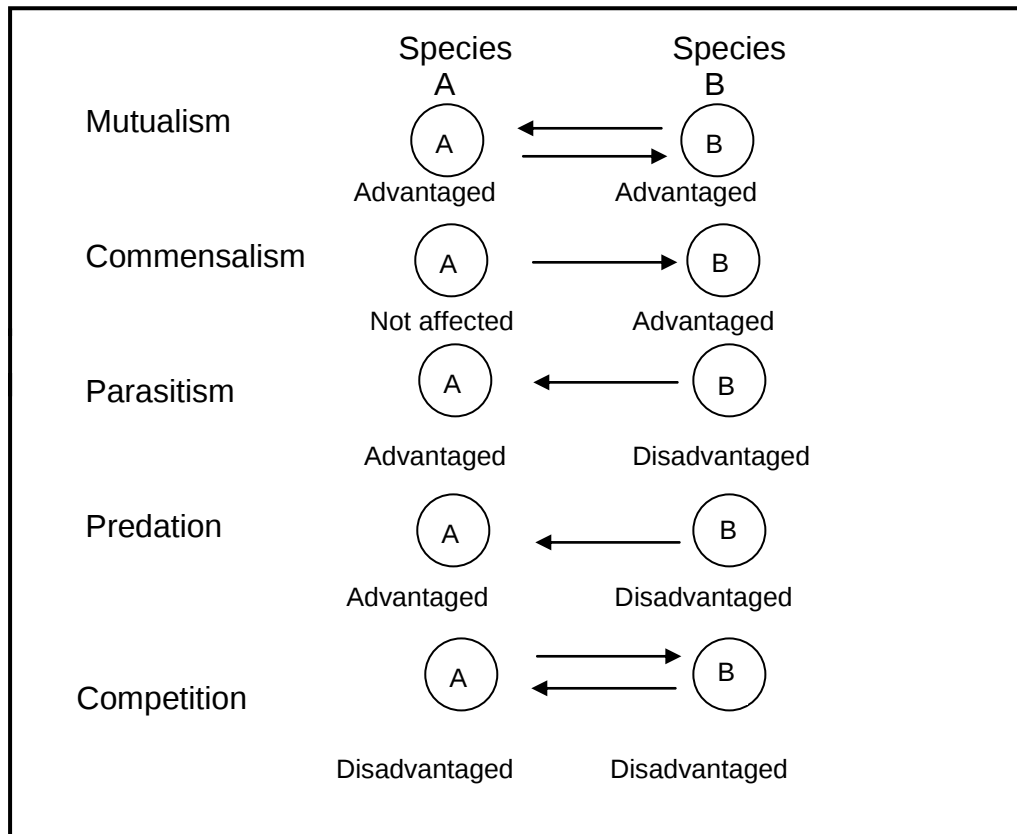


Commensalism between a shark and remoras

An interesting relationship exists between the remora and the shark. The remora belongs to a group of

saltwater attaching fishes. They have a dorsal fin behind their head that looks like a hook. The remora can attach itself to a shark using its hook-like fin and benefits by getting free transportation and food. It feeds on food scraps left over by the shark. The remora is also protected by the shark. No organism picks a fight with a shark so that means no organism comes closer to a shark so the remora has nobody to fear. The shark appears to be unaffected by the remora.

Summary of symbiotic relationships



Activity: Now test yourself by doing this activity.

Part A. Selecting Right Answers

Select the biotic relationship from the following list that is associated with each description. A choice can be used more than once or not at all. Write and explain the word of your choice on the space provided.

- A. Commensalism B. Interspecific competition C. Mutualism
D. Parasitism E. Predator-prey relationship

1. Birds are often infected with lice that suck their blood.

2. Hawks and owls both feed on small rodents such as mice.

3. The red-billed oxpecker bird eats ticks and lice off the skin of a rhinoceros.

4. The clown fish swims among the stinging tentacles of the sea anemone where it is protected from being eaten by other fish. The sea anemone tolerates the presence of the clownfish.

Part B. Table Completion

Complete the table by writing yes or no to describe the types of relationship.

Type of Relationship	Both organisms benefit	One organism is harmed
Mutualism	yes	no
Commensalism		
Parasitism		
Predation		



Summary

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

- predation occurs when one animal hunts, kills and eats another.
- competition occurs when a limited or shared resource like food, water, light and territory are in short supply. There is a struggle between organisms for scarce resources.
- symbiosis is a relationship between two organisms that live together where at least one of the organisms benefits from the association.
- there are three kinds of symbiotic relationships and they are mutualism, commensalism and parasitism.

NOW DO PRACTICE EXERCISE 5 ON THE NEXT PAGE.



Practice Exercise 5

Answer the following questions.

1. Name the five major types of species interactions.

- (a) _____
- (b) _____
- (c) _____
- (d) _____
- (e) _____

2. Define symbiosis.

3. How are commensalism and mutualism similar and how do they differ?

4. What is the situation in which two living things affect each other?

5. How are relationships formed in nature?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 1.

Answers to Activity

1. **D. Parasitism.** In parasitism one organism benefits (the parasite), and the other is harmed (the host). In this example, the parasites are the lice and the hosts are the birds.
2. **B. Interspecific competition.** Interspecific competition is competition between organisms of different species. The hawk and the owl are in different species, but they compete for many of the same kinds of foods.

3. **C. Mutualism.** Mutualism is a symbiotic relationship where both organisms benefit. The bird in this example gets food, and the rhinoceros gets rid of parasites.
4. **A. Commensalism.** Commensalism is a symbiotic relationship where one organism benefits and the other is not affected. The clown fish benefits from the protection of the sea anemone, which is not affected by the presence of the clown fish.

Part B. Table Completion

Type of Relationship	Both organisms benefit	One organism is harmed
Mutualism	yes	no
Commensalism	no	no
Parasitism	no	yes
Predation	no	yes

Answers to Practice Exercises 1 – 5

Practice Exercise 1

Part A

1. C. Home
2. B. Non-living things
3. B. Living things
4. B. Humans

Part B:

1. Producers, Consumers, Decomposers
 2. Sunlight, Water, Temperature, Wind, Soil types
-

Practice Exercise 2

1. Water is important because all organisms need water. This is mainly because the chemical reactions in their cells must take place in a water solution.
2. In the ocean, sunlight cannot penetrate much beyond 100 metres, though this depends on how clear the water is. There is no plant life in the depths of the ocean because the plants need light for food production.
3. The three main types of soil are sandy soil, clay soil and loamy soil.
 - (i) Sandy soil is looser and holds only a little water.
 - (ii) Clay soil holds a lot of water, but plants cannot easily absorb water from clay soils.
 - (ii) Plants grow well in loamy soil than sandy or clay soil because loamy soil has good drainage, holds water which is readily available to plants, has good aeration and does not crack when it dries out.
4. All the physical factors of the environment are limiting factors for living things. This means that living things need the right amount of a particular factor.
5. Light is essential for photosynthesis. Without light plants would not be able to make food and this would affect the feeding relationship of organisms in that particular area.
6. There would be no wind and this would affect cloud movement and distribution of rainfall.
7. It would lose too much water and die.

Practice Exercise 3

1. C. community
 2. A. All the mice living in a warehouse
 3. A. Ecosystem
 4. C. Ecosystem
 5. B. Population
-

Practice Exercise 4

1.
 - a) A habitat is the actual place in the ecosystem where an organism lives and can satisfy its needs.
 - b) The ecological niche is the role the plant or animal plays in the community found in the habitat.
 - c) An adaptation is a feature of an organism which improves its chances of surviving in a particular environment
 2. Terrestrial habitats are located on land surfaces and include deserts, forests and grassland while aquatic habitats are located in water and include lakes, ponds, swamps, rivers, seas and oceans.
 3.
 - a) No, they are not in direct competition for food.
 - b) They eat the same food but they do not compete because they have different ways of finding their food.
 4. The niche of a cuscus would be its role in its habitat. In order for a cuscus to survive in its habitat it must have plenty of seeds and nuts to eat, it must have a sheltered place to nest, and its natural predators must not be plentiful. When we destroy habitats or the home of a cuscus, the type of food the cuscus eat would run out, its sheltered place would be destroyed and eventually it would no longer exist.
-

Practice Exercise 5

1.
 - (a) Mutualism
 - (b) Commensalism
 - (c) Parasitism

(d) Predation

(e) Competition

2. Symbiosis is a relationship between two organisms that live together where at least one of the organisms benefits from the association

3. Similarities- They are both relationships between two different species.

Differences - In commensalism only one species benefits from the association and the other is neither helped nor harmed or is not affected at all whereas in mutualism is a close relationship between two organisms of different species that benefits both and harms neither.

4. Interaction

5. Relationships form in nature when organisms interact with each other.

REVISE TOPIC 1 USING THE MAIN POINTS ON THE NEXT PAGE.

REVIEW OF TOPIC 1: Ecology

Now, revise all lessons in this Topic and then do **ASSIGNMENT 2**.

Here are the main points to help you revise.

Lesson 1: Biotic Factors in the Ecosystem

- Ecology is the study of how living things interact with each other and with their environment.
- The living organisms and the non-living surroundings in an area are called an ecosystem.
- The environment is all the biotic and abiotic factors in the surroundings of organisms that directly or indirectly have an effect on the organism.
- All the parts of an ecosystem work together to function as a whole.
- The place where an animal or plant lives is its habitat.
- The role that each organism plays in the ecosystem is its niche or ecological niche.

Lesson 2: Abiotic Factors in the Ecosystem

- The physical factors in an environment determine the kind of organisms that can survive in an area.
- Some physical factors that can affect organisms are climate, light, water, temperature, wind and soil.
- Sunlight is the main source of energy for living things and is essential for photosynthesis.
- Water is another important factor that supports life.
- The main physical factors of the soil are known as edaphic factors and they determine which particular plants can grow in the soil and what animals live there.
- Winds are important because they control cloud movement and the distribution of rainfall.

Lesson 3: Levels of Organisation in Ecosystems

- Species refers to organisms that can mate and produce young like themselves
- Population refers to organisms of the same species that live together in a given area at a particular time.
- A community is made up of different populations living together in a given area.
- An ecological organisation begins with the smallest category and ends with the largest category and they are individual or species, population, community, ecosystem and biosphere.

Lesson 4: Ecological Niches and Habitats

- A habitat is the actual place in the ecosystem where an organism lives and can satisfy its needs.
- The ecological niche is the role the plant or animal plays in the community found in the habitat.
- An adaptation is a feature of an organism which improves its chances of surviving in a particular environment.
- Terrestrial habitats are located on land surfaces.
- Aquatic habitats are located in water.

- The term arboreal refers to animals that live in or among trees. Arboreal creatures are usually highly adapted for living and moving about in trees.

Lesson 5: Interactions

- Predation occurs when one animal hunts, kills and eats another.
- Competition occurs when a limited or shared resource like food, water, light and territory are in short supply. There is a struggle between organisms for scarce resources.
- Symbiosis is a relationship between two organisms that live together where at least one of the organisms benefits from the association.
- There are three kinds of symbiotic relationships and they are mutualism, commensalism and parasitism.

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

TOPIC 2

HOW ECOSYSTEMS WORK

In this topic you will learn about:

- **roles of organisms in ecosystems**
- **life processes**
- **food chains and food webs**
- **energy flow and trophic levels**
- **the carbon cycle**
- **the nitrogen cycle**

INTRODUCTION TO TOPIC 2: HOW ECOSYSTEMS WORK

An ecosystem refers to all the living organisms and their non-living environment within a given area. The living components consist of the animals, plants and microbes, and the non-living components refer to air, water, rocks, soil and weather.

When we study how ecosystems work, we will realise an important point about ecosystems. That is, the interaction between plants and animals and their non-living environment to maintain their survival.



You should know all about how ecosystems work. The questions you should ask yourself are

- How can we classify organisms according to the different roles they play in the ecosystem?
- Where do organisms get the energy to survive?
- How is energy transferred between organisms?
- How are materials being constantly reused?

In this topic, you will find the answers to these questions and all other questions relating to how ecosystems work.

Lesson 6: Roles of Organisms in the Ecosystems



Welcome to Lesson 6. In this lesson you will learn that living things can be classified into different groups based on the different roles they play in the ecosystem.



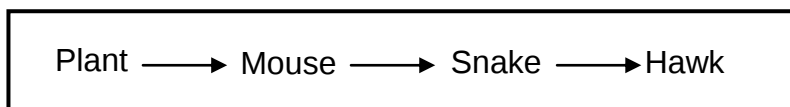
Your Aims:

- define ecological cycles
- classify organisms according to the type of food they eat
- describe the ecological roles of organisms in their habitat

Energy Flows

All organisms need a continual flow of energy to stay alive. This energy called sunlight comes from the sun. The constant flow of energy from the sun to Earth supports life.

For example, energy flows through a food chain when a plant changes the sun's energy through photosynthesis, a mouse eats the plant, a snake eats the mouse and a hawk eats the snake as shown in the simple food chain below.



In each transfer, some energy is lost as heat, requiring an ongoing energy flow into the system. We will discuss this later on in the topic when we study lesson 9.

Ecological Cycles/Recycling

Ecological cycles refer to the recycling of carbon, water, nitrogen and other elements that support life. Recycling of chemicals by organisms is very important. As you know, there are almost no resources on our planet which are in endless supply. If chemicals were not recycled, eventually there would be no nutrients available for organisms.

Roles of Organisms in an Ecosystem

Ecosystems have lots of different living organisms that interact with each other. These organisms can be divided into three nutritional or feeding groups which are the producers, consumers and decomposers. They are all important parts of an ecosystem.

The living things in an ecosystem are producers, consumers or decomposers.

Nutritional or Feeding Groups

Autotrophs are green plants that can make their own food by the process of photosynthesis. Photosynthesis is like a kitchen in a leaf that makes food for the plant. During photosynthesis, green plants use light energy to change carbon dioxide and water into glucose and oxygen. Green plants as we all know are often called producers.

Heterotrophs are often called consumers and are organisms that eat to obtain food needed for energy production. 'Hetero' means different and 'trophy' means food. So

heterotrophs do not make their own food but they get their food from a different source. They also eat autotrophs or other heterotrophs. Therefore, they can be classified by the kinds of organisms they eat.

The table below shows the different kinds of heterotrophs and the organisms they eat.

Heterotroph	Examples	Type of Organism They Eat
Herbivore	Cow, cuscus rabbit, grasshopper	Plants
Insectivore	Bats, frogs, lizard	Small vertebrates, plants and animals and other small invertebrates
Carnivore	Eagle Hawks, Dog sharks, snake, cat, owl	Meat
Omnivore	Human, chicken, pig	Plants and meat
Predator	Eagle, Dog, cat, snake, owl	Meat that has been hunted
Scavenger	Vultures	Meat that is left over by a predator
Detritivores	Bacteria, earthworms, many insects	Decaying animal or plant material
Decomposers	Bacteria, fungi	Dead plants and animals

Table of heterotrophic classification

Herbivores are animals that eat plants only, therefore they are primary consumers. Cows, mice and plant-eating insects are some examples of primary consumers. Animals that eat other animals are called carnivores. Carnivores eat herbivores and sometimes other carnivores. Carnivores are secondary consumers. Pigs and hawks are secondary consumers and omnivores are animals that eat plant and other animals. Humans and pigs are omnivores.

Insectivores can also be classified under consumers. Insectivores are carnivorous animals or insects that survive by eating almost nothing but small insects for food. Insectivores include bats, frogs, lizards and anteaters.



A frog and a bat are examples of insectivores

Decomposers

The third types of living organisms in an ecosystem are the **decomposers**. These are organisms that help in the decomposition of dead or dying organism. They break down dead plants and animals. They also break down animal wastes. Fungi, such as mushrooms and moulds, and bacteria are decomposers. They turn dead material and waste into nutrients that go back into the soil. Plants take up the nutrients with their roots. They use the nutrients to make more food. In biology, decay or decomposition is the natural breakdown of complex organic compounds into simpler substances. Decay occurs in dead plant and animal tissue and is essential to the cycle of life.



Fungi- primary decomposers in most environments



An earthworm –a soil dwelling detritivore

Scavengers

Recycling helps us make good use of our resources. In nature there are lots of animals responsible for recycling.



Vultures are full time scavengers

Some animals eat dead animals or carrion. They are called scavengers. They help break down or reduce organic material into smaller pieces. These smaller pieces are then broken down by decomposers. Decomposers break down dead materials into chemical parts. Without decomposers and scavengers, the world would be covered with dead plants and animals!

Detritivores

Detritivores do the same work as that of decomposers. They feed on dead plant and animal matter, but perform an additional function which is to return essential nutrients back to the ecosystem. As a result they become an important part of the ecosystem in which they live. They can live in the soil as well as in the marine ecosystems. Some examples of detritivores are worms, millipedes, sea stars, crabs and dung flies.

The word **detritivores** comes from the word detritus which means non-living plant and animal remains and wastes. Detritivores consume this detritus to get their energy to survive. By doing so, they contribute to decomposition and the nutrient cycles.

Are decomposers the same organisms as detritivores?



Difference between Decomposers and Detritivores

You might think that decomposers and detritivores are the same organisms, but these are two different organisms. It is clear that both detritivores and decomposers help in the **decomposition** of dead or decaying matter.

Decomposition is a chemical reaction where a complex compound is broken down into simpler compound.

Detritivores help in producing essential nutrients. Both decomposers and detritivores get energy from decaying matter but while detritivores actually eat organic matter, decomposers secrete chemical fluids to digest organic matter and then absorb what they need for nutrition.

Ecological Roles

All of the organisms within an ecosystem have different roles. These roles are called **niches** as we have already learnt in Topic 1 Lesson 4. Organisms can have more than one niche and knowing the niches of an organism can help to explain why they act and interact the way they do.

To determine an organism's niche, you need to identify **what it eats, where it lives, and how it interacts** with the other organisms in the ecosystem.

Niches include:

Producers - produce food energy for themselves and others

Consumers - consume the food made by the producers

Herbivores - eat producers (plant eating niche)

Carnivores - eat other consumers (meat eating niche) **Predators eat prey**

Omnivores - eat both producers and consumers



Activity: Now test yourself by doing this activity.

Fill in the Blanks

Use the following words to complete the paragraph given below.

Consumers	Prey	Decomposers	Omnivores
Producers	Sun	Carnivores	Scavengers

Herbivores

In any ecosystem, _____ make their own food. They rely on the _____ for energy. Organisms that cannot make their own food are called _____. Some, such as grasshoppers are _____, which eat producers. Others, like cats, are _____, which eat other animals. Predators hunt other living things

called _____ for food. Some meat eaters known as _____ eat the remains of dead animals. People are _____ because they eat both plants and animals. And lastly we have the _____, which break down waste.



Summary

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

- the Sun is the main source of energy that supports life on Earth.
 - ecological cycles refer to the recycling of the essential elements that support life on Earth.
 - green plants make their own food through photosynthesis and are called producers.
 - consumers are organisms that eat food to obtain their energy and maintain their survival.
 - consumers are grouped according to the type of food they eat.
-

NOW DO PRACTICE EXERCISE 6 ON THE NEXT PAGE.



Practice Exercise 6

Answer the following questions.

1. Name the three nutritional or feeding groups of living things and describe each?

i) _____
ii) _____
iii) _____

-
2. Define the following terms

i. Ecological cycles

ii. Decomposition

-
3. Describe each consumer by the type of food that they eat.

A. Insectivores - _____

B. Scavengers - _____

C. Detritivores - _____

D. Decomposers - _____

-
4. Identify three things that are needed to determine an organism's niche.

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

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activity

Producers, Sun, Consumers, Herbivores, Carnivores, Prey, Scavengers, Omnivores, Decomposers

Lesson 7: Life Processes



Welcome to Lesson 7. In your last lesson you learnt about the different roles that living things play in their different groups in the ecosystem. In this lesson, you will learn about life processes of living things.



Your Aims:

- define photosynthesis
- discuss how all living things respire
- write equations for photosynthesis and respiration

Green plants are amazing organisms. Without green plants, life on earth would not exist as we know it today. Green plants are autotrophs; they need carbon dioxide and water, so that they are able to make their own food (glucose) by a process called **photosynthesis**.

Making Food

What is the colour of most plants around you? The answer is green. Do you know why most plants are green? This is because they contain **chlorophyll**. Chlorophyll is the pigment which makes plants look green.

Green plants make their food through the process of photosynthesis by using sunlight, carbon dioxide, water and a variety of minerals. The food that is formed is a carbohydrate called glucose. Oxygen is also given off at the same time.

That sounds interesting, you may say. But how do they make their food, would be your question. Well! Let us try and answer your question.



If I mix carbon dioxide and water together, would they combine?

Your friend above is confused and is asking you a question. What would be your answer? The answer is, yes in the presence of light energy and chlorophyll. Now, where does this energy come from? It comes from the sun and is called sunlight or solar energy. The light energy has to be absorbed, and then used in the reaction. Chlorophyll is the substance which does this.

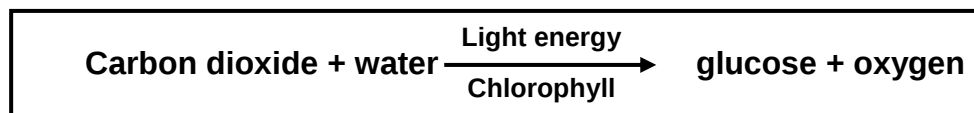
Chlorophyll is very important in the survival of a plant because it absorbs light energy from the sun.

With this light energy, raw materials such as carbon dioxide and water combine to make food during photosynthesis. 'Photo' means light, and 'synthesis' means manufacture.

The process by which plants use water and carbon dioxide to make carbohydrates, in the presence of sunlight and chlorophyll, is called photosynthesis.

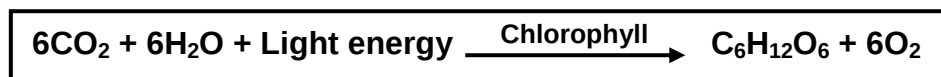
Photosynthesis produces a simple sugar called glucose. This sugar is transported to all parts of a plant where some are respired to produce energy, some are changed into starch and others stored for future use. The glucose is also used in combination with chemicals absorbed from the soil to manufacture all the substances in the cells of a plant. Photosynthesis powers almost all food chains and food webs on Earth.

The general process of photosynthesis is described by the following word equation:



The above equation simply means light energy is absorbed by the green chemical chlorophyll. This energy allows the production of glucose by the reaction between carbon dioxide and water. Oxygen is also produced as a waste product. We can also say it means that carbon dioxide from the air and water combine in the presence of sunlight to produce glucose and oxygen is released as a by-product of this reaction.

The chemical equation for photosynthesis is:



The above chemical equation is read as six molecules of carbon dioxide plus six molecules of water produce one molecule of sugar and six molecules of oxygen.

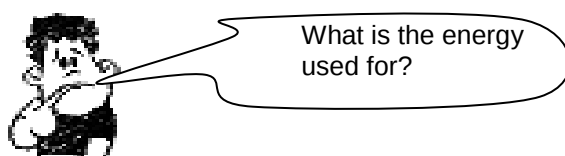
Respiration

Do you play when you are hungry? No, you do not because you feel that your body does not have enough energy. After you have eaten some food, you will now feel that you can play. Is that true? Of course, we all have felt like that sometimes.

We all need energy to function. Every cell in every living organism needs energy. And where do we get this energy from? From the foods we eat. Our body uses food (glucose) and air (oxygen) to respire to stay alive. The energy is released from the food by a process called **respiration**. In respiration, energy is released from the food by combining it with oxygen.

Respiration is the process that takes place inside cells in which glucose is broken down to release energy that the cell can use.

Respiration turns food and oxygen into energy. In simplest terms glucose means the food we eat and oxygen means the air we breathe. The human body uses glucose (digested food) as fuel to create energy. This energy is used for many different processes, but in all of them energy transfer occurs.



Here are some of the things that organisms need energy for:

- Animals need energy for movement (muscle contraction), for sending messages through nerves, for transporting substances inside the body and for keeping warm.
- Plants need energy to take up mineral salts from the soil, for opening and closing the stomata on their leaves and for transporting food substances.
- All organisms need energy for growth, for cell division and just for staying alive.

We can sum up by saying that food serves as a fuel. Respiration can be described as burning without flames. The breaking down of food in respiration drives our bodies, just as the burning of petrol drives a car.

Respiration is a key feature of life and is carried out by all living cells. It can be described using the following word equation.



The above equation simply means when a piece of food is burned using oxygen, carbon dioxide is given off, water is formed and heat energy is produced.

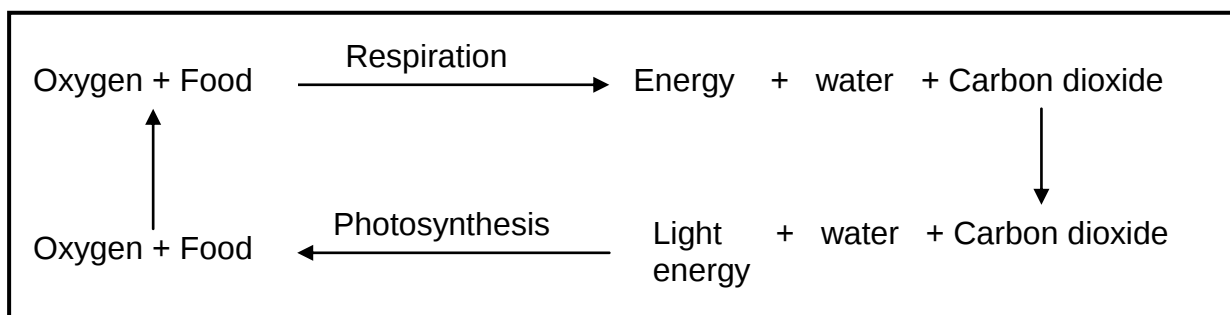
The carbon dioxide and water are by-products. The reaction produces energy for the cell. Much of the energy that is released in respiration is used by the cell.

Respiration can be summarised further with its chemical equation.



The equation simply means that glucose and oxygen are needed to form carbon dioxide, water and energy. In addition, the numbers mean that the complete breakdown of a glucose molecule requires six oxygen molecules and forms six carbon dioxide molecules, six water molecules and energy.

Respiration and photosynthesis are basically opposite processes. Photosynthesis is the reverse of respiration. Photosynthesis uses the products of respiration, and respiration uses the products of photosynthesis. This is illustrated below.



Can you now see what Mother Nature can do?



Of course! I see something. Nature takes the outputs of cellular respiration which is carbon dioxide and water and makes them the inputs to photosynthesis

That is right! What else can you see?

I can also see the opposite where nature takes the outputs of photosynthesis which is oxygen and glucose and makes them the inputs to cellular respiration.



And the cycle of life goes round and round or we can say that the gases are being recycled. The product of photosynthesis which is oxygen is used by animals in respiration. The animals give out carbon dioxide when they respire. This carbon dioxide is then used by producers again in photosynthesis. So the carbon dioxide and oxygen are recycled.



Activity: Now test yourself by doing this activity.

A. Multiple Choice Questions

Circle the letter corresponding to the best answer.

1. What kind of energy does a plant use to make carbon dioxide combine with water?
 - A. Electrical
 - B. Sunlight
 - C. Mechanical
 - D. Gravitational
2. What do plants use to make carbohydrates during photosynthesis?
 - A. Water and oxygen
 - B. Glucose and oxygen
 - C. Carbon dioxide and water
 - D. Oxygen and carbon dioxide
3. The food that is formed by photosynthesis is a carbohydrate called _____.
 - A. sugar
 - B. glucose
 - C. starch
 - D. Maltose

4. What does respiration produce?

- | | |
|-------------------|-----------|
| A. Carbon dioxide | B. Energy |
| C. Oxygen | D. Water |
-

5. Respiration takes place in the

- A. air around us.
 - B. leaves of plants.
 - C. lungs of animals.
 - D. cells of all living organisms .
-

B. Fill in the blanks

Use the following words to answer the questions. One word can be used more than once.

carbon dioxide nitrogen oxygen

Which of the above is

- a) taken in by plants during photosynthesis?

 - b) produced by plants during photosynthesis?

 - c) used up during respiration?

 - d) produced during respiration?

-

C. Short Answers

Briefly answer the questions on the space provided.

1. What are the products of photosynthesis?

2. What substances does a plant use to make food through photosynthesis, and what food does this process make?



Summary

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

- photosynthesis is the process in which green plants combine carbon dioxide and water in the presence of sunlight to make their food.
- the food that is produced by plants is a carbohydrate called glucose.
- the by-product of photosynthesis is oxygen.
- respiration is the process in which glucose is broken down to release energy.
- the by-products of respiration are water and carbon dioxide.

NOW DO PRACTICE EXERCISE 7 ON THE NEXT PAGE



Practice Exercise 7

Short Answer Questions

Answer the following questions on the spaces provided.

1. Explain photosynthesis in your own words.

2. What is the name of the pigment that makes plants appear green and why is it important to plants?

3. What is respiration?

4. Write the word equation for photosynthesis in the box below.

5. Write the word equation for respiration in the box below.

6. What can you conclude from the two equations?

7. Without photosynthesis the air would quickly become unbreathable. Explain why this is so?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activity**A. Multiple Choice**

1. (B)
2. (C)
3. (B)
4. (B)
5. (D)

B. Fill in blanks

- a) carbon dioxide
- b) oxygen
- c) oxygen
- d) carbon dioxide

C. Short Answers

1. A carbohydrate called glucose and oxygen.
2. Plants combine carbon dioxide from the air and water from the soil in the presence of sunlight to make food which is a carbohydrate called glucose.

Lesson: 8 Food Chains and Food Webs



Welcome to Lesson 8. In your previous lesson you learnt about the life processes of living things. In this lesson, you will learn about food chains and food webs. In the natural world, animals feed on plants and on other animals that supply them energy, nutrients and minerals for their survival.

The flow of energy through the ecosystem is unidirectional (one way). Energy is never recycled. Food chains, webs and pyramids illustrate the transfer of energy from one organism to another.



Your Aims:

- define food chain and food web
- describe the flow of energy through a food chain
- identify the organisms at each level of a food chain

Food Chains

A food chain shows how living things feed on other living things. We can define this better by saying that a food chain shows how energy is transferred from one organism to another in an ecosystem. For example, if a snake feeds on frogs, and the frogs feed on grasshoppers and grasshoppers feed on grasses, then the food chain is as shown in the diagram below.



Diagram 1. Simple Food Chain

Each arrow runs from the organism being eaten to the organism that is eating it or you can say that the arrows are drawn from food source to food consumers. In other words, you can substitute the arrows with the words “eaten by”.

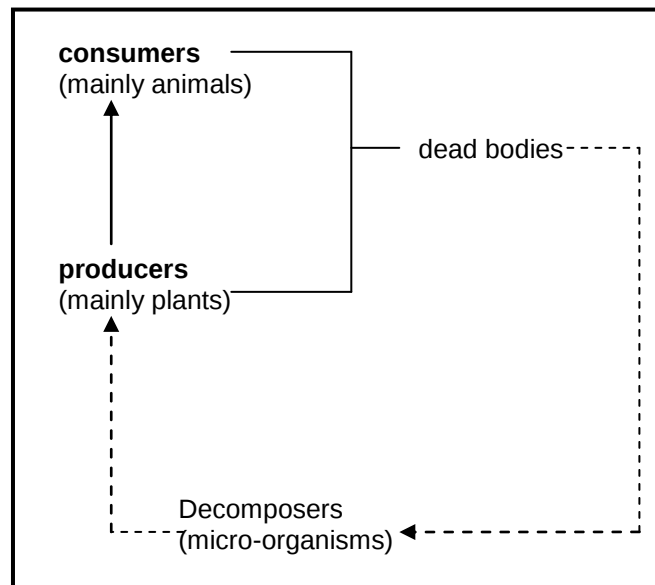
The energy needed for survival passes from one organism to the next in a food chain.

We give special names to the positions of organisms in a food chain. We can see from this that all the organisms in a food chain depend on the producer, which is the grass. The producers are **autotrophs**. They make their own food by photosynthesis, using energy from the sun. Because they make food we call them **producers**.

The herbivore is always called a **first-order consumer**. First-order consumers are also called **primary** consumers. The animal feeding on the herbivore is a **second-order consumer**. This was the frog in our example. The animal feeding on this is a **third-order consumer**, and so on. The second-order and third-order consumers are also called secondary and tertiary consumers and are carnivores.

Sometimes a fourth consumer exists in a food chain. More than four consumers in a food chain is unusual because by the time the fourth consumer is reached, little energy remains to be transferred. When any of the organisms in a food chain die, they are broken down by organisms of decay called decomposers. Decomposers include bacteria and fungi, and can be considered the final consumers. They feed on

dead organisms and animal wastes breaking them into simple substances which provide nutrients in the soil.



Decomposers break down dead organisms into simple substances

Decomposers enable the nutrients in the bodies of the producers and consumers to be used again.

Food Webs

There are many food chains in each community of organisms. They are not usually separate from each other. For example, the frog in our food chain in diagram 1 on the previous page may be in another food chain as shown below.

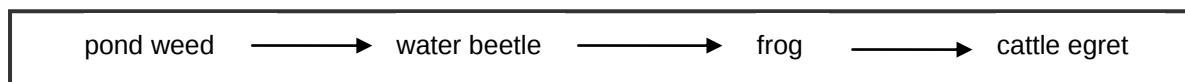
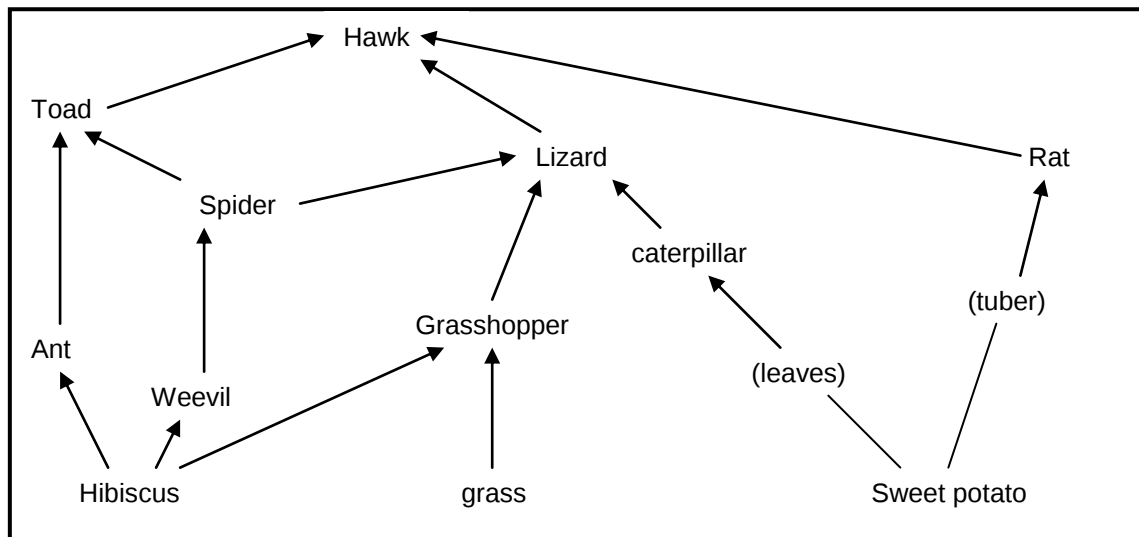


Diagram 2. Another example of a food chain

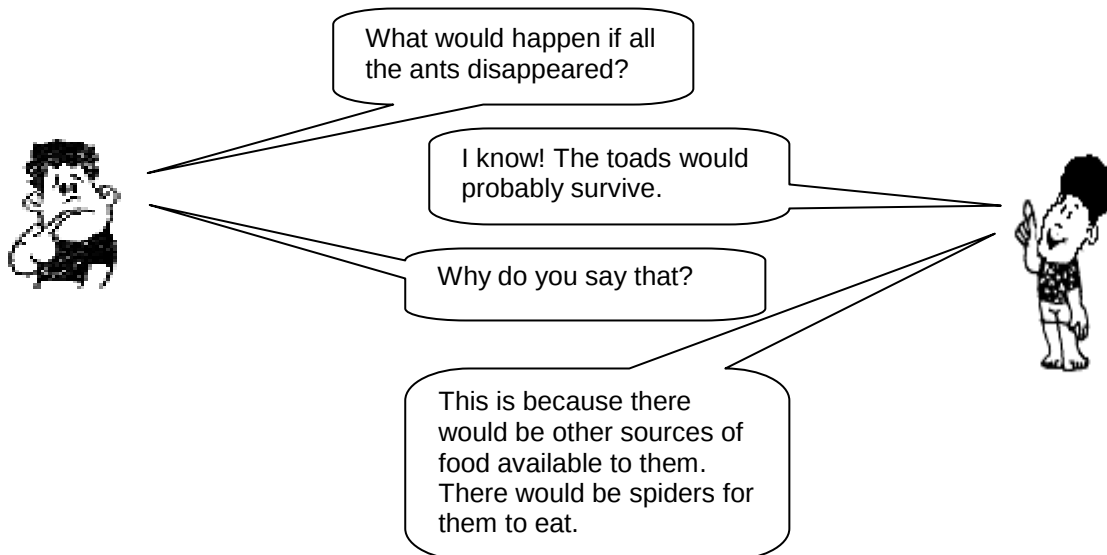
In this way, many food chains in a community are linked together. All the linked food chains are known as a **food web**.

Most animals are part of more than one food chain and eat more than one kind of food in order to meet their energy and food requirements. These interconnected food chains form a food web. Food webs are usually very complex. Some organisms may be in many food chains. Shown on the next page is part of a food web, which demonstrates that most organisms are in several food chains. You can see that the lizard is in five food chains, while the toad is in three.

A food web is made up of several interconnecting food chains.



Part of a food web, showing how some of the organisms may be in many food chains



When an animal is in a number of food chains it can consume a number of different organisms. When a large number of different organisms live together we say the community is very **diverse**. Communities that are diverse do not usually change greatly overtime because each consumer has an alternative food supply.

Most consumers eat more than one kind of plant or animal. These consumers will not die if they cannot eat one particular kind of plant or animal. They can eat another kind of plant or animal. Consumers that eat a variety of organisms can survive by eating a little of each of the plants or animals available. This means that less of a particular organism is consumed.

The disadvantage of a food chain is that it is only as strong as its weakest link. If a disease kills all the primary consumers, the secondary and tertiary consumers will be affected. A food web has the advantage of providing alternate sources of food.



Activity: Now test yourself by doing this activity.

Part A. Definitions

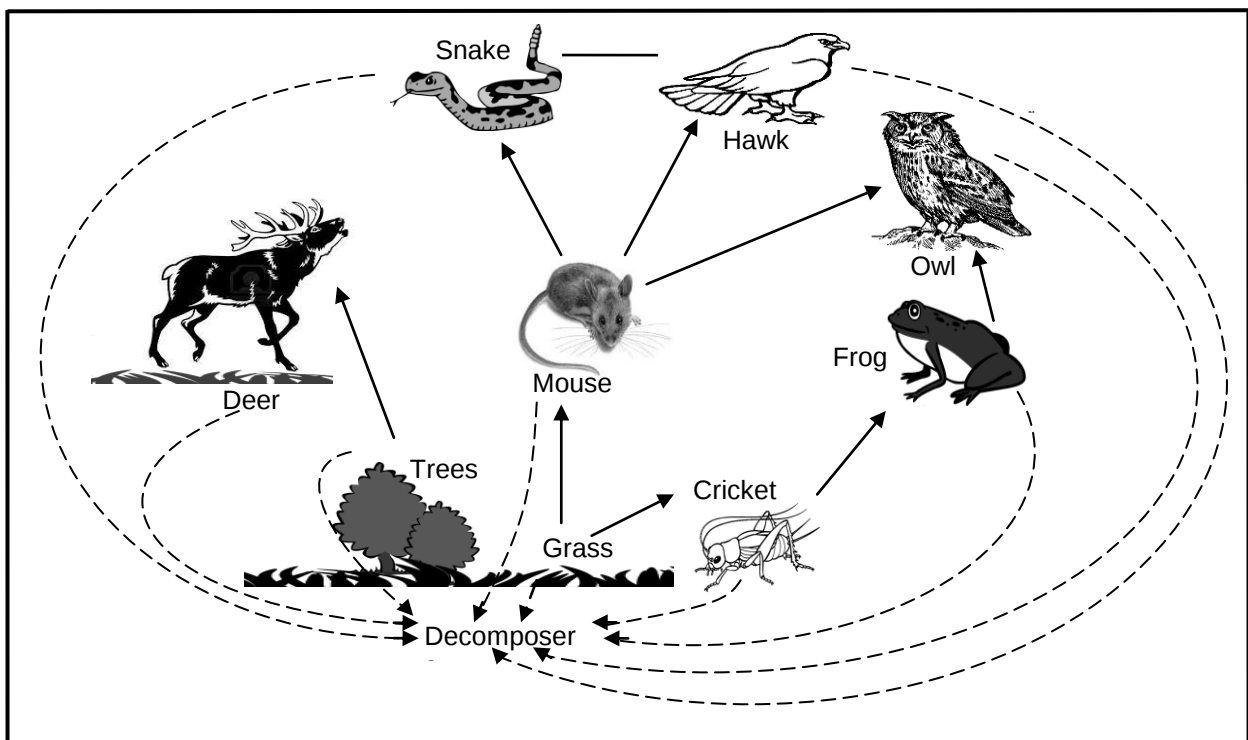
Define the following terms.

(a) Food Chain

(b) Food web

Part B. Fill in the Blanks.

Complete the following paragraphs by filling in the missing terms based on the diagram of the food web below. Write a description of each term.



The above diagram shows a 1. _____. The organisms represented by grass and trees are known as the 2. _____. Deer, mice and crickets are the 3. _____. These organisms are also known as 4. _____ because they eat plants. The snake and frog are the 5. _____. These organisms are also known as 6. _____ because they eat animals. The hawk and the owl are 7. _____ consumers. If a disease killed the frog, the owl would survive because it can also eat the 8. _____. The two organisms that have the least amount of energy available to them are 9. _____. When any of these organisms die, their energy is transferred to the 10. _____.



Summary

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

- a food chain shows how a living thing gets its food.
- producers make their own food through photosynthesis.
- animals cannot make their own food so they must eat plants and/or other animals. They are called consumers.
- there are three groups of consumers and they are herbivores, carnivores and omnivores.
- animals that eat only plants are called herbivores or primary consumers.
- carnivores that eat herbivores are called secondary consumers.
- carnivores that eat other carnivores are called tertiary consumers.
- animals and people who eat both animals and plants are called omnivores.
- decomposers are fungi and bacteria which feed on decaying matter.
- a food web is made up of several interconnecting food chains.

NOW DO PRACTICE EXERCISE 8 ON THE NEXT PAGE.



Practice Exercise 8

Answer the following questions.

1. Where do arrows in a food chain point to? What do the arrows mean?

2. Construct a food chain using the following animals. The ecosystem represents a flower garden. You do not have to draw pictures; you can just use the animal names and draw arrows between them. Also state the position of each organism in your food chain. (Draw your food chain in the box below).

SNAKE, HIBISCUS, FROG, BUTTERFLY,

3. Define and provide two examples each for each of the following groups of heterotrophs.

a) Herbivores

b) Carnivores

c) Omnivores

d) Decomposers

4. What happens to energy the further you go along a food chain?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activity

Part A. Definitions.

1. A food chain shows how energy is transferred from one organism to another in an ecosystem.
 2. A food web is made up of all the linked food chains in a community.
-

Part B. Fill in the Blanks

1. **Food web.** This food web consists of several interconnecting food chains.
2. **Producers.** Green plants are producers. Green plants convert light energy from the sun into chemical energy stored in glucose molecules.
3. **Primary consumers.** In a food chain the first group of organisms to eat are called primary consumers.
4. **Herbivores.** Animals that eat plants are called herbivores.
5. **Secondary consumers.** The snake and frog are called secondary consumers because they are the second group of organisms to eat. The snake ate the mouse, which is a primary consumer. The frog ate the cricket, which is a primary consumer.
6. **Carnivores.** Animals that eat meat (other animals) are called carnivores.
7. **Tertiary consumers.** The hawk and owl are called tertiary consumers because they are the third group of organisms to eat.
8. **Mouse.** The advantage for organisms in a food web is that they have alternative sources of food in case one particular food is unavailable.
9. **The hawk and the owl.** In a food chain or a food web, the organisms that are at the end have the least amount of energy available to them because the organisms behind them use energy performing their life functions.
10. **Decomposers.** The decomposers are the organisms of decay. Decomposers return minerals and nutrients to the soil. Sooner or later the decomposers are going to get you.

Lesson 9: Energy Flow and Trophic Levels



Welcome to Lesson 9. In your last lesson you learnt that all living things need food. Food performs two main functions in an organism's body. It supplies the building materials from which new cells and tissues will be built, and a source of energy to enable life processes. All organisms must make use of the sun's energy, either directly as in the case of plants, or indirectly as in the case of nearly all other organisms. In this lesson, you will learn that food chains, food webs and food pyramids illustrate the transfer of energy from organism to organism.

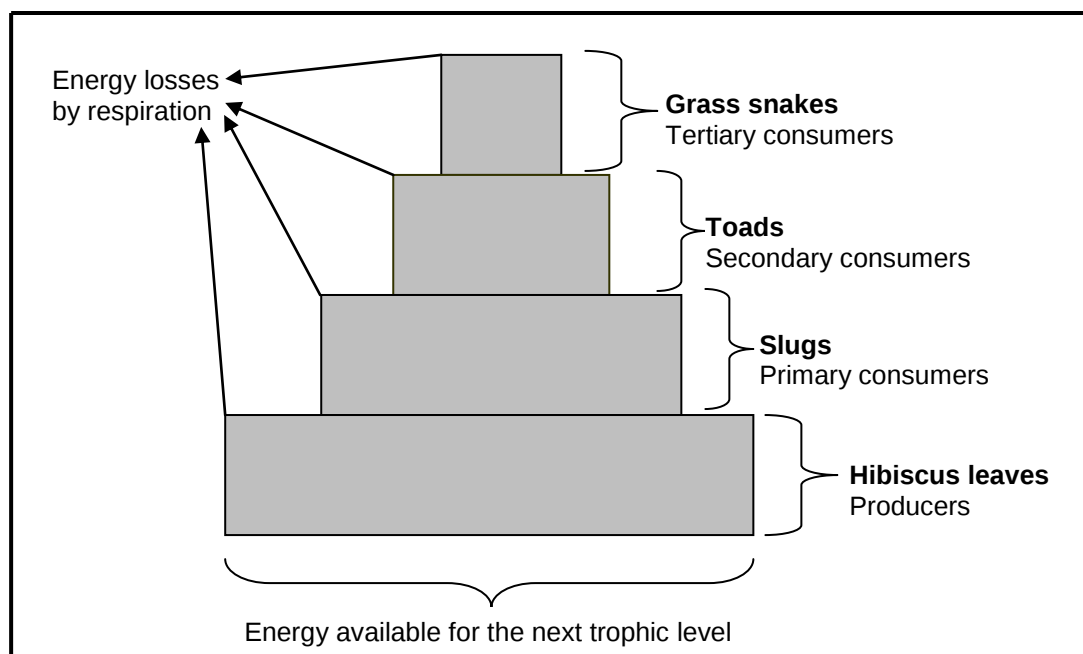


Your Aims:

- define a trophic level
- discuss the role of sunlight as the primary source of energy on earth
- discuss the flow of energy and how it is lost at the Earth level

Trophic Levels of a Food Chain

The position that an organism occupies on a food chain is called its **trophic level**, which means its feeding level. This position depends on whether it is a plant or an animal and what it eats. The trophic levels of any food chain can be arranged in a pyramid shape. The first trophic level is placed at the bottom and the trophic levels that follow are stacked on top in their 'feeding sequence'. The diagram below illustrates these points using a simple food chain.



Flow of energy through food chains

Green plants occupy the first trophic level of any food chain, since they produce the food which supports the whole chain. The second trophic level is occupied by herbivores. These are called primary consumers because they eat producers. The third trophic level is occupied by secondary consumers. These are carnivores which eat herbivores. The fourth trophic level is occupied by tertiary consumers. These are

carnivores which eat smaller carnivores. Some food chains have fifth trophic levels, usually occupied by large carnivores.

A trophic level is simply a feeding level represented in a food chain or food web.



Huh! Now I see. So the primary producers make up the bottom trophic level, followed by primary consumers, then secondary consumers and so on.

Why is Sunlight Important?

In the ecosystem there is energy, and this is what allows organisms to live. This energy mainly comes from the sun. Sunlight is the primary source of energy on earth. This energy drives food chains, food webs, and the life processes for all living things on Earth. The energy from the sun is absorbed by plants and used combined with water and carbon dioxide to make carbohydrates. As the plants are eaten by animals (consumers), the energy is transferred as well. In the same way, when plants and animals die and decompose, the energy in their carbohydrates is used by the decomposers. At all levels, the organisms use some of the energy for their own activities; once used, this energy is lost from the system as heat.

Flow of energy through food chains



Why are there only few food chains that have more than four trophic levels?

The answer lies with the fact that some energy is lost at each trophic level, and so cannot be passed on to the next, higher level. Let us look at our simple food chain again.

Hibiscus → Slug → Toad → Grass snake

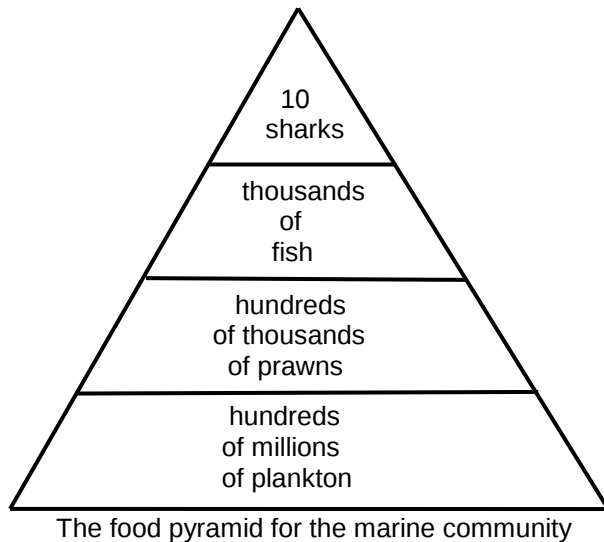
The hibiscus plant uses the sun's light energy to make its own food. But only a very small amount of the sun's energy that falls upon the hibiscus ends up in its food store. This food store is in the leaf which the slug eats. When a slug eats the hibiscus leaves only about one tenth of the energy in the plant becomes built up into the body of the slug. Some of that energy was lost as heat as the hibiscus respired. The slug does not eat the entire plant like its roots, leaves, flowers, seeds and all. It cannot digest all the plant material it eats. Some undigested material passes through its body and out as faeces. A slug, therefore, gets only a fraction of the energy from the hibiscus plant. The same things happen when a slug is eaten by a toad, and when a toad is eaten by a grass snake. In other words, at each step of the food chain a lot of energy is lost.

At each level of the food chain energy is lost because it is used by the organism itself for respiration.

Food pyramids

In the ocean you will find many more fish than sharks and in the bush there will be many more bandicoots and wallabies. In every ecosystem there are more herbivores than carnivores. Why is this?

Consider a community on the coast of Port Moresby. It contains a certain shark species, fish, prawns and **plankton**. Plankton are the tiny plants and animals which float in the oceans. How much food is needed to keep ten sharks alive?



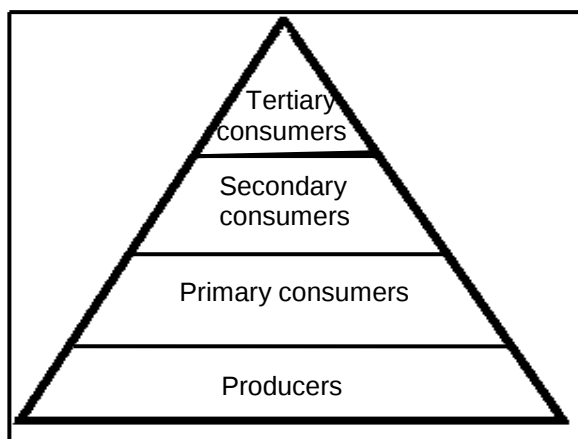
These sharks eat only fresh fish. *Ten sharks would eat thousands of fish.* What do the fish eat? They eat prawns. Each fish eats hundreds of prawns each week. *Thousands of fish would eat hundreds of thousands of prawns.* What do the prawns eat? The prawns eat floating water plants called plankton. Each prawn eats thousands of plankton in order to stay alive and grow. *Hundreds of thousands of prawns would eat hundreds of millions of plankton.* These hundreds of millions of plankton feed only ten sharks! These numbers are shown in a food pyramid.

The areas shown in the food pyramid represent the numbers, and the weight, of all the organisms at each level of the food chain. You need hundreds of millions of plankton, which weigh thousands of kilograms, to be the food for the hundreds of thousands of prawns, which weigh hundreds of kilograms. And so on, until at the top of the food chain there are just ten sharks.

The mass of all the living things in the environment is called the **biomass**. This is a shortened version of the words 'biological mass'. The biomass of the producers is always the largest, and the biomass of the herbivores is smaller. The biomass of the carnivores is even smaller.

Energy pyramids

An energy pyramid is a good way of describing the feeding and energy relationships within a food chain. It shows how the energy flows through a food chain. Each step in the pyramid shows that much of the energy is lost when one organism in the food chain eats another.



The picture on the left is an energy pyramid. Producer organisms represent the greatest amount of living tissue or biomass at the bottom of the pyramid. The organisms which occupy the rest of the pyramid belong to the feeding levels as shown. On average, each feeding level only contains 10% of the energy as the one below it, with the energy that is lost mostly being transformed to heat.

An energy pyramid shows how the amount of useful energy in the form of food that enters each level decreases, as it is used by the organisms in that level.

The third level consumers at the top of a food pyramid do not have much energy available to support them than those closer to the bottom. That is why their numbers are relatively few in most communities. Eventually, the amount of useful energy left will not be able to support another level. That is why energy flow is depicted in the shape of a pyramid. The energy that enters a community is ultimately lost to the living world as heat.

Energy is used up and lost as heat when it moves through ecosystems, and new energy is continually added to the earth in the form of solar radiation.

The Ten Percent (10%) Law

This rule applies as energy passes from one trophic level to another trophic level. The **Ten Percent Law** states that the total energy content of a trophic level in an ecosystem is only about one-tenth or 10 percent that of the preceding level.

Only a fraction of the energy available at one trophic level is transferred to the next trophic level.

The amount of energy available to one trophic level is limited by the amount stored by the level below. Because energy is lost when transferred from one level to the next, there is less total energy as you move up trophic levels. In general, higher trophic levels would have a less total biomass than those below, because less energy is available to them.



Activity: Now test yourself by doing this activity.

Answer all questions on the spaces provided.

1. What is a trophic level?

2. Which organisms occupy the first trophic level of any food chain?

3. What does an energy pyramid show?

4. what is the Ten Percent Law?

5. Why would you expect higher trophic levels to have less total biomass than those below?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 9.



Summary

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

- the position that an organism occupies on a food chain is called its trophic level.
- every organism needs energy to stay alive and this energy comes from the Sun.
- few food chains have more than four trophic levels because some energy is lost at each trophic level.
- the mass of all the living things in the environment is called the biomass.
- an energy pyramid shows how energy flows through a food chain.
- the Ten Percent Law states that only about 10 percent of the energy available at one trophic level is transferred to the next trophic level.

NOW DO PRACTICE EXERCISE 9 ON THE NEXT PAGE.



Practice Exercise 9

Write your answers on the space provided.

1. What is the name given to the position that an organism occupies on a food chain?

2. What is the source of energy that flows through an ecosystem?

3. Which trophic level has the most energy?

4. “Living things need energy in order to survive”.

a) How do plants obtain the energy they need in order to survive?

b) How do animals obtain the energy they need in order to survive?

5. In each of the following, which has the greater biomass?

a) Fish or sharks

b) Prawns or sharks

c) Carnivores or herbivores

d) Plants or animals

6. What happens to the energy as it flows from one trophic level to the next?

7. Explain why there are usually no more than four organisms in a food chain?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.
--

Answers to Activity

1. A trophic level is the position that an organism occupies on a food chain.
2. Green plants occupy the first trophic level of any food chain.
3. An energy pyramid shows how useful energy in the form of food that enters each level decreases as it is used by organisms in that level.
4. The Ten Percent Law states that the total energy content of a trophic level in an ecosystem is only about one-tenth or 10 percent that of the preceding level.

Lesson 10: The Carbon Cycle



Welcome to Lesson 10. In this lesson you will learn about how carbon is recycled in the atmosphere. The recycling of nutrients is one example of the interactions between living organisms and the abiotic environment in an ecosystem.



Your Aims:

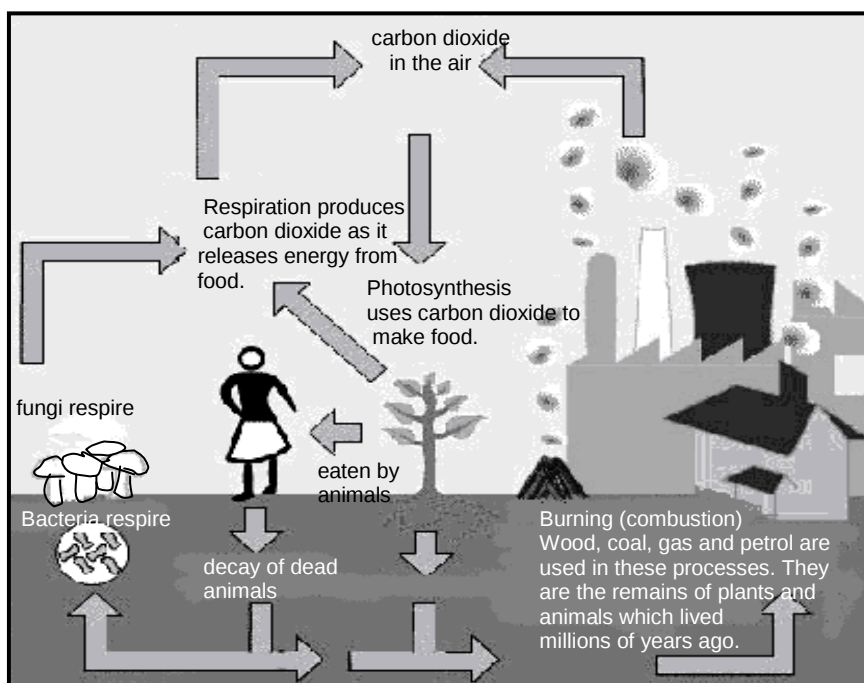
- describe the carbon cycle
- identify the processes involved in the carbon cycle
- explain how carbon is used in the body of plants and animals

Nutrient Recycling in Ecosystems

Nutrients are not usually resupplied to ecosystems. They must be used again and again by recycling. Essential elements that are recycled include carbon, nitrogen, oxygen and water. They are absorbed from the environment, used by living organisms and returned to the environment. Recycle means to use it over and over again.

The Carbon Cycle

The carbon cycle is an example of how an element is recycled continuously within the environment. Carbon moves from living things to the atmosphere. Carbon is found in all living things and is needed to make sugar and starch, which are both carbohydrates.



The carbon cycle

The basic cycle begins when green plants combine carbon dioxide from the atmosphere and hydrogen from the water that they get from the soil to make carbohydrates. Some of these carbohydrates are stored in the tissues of the plant. Others are used by the plant for energy. This releases carbon dioxide back into the atmosphere.

When a plant is eaten by a herbivore, its tissues are broken down by the cells in the animal's body during digestion. Carbon atoms in the carbohydrates, fats and proteins of plants are then transferred to the bodies of herbivores. This releases the stored carbon and other nutrients into the animal's system. Later these carbon atoms may be transferred again if the herbivores are eaten by carnivores or omnivores. As these animals respire some of the carbon atoms are released to the atmosphere as carbon dioxide.

Animals and plants get rid of carbon dioxide through respiration.



Hmm! So the carbon dioxide is released into the atmosphere so that the cycle can begin again.

Do you think that respiration is the only way that carbon dioxide is released into the atmosphere by plants and animals? The answer is, No. Carbon dioxide is also released when dead plants and animals are decomposed and when fossil fuels are burned.

Decay and decomposition

When plants and animals die their bodies are decomposed and absorbed as food by **saprophytes**. A saprophyte is an organism especially a fungus or bacterium that feeds on dead or decaying organic matter. Carbon atoms in this absorbed material are released to the atmosphere as the bacteria and fungi respire.

Combustion

Combustion occurs when any organic material is burned in the presence of oxygen to give off the products of carbon dioxide, nitrogen dioxide, sulphur dioxide, water and energy. The organic material can be any fossil fuel such as natural gas, wood, oil or coal.

Organic materials contain at least carbon and hydrogen and may include oxygen, nitrogen and sulphur.

Carbon moves from fossil fuels to the atmosphere when fuels are burned. Combustion or burning of materials that can be easily burned results in the release of carbon atoms as carbon dioxide. Combustion can form part of the carbon cycle in the following ways:

1. A tree absorbs carbon during photosynthesis. This carbon is used to build the woody tissue of the tree's trunk. When the tree is chopped down, left to dry and burned as fuel, then this carbon will be returned to the atmosphere.
2. Over millions of years, the bodies of dead organisms have produced fossil fuels such as coal, oil and natural gas. Some of these organisms were plants which took carbon from the air during photosynthesis, and some were animals which fed on the plants or on other animals. Therefore, when these fossil fuels are burned today, they release carbon atoms which were trapped by photosynthesis in plants that lived millions of years ago.

Recycling of chemicals by organisms is extremely important. If chemicals were not recycled, eventually there would be no nutrients available for organisms.

Do Humans have an impact on the carbon cycle?

Humans do have an impact on the carbon cycle. Do you think fossil fuels can burn themselves? No, they cannot. Humans have an impact on the carbon cycle during the combustion of any type of fossil fuel.

Fossil fuels were formed very long ago from plant or animal remains that were buried, compressed, and transformed into oil, coal, or natural gas. Because they are deeply buried, the carbon in them is locked out of the natural carbon cycle. Humans become involved by burning the fossil fuels as a source of energy. During combustion in the presence of air, that includes oxygen and carbon dioxide, water molecules are released into the atmosphere.

Substances in Plants and Animals that Contain Carbon

All living things contain organic molecules such as carbohydrates, fats, proteins and a complex acid.

Carbohydrates are the main energy source for the human body. Animals break down carbohydrates during the process of **metabolism** to release energy. Metabolism is the various processes in the body that convert food and other substances into energy. In simpler terms, we can say that metabolism is the amount of energy our body burns to maintain itself.

Fats are **lipids** that are used by living organisms for stored energy, meaning they store a lot of energy. They serve as a reserve energy supply to the organism. Lipids are organic compounds that contain the same elements as carbohydrates: carbon, hydrogen and oxygen. Lipids do not dissolve in water.

Proteins are amongst the most complex of all organic compounds. They are composed of **amino acids**, which contain carbon, hydrogen, oxygen and nitrogen atoms. Amino acids are the building blocks of proteins.



Activity: Now test yourself by doing this activity.

Part A. Word Scramble

Unscramble the following words. The answer pattern and clues are given.

Scrambled Words	Answer Pattern	Clues
1. brnoca	_____	This element is an essential component of proteins, lipids, carbohydrates, and nucleic acids
2. sehsioyntphtos	_____	Process by which producers absorb carbon dioxide from the air and convert it into glucose and oxygen

3. ietiprrnosa	-----	Process by which consumers take in carbon in the form of glucose and break down that glucose into energy and carbon dioxide
4. bxrcnaiodidoe	-----	Carbon containing gas taken in by plants during photosynthesis and released by consumers during cellular respiration
5. osisuslflef	-----	The carbon containing remains of once living organisms now changed into coal, oil, or natural gas.

Part B: Short Answers

Answer the following questions on the spaces provided.

1. Why do living organisms need carbon?

2. Explain how carbon atoms become part of a plant.

3. What happens to some of these carbon atoms when a plant respire?

4. Explain the role of decomposers in the carbon cycle.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 10.
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Summary

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

- carbon cycle is the recycling of the carbon element within the environment.
- the element carbon is important in the atmosphere because it is needed by all living things to make sugar and starch, which are both carbohydrates.
- carbon is absorbed from the atmosphere through the process of photosynthesis.
- carbon is released back into the atmosphere through the process of decomposition, burning and respiration.
- fossil fuels are formed from the organic remains of plants and animals that lived millions of years ago.
- combustion occurs when any organic material is burned in the presence of oxygen to give off the products of carbon dioxide, nitrogen dioxide, sulphur dioxide, water and energy.
- humans impact the environment when they burn fossil fuels and use them as a source of energy.
- all living things contain carbohydrates, fats, proteins and nucleic acids.

NOW DO PRACTICE EXERCISE 10 ON THE NEXT PAGE.
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Practice Exercise 10

Part A. True or False

Write true if the statement is correct and false if the statement is incorrect in the space provided.

1. The carbon cycle begins with photosynthesis in plants. _____
2. Plants are primary consumers of carbon dioxide. _____
3. Animals are primary consumers of carbon dioxide. _____
4. Humans are producers of carbon dioxide. _____
5. Humans and animals release carbon dioxide into the air during photosynthesis. _____
6. All of the carbon in existence is continually recycled in the carbon cycle. _____

Part B. Short Answers

Answer the following questions in the spaces provided.

1. Where can carbon be found in the environment?

2. Where do plants get the carbon they need for photosynthesis?

3. How do plants release carbon into the atmosphere?

4. Explain why recycling of carbon is important?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.

Answers to Activity**Part A. Word Scramble**

1. carbon 2. photosynthesis 3. respiration 4. carbon dioxide
 5. fossil fuels
-

Part B. Short Answers

1. Carbon is found in all living things and is needed to make sugar and starch which are both carbohydrates.
2. Carbon atoms become part of a plant when a plant combines carbon dioxide from the air and water to make carbohydrates.
3. Plants release carbon dioxide into the atmosphere through respiration.
4. Decomposers decompose the bodies of dead plants and animals and absorb it as food and in doing so the carbon atoms in the absorbed food are released into the atmosphere as the decomposers respire.

Lesson 11: The Nitrogen Cycle



Welcome to Lesson 11. In your last lesson you learnt that carbon cycle is the recycling of the carbon element within the environment. This lesson is about the nitrogen cycle. The nitrogen cycle describes how nitrogen is recycled in the atmosphere.



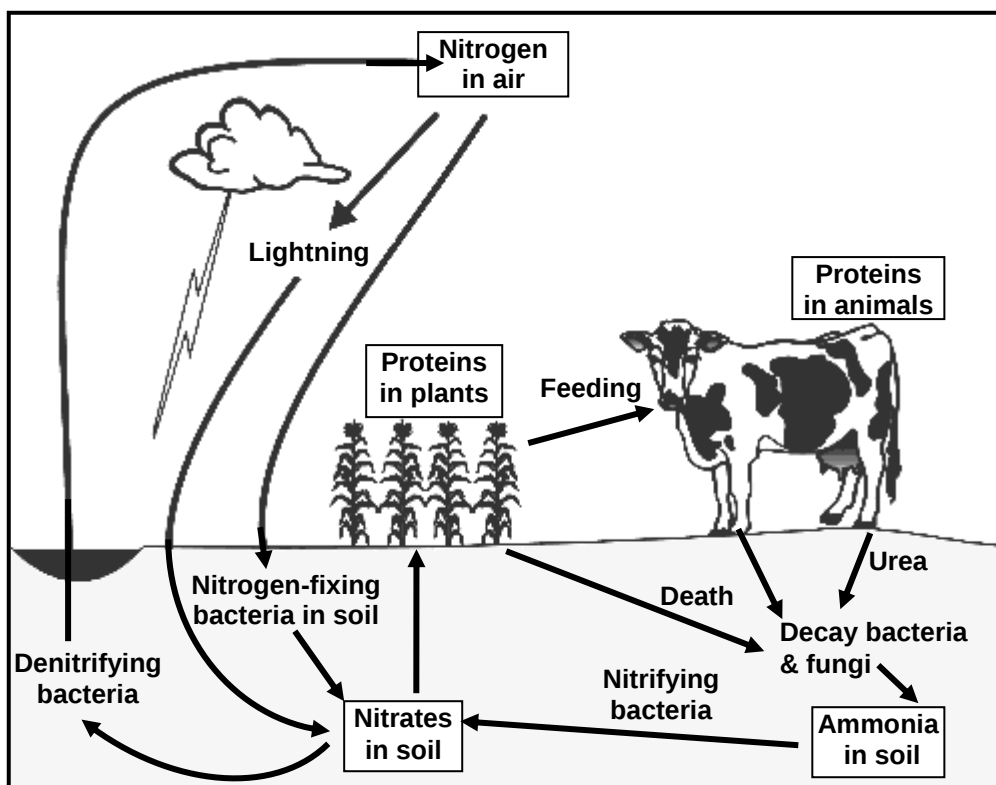
Your Aims:

- describe how the nitrogen cycle works
- identify the processes involved in the nitrogen cycle
- discuss the important roles of bacteria in the nitrogen cycle

The Nitrogen Cycle

All living things need nitrogen to make proteins. Protein is a compound that contains the element nitrogen and some of this protein is found in all plants and animals. Proteins are used for growth, repair and reproduction of new cells.

Nitrogen makes up 78% of the Earth's atmosphere, but plants and animals cannot take it directly from the air when it is in the gaseous form. It has to be changed into a chemical form before it can be used by plants and animals. This happens through the nitrogen cycle, in which gaseous nitrogen is converted to ammonia or nitrates. The process in which gaseous nitrogen is changed into ammonia (NH_3) or nitrates (NO_3^-) is called **nitrogen fixation**. Some fixation occurs in lightning strikes, but most fixations are done by free living bacteria. The diagram below shows how nitrogen is circulated and used by living things.



The Nitrogen Cycle

Atmospheric nitrogen must be processed or fixed to be used by plants

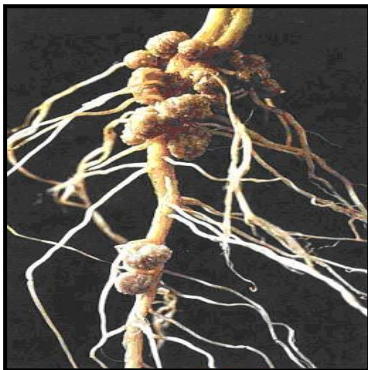
Lightning



Lightning during a thunderstorm

When there is heavy rain and thunderstorms you will see lightning. Lightning is formed inside thunderstorms. It makes the air so hot that nitrogen and oxygen gases combine forming nitrogen oxides. These dissolve in rain, and are washed into the soil, where they form nitrates. Only small amounts of nitrates form this way.

Nitrogen-fixing bacteria



Root nodules of a legume plant

Plants cannot make use of atmospheric nitrogen. However certain bacteria can absorb nitrogen and build it up into nitrates and protein. They are called **nitrogen- fixing bacteria** and they are a special group of nitrifying bacteria. These special bacteria use nitrogen gas from the air spaces in the soil and combine it with oxygen to produce nitrites which then is converted to nitrates which is taken up by plants. Some nitrogen fixing bacteria live freely in the soil. Others live in the roots of legume plants where they cause swellings called root nodules. Examples of legume plants are beans, peanuts, rain trees and leucena trees.

The nitrogen fixing bacteria in the roots give some of their nitrogen compounds to the host plant, while they in turn get protection. The relationship is therefore helpful to both organisms, and is an example of symbiosis.

Nitrogen bacteria

Once the nitrogen has been fixed, it can now be absorbed by the roots of plants, and used to make proteins. Animals eat the plants, so animals get their nitrogen in the form of proteins. So you see, the nitrogen then passes through the food chain from plants to herbivores to carnivores.

When an animal or plant dies, bacteria and fungi decompose the body. The protein in their body which contains nitrogen is broken down to ammonia and this is released. Another group of bacteria, called **nitrifying bacteria**, turn the ammonia into nitrates, which plants can use again.

Nitrogen is also returned to the soil when animals excrete nitrogenous waste material. It may be in the form of ammonia or urea. Again, nitrifying bacteria will convert it to nitrates.

Denitrifying bacteria

A third group of bacteria complete the nitrogen cycle. They are called **denitrifying bacteria**, because they undo the work done by nitrifying bacteria. They turn nitrates and ammonia in the soil into nitrogen gas, which goes into the atmosphere. Denitrifying bacteria live in wet and waterlogged soils so these soils are very short of nitrates. Plants living in these places manage with very little nitrogen.

Bacteria in the nitrogen cycle

Helpful	Unhelpful
Decay bacteria (decomposers) break down amino acids(from proteins) to ammonia	Denitrifying bacteria reduce nitrates to nitrites, ammonia or nitrogen
Nitrifying bacteria group 1 oxidise ammonia to nitrites	
Nitrifying bacteria group 2 oxidise nitrites to nitrates	
Nitrogen-fixing bacteria Build up nitrogen into nitrates and proteins	



Activity: Now test yourself by doing this activity.

Part A. Multiple Choice

Circle the letter of the correct answer.

1. Where are most nitrogen fixing bacteria found? In

- A. the soil
- B. the water
- C. clusters in the air
- D. wet and waterlogged soil

2. The breaking down of dead animals by fungi and bacteria releases _____.

- A. nitrates
- B. ammonia
- C. nitrogen
- D. protein

3. Plants can absorb nitrate or ammonium ions from the soil through their _____.

- A. stem
- B. roots
- C. petals
- D. leaves

4. The conversion of nitrogen gas to nitrates by bacteria is called _____.

- A. nitrification
- B. denitrification
- C. decomposition
- D. nitrogen fixation

5. Swellings in the roots of legume plants caused by nitrogen fixing bacteria is called _____.

- A. noodles B. needles C. nodules D. lumps
-

Part B. Short Answers

Write your answers on the spaces provided.

1. What is the percentage composition of nitrogen in the air? _____

2. Why is nitrogen important to living organisms?

3. In what form does each of the following obtain their nitrogen?

(i) A green plant

(ii) Nitrogen fixing bacteria

(iii) A mammal

4. Which group of bacteria undo the work done by nitrifying bacteria?

5. Explain how the bacteria you named above undo the work done by nitrifying bacteria?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 11.
--



Summary

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

- the nitrogen cycle is important to all living things because it maintains the supply of the element nitrogen.
- the composition of nitrogen in the Earth's atmosphere is 78%.
- all living things need nitrogen to make protein.
- organisms cannot get their nitrogen directly from the air. It has to be fixed before they can use it.
- nitrogen fixation refers to the process where gaseous nitrogen is changed into ammonia or nitrates.
- some fixation occurs in lightning strikes but most fixations are done by free living bacteria in the soil.
- plants get their nitrogen in the form of nitrates
- animals get their nitrogen by eating plants and other animals
- nitrifying bacteria use ammonia from decaying organisms to produce nitrates.
- nitrogen-fixing bacteria absorb nitrogen from the air to build into compounds such as nitrates and proteins.
- denitrifying bacteria undo the work of nitrifying bacteria by breaking down nitrates to nitrogen gas.

NOW DO PRACTICE EXERCISE 11 ON THE NEXT PAGE.



Practice Exercise 11

Short Answer Questions

Write your answers on the spaces provided.

1. Why do living things need nitrogen?

2. How do plants obtain nitrogen?

3. How do animals obtain nitrogen?

4. How are nitrates changed back into nitrogen?

5. Describe three ways in which nitrogen is changed into nitrates.

(i)

(ii)

(iii)

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 2.
--

Answers to the Activity**Part A. Multiple Choice**

1. (A) 2. (B) 3. (B) 4. (D) 5. (C)
-

Part B. Short Answers

1. 78%
2. Living organisms need nitrogen to make protein
3. (i) In the form of nitrates through their roots
(ii) Directly from the air
(iii) By eating a plant or another animal.
4. Denitrifying bacteria
5. They turn nitrates and ammonia in the soil into nitrogen gas, which goes into the atmosphere.

Answers to Practice Exercises 6 – 11

Practice Exercise 6

1.
 - i) Producers are green plants that can make their own food by the process of photosynthesis. During photosynthesis, green plants use light energy to change carbon dioxide and water into glucose and oxygen.
 - ii) Consumers are organisms that eat to obtain food needed for energy production. Consumers do not make their own food but they get their food from a different source.
 - iii) Decomposers break down dead materials into chemical parts. Without decomposers the world would be covered with dead plants and animals!
 2.
 - i. Ecological cycles refer to the recycling of carbon, water, nitrogen and other elements that support life.
 - ii. Decomposition is a chemical reaction where a complex compound is broken down into simpler compound.
 3.
 - A. Insectivores are carnivorous animals or insects that survive by eating almost nothing but small insects for food.
 - B. Scavengers are animals that eat dead animals.
 - C. Detritivores perform the same function as that of decomposers. They feed on dead plant and animal matter, but perform an additional function which is to return essential nutrients back to the ecosystem in the process.
 - D. Decomposers aid or assist in decomposition of already dead or dying organism. They break down dead plants and animals and animal wastes.
 4. You need to identify what it eats, where it lives, and how it interacts with the other organisms in the ecosystem.
-

Practice Exercise 7

1. Green plants make their own food in the process of photosynthesis where they combine carbon dioxide and water in the presence of sunlight to make a simple sugar called glucose (food).
2. Chlorophyll is the green substance that absorbs sunlight to enable the plant to make its own food.

3. Respiration is the process that takes place inside cells in which carbohydrate, particularly glucose, is broken down to release energy that the cell can use.

4. Word equation for photosynthesis.

Carbon dioxide + water + Light energy $\longrightarrow$ Glucose + Oxygen

5. Word equation for respiration.

Food + Oxygen $\longrightarrow$ Carbon dioxide + Water + energy

6. Respiration and photosynthesis are basically opposite processes.

Photosynthesis is the reverse of respiration. Photosynthesis uses the products of respiration, and respiration uses the products of photosynthesis.

7. When plants photosynthesize they produce oxygen that we breathe. Without plants and the process of photosynthesis, there would be no oxygen for us to breathe.

Practice Exercise 8

1. Each arrow points from the thing being eaten to the thing that is eating it or you can say that the arrows are drawn from food source to food consumers. In other words, you can substitute the arrows with the words “eaten by”.

2.

Hibiscus	$\longrightarrow$	Butterfly	$\longrightarrow$	Frog	$\longrightarrow$	Snake
Producers		Herbivore		First consumer		Second consumer

- 3.
- a) The herbivore is always called a first-order consumer. First order-consumers are also called primary consumers. Herbivores are animals that feed on plants. For example, grasshoppers and cows
 - b) Animals that eat meat (other animals). For example, dogs and hawks
 - c) Animals that eat both plants and animals. For example, man and pigs
 - d) Decomposers are organisms that break up dead material. Decomposers return minerals and nutrients to the soil. For example, fungi and bacteria
4. The energy gets lesser as it is transferred from one organism to the next.

Practice Exercise 9

1. Trophic level
 2. The Sun is the source of energy that flows through an ecosystem
 3. Green plants occupy the first trophic level of any food chain. It is the first trophic level therefore, plants have the most energy.
 4.
 - a) The energy from the sun is absorbed by plants and used combined with water and carbon dioxide to make food in the form of glucose.
 - b) As the plants are eaten by animals (consumers), the energy is transferred from the plants to them as well as to other animals in the food chain.
 5.
 - a) Fish
 - b) Prawns
 - c) Herbivores
 - d) Plants
 6. Energy is used up and lost as heat as it moves from one trophic level to the next.
 7. This is because some energy is lost at each trophic level, and less amount of energy is passed on to the next, higher level. The third level consumers at the top of a food pyramid do not have much energy available to support them than those closer to the bottom. That is why their numbers are relatively few in most communities. Eventually, the amount of useful energy left will not be able to support another level.
-

Practice Exercise 10**Part A**

1. True
2. True
3. False
4. True
5. False
6. True

Part B

1. Carbon is found in all living things and is needed to make sugar and starch, which are both carbohydrates.
2. Plants get the carbon from the carbon dioxide in the atmosphere.

3. Plants make carbohydrates and use it for energy. This releases carbon dioxide back into the atmosphere.
 4. Recycling of carbon is important because there are almost no resources on our planet which are in endless supply. Therefore, if chemicals like carbon were not recycled, eventually there would be no carbon available for organisms to make sugar and starch.
-

Practice Exercise 11

1. All living things need nitrogen to make proteins.
2. Plants get their nitrogen in the form of nitrates. They cannot get their nitrogen directly from the air. It has to be fixed before they can use it.
3. Animals get their nitrogen by eating plants and other animals
4. A group of bacteria called denitrifying bacteria turn nitrates and ammonia in the soil into nitrogen gas, which goes into the atmosphere.
5.
 - i. Nitrifying bacteria use ammonia from decaying organisms to produce nitrates.
 - ii. Nitrogen-fixing bacteria absorb nitrogen from the air to build into compounds such as nitrates and proteins.
 - iii. When there is lightning during heavy storms, it makes the air so hot that nitrogen and oxygen gases combine forming nitrogen oxides. These dissolve in rain, and are washed into the soil, where they form nitrates. Only small amounts of nitrates form this way.

REVIEW OF TOPIC 2: **How Ecosystems Work**

Now, revise all lessons in this Topic and then do **ASSIGNMENT 2**.
Here are the main points to help you revise.

Lesson 6: Roles of Organisms in Ecosystems

- The Sun is the main source of energy that supports life on Earth.
- Ecological cycles refer to the recycling of essential elements that support life on Earth.
- Green plants make their own food through photosynthesis and are called producers.
- Consumers are organisms that eat food to obtain their energy.
- Consumers are grouped according to the type of food they eat.

Lesson 7: Life Processes

- Photosynthesis is the process in which green plants combine carbon dioxide and water in the presence of sunlight to make their food.
- The food that is produced by plants is a carbohydrate called glucose.
- The by-product of photosynthesis is oxygen.
- Respiration is the process in which glucose is broken down to release energy.
- The by-products of respiration are water and carbon dioxide.

Lesson 8: Food Chains and Food Webs

- A food chain shows how a living thing gets its food.
- Producers make their own food through photosynthesis.
- Animals cannot make their own food so they must eat plants and/or other animals. They are called consumers.
- There are three groups of consumers and they are herbivores, carnivores and omnivores.
- Animals that eat only plants are called herbivores or primary consumers.
- Carnivores that eat herbivores are called secondary consumers.
- Carnivores that eat other carnivores are called tertiary consumers.
- Animals and people who eat BOTH animals and plants are called omnivores.
- Decomposers are fungi and bacteria which feed on decaying matter.
- A food web is made up of several interconnecting food chains.

Lesson 9: Energy Flow and Trophic Levels

- The position that an organism occupies on a food chain is called its trophic level.
- Every organism needs energy to stay alive and this energy comes from the Sun.
- Few food chains have more than four trophic levels because some energy is lost at each trophic level.
- The mass of all the living things in the environment is called the biomass. An energy pyramid shows how energy flows through a food chain.
- The Ten Percent Law states that only about 10 percent of the energy available at one trophic level is transferred to the next trophic level.

Lesson 10: The Carbon Cycle

- Carbon cycle is the recycling of the carbon element within the environment.
- Carbon is important in the atmosphere because it is needed by all living things to make sugar and starch.
- Carbon is absorbed from the atmosphere through the process of photosynthesis.
- Carbon is released back into the atmosphere through the process of decomposition, burning and respiration.
- Fossil fuels are formed from the organic remains of plants and animals that lived millions of years ago.
- Combustion occurs when any organic material is burned in the presence of oxygen to give off the products of carbon dioxide, nitrogen dioxide, sulphur dioxide, water and energy.
- Humans impact the environment when they burn fossil fuels and use them as a source of energy.
- All living things contain carbohydrates, fats, proteins and nucleic acids.

Lesson 11: The Nitrogen Cycle

- The nitrogen cycle is important to all living things because it maintains the supply of the element nitrogen.
- The composition of nitrogen in the Earth's atmosphere is 78%.
- All living things need nitrogen to make protein.
- Organisms cannot get their nitrogen directly from the air. It has to be fixed before they can use it.
- Nitrogen fixation refers to the process where gaseous nitrogen is changed into ammonia or nitrates.
- Some fixation occurs in lightning strikes but most fixations are done by free living bacteria in the soil.
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- Denitrifying bacteria undo the work of nitrifying bacteria by breaking down nitrates to nitrogen gas.

NOW DO TOPIC TEST 2 IN YOUR ASSIGNMENT 2.
--

TOPIC 3

ECOLOGICAL ISSUES

In this topic you will learn about:

- **pollution**
- **eutrophication**
- **mining and logging**
- **other threats to ecosystems**
- **endangered and endemic species**

INTRODUCTION TO TOPIC 3: ECOLOGICAL ISSUES

Problems of the environment are also problems of ecology. All sorts of pollution, deforestation, endangered animals are all ecological problems since ecology uses scientific approach or ways to find solutions to these problems.

When we study ecological issues, we will come to realise that our mission is to safeguard the Earth, its people, its plants and animals and the natural systems on which all life depends.



You should know all about ecological issues. Some of the questions you may be asking yourself now are:

- How can we reduce pollution to the environment?
- How can we ensure water is safe and plentiful?
- How can we mine and log natural resources in a sustainable way?
- How can we prevent destruction to our natural resources?
- How can we take good care of the natural environment?

In this topic, you will find the answers to these questions and all other questions relating to ecological issues.

Lesson 12: Pollution



Welcome to Lesson 12. Do you know that our planet is in danger? Our planet is the home of all living things but is suffering due to destruction from man-made activities. If this destruction continues, then our Earth will not be a nice place to live in.



Your Aims:

- define pollution and pollutants
- find out and discuss the major sources of pollution
- discuss how pollution can affect living things

What is Pollution?

Pollution is the contamination of the environment due to harmful substances released through irresponsible human activities. These harmful substances are called **pollutants**.

The main sources of pollution are the burning of fossil fuels, industrial waste, agricultural wastes and domestic wastes. Not all pollutants are man-made. For example, volcanic eruptions give out ash and other particles in the air that normally do not belong there.



Burning of fossil fuels



Water release of industrial waste



Domestic wastes of plastics, containers and tins



Agricultural wastes of carrots and potatoes

A substance is a pollutant when its presence harms living things.

Pollutants can spread through air, water and soil and through food chains. They are harmful to humans and other organisms in the environment.

Burning of Fossil Fuels

We burn fossil fuels to run our cars, to produce electricity and to fuel various industrial processes. Because these fuels were once living organisms, they contain the same elements which make up living things and these elements are carbon, hydrogen and oxygen, with lesser amounts of nitrogen, sulphur and other elements. When the fuels are burned in air, these elements combine with oxygen to form various air pollutants.

These air pollutants include carbon dioxide, carbon monoxide, sulphur dioxide, oxides of nitrogen, lead, hydrocarbons and smoke.



The air can contain substances that are unhealthy and this is called air pollution.

Common Air Pollutants

Carbon dioxide is formed when fuel is burnt sending a pollutant into the air and the carbon in them react with oxygen. Carbon dioxide is an essential part of the carbon cycle, but scientists are concerned that the increasing levels of carbon dioxide in the atmosphere may lead to global warming and major climate changes.

Sulphur dioxide is formed when coal or oil containing sulphur is burned in air. This gas dissolves in water in the air to form sulphuric acid which in turn can lead to 'acid rain'.

Nitrogen oxides are formed when fuels are burned at high temperatures in engines and furnaces. Nitrogen and oxygen in the air react to form nitrogen monoxide. When more oxygen is available, the nitrogen oxide changes to nitrogen dioxide which can also dissolve in water in the air to form acid rain.

Particulates are tiny particles of solids and liquids released into the air when fuels and other materials are not burned properly. They often remain suspended in the atmosphere and can travel large distances on air currents. Particulates include dust, smoke and ash.



Smoke Pollution

Smoke is an air pollutant which spreads widely and comes from the burning of fossil fuel. The smoke contains tiny carbon particles called **soot** which float through the air and settle on the surface of buildings and trees, turning them black. When the leaves are covered by soot, photosynthesis slows down because the chlorophyll cannot capture enough sunlight for the plant to photosynthesize.



Haze over a city

Haze is formed when smoke, dirt and particulate matter combine with water vapour in the atmosphere. When there is no wind, smoke may be trapped by wind to form **smog**.

Acid rain

The burning of fossil fuels releases large amounts of sulphur dioxide and oxides of nitrogen. Both sulphur dioxide and oxides of nitrogen combine with water vapour in the atmosphere to form sulphuric acid and nitric acid. They then fall to Earth as **acid rain**.

The effects of acid rain are listed below. Study these effects so that you know how they affect the environment.

- Acid rain causes the soil to become very acidic and unsuitable for the cultivation of crops.
- Acid rain causes the **leaching** of minerals such as potassium, calcium and magnesium. Leaching is the draining away of minerals from the soil when they are dissolved the rainwater. This affects the growth of crops.
- Photosynthetic tissues are destroyed. Plant leaves turn yellow and fall off. The roots are damaged and cannot absorb minerals and trees are sickly and stunted.
- Acid rain causes insoluble aluminium to build up in lakes and rivers. The concentration of aluminium eventually reaches a toxic level which can kill aquatic organisms such as fish and invertebrates.
- Increased acidity in aquatic ecosystems kills **phytoplankton** which changes the food chain. Phytoplankton are tiny, free floating aquatic plants. They form the beginning of the food chain for aquatic animals.
- Acid rain causes the release of heavy metals such as cadmium, lead and mercury from the soil into the food chain. This may also contaminate the supply of drinking water.
- Metal railings and bridges corrode.
- Limestone, stonework and marble monuments are eroded due to chemical weathering



Carved stone damaged by acid rain

As you can see from our list in the previous page, acid rain can have very bad effects on our environment, but we can reduce these effects in the ways below.

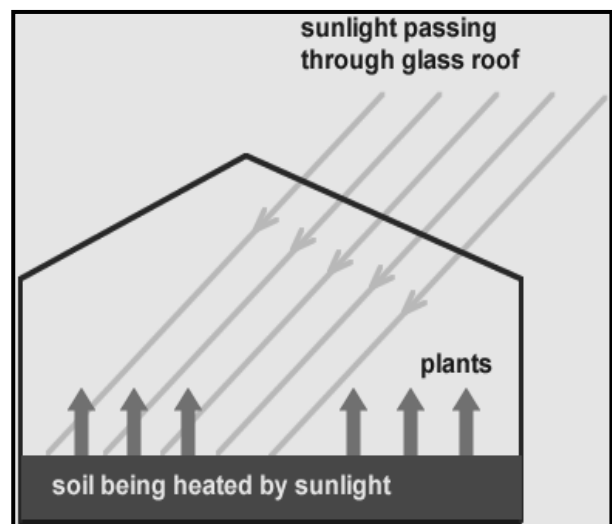
Ways to Reduce Acid Rain

1. Cleaning up the emission (production and discharge of gases) from power stations and industrial plants with **scrubbers**. A scrubber is an air-stream pollution control device which uses liquid spray to trap pollutants.
2. Cleaning up emissions from vehicle exhausts through the use of **catalytic converters**. A catalytic converter is a simple device that reduces the pollutants a car makes. The pollutants react with one another in the catalytic converters to produce less harmful products.

Global Warming

Global warming is caused by the greenhouse effect, which causes heat to be trapped by the earth's atmosphere. Before we look at the greenhouse effect, let us first look at what a greenhouse is.

A **greenhouse** is used by plant growers in cold climates who want to grow hot climate plants. Vegetables and plants grow in a greenhouse during winter. A greenhouse is designed to trap the heat of the sun or solar energy. Sunlight penetrates the glass roof of a greenhouse to warm the soil. However, the heat given off by the soil cannot pass through the glass, so it remains inside to warm the air. This means that the heat from the Sun is trapped inside the greenhouse and this keeps the plants warm throughout the winter.



A greenhouse is used to grow plants and vegetables during winter

The Greenhouse Effect

The Earth gets energy from the sun in the form of sunlight. The Earth's surface absorbs some of this energy and heats up. That is why the surface of a road can feel hot even after the sun has gone down—because it has absorbed a lot of energy from the sun. The Earth cools down by giving off a different form of energy, called **infrared radiation***. But before all this radiation can escape to outer space, greenhouse gases in the atmosphere absorb some of it, which makes the atmosphere warmer. As the atmosphere gets warmer, it makes the Earth's surface warmer, too.

Without the greenhouse gases in the atmosphere the temperature every night would drop to -100°C , and in the day would rise to $+80^{\circ}\text{C}$. The atmosphere is like a blanket, or like the air in a greenhouse.

The greenhouse gases in the atmosphere trap heat that would otherwise escape into space thereby, keeping the planet warm. These greenhouse gases include carbon dioxide, nitrogen dioxide, sulphur dioxide and water vapour.

If it were not for greenhouse gases trapping heat in the atmosphere, the Earth would be a very cold place. Greenhouse gases keep the Earth warm through a process called the **greenhouse effect**.

However, humans are changing the strength of the greenhouse effect by increasing the amount of greenhouse gases in the air. These gases stay in the atmosphere and absorb and hold the heat which should be radiated into space. As a result the atmosphere is warming and this is warming the land and the oceans.

The main greenhouse gas is carbon dioxide. As we already know, it is formed by the burning of fossil fuels such as coal, petrol, oil and gas. The amount of carbon dioxide in the atmosphere is steadily increasing due to the use of fossil fuels by our society. The main greenhouse gases are carbon dioxide, methane, chlorofluorocarbons (CFCs) and nitrous oxide.

Most of the greenhouse gases occur naturally except CFCs. However, all of them are the results of human activities. The human activities contributing to greenhouse gas production starting from the activity which causes the greatest effects are burning of fossil fuels, industrial processes, deforestation and agriculture. Scientists believe that these are the primary reasons for the increased concentrations of atmospheric carbon dioxide.

As the concentration of greenhouse gases rises, the greenhouse effect increases, trapping more heat in the atmosphere and raising the average temperature on Earth. This overall rise in the average temperature of the atmosphere is known as **global warming**. The increase in atmospheric temperature has been high enough to cause changes in the global climate.

Listed below are the effects of global warming.

(i) Occurrence of flood

As the average temperature rises, the polar ice caps and glaciers melt. This causes a rise in sea levels. A rise in sea levels causes low-lying areas to be flooded.

(ii) Climate changes

- Global warming leads to changes in wind direction and the distribution of rainfall. As a result, agricultural activities are affected.
- Global warming causes weather patterns to change. This affects the distribution of species in certain regions.

(iii) Occurrence of drought

Global warming increases the frequency of droughts. The land becomes dry and infertile. This leads to a drop in crop yields.

The greenhouse effect is a global problem. It affects every country in the world. If people and countries can reduce the amounts of greenhouse gases they release into the atmosphere then the greenhouse effect may not be so severe.

Solutions to Global Warming

1. Below are some of the ways that can be taken to reduce the greenhouse effect.

- (a) Reduce the burning of fossil fuels to conserve energy
- (b) Develop alternative sources of energy such as wind, solar and geothermal
- (c) Reduce deforestation for farming
- (d) Replant trees which have been cut down

2. International cooperation as well as individual action is needed to lessen the effects of global warming.
3. International treaties that bind countries to their commitment of limiting and reducing the amount of carbon dioxide as well as other greenhouse gases which are released into the atmosphere must be implemented.

Water Pollution

All the many different types of plants and animals that live in water can be damaged by pollution. Our health depends on clean water supplies. We use clean water every day for drinking, cooking, washing, flushing the toilet and so on; and the plants and animals around us also rely on clean water. But much of our water is polluted. Streams, rivers and the sea are polluted by industrial, domestic and agricultural wastes, untreated sewage and spilled oil. But the most easily-damaged aquatic environment is the still, slow-moving water of a lake.

Sewage contains body wastes, food scraps, detergents and grease. The **effluent** from sewage treatment plants flows into creeks, rivers and the ocean. Effluent refers to the liquid waste, especially from chemicals produced by factories or sewage. Industries also produce wastes, and in agricultural areas and farms pesticides and fertilizers can cause water pollution.



Waste water discharged from households

Biodegradable Wastes

Biodegradable waste is waste that can be broken down by micro-organisms in water. Examples are sewage, animal wastes, decaying plants and wastes from some industries like food and beverage processing industries. The micro-organisms degrade or break down the wastes and use up oxygen in the process. Serious oxygen depletion can occur in heavily polluted water and this can result in fish and other living things suffocating and dying.

Domestic wastes like detergents, wastes such as sewage and run-off from farms contain the nutrients nitrates and phosphates which can act as plant fertilizers. Algae and other aquatic plants feed on these nutrients and grow in large numbers. When these plants die bacteria decompose them, using up much of the oxygen in the water. Most living things die through lack of oxygen, and the water turns foul. The whole process is called **eutrophication** and will be discussed in the next lesson.

Non-biodegradable wastes

Wastes that do not break down or that do so very slowly are said to be **non-biodegradable**. Examples of non-biodegradable pollutants are:

- Some insecticides, example DDT (dichlorodiphenyltrichloroethane pronounced as *dy-chlo-ro dee-f-en-il-try-chlo-ro-e-th-ay-n*)
- Heavy metals such as lead, mercury and cadmium
- Salts such as sodium chloride

These chemicals are usually released into the environment in only small amounts, but many of them can build up in food chains.

Solutions to Water Pollution

- Control the use of fertilizers and use **biological pest control** methods in agriculture,
- Treat sewage before it enters rivers
- Prevent liquid manure from entering rivers and ponds
- Use biodegradable detergents with low phosphate content
- Take legal action against illegal dumping of toxic wastes



Activity: Now test yourself by doing this activity.

Part A. Multiple Choice

Circle the letter of the correct answer.

1. Which phenomenon occurs as a result of excessive sulphur dioxide and nitrogen dioxide in the atmosphere?

- | | |
|-------------------|--------------------|
| A. Acid rain | B. Eutrophication |
| C. Global warming | D. Ozone depletion |

-
2. Which of the following is the main greenhouse gas?

- | | |
|-------------------|-----------------------|
| A. Ozone | B. Oxygen |
| C. Carbon dioxide | D. Chlorofluorocarbon |

-
3. Which of the following is a non-biodegradable waste?

- | | |
|-------------------|------------------|
| A. Fruit skins | B. Newspaper |
| C. Left-over food | D. Aluminium can |

4. The pollutants insecticides, phosphates and nitrates were found in an ecosystem.

What is the type of pollution in the ecosystem?

- A. Air pollution
B. Noise pollution
C. Water pollution
D. Thermal pollution
-

5. Which of the following causes eutrophication?

- A. Herbicide
B. Fertiliser
C. Insecticide
D. Carbon dioxide
-

Part B. Matching Type

Write the letter of the definition in column B that best matches the term in column A on the spaces provided for.

Column A	Column B
_____ 1. Pollutants	A. Tiny carbon particles that are found in smoke and they can float through the air and settle on the surface of buildings and trees, turning them black.
_____ 2. Particulates	B. An increase in gases such as carbon dioxide which prevents heat escaping from the Earth and makes the Earth slightly warmer.
_____ 3. Soot	C. A substance whose presence in the environment in large amounts can harm living things.
_____ 4. Global warming	D. Tiny particles of solids and liquids released into the air when fuels and other materials are not burned properly.
_____ 5. Greenhouse effect	E. The overall rise in the average temperature of the atmosphere.



Summary

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

- pollution can be defined as any undesirable change in the physical, chemical or biological characteristics of the natural environment.
- a substance is a pollutant when its presence harms living things.
- the main sources of pollution are the burning of fossil fuels, industrial waste, pesticides, insecticides, fertilizers and biological waste.
- burning of fossil fuels leads to the greenhouse effect, global warming and air pollution.
- air pollution consists of gases, liquids and solids present in the atmosphere in high enough levels to harm living things.
- water pollution can involve a wide range of contaminants from domestic to industrial, to agricultural in origin.
- wastes can be biodegradable or non-biodegradable.

NOW DO PRACTICE EXERCISE 12 ON THE NEXT PAGE.



Practice Exercise 12

Answer the following questions.

1. What elements are fuels composed of?

 2. What happens to fuels when they are burned in air?

 3. How is carbon dioxide formed as an air pollutant?

 4. Sulphur dioxide is a dangerous air pollutant. How is it formed?

 5. Which greenhouse gas does not occur naturally? Write down its full name.

 6. What effects can the increasing levels of carbon dioxide have on Earth?

 7. Explain how acid rain is formed?

-

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.

Answers to Activity

Part A. Multiple Choice

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

Part B. Matching

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

Lesson 13: Eutrophication



Welcome to Lesson 13. In your previous lesson you learnt that the environment is being polluted by irresponsible human activities like burning and dumping of domestic, industrial and agricultural wastes. In this lesson, you will learn about eutrophication.



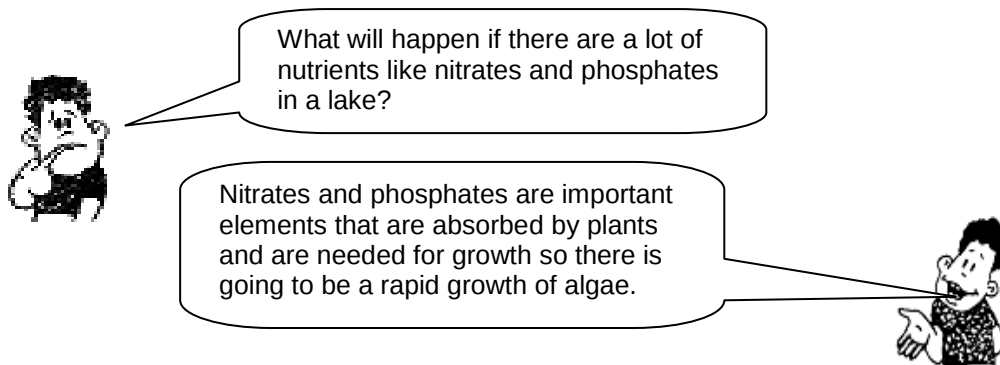
Your Aims:

- define eutrophication
- discuss the processes of eutrophication
- describe the effects of eutrophication on aquatic habitats

What is Eutrophication?

Eutrophication originates from a Greek word meaning “nutrients are sufficiently supplied” or “good food”. Eutrophication is a natural process and occurs when nutrients are sufficiently supplied to streams and lakes. It is mainly caused by an increase in nitrate and phosphate levels in lakes and the lakes become ‘over fertilized’. This can also have a negative influence on water life.

Let us see how it happens.



When there is an increase in nitrate and phosphate levels, water plants such as algae will grow rapidly. This process is known as eutrophication.

Natural and Artificial Processes of Eutrophication

Natural eutrophication occurs in an aging lake or pond. When lakes gradually age or get older they become more productive and get to have a lot of nutrients, like nitrogen and phosphorus. This process happens naturally over a long period of time. It normally takes thousands of years for that body of water to gradually build up its concentration of plant nutrients.

Eutrophication naturally appears, but if the amount of the nutrients that flow into lakes and ponds by human activities goes up, eutrophication will happen fast and this is known as artificial eutrophication. Artificial eutrophication is water pollution caused by excessive plant nutrients and happens for a very short time unlike natural eutrophication

Artificial eutrophication is the process when human activities are involved in introducing increased amounts of nitrates and phosphates into lakes and ponds, which speed up plant growth and eventually depletes oxygen content leading to the death of all its animal life.

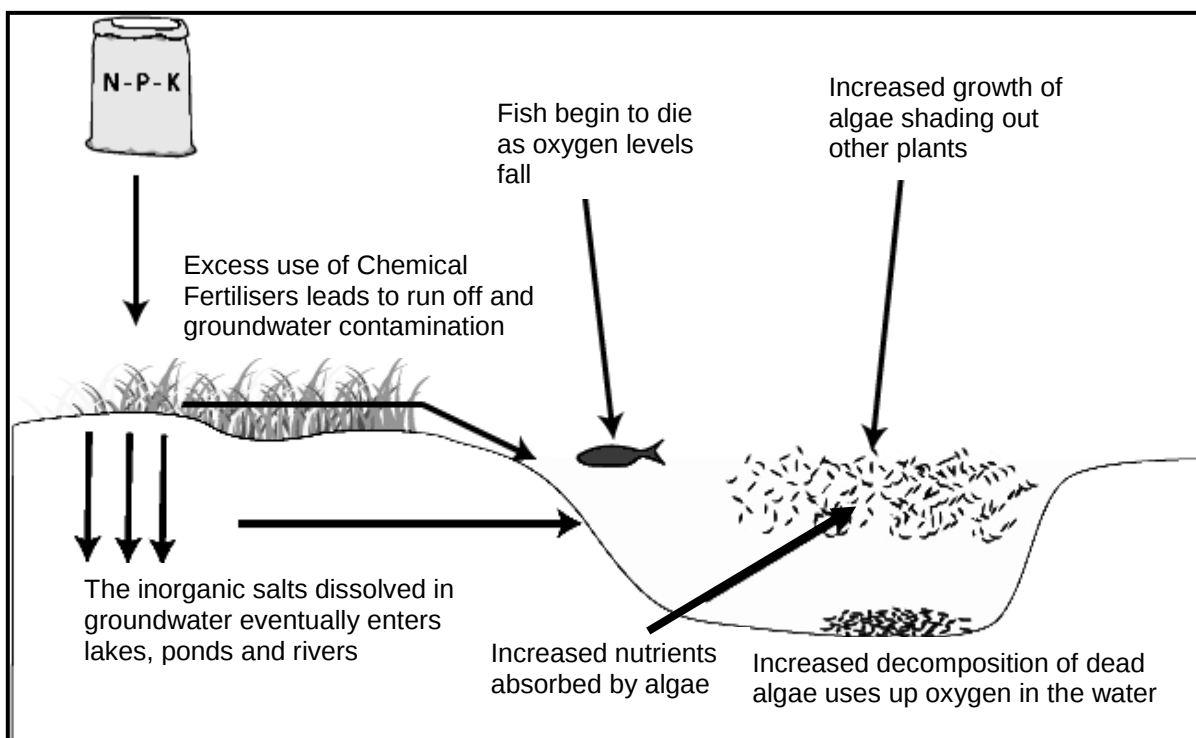
Artificial or human-caused eutrophication has become so common that the word eutrophication by itself has come to mean a very harmful increase and acceleration of nutrients. It is as if something receives too much fertilizer or has too much of what is a good thing.

What Causes Eutrophication And What Are The Dangers?

Most human activities have always resulted in the creation of waste, and many of these waste products often contain nitrates and phosphates. Both nitrates and phosphates are absorbed by plants for growth.

However, the human use of detergents and chemical fertilizers has increased the amount of nitrates and phosphates washed into our lakes and ponds. When this occurs in a sufficient quantity, they act like fertilizers and encourage the rapid growth of photosynthesising organisms, especially algae. This results in a population explosion known as an **algal bloom**.

Algae are a group of plant-like organisms that live in water and make their own food through photosynthesis. Fertilizers contain phosphates and nitrates and when they are drained into a body of water, the algae begins to multiply rapidly, making the colour of the water to turn green or brown. In the process, the algae consume greater amounts of oxygen in the water, robbing fish and other species of necessary dissolved oxygen.



The Process of Eutrophication

One of the negative effects of eutrophication and increased algal growth is a loss of available dissolved oxygen.

This loss of oxygen can kill fish and other aquatic organisms such as amphibians.

How does eutrophication actually lower oxygen levels when it is a common knowledge that algae produce oxygen?



It is true algae produce oxygen, but only when there is enough light. This is what happens. When there is eutrophication which is the excessive growth of algae, light is prevented from penetrating into the water. In eutrophic lakes where algae are plentiful, competition for light is also very high. As a result, the photosynthesis of algae and other aquatic plants are greatly reduced and they stop producing oxygen and in turn begin consuming oxygen.

The algae also grow faster than their consumers to very large amounts. Most of these algae will eventually die without being consumed. As the algae and other aquatic plants die and fall to the bottom of the lake, decomposing microorganisms, especially bacteria require oxygen to decompose the dead algae. The bacteria grow rapidly and use up oxygen in the waters at a faster rate. The bacteria use up oxygen faster than it can be replenished. As levels of oxygen in the body of water become lower, life in the water will also become impossible for species such as fish and other organisms and they will suffocate to death.

Eutrophication can quickly remove much of the oxygen from a lake, leading to an underwater environment without oxygen.

As we have learnt from our lesson, all the algae will die. As the plants die and turn to sediments that sink, the lake bottom builds up. The waters grow shallower and finally the body of water disappears. This also can happen to wetlands, which are already shallow. Eventually, there are shrubs growing where a body of water used to be.

Dad! I remember you once told me that where our garden is, used to be a pond where you and grand dad used to fish when you were small like me.



That's right, my son. That was a long time ago. Now the pond has dried up and the fish have all died and we have our garden there now instead of a pond.

The causes of eutrophication

The main causes of eutrophication are listed below:

- natural run-off of nutrients from the soil and the weathering of rocks,
- run-off of inorganic fertiliser which contains nitrates and phosphates,
- run-off of manure from farms which contains nitrates, phosphates and ammonia,
- run-off from erosion following mining, construction work or poor land use,
- discharge of detergents containing phosphates and
- discharge of partially treated or untreated sewage containing nitrates and phosphates.

Essentially, the entire aquatic ecosystem changes with eutrophication.

It takes several years to recover the loss by eutrophication because rotten organic matters discharge nutrients to water again so the eutrophication status does not change. In order to prevent eutrophication of lakes and marshes, the inflow of nitrogen and phosphorous should be reduced.



Summary

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

- eutrophication is the increase in the nitrate and phosphate levels of an aquatic ecosystem which results in the excessive growth of aquatic plants such as algae.
 - there are two types of eutrophication, the natural and artificial.
 - eutrophication leads to a loss of available oxygen from a lake leading to an underwater environment without oxygen.
 - the main causes of eutrophication are
 - the overuse of fertilizers,
 - run-offs from nutrients from the soil and weathering of rocks,
 - run-offs of manure from farms,
 - run-offs from erosion and
 - discharge of detergents and partially treated or untreated sewage.
-

NOW DO PRACTICE EXERCISE 13 ON THE NEXT PAGE.
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Practice Exercise 13

Answer the following questions.

1. What is eutrophication?

2. What are the two types of eutrophication?

3. When does natural eutrophication occur?

4. How fast does natural eutrophication occur compared to artificial eutrophication?

5. What is the main negative effect of eutrophication and an increased algal growth?

6. What happens to life in the water as levels of oxygen become lower?

7. How can we prevent eutrophication?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.
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Lesson 14: Mining and logging



Welcome to Lesson 14. In your previous lesson you learnt about eutrophication and its main causes. In this lesson, you will learn about mining and logging and their effects on the environment.



Your Aims:

- define mining and logging
- explain reasons why trees are harvested and minerals are extracted
- discuss the effects of mining and logging on the natural environment
- suggest ways on how lands can be logged and mined sustainably

What is Mining?

Mining is a process of obtaining or extracting minerals from the earth's crust.

A **mineral** is any naturally occurring substance or compound or chemical element from which valuable metals are obtained. Minerals are most often mined in the form of ore. An **ore** is a mineral or combination of minerals from which a useful metal such as gold, copper and iron can be extracted and marketed at a price that will recover the costs of mining and make a profit.



A mine site

Mining has played a very important part in the development of Papua New Guinea and other developed and developing countries. Providing metals of useful properties, creating many jobs and brings income which help maintained high living standards are advantages of mining. Disadvantages are loss of wildlife habitat, polluting of different water systems and the atmosphere.

One of the major pollutants released during the extraction of metals from their ore is sulphur dioxide gas which is the main producer of **acid rain**. Acid rain is produced when sulphur dioxide reacts with moisture in the air to produce acid called sulphurous acid. When rain falls it carries the acid with it called acid rain. Acid rain collects in streams, rivers and lakes, causing harm to animals and plants. It can also damage buildings, bridges, statues and other structures.

After the extraction process the minerals are treated and pure metals are obtained for marketing to make a profit. The main stages in extracting pure metals from their mineral ores include:

1. **Mining** - the ore is dug out from the ground;
2. **Concentrating** - involves physically separating valuable minerals from the waste rock
3. **Smelting** - the metal is removed from its compound by chemical reaction and
4. **Refining** – the process of purifying the metal.

The table below shows some important minerals and the metals that can be obtained or extracted from them.

Mineral	Formula	Metal obtained	Formula
Bauxite	Al_2O_3	Aluminium	Al
Chalcopyrite	CuFeS_2	Copper	Cu
Haematite	Fe_2O_3	Iron	Fe
Cinnabar	HgS	Mercury	Hg
Rock salt	NaCl	Sodium	Na
Galena	PbS	Lead	Pb
Calamine	ZnCO_3	Zinc	Zn

And this table shows some of the minerals found in PNG and the metals which are extracted from them.

Mineral	Formula	Metal obtained	Formula
Gold	Au	Gold	Au
Chalcopyrite	CuFeS_2	Copper	Cu
Gibbsite	$\text{Al}(\text{OH})_3$	Aluminium	Al
Silver	Ag	Silver	Ag
Niccolite	NiAs	Nickel	Ni
Linnaerite	CO_3S_4	Cobalt	Co

Major mines in Papua New Guinea

1. OK Tedi – Tabubil, Western province
2. Porgera – Wabag, Enga province
3. Lihir – Kavieng, New Ireland province
4. Hidden Valley – Bulolo, Morobe province
5. Yandra – Bundi, Madang province

Mining and the environment

Mining is a major human activity which can upset the ecosystem of a forest, lake, river or sea and can harm animals and plant life.

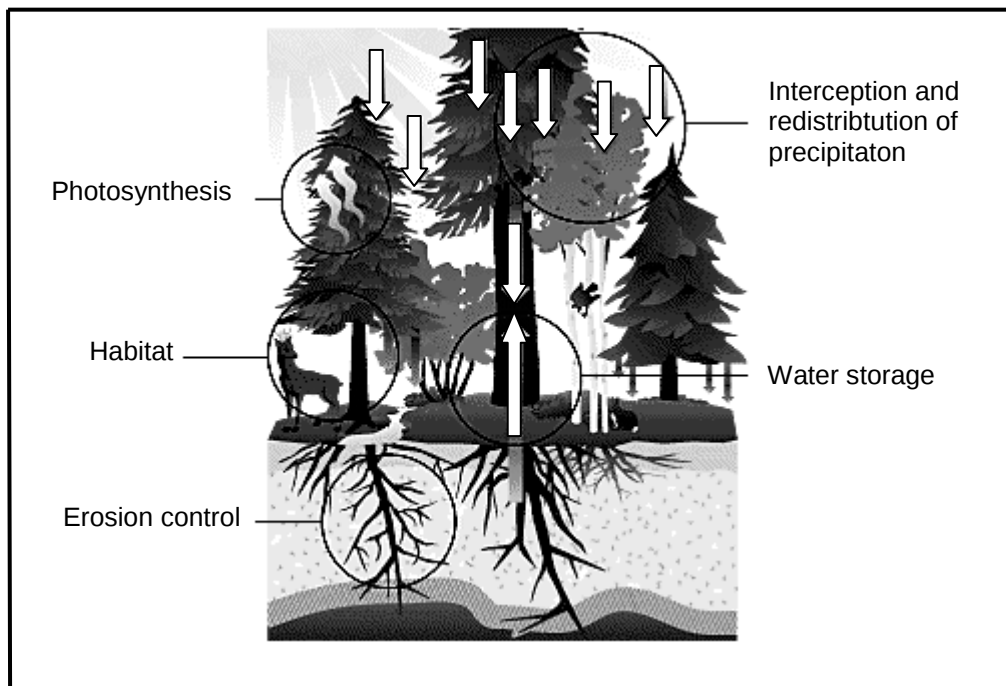
Mining can affect the environment in four main ways and they are:

1. soil erosion and loss of vegetation in the area which is cleared for mining.
2. loss of different organism species and their habitats or homes.
3. polluting rivers, lakes and seas from the tailings and waste rocks produced.
4. pollution occurs due to chemicals that are used during the extraction process and released into the environment through the tailings – solid waste products of metal extraction.

The importance of forests

Forests provide habitat (home) for many different plants and animals and perform many other important functions that affect humans. Forests remove carbon dioxide from the atmosphere and supply the world with oxygen for breathing through photosynthesis. Forests also provide food and shelter for wildlife.

Forests also increase the ability of the land to store water. The forest floor can hold as much as five times its weight in water and a tree contains water in its roots, trunk, stems, and leaves. Forests have many important roles.



Some roles of the rainforest

Because of all this stored moisture, forests help to maintain an even flow of water in rivers and streams. The roots of the trees and other vegetation hold the soil in place and preventing soil erosion from rain and wind.

What is Logging?

The job of cutting (felling), trimming and transporting trees to a saw mill is called **logging**.



Selective logging in a forest area



Example of clear-cutting in a certain area

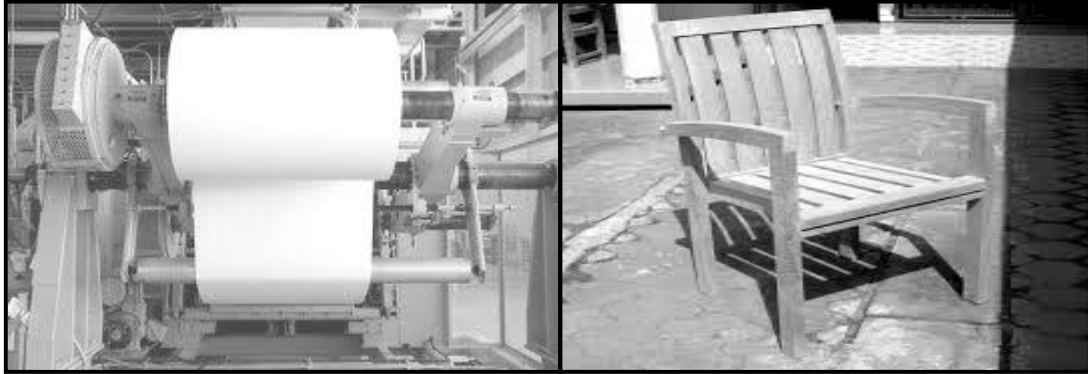
There are two main techniques used in forestry harvesting. **Clear-cutting** is a forestry harvesting technique in which all the trees in a given area are removed. The disadvantages of this technique include the removal of old growth forest and animal habitat (home) and soil erosion.

In an effort to conserve forest resources, the timber industry is modifying clear-cutting techniques to include the complete use of all harvested trees and the replanting of clear-cut areas.

The second technique is called **selective logging**. Selective logging involves cutting of only selected trees.

Why Man Harvest Trees and Extract Mineral Resources

Mineral resources are mined to extract metals that we cannot seem to live without and also create wealth and maintain high living standard. Trees are harvested for timber and plywood for building and furniture. Trees are also harvested for the manufacturing of papers and other paper products.



Trees are harvested for the manufacturing of paper and for making furniture

Logging and the environment

- Destroying forests reduce the number of plants which can take in carbon dioxide and make oxygen for breathing.
- Cutting trees for timber adds to global warming by putting more carbon dioxide into the atmosphere.
- Removing trees exposes soil which is then lost by erosion. Lack of vegetation also affects the amount of water vapour in the air.

Suggested ways on how land can be logged and mined sustainably.

1. Before mining on a new site begins, seeds of the natural vegetation should be collected so that seedlings may be cultivated at a later stage. The seedlings can be grown in special nurseries until they are mature enough to return to the mine site.
2. During open- cut mining, the over burden (the material removed from the site to expose the mineral ore) should be used to fill the holes left from earlier stages of the mining operation. Fresh top soil can be used to cover the over burden so that new vegetation will grow.
3. The soil surface can be shaped to fit in with the surroundings, fertilized and sown with seeds or planted with seedlings. Care will be taken to provide contours that will prevent the newly sown soil from being eroded or washed away by rain or wind.
4. Forests should be selectively logged so that only certain kinds and sizes of trees are cut down. Young trees should not be felled or cut but left to grow so that they can be harvested in the future. This is called **selective logging**.
5. Instead of leaving the natural young trees to grow, an area can be replanted with nursery- grown trees.

Clear felling or clear cutting should not be practiced to avoid soil erosion and making regeneration very difficult.



Summary

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

- mining is the process of extracting or obtaining minerals from the earth's crust.
- minerals are compounds which occur naturally within the earth's crust.
- ore minerals are minerals from which useful metals can be extracted profitably. Metals are very important because of their many useful properties.
- destruction of wildlife habitat, pollution of rivers, lakes, seas and air are environmental problems associated with all types of mining.
- logging is the cutting, trimming and transporting of trees to a saw mill.
- forests are being cut down faster than they are regrowing.
- forests should be selectively logged so that only certain kinds and sizes of trees are cut down.
- clear-felling occurs when all the trees are cut down. This results in soil erosion and makes regeneration difficult.

NOW DO PRACTICE EXERCISE 14 ON THE NEXT PAGE.



Practice Exercise 14

Answer the following questions.

1. Name four important minerals and their metals mined in Papua New Guinea.

2. Explain the difference between clear-felling or clear cutting and selective logging.

3. What effects will the mining of mineral resources have on the natural environment?

4. What effects will the logging of a forest have on the natural environment?

5. List down three reasons why trees are logged.

(i)

(ii)

(iii)

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.
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Lesson 15: Other Threats to Ecosystems



Welcome to Lesson 15. In lesson 12, you learnt that some pollutants are non-biodegradable. These chemicals are usually released into the environment in only small amounts, but many of them can build up in food chains. In this lesson, you will learn more on how this occurs in the ecosystem



Your Aims:

- define biological magnification
- describe the effects of population explosion on the environment
- describe how the introduction of new species can affect our local flora and fauna

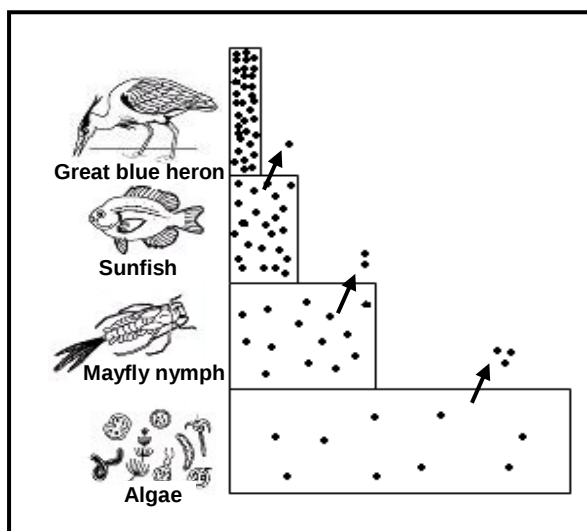
Chemical pesticides

A **pesticide** is a chemical that is used to kill a pest, a weed or a disease. Types of pesticides include *insecticides* to kill insects, *herbicides* to kill weeds and *fungicides* to kill fungi.

People use pesticides for their benefit by killing other living things. Pests are killed so that crops can better survive. This activity affects the stability of communities. Unfortunately, the pest is not the only living thing that is affected by the pesticide. For example, pesticides can be passed along food chains, and insecticides can kill useful insects as well as insects that are pests.

Biomagnification

Some of these chemicals that are taken in from the environment by plants, or consumed by animals, are not soluble in water and cannot be excreted easily by the body. They accumulate or build up in the body by the organisms, sometimes up to toxic levels. The more organisms there are in a food chain, the greater is the accumulation in the higher order consumers. Such chemicals include the pesticide DDT, and heavy metals such as mercury.



The build-up of the concentration of DDT in the body of organisms through a food chain

As one organism is eaten by another in a food chain, the chemicals also accumulate in the bodies of organisms through that food chain as shown in the diagram. These chemicals build up in the fatty tissues of organisms. Organisms at lower trophic levels accumulate small amounts. Organisms at the next higher level eat many of these lower-level organisms and hence accumulate larger amounts. At the highest trophic levels the increased concentrations in tissues may become toxic. This build-up of the concentration of a chemical through a food chain is called **biomagnification** or **bioaccumulation**.

Biomagnification is the increase in concentration of a pollutant from one link in a food chain to another

Biomagnification is also known as bioamplification or biological magnification. We will be using the word biomagnification in our lesson.

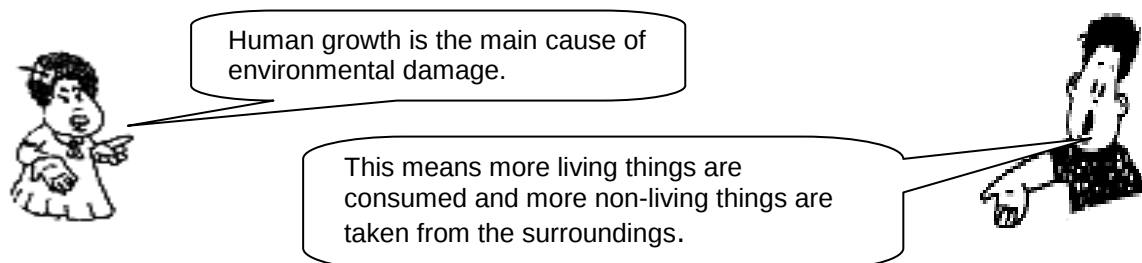
Here is another example of biomagnification. Suppose that a crop in a farm is sprayed with a non-biodegradable insecticide. One insect might eat ten plants a day. Then at night one frog might eat ten of these insects. The next day one kookaburra might eat ten frogs. So the kookaburra has effectively eaten all the insecticides on 1000 plants.

Effects of Population Explosion on the Ecosystem

Thousands of years ago human beings lived a simple life. Their basic needs for food, shelter and clothing were supplied from their surroundings. They hunted wild animals and gathered useful plants. They also used non-living things such as rocks, fire and water. At this time the human population was small and because of the way people lived they did not have a serious effect on other living things or on the surroundings.

Then about ten thousand years ago agriculture was introduced and people became no longer just hunters and gatherers. The beginning of agriculture meant that people began to have a greater effect on the environment

Today most people in the world live a different way of life. People have developed agriculture, mining and industry to meet the needs of a large population.



Look at the cartoons.

The front page of the woman's paper says that the world population would be 6 billion by 2000. Try to answer these questions yourself.

- What do you think is the world population by now?
- Do you think the world leaders are doing anything about population control?
- What are our leaders in this country doing about population control?
- As a student who knows about the effects of population explosion, what would you do about population control?

Increased population growth means more demands on the Earth's limited resources of energy, food, water and living space.



More people mean more pollution, waste, destruction of the environment, and decreased biodiversity

The activities of modern societies also produce wastes that damage living things and pollute the surroundings. People have always had an effect on the environment. However, because the human population is growing so rapidly the activities of humans are having a large effect on the environment. Many of these effects are destructive and destroy ecosystems.

One of the largest environmental effects of human population growth is the problem of global warming which we have already looked at in Lesson 12. The burning of fossil fuels to support human life is increasing the emission of greenhouse gases into the atmosphere, leading to rising global temperatures.

Of all the species on earth, humans have the greatest ability to change the environment. This ability can be used in a responsible manner with consideration for the environment and the organisms that share the biosphere, or it can be used irresponsibly.

Effects of habitat destruction

Habitat destruction is the process by which natural habitat is damaged or destroyed to such an extent that it is no longer capable of supporting the species and ecological communities that naturally occur there. It often results in the extinction of species and the loss of **biodiversity**. Biodiversity means a variety of living things and other plants and animals in a particular area or region.

The causes of habitat destruction are many. Habitats can be destroyed directly by human activities, pollution and or by natural causes.

The human activity that destroys habitat mostly involves the clearing of land for other uses such as agriculture, mining, logging, building highways and hydroelectric dams and urbanization.



Clearing land for logging destroys habitats



Habitat destruction caused by the Bougainville mine

Habitat can also be destroyed by pollution. When chemicals enter the water supply or soil, they destroy food and water for wild animals or wildlife. Smoke, smog and acid rain are harmful on the vegetation that provides food and cover for wildlife



Baruni dump outside Port Moresby

Landfills introduce unnatural substances into the soil and habitat, thereby reducing the natural effects for plants and animals to live. A landfill is a carefully constructed space on the ground where waste materials are disposed of by burial. It is also known as a tip, dump or rubbish dump.

Habitat is also destroyed by natural causes, such as lightning strikes, bushfires, floods, volcanic eruptions, hurricanes, earthquakes and climate changes.



A habitat being destroyed by fire



Habitat destroyed by mudslide in the Tumbi Valley of Southern Highlands

Some areas of Papua New Guinea have been cleared for agriculture, logging and mining. This has had disastrous effects on the communities that existed there. The populations of many native animals have decreased. Many herbivores cannot survive without the native plants on which they feed. This has also meant a decline in the carnivores that eat the herbivores.

Animals, such as bandicoot, wallaby, cassowary, birds of paradise, and many others, have declined in numbers during the period of agricultural development. However, some have increased in numbers because of the increased food supply. Rhinoceros beetles and rats are animals that have both increased in numbers.

The problems of habitat destruction can be reduced by:

1. careful management of the habitat by controlling agricultural, logging and mining activities; and
2. careful use of fertilisers and pesticides. For example, not using pesticides that kill enemies of pests.

The activities of humans are having an increasingly large effect on the environment. These activities or actions arise from the need to provide resources for the growing human population and from the pursuit of economic development.

The natural bush land is home to hundreds of different plants and animals. When we clear land for agricultural, mining or industrial activities, we destroy habitats.

We destroy habitats for our own use. The destruction of habitats is the price we must pay if we are to feed, clothe, and find homes for an ever-increasing population.

Effects of Introduction of New Species

One of the main causes of biodiversity loss in many aquatic ecosystems is the introduction of **exotic species**.

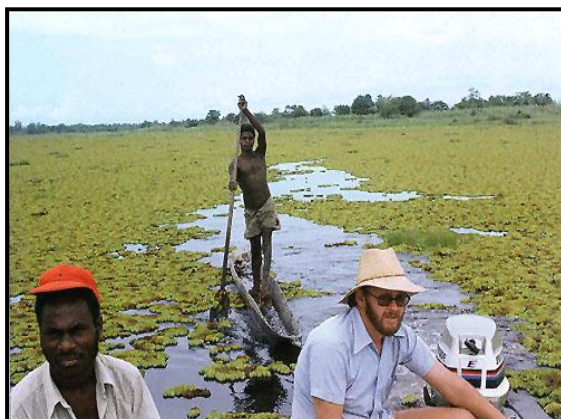
Communities are stable and not easily disturbed. But this stability is now affected not only by the destruction of their habitat, but also by the introduction of new plants and animals.

The introduction of **exotic species** is one of the main causes of biodiversity loss in many aquatic ecosystems. An exotic species is a non-native plant or animal deliberately or accidentally introduced into a new habitat. Such species include plants, fishes, frogs and bacteria. Such species that are able to reproduce and survive outside of the habitats where they **evolved** are also referred to as alien, introduced, invasive, non-native, or non-indigenous.

Evolve is the gradual development of a species from its original or primitive ancestor to its present specialized state. Some species cannot reproduce and survive outside their original habitats but some can.

Some plants and animals have been brought to Papua New Guinea from other countries with disastrous results for the local species. Sometimes their population increases very quickly because they have few natural enemies. This means that fewer native plants and animals survive because of the competition with the introduced ones.

Salvinia, which was introduced as an aquarium plant, became established in the Sepik River. This made it difficult for fish to live in the river and for people to travel by canoe.



Boats hindered by salvinia molesta in the blackwaters of Sepik.

The person on the right is directing somebody in front to steer through a maze of weeds, including water hyacinth and *Salvinia molesta*, invasive species that can seal off remote villages from the outside world for months at a time.



The *water hyacinth* is another introduced plant that is becoming a problem because it is not eaten by animals in Papua New Guinea. This plant can also make it difficult for people to travel by canoe.

The cane toad is another introduced animal that is now found in large numbers all over Papua New Guinea. It produces a poison and so other animals will not eat it.



A snake is dead by being poisoned by a cane toad

The problem of introduced plants and animals can be avoided by:

- 1) *quarantine* laws to control the movement of plants and animals from one country to another; and
- 2) controlling an introduced plant or animal, which has become a pest, by introducing another organism that is an enemy of the pest. This is called *biological control*.

For example, the water weed salvinia has been controlled in the Sepik River by the introduction of a weevil that feeds on the weed. In this case, ecologists even put fertilizer in the water to make the weed grow better. This allowed the weevil to become well established.



Weevils like these feed on the water weed salvinia

Biologists are investigating how these "invaders" succeed in establishing themselves in new environments, so that they can be controlled and eradicated where necessary.



Summary

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

- a pesticide is a chemical that is used to kill a pest, a weed or a disease.
 - the build-up of the concentration of a chemical through a food chain is called biomagnification.
 - increased population growth is having an increasingly large effect on the environment.
 - habitat destruction is the process by which the natural habitat is damaged or destroyed that it is unable to support the species and ecological communities that naturally occur there.
 - the three main causes of habitat destruction are human activities, pollution and natural causes.
 - the introduction of exotic species is one of the main causes of biodiversity loss in many aquatic ecosystems.
-

NOW DO PRACTICE EXERCISE 15 ON THE NEXT PAGE.
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Practice Exercise 15

Answer the following questions on the spaces provided.

1. Define the following terms.

a) Pesticides

b) Biomagnification

c) Exotic species

2. What is the **main** cause of environmental damage?

3. What are the three main causes of habitat destruction?

- a) _____
b) _____
c) _____

4. How can the problems of habitat destruction be reduced?

- a) _____

- b) _____

5. What are two ways of avoiding the problems of introduced plants and animals?

- a) _____

- b) _____

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.

Lesson 16: Endangered and Endemic Species



Welcome to Lesson 16. In your last lesson, you learnt that human growth is the main cause of environmental damage. More people mean more pollution, waste, destruction of the environment, and decreased biodiversity. It is important that we protect our natural species from harm so that they do not decline or die out completely. In this lesson, you will learn about endangered and endemic species.



Your Aims:

- list examples of endemic species of flora and fauna
- identify human activities that contribute to the decline in numbers of some plants and animals
- explain the importance of protecting endangered and threatened species

Endangered, threatened and endemic Species

We have to first of all define these three important words.



An **endangered species** is a population of organisms which is at risk of becoming extinct because it is few in numbers, or threatened by the changing environment or predation.

A **threatened species** is a plant, animal or other living thing that is rare and may become an endangered species in the future.



And an **endemic species** refers to a species which is only found in a given region or location and nowhere else in the world.

Species can become endangered or be in danger of extinction due to natural or human-made factors.

Let us look at it in a simpler way.

When a habitat is destroyed, the plants, animals and other organisms that occupied the habitat have a reduced carrying capacity.



In lesson 5, we defined carrying capacity of the land as the land's capability to supply enough food to feed a population.

When a habitat is destroyed, its ability to supply enough food to feed a population will be reduced. The land will no longer produce enough food to feed its population. The

waters will become polluted and shelters will be destroyed. When that happens, populations decline and **extinction** becomes more likely.

Extinction refers to a plant or animal species that no longer exists.

A threatened species is a plant, animal or other living thing which may become endangered in the near future. These species have a declining population or smaller populations that we say they are rare. The cause of its rarity may be due to threats such as habitat destruction, climate change or pressure from invasive species. An example of a threatened species is an animal of which there is only five of its kind left in the whole world.

What are flora and fauna?

Flora refers to a collection of plant life in a particular place at a particular time. **Fauna** refers to a collection of animal life in a particular place and time. The native plants and animals of a region are often referred to as that region's flora and fauna.

Endemic Species of Flora and Fauna

An endemic species refers to a species which is only found in a given region or location and nowhere else in the world. In Papua New Guinea, the Upper Sepik is home to some of Papua New Guinea's rarest plants and more than half of the region's species are endemic - they are not found anywhere else in the world.

Examples of fauna native to Papua New Guinea include the Blue Bird-of-paradise and Goldie's Bird-of-paradise, the Huon Tree Kangaroo, Toricelli Mountain Frog, Blue-eyed cockatoo, the Bougainville coral snake, Popondetta blue-eyed rainbowfish.



Blue Bird of paradise



Goldie's Bird of Paradise



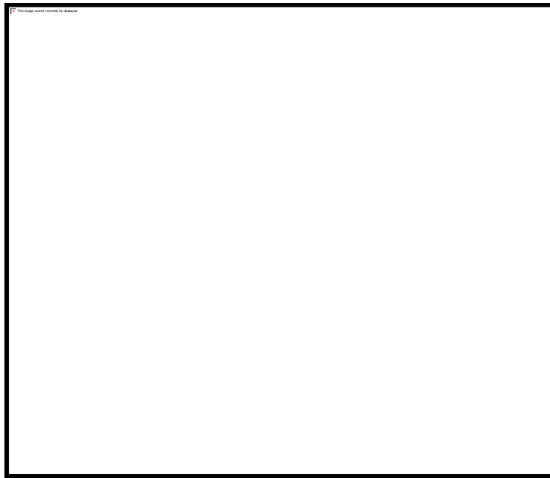
Huon tree kangaroo



Blue-eyed Cockatoo

Flora of Papua New Guinea includes the night-flowering orchid and the Sepik blue orchid.

The banana species *Musa ingens* is the largest banana species and is endemic to Papua New Guinea and only grows in the tropical forests of the Highlands.



The giant banana species of Papua New Guinea



The Sepik Blue orchid is endemic to the Sepik Region

Activities That Contribute to the Decline in Number of Some Plants and Animals

The extinction of animal and plant species results from many factors operating in our societies. Some of these factors affect the species directly and others affect it indirectly.

Man is responsible for the extinction of plant and animal species either directly or indirectly.

Let us look at each of these factors in a little more detail.

i) Habitat Destruction

Destruction of habitat or the native home of a plant or animal is usually the most common cause of species becoming endangered. The habitat may be destroyed by deforestation, agricultural activities, road construction or dam building and development for urbanization. As a result of destruction of its habitat, the species must adapt to the changes, move elsewhere or many die from the effect of predation, starvation or disease.

ii) Hunting for Money and Sport

In the past humans hunted animals for food. Nowadays, they hunt animals to sell for money or even for sport. Man hunt animals for the value of their fur, hides, tusks, antlers and various other body parts to sell for money. In Africa, Rhinoceros are hunted for their horns. Gharial and crocodile are hunted for their skin, which is used for various purposes. Many rare or exotic species, such as parrots and other tropical birds, are taken from their natural habitats for the **pet trade**. A pet trade is the practice of importing and exporting wild animals as pets.

iii) Introduction of New Species

In Lesson 15, we saw that one of the main causes of biodiversity loss is the introduction of new species. When a species is taken from its native habitat and introduced into a new, non-native habitat, it can cause environmental harm. The new species may become more successful in competing for food and other resources with the native species, or by preying on them or parasitizing them resulting in its extinction.

iv) Pollution

Land, air and water pollution can damage habitats and kill or make plants and animals sick. Pollution comes from a variety of sources including industrial plants, mining, and agricultural products such as pesticides, insecticides and fertilizers. Even animals that are not directly exposed to pollution can be affected as the species that they rely on for food, shelter or other purposes die out.

v) Disturbance

The presence of man and the noise of his machines in an area over a period of time may cause some animals to leave an area, even if the habitat is not harmed.

vi) Collection for zoos, private collections and research

Animals and plants are gathered throughout the world for zoos, private collectors and researchers in biology and medicine. Among the animals that the law allows to be exported or sold to another country, there are many endangered, threatened and rare species as well. Researchers throughout the world use different kinds of animals for their studies from which many come from the wild. It is not only animals but plants like cacti and orchids are also being uprooted for sale elsewhere.

vii) Species endangered by unsustainable hunting

Overfishing and overhunting have also threatened animal species since effective hunting methods were developed by our ancestors thousands of years ago. Some animals that we may not have known about may have been hunted to extinction. Unsustainable hunting and fishing continue to endanger numerous animals worldwide.

The increase in human population has led to increased fishing, hunting, gardening, logging and mining activities and because of these, some plants and animals are in danger of dying out.



A weird female pig-nosed turtle which is under threat from traditional hunting.

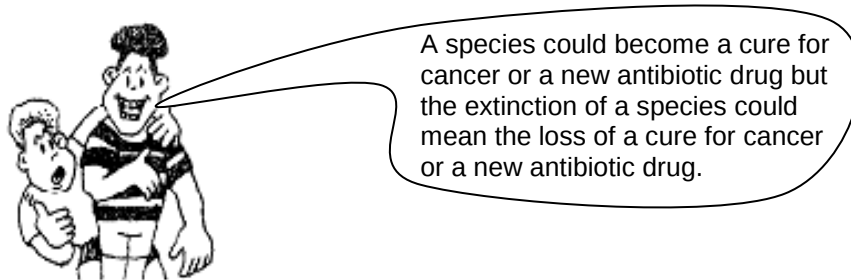
In Papua New Guinea, our government has declared these animals in danger of dying out **“National Animals”** in order to protect them. These animals can only be caught or collected by Papua New Guineans using traditional methods and can only be used for traditional purposes. If we continue to use the environment unwisely, then more and more plants and animals will be endangered.

Importance of Protecting Endangered Species

Rare, endangered, or threatened species are declining rapidly and are more likely to vanish or become extinct. These plants and animals exist in small numbers and may be lost forever if we do not take quick action to stop their decline. We must cherish these species like we cherish other rare and beautiful objects. If we cherish them, then these living organisms will be seen as treasures of higher value.

Why do we Preserve Endangered Plants and Animals?

Preservation involves efforts to protect an ecosystem so that natural resources are used wisely and saved for future generations. It is important that we preserve plants and animals, not only because many of these species are beautiful, or can provide economic benefit for us in the future, but because they already provide us many valuable resources.



Each living plant or animal may have values that are yet to be discovered. There are thirty to forty million species on Earth. We know very little about most species so we would not even know if a plant or animal becomes extinct. Wild animals and birds that are killed for sport or food and a few insects are watched and studied. Other species need attention too. Perhaps we may find in them a cure for the common cold or a new organism that may prevent thousands of kinas of loss to farmers in their constant fight against crop diseases like cocoa pod disease.

There are many examples of a species' value to society. For instance, an antibiotic was discovered in the soils of the threatened New Jersey Pine Barrens Natural Area. A species of perennial corn was found in Mexico; it is resistant to several diseases of corn. An insect was discovered that when frightened produces an excellent insect-repelling chemical.

Can Extinction Be Prevented?

Yes, extinction can be prevented by one important way highlighted below.

Habitat protection is the key to protecting our rare, threatened and endangered species.

A species cannot survive without a home. Our priority in protecting a species is to make sure its habitat remains unchanged. Before we protect a plant's or animal's habitat, we need to know where this habitat is found.

The first step is to identify where these declining species can be found. This is being carried out successfully by countries signing up international agreements to protect endangered and threatened species.

Second to identification is planning to protect and manage. When planning, we look at how best we can protect the species and its habitat. We also look at how we can

make sure the species continues to be healthy in its protected home once it is declared protected.

Each species and habitat are different and must be planned and researched carefully on how it is going to be well protected. A few protection and management efforts have been proven successful for some species.

A group of law or legislation was passed to protect the most endangered species in the United States. These special species cannot be destroyed nor can their habitat be removed. Our government can do the same so that endangered species and other elements of biodiversity are protected.

Several governments and organizations are beginning to manage threatened and endangered species on public lands. Plans are also underway to recognize private landowners who have voluntarily agreed to protect rare plants and animals. All these efforts need to continue and expand to keep our natural species from becoming rare, endangered or extinct.

Effective management is vital to help threatened species survive into the future.



Summary

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

- an endangered species is a population of organisms which is at risk of becoming extinct.
- a threatened species is a plant or animal that is rare and may become an endangered species in the future.
- an endemic species refers to a species which is only found in a given region or location and nowhere else in the world.
- extinction refers to a plant or animal species that no longer exists.
- flora can refer to a collection of plant life in a particular place at a particular time and fauna can refer to a collection of animal life in a particular place at a particular time
- the activities of man are responsible for the extinction of plant and animal species.
- habitat protection is the key to protecting our rare, threatened and endangered species.
- effective management is vital to help threatened species survive into the future.

NOW DO PRACTICE EXERCISE 16 ON THE NEXT PAGE.



Practice Exercise 16

Answer the following questions.

1. What is the difference between a threatened and an endangered species?

2. What is meant by endemic? Give an example of a bird that is endemic to Papua New Guinea.

3. What is usually the main cause of species becoming endangered?

4. What would be the best and important way to prevent extinction?

5. What has the government done to animals that are in danger of dying out in Papua New Guinea?

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 3.
--

Answers to Practice Exercises 12 – 16

Practice Exercise 12

1. Fuels are made up of the elements carbon, hydrogen and oxygen, with lesser amounts of nitrogen, sulphur and other elements.
 2. When fuels are burned in air, the elements that they (fuels) are composed of combine with oxygen to form various air pollutants.
 3. Carbon dioxide is formed when fuels burn in air and the carbon in them react with oxygen.
 4. Sulphur dioxide is formed when coal or oil containing sulphur is burned in air.
 5. Chlorofluorocarbon
 6. The increasing levels of carbon dioxide in the atmosphere may lead to global warming and major climate changes.
 7. The burning of fossil fuels releases large amounts of sulphur dioxide and oxides of nitrogen. Both sulphur dioxide and oxides of nitrogen combine with water vapour in the atmosphere to form sulphuric acid and nitric acid respectively. They then fall to the Earth as acid rain.
-

Practice Exercise 13

1. Eutrophication is the increase in the nitrate and phosphate levels of an aquatic ecosystem which results in the excessive growth of aquatic plants such as algae.
2. The two types of eutrophication are natural and artificial.
3. Natural eutrophication occurs in an aging lake or pond. When lakes gradually age or get older they become more productive and get to have a lot of nutrients, like nitrogen and phosphorus.
4. Natural eutrophication occurs naturally over a long period of time whereas artificial eutrophication involves human activities and happens for a very short time.
5. One of the negative effect of eutrophication and increased algal growth is a loss of available oxygen.
6. Life in the water will become impossible for species such as fish and other organisms and they will suffocate to death.
7. By reducing the inflow of nitrogen and phosphorus into lakes and rivers.

Practice Exercise 14

1. (Any of the four answers below is accepted)

Mineral	Metal obtained
Gold	Gold
Chalcopyrite	Copper
Gibbsite	Aluminium
Silver	Silver
Niccolite	Nickel
Linnaerite	Cobalt

2. Clear-felling is a forestry harvesting technique in which all the trees in a given area are removed. Selective logging involves cutting of only selected trees.
3. Destruction of wildlife habitat, pollution of rivers, lakes, seas and air are environmental problems associated with all types of mining.
- 4.
- Destroying forests reduce the number of plants which can take in carbon dioxide and make oxygen for breathing.
 - Cutting trees for timber adds to global warming by putting more carbon dioxide into the atmosphere.
 - Removing trees exposes soil which is then lost by erosion. Lack of vegetation also affects the amount of water vapour in the air.
5. Trees are harvested for
- (i) timber.
 - (ii) plywood for building and furniture.
 - (iii) the manufacturing of papers and other paper products.

Practice Exercise 15

- 1.
- a) A pesticide is a chemical that is used to kill a pest, a weed or a disease. People use pesticides for their benefit by killing other living things.
 - b) Bio-magnification is the build-up of the concentration of a chemical through a food chain.
 - c) An exotic species is a non-native plant or animal deliberately or accidentally introduced into a new habitat.
2. Human population growth

3.
 - a) Human activities
 - b) Pollution
 - c) Natural causes
 4. The problems of habitat destruction can be reduced by:
 - a) careful management of the habitat by controlling agricultural, logging and mining activities; and
 - b) careful use of fertilisers and pesticides. For example, not using pesticides that kill enemies of pests.
 5. The problem of introduced plants and animals can be avoided by:
 - a) quarantine laws to control the movement of plants and animals from one country to another; and
 - b) controlling an introduced plant or animal, which has become a pest, by introducing another organism that is an enemy of the pest. This is called biological control.
-

Practice Exercise 16

1. An endangered species is a population of organisms which is at risk of becoming extinct while a threatened species is a plant or animal that is rare and may become an endangered species in the future.
2. An endemic species refers to a species which is only found in a given region or location and nowhere else in the world. Blue Bird of Paradise, Goldie's Bird of Paradise or Blue eyed cockatoo.
3. Destruction of habitat or the native home of a plant or animal is usually the most important cause of endangerment.
4. Habitat protection is the key to protecting our rare, threatened and endangered species.
5. In Papua New Guinea, our government has declared these animals in danger of dying out "National Animals" in order to protect them.

REVIEW OF TOPIC 3: Ecological Issues

Now, revise all lessons in this Topic and then do **ASSIGNMENT 2**.

Here are the main points to help you revise.

Lesson 12: Pollution

- Pollution can be defined as any undesirable change in the physical, chemical or biological characteristics of the natural environment.
- A substance is a pollutant when its presence harms living things.
- The main sources of pollution are the burning of fossil fuels, industrial waste, pesticides, insecticides, fertilizers and biological waste.
- Burning of fossil fuels leads to the greenhouse effect, global warming and air pollution.
- Air pollution consists of gases, liquids and solids present in the atmosphere in high enough levels to harm living things.
- Water pollution can involve a wide range of contaminants from domestic to industrial, to agricultural in origin.
- Wastes can be biodegradable or non-biodegradable.

Lesson 13: Eutrophication

- Eutrophication is the increase in the nitrate and phosphate levels of an aquatic ecosystem which results in the excessive growth of aquatic plants such as algae.
- There are two types of eutrophication, the natural and artificial.
- Eutrophication leads to a loss of available oxygen from a lake leading to an underwater environment without oxygen.
- The main causes of eutrophication are
 - the overuse of fertilizers,
 - run-offs from nutrients from the soil and weathering of rocks,
 - run-offs of manure from farms,
 - run-offs from erosion and
 - discharge of detergents and partially treated or untreated sewage.

Lesson 14: Mining and Logging

- Mining is the process of extracting or obtaining minerals from the earth's crust.
- Minerals are compounds which occur naturally within the earth's crust.
- Ore minerals are minerals from which useful metals can be extracted profitably. Metals are very important because of their many useful properties.
- Destruction of wildlife habitat, pollution of rivers, lakes, seas and air are environmental problems associated with all types of mining.
- Logging is the cutting, trimming and transporting of trees to a saw mill.
- Forests are being cut down faster than they are regrowing.
- Forests should be selectively logged so that only certain kinds and sizes of trees are cut down.
- Clear-felling occurs when all the trees are cut down. This results in soil erosion and makes regeneration difficult.

Lesson 15: Other Threats to Ecosystems

- A pesticide is a chemical that is used to kill a pest, a weed or a disease.
- The build-up of the concentration of a chemical through a food chain is called biomagnification.
- Increased population growth is having an increasingly large effect on the environment. Many of these effects are destructive and can destroy ecosystems.
- Habitat destruction is the process by which the natural habitat is damaged or destroyed that it is unable to support the species and ecological communities that naturally occur there.
- The three main causes of habitat destruction are human activities, pollution and natural causes.
- The introduction of exotic species is one of the main causes of biodiversity loss in many aquatic ecosystems.

Lesson 16: Endangered and Endemic Species

- An endangered species is a population of organisms which is at risk of becoming extinct.
- A threatened species is a plant or animal that is rare and may become an endangered species in the future.
- An endemic species refers to a species which is only found in a given region or location and nowhere else in the world.
- Extinction refers to a plant or animal species that no longer exists.
- Flora can refer to a collection of plant life in a particular place at a particular time and fauna can refer to a collection of animal life in a particular place at a particular time
- The activities of man are responsible for the extinction of plant and animal species.
- Habitat protection is the key to protecting our rare, threatened and endangered species.
- Effective management is vital to help threatened species survive into the future.

NOW DO TOPIC TEST 3 IN YOUR ASSIGNMENT 2.
--

TOPIC 4

MAINTAINING BALANCE

In this topic you will learn about:

- **limiting factors**
- **ecological succession**
- **renewable and non-renewable resources**
- **conservation and management**

INTRODUCTION TO TOPIC 4: MAINTAINING BALANCE

A balanced ecosystem is an ecological community together with its environment, functioning together as a unit. Plants and animals depend on each other to survive. Any change in the environment can affect a group of organisms and those that rely on it are also affected.

When we study maintaining balance, we will come to know that if the environment is disturbed and polluted, then we must try to improve it. However, if it was in a naturally undisturbed state there would be no point in changing it. You would maintain it wisely.



You should know about how balance is maintained in ecosystems. Some of the questions you should be asking yourself are:

- Why are habitats constantly changing?
- What happens to organisms when habitats are constantly changing?
- How can we take care of natural resources?
- How can we preserve and keep the natural resources for the future?

In this topic, you will find the answers to these questions and all other questions relating to maintaining balance.

Lesson 17: Limiting factors



Welcome to Lesson 17. In this lesson, you will learn about limiting factors. Living things have the ability to produce populations of a very great size, but resources in the environment are limited. This can have an effect on the interactions between organisms.



Your Aims:

- define limiting factors
- identify examples of limiting factors in the environment
- describe how these factors affects the population of organisms in a given area

Populations Cannot Grow Without Limit

No population can grow forever. There has to be some limitations or stop to this growth. In our natural world, populations increase or decrease in response to the changes in the abiotic and biotic factors of the environment that restrict growth. These factors are called **limiting factors** since they limit the population. Limiting factors are necessary for survival. A limiting factor either slows the growth of an animal population or causes the population to decline.

Limiting factors are any conditions that affect the survival of an organism or population of organisms.

Limiting factors and population interactions in each ecosystem controls population growth. Resources such as food, water, oxygen and space availability, as well as predation, competition and parasitism place environmental limits on population growth. These limits set the **carrying capacity** of the ecosystem. Carrying capacity is the maximum number of organisms the resources of an ecosystem can support. The carrying capacity of the environment is limited by the available abiotic and biotic resources (limiting factors).

Every population has a maximum size that it can reach before it exceeds or go beyond the carrying capacity. If a population in a habitat exceeds its carrying capacity, the population will decrease due to limited resources.

Increases in a population are not always good. Sometimes a population will grow too large for the environment to support. Other changes in limiting factors will cause a population to decrease.

What are some of the limiting factors that reduce the populations of organisms in ecosystems?

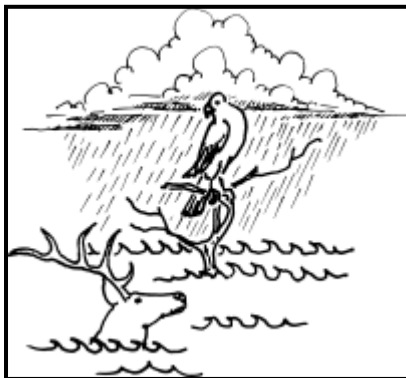


Let us now look at some limiting factors that can contribute to the reduction of populations of organisms.

Some of the factors that can reduce populations of organisms are natural disasters like bushfires, flood and drought, competition, parasitism, diseases and natural predation.

How does each factor affect populations?

Natural disasters such as droughts, floods, cyclones and bushfires can be devastating. For example, a severe drought could lower the water levels of a lake and decrease its carrying capacity causing the fish population to decrease.



Flood

During flooding, habitat and wildlife are washed away. Sometimes organisms are covered by floodwaters and vegetation drowns resulting in population reduction.



Fires

In a natural bushfire, animals could get burned and their food and shelter would also be destroyed. Water source may evaporate or become polluted resulting in a decline in population.

Resources are limited in a habitat so organisms must compete for food, water, space and shelter.



Environmental resources are limited and individuals must compete for their share

Competition occurs between individuals of the same species when individuals become crowded as the population grows. Since individuals within a population require the same resources, crowding causes resources to become more limited. Some individuals, especially the old, sick and weak do not acquire enough resources and die or do not reproduce. This reduces population size and slows population growth.

Parasites can limit the growth of a population. They take nourishment from their hosts, often weakening them and causing disease or death.

Diseases can also occur in a population when individuals become crowded as population grows. Over-crowding makes it easier for parasites to find hosts and spread the disease. When individuals are diseased they become weak, cannot compete for resources and die or do not reproduce. This also reduces population growth and the population of animals that eat the diseased animals will also decrease.



Predation

Predators are often a major limiting factor on the growth rate of a prey population. Prey populations can also limit the size of the predator population if they are the only source of food available.

The picture above shows the predator wolves of the North Pole feasting on their prey. You may refer back to lesson 5 on interactions to see what happens during predation.



Summary

You have come to the end of Lesson 17. In this lesson you have learnt that:

- limiting factors are any conditions that affect the survival of an organism or population of organisms
 - limiting factors can be abiotic or biotic and they include food, water, shelter, space availability, natural disasters, competition, parasitism, diseases and predation
 - carrying capacity is the maximum number of organisms the resources of an ecosystem can support
 - a population will decrease due to limited resources if it exceeds its carrying capacity
 - limiting factors like natural disasters, competition, parasitism, diseases and natural predation reduces population.
-

NOW DO PRACTICE EXERCISE 17 ON THE NEXT PAGE.



Practice Exercise 17

A. Answer the following questions.

1. What is a limiting factor?

2. How does a limiting factor affect a population of organisms?

3. Suggest a factor that could be limiting the growth rate of a prey population.

4. Why does competition occur?

5. What are some limiting factors in the environment that can reduce populations of organisms?

B. For questions 6-10, write true if the statement is true. If the statement is false, change the underlined word to make the statement true.

6. Limiting factors determine the immigration capacity of a population.

7. A limiting factor controls the growth of a population.

8. Populations grow too large in the absence of limiting factors.

9. Competition is an example of a limiting factor.

10. Population size can be limited by factors such as predation.

NOW CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.
--

Lesson 18: Ecological Succession



Welcome to Lesson 18. In your last lesson you learnt that limiting factors affect the survival of an organism or population of organisms. In this lesson you will learn about ecological succession. Do you know that ecosystems change overtime? In some cases, changes result from natural events such as floods, forest fires, or volcanic eruptions. In other cases, changes to ecosystems are caused by human activities, such as clearing of forests or filling in of wetlands to make land available for homes, farming, roads and bridges or other developments.



Your Aims:

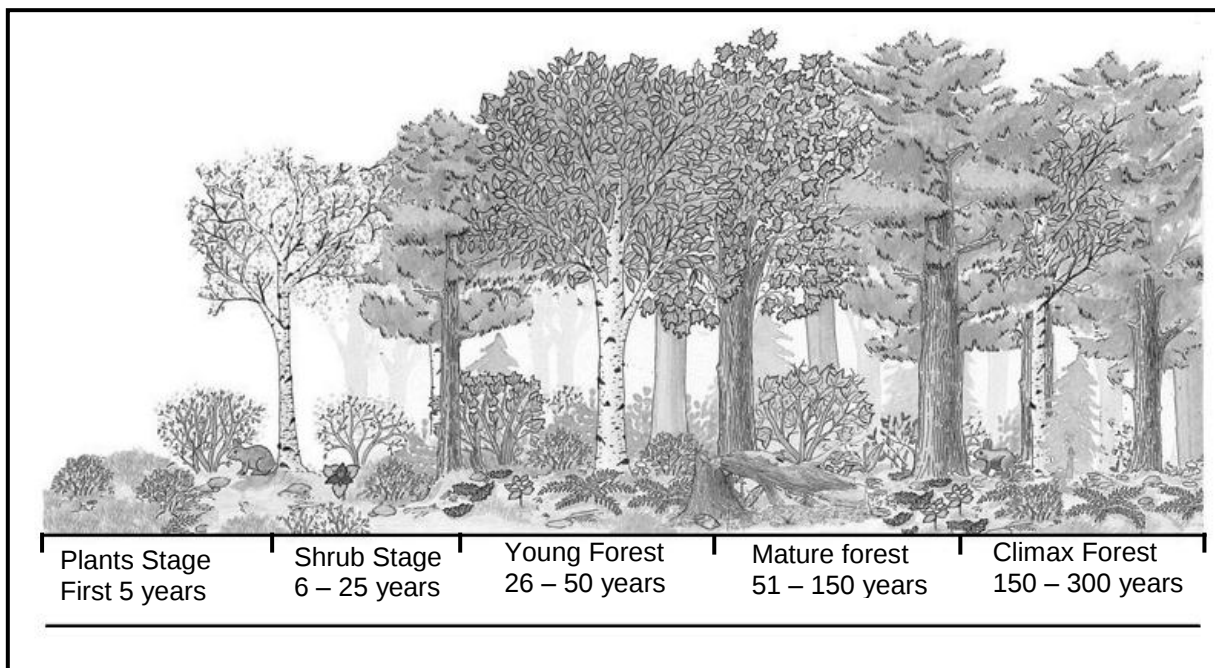
- define ecological succession
- discuss the two types of succession
- identify the stages of ecological succession

Colonisation

New habitats can be man-made or natural. At first new habitats are lifeless. For example, an environment of bare rocks and sand left behind by a forest fire is not suitable for most organisms. Soon, however, spores and seeds of certain plants start to germinate and grow. This process is known as colonisation. **Colonisation** is a process whereby a species invades and occupies a newly formed area where no life has previously existed.

Succession

Succession is the process in which the communities in ecosystems are replaced by new communities. It is a gradual process in which one community changes the environment so that it is replaced by another community. During succession, changes occur in the species structure and in the organisation of an ecological community over time.



An example of a forest succession

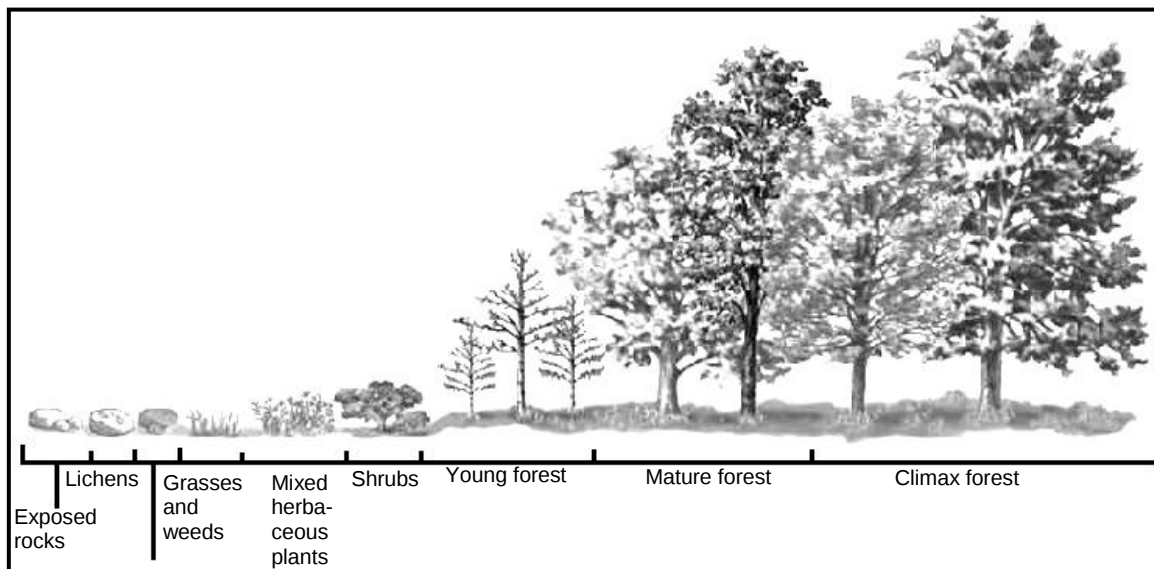
Nothing remains the same and habitats are constantly changing. Succession is a gradual and continuous process which may take hundreds of years.

Ecological succession is the term used to describe a situation in which communities colonise an ecosystem and are then replaced over time by other communities.

There are two types of succession and they are called primary and secondary.

Primary succession occurs when organisms start to live in a barren environment for the first time. This would mean an entirely new habitat which has never been colonized before. It can start on bare rocks, on volcanic ash after eruptions and on newly formed beaches.

Let us study a bare rock.



Succession in a forest

A bare rock does not have soil for plants to grow on it so that would be an entirely new habitat. The first organisms to colonize the barren rock would be lichens and algae. These can produce acids that can break down the rock and they trap organic material and form humus.

Primary succession is the development of soils.

A community develops because the lichens and algae provide food for other organisms like insects which are attracted to the area to feed.

A pioneering community refers to the first species to colonise an uninhabited area. For plants it begins with lichens and mosses and for animals, generally the insects.

The small amount of soil formed by the lichens is suitable for the growth of mosses and liverworts which do not have roots and require little soil. These plants begin to grow over the lichens and attract other animals to the area to feed.

Over several generations some of the mosses and liverworts gradually die and decay and the soil becomes a little deeper. Then plants that require this depth of soil can grow. Ferns are among the next organisms in the new community. As these seedless plants live and die, the soil continues to develop to the point that grasses can successfully grow and a grassland community forms. Over time, the soil level increases to the point that shrubs can grow in the grassland. The grassland is replaced by a shrub community. Small trees may then become established, which eventually may develop into a forest.

The plant communities will generally change as the soil develops.



A diversity of animals comes along with a change in plant communities

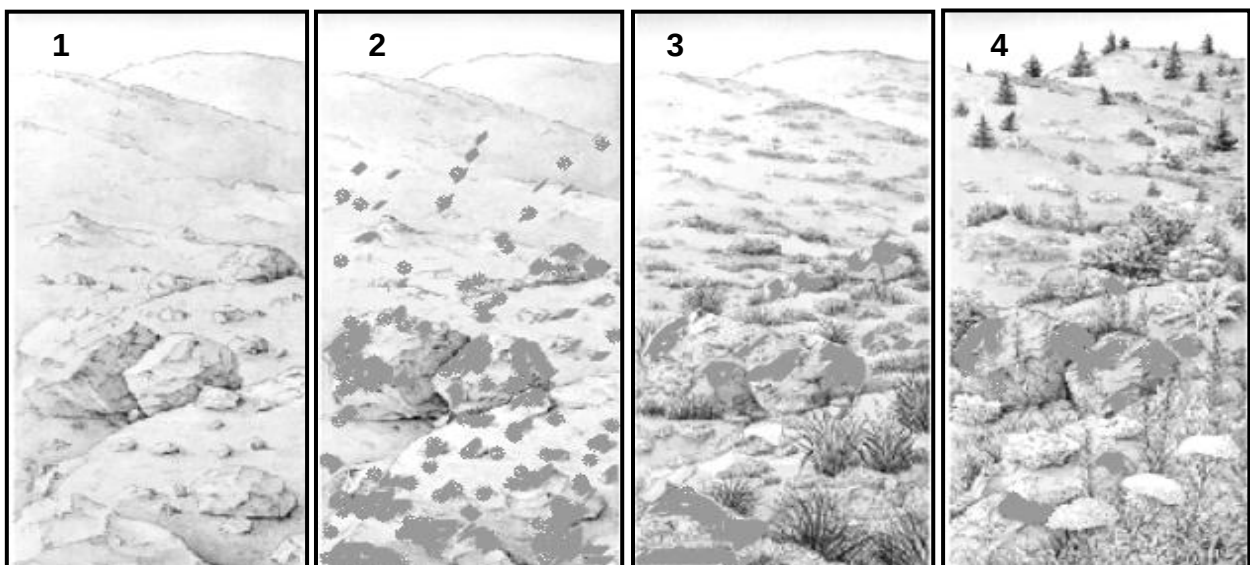
Our study has shown that, each stage in the process changes the habitat in such a way that it prepares the way for the next invasion of species.

As succession continues, soil is formed and thickens as a result of decomposition. When the changes in the composition of plants stop and the plant community remains generally the same for many years, the community is now stable or mature and at a climax.

A climax community is the relatively stable community at the end of succession

Ecological succession will not start again unless there is a major change to the physical or abiotic factors in the environment.

Another example of primary succession would be on a newly exposed surface such as this newly deposited volcanic rock and ash shown in the pictures below. A volcanic eruption destroys the previous ecosystem.



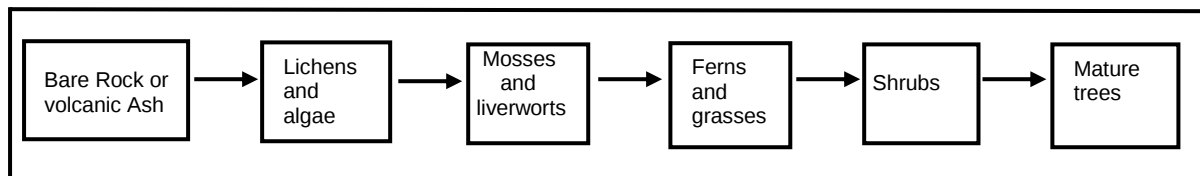
Different stages of primary succession on a newly deposited volcanic rock and ash

In the pictures in the previous page, each number represents the different stages and they are:

1. newly deposited volcanic rock and ash.
2. the first organisms to appear are the lichens.
3. mosses soon appear, and grasses take root in the thin layer of soil.
4. eventually, tree seedlings and shrubs sprout among the plant community.

Look at the different stages and predict what type of animals you would expect to appear at each stage and why?

The stages of ecological succession can be summarized in a flow chart as shown below.



A Flow Chart Showing the Stages of Ecological Succession

Each stage changes the habitat in such a way that it prepares the way for the next invasion of species.

Secondary Succession

A plant community can be disturbed causing some plants to be destroyed. These disturbances can come from tree-felling or logging in a rainforest, destructive events such as fires, agriculture and bulldozers clearing sides of roads. If the disturbance stops, the community will begin a succession where changes in the vegetation will lead back to a climax community. These types of successions are called secondary successions and take place in areas where there is soil and living things have already made that place their home. Since the soil is already in place, secondary succession can take place five to ten times faster than primary succession.

Secondary succession takes place on a previously colonised, but disturbed or damaged habitat.

Secondary succession is usually much quicker than primary succession for the following reasons:

- there are already seeds of different suitable plants in the soil.
- root systems undisturbed in the soil, stumps and other plant parts from previously existing plants can rapidly regenerate.
- the fertility and structure of the soil has also already been greatly changed by previous organisms to make it more suitable for growth and colonisation.



In secondary succession, the gradual changes in the plant communities occur on areas where there has been previous vegetation.

That's right! And that is why secondary succession is much quicker than primary succession.



Traditional agriculture makes use of secondary succession. Plants in a community are disturbed when a garden is made. The crops that are planted reduces the fertility of the soil. At the same time, people are changing the relationships between living things and their surroundings in favour of the crops that have been planted.

When a garden is no longer producing, it is abandoned and secondary succession takes place. This allows the soil to regain its fertility and eventually the land may be used again for gardening. This is sometimes called **shifting agriculture** and works well where the human population is small and the cycle of secondary succession is fifteen years or more.

Try to compare the two types of succession and see how they occur.

An example of primary succession forming an oak woodland:	An example of secondary succession forming an oak woodland:
1. Bare rock is colonised by mosses and lichen.	1. Bare soil is colonised by grasses and pioneer plants.
2. Small plants, ferns and grasses take over.	2. Grasses begin to predominate with time.
3. Larger plants with deeper roots appear.	3. Shrubs replace the grasses.
4. Bushes and shrubs replace non-woody plants.	4. Fast growing trees appear.
5. Fast growing trees form a dense, low wood.	5. Slow growing oaks create the climax community.
6. Larger, slow growing oak trees create the oak woodland.	



Activity: Now test yourself by doing this activity.

Write the word or phrase on the space provided, that best matches the given description. You can use some of the terms more than once.

ecosystem

diversity

lichens,

pioneer organisms

primary succession

secondary succession

climax community

succession

1. A forest of pine trees is burned over a 10 kilometre area when lightning strikes a tree. In the spring, a few seedlings begin to sprout.

2. A small symbiotic organism secretes acid into a rock to anchor itself in place.

3. The old-growth forest has remained the same combination of rain trees and eucalyptus for 100 years.

4. Small organisms, such as lichens, help break up bare rock into soil.

 5. This may take hundreds or thousands of years.

 6. A pond slowly fills in as algae and other plants die and fall to the bottom.

 7. A volcano erupts creating a new island. After a few years, small plants begin to grow.

-

CHECK YOUR WORK. ANSWERS ARE AT THE END OF LESSON 18.



Summary

You have come to the end of Lesson 18. In this lesson you have learnt that:

- ecological succession is a sequence of different communities in an ecosystem over a period of time.
 - primary succession occurs when organisms start to live in a barren environment for the first time.
 - secondary succession occurs when living things are already established.
 - a pioneering community refers to the first or initial living things to colonise an uninhabited area.
 - when ecological succession no longer occurs the community is stable and is called a climax community.
-

NOW DO PRACTICE EXERCISE 18 ON THE NEXT PAGE.



Practice Exercise 18

Answer the following questions on the spaces provided.

1. Define the terms:

(a) Primary Succession

(b) Secondary Succession

2. Explain why lichens are so important in the establishment phase of a community on bare rock.

3. Draw a flow chart in the box below and explain the stages of ecological succession on a bare rock.

CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.

Answers to activity

1. Secondary succession
2. Lichens
3. Climax community
4. Pioneer organisms
5. Succession
6. Secondary succession
7. Primary succession

Lesson 19: Renewable and Non-renewable Resources



Welcome to Lesson 19. In the previous lesson, you learnt that succession is a process in which communities in ecosystems are replaced by new communities. In this lesson, you will learn about renewable and non-renewable resources.



Your Aims:

- define renewable and non-renewable resources
- discuss ways of taking care of natural resources

A **natural resource** is anything of value people get which comes from nature. People do not make natural resources but gather them from the Earth. The Earth is full of important natural resources, for example, the sea and the forest, air, water, sunlight, wood, soil, minerals, plants and animals and there are many more which you can name. Humans need these natural resources to fulfill their needs for survival.

Air, water and sunlight are natural resources that nearly all living things need to survive. Many natural resources can be classified as either renewable or non-renewable.

Renewable and Non Renewable Resources

Some resources are renewable which means they can be replaced naturally. For example sunlight, water and trees are **renewable resources**. They have an unlimited supply. They are always available and do not run out after we use them.

Trees as we discussed earlier are renewable resources. After they are harvested, more seedlings can be planted and grown. Wind power is a renewable resource that has been used for thousands of years to pump water, irrigate crops and sail boats in some parts of the world. Some coastal villages in Papua New Guinea also use wind energy to sail their boats.

Other resources however, are **non-renewable**. They cannot be easily replaced once they are consumed. Once we use up their supply, there will be no more available for future needs. Examples of non-renewable resources would include any naturally occurring elements or compounds that once mined and used, cannot be replaced.

Fossil fuels such as coal, oil and natural gas are considered non-renewable resources. These resources take thousands of years to form naturally and cannot be replaced as fast as they are being consumed.

Resource Depletion

Resource depletion is the term used to describe how fast the resources in a country or area are being used up and there is no more of that resource. The use of natural resources like trees, fish, oil and fossil fuels beyond their rate of replacement is considered to be resource depletion. The problem occurs due to overpopulation and limited resources. Humans have wants and needs in a world of limited resources.

In order to obtain these natural resources, humans carry out activities such as logging, fishing, land clearing and mining.

Ways that people use natural resources

There are many different ways that people use natural resources. It is important that you learn how much in your daily lives comes from the Earth and its environment.

Let us look at some of the ways that we use natural resources. We use trees to make paper products, but we also harvest wood for building materials and to make furniture. We use animals like cattle for food and dairy products but we also rely on them for leather. We use rocks and minerals to make a variety of materials, including glass, metal and ceramics. We convert fossil fuels into energy to power and heat our homes and fuel modes of transportation, including planes, buses, boats and cars. We also use petroleum, a fossil fuel, to make a variety of materials including plastics.



We depend on fossil fuels for nearly everything that we do including cooking, heating, transporting, lighting and manufacturing.

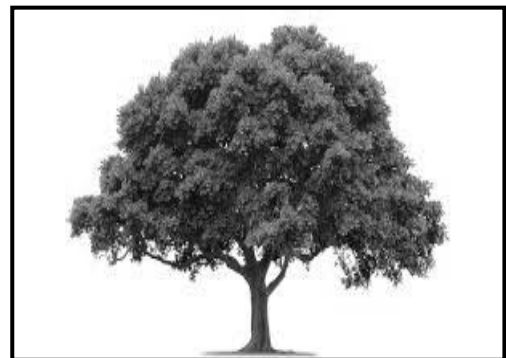
People are using up natural resources faster than they are replaced. For example, forests are being cut down in order to supply the demand for wood and land.



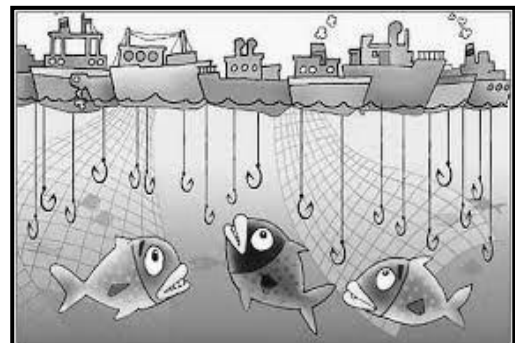
The fast depletion of resources from the Earth is a dangerous sign for the future.

An example of the effect of this fast depletion which is now being felt is the recent rise in the prices of fuels especially oil.

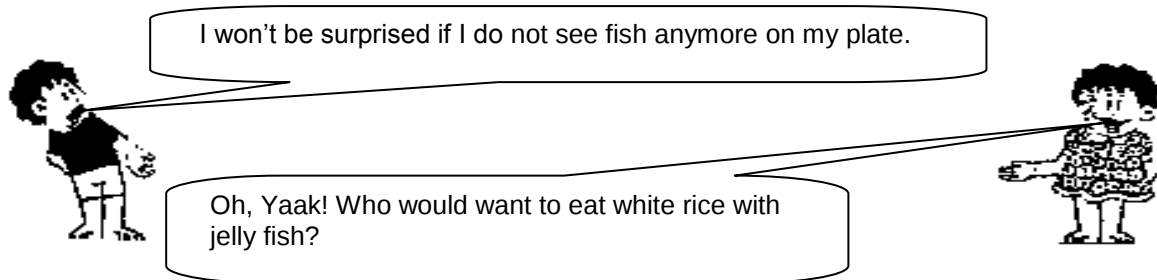
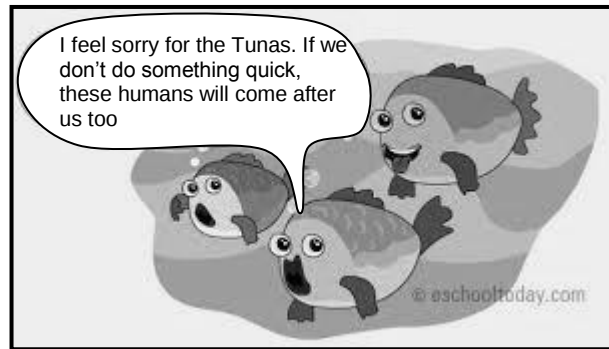
Trees play an important role in our lives. They provide us with a lot of things such as oxygen, paper, furniture, toys and building materials. Trees are very important to our survival on Earth. You may think that wood is a renewable resource because you can plant as many trees as you want to. However, in many parts of the world trees are fast depleting in numbers. More trees are cut down than are being replanted which will eventually mean running out of trees to cut and therefore affect our future conditions.



Overfishing may upset the balance in a marine ecosystem. When huge nets are dragged through the oceans different fishes are caught. When too many fish are caught, the population cannot sustain their itself. The fish get fewer and fewer, until finally there are none to catch.



In many parts of the world, top predator fishes like sharks are disappearing at a frightening rate. Not long most of the large fish that many of us like to eat like tuna and marlin may be fished out. The depletion of these top predators can cause a slight change in the entire ocean ecosystems where valuable fish are replaced by smaller, plankton feeding fish. We may see jelly fish replace fish consumed by humans this century.



Overhunting of animals for their meat or certain parts of their body for profit or fashion may not only upset the balance in the ecosystem, but may also make a species become extinct. Overhunting has been the major cause of the extinction of hundreds of species and many more have become endangered such as dugongs, Birds of Paradise and giant sea turtles in Papua New Guinea.

Conservation and Management

As the human population is continuously growing, the consumption of natural resources is also increasing. If these resources are not used properly and managed well, we will run out of them. Therefore, we need to conserve the natural resources.

Proper management is necessary to control the activities of humans so that they do not deplete the natural resources. Natural resources can be conserved and can start from the process of the three R's. **Reduce, Reuse and Recycle.**

Conservation is the proper management of a natural resource to prevent its destruction.

Every time we reduce our level of energy consumption, we help to reduce dependence on fossil fuels. One of the biggest consumers of fossil fuels is the transportation industry. We can help to conserve the remaining fossil fuel supplies if we reduce our dependence on cars and choose more environment friendly transportation options. Whenever possible, people can leave their cars at home and walk or ride a bicycle.

We can switch to other alternate energy sources to generate electricity. While fossil fuels are our biggest source of energy, a number of alternate sources are available. We can reduce wasteful energy using wind energy, solar energy, nuclear energy or hydroelectric plants to further reduce our fossil fuel consumption.

Natural resources are being depleted rapidly, particularly with the increasing use of disposable products and packaging. Reprocessing used materials to make new products and packaging reduces the consumption of natural resources.

By recycling, we can conserve natural resources and energy. Recycled materials can be processed and made into new products, so it is not only important to recycle, but to also purchase goods with recycled content.

Resources can be reused by recycling them.

Recycling reduces the need to harvest natural resources.

The table below shows some proper management of natural resources.

Activity	Proper Way of Management
Logging - Forests stop erosion and homes to many species of flora and fauna. - Plants can absorb carbon dioxide for photosynthesis. - Logging is carried out to obtain wood for building purposes, making furniture and producing paper.	- Selective logging of trees is practiced to ensure only mature trees are cut down. - Replanting of trees is carried out to ensure the forest is not destroyed and continues to survive. - Enforcement of laws and restricting areas for deforestation.
Fishing - Rivers and seas are our main supply of fish. - These ecosystems must be protected from pollution and exploitation for constant supply of safe marine products.	- Allow catching of mature fish only to ensure a constant supply of fish. - Establish fixed fishing zones. - Limit the use of trawl nets because this net catches small fish as well.
Clearing of land Land is cleared for agriculture, housing projects, building of roads, recreational parks and factories.	- Forests above 1000 metres are not allowed to be cleared as this may lead to soil erosion. - Environment Impact Assessment must be carried out before clearing of land. - Proper drainage must be built around areas cleared for developmental projects.
Mining Mining includes mining for minerals, such as petroleum, tin or gold.	- Mining for petroleum should be closely monitored to prevent water pollution. - Abandoned mining ponds should be converted into recreational parks.



Summary

You have come to the end of Lesson 19. In this lesson you have learnt that:

- a natural resource is anything of value people get which comes from nature. Examples include air, water, sunlight, wood, soil, minerals, plants and animals.
- natural resources can be renewable or non-renewable. Renewable resources can be replaced naturally and non-renewable resources cannot be replaced once they are consumed.
- resource depletion is the use of natural resources beyond their rate of replacement.
- natural resources will run out if they are not used properly. Therefore, they need to be conserved. Proper management is necessary to control the activities of humans so that they do not deplete the natural resources.

NOW DO PRACTICE EXERCISE 19 ON THE NEXT PAGE.



Practice Exercise 19

Answer the following questions.

1. Explain the difference between a renewable resource and a non-renewable resource.

-
2. Why are fossil fuels considered non-renewable resources?

-
3. Explain what is meant by resource depletion.

-
4. Name four activities that humans carry out to obtain natural resources.

(i) _____

(ii) _____

(iii) _____

(iv) _____

-
5. What measure must be taken to help avoid running out of renewable and non-renewable resources?

NOW CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.
--

Lesson 20: Conservation and Management



Welcome to Lesson 20. In the last lesson, you learnt that natural resources will run out if they are not used properly therefore, they need to be managed. In this lesson, you are going to learn about how to conserve and manage our resources for the benefit of our future generations.



Your Aims:

- define environmental conservation and management
- identify reasons for conserving and managing resources
- describe ways of conserving and managing natural resources
- list and explain some traditional methods used in managing the environment

Environmental Conservation and Management

Everywhere on Earth, people are affecting their environment by farming the land, harvesting the forests, fishing the seas and mining the Earth's surface.



Why do they do this?

They do this so that the many essential things they need for survival are met and to improve the quality of life. But on the other hand they are destroying the environment



Our needs increase as we increase in numbers. The increase in population has led to an increase in the activities listed above and this results in environments becoming affected. To save our environment from destruction, we must manage it well.

Environmental management is the process by which the balance in nature is regulated or controlled.

Managing the environment is very important. The reason is to maintain and improve the state of an environment that is affected by human activities. It is the process where we take positive steps and behaviours to have a positive effect on the environment.

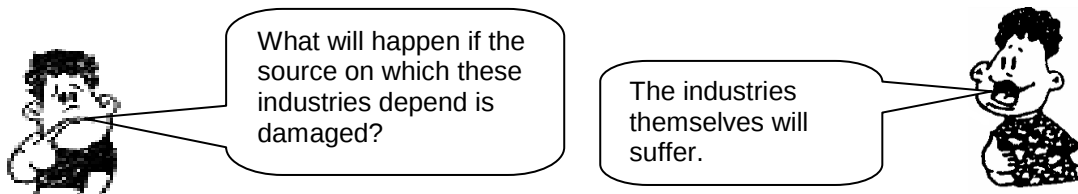
To conserve natural resources means to protect them from loss or danger. It also means when using natural resources, you think and use them wisely so that you do not waste them or use them up completely. Conserving natural resources can help them to last and be available for future generations. Conservation is important to ensure that changes do not happen too quickly. Rapid change can force animals and plants to become endangered and extinct.

Conservation involves efforts to return an affected ecosystem to its natural balance.

There are economic, cultural, moral, aesthetic and scientific reasons why it is important to manage and conserve resources.

1. Economic

Most sections of our economy are dependent on natural resources. For example, industries such as forestry, fishing, agriculture and tourism, are all dependent on the healthy functioning of the natural environment.



Here is an example of what the cartoons are saying. If overfishing of an economically important fish takes place, then this would result in the collapse in the fish population and harvests would also drop greatly.

We can support the economy of our country if we help to maintain a healthy natural environment. This depends on understanding and respecting the ecology of the country. Our natural resources (especially the land and sea resources) must be used carefully and wisely, if we want a productive and profitable world for people in the future.

2. Traditional and cultural reasons

Our way of life and culture has been depending on the living things and the surroundings for thousands of years. Our traditional stories are based on mountains, lagoons and caves. The plants are useful as food and medicinal herbs. Some animals are food while others have their own values in different societies and we use the land for gardening. If we do not look after these resources and the surroundings, we will lose part of our culture which we value so much.



A dancer from the highlands dressed in feathers and leaves



Women from Oro Province dressed in feathers, leaves and tapa which are made from the bark of a special tree.

3. Responsibility

It is our responsibility to leave a living, productive natural world for future generations to enjoy. We have a duty to respect living organisms and their surroundings. We must not think that these resources are there only for people to use and destroy.

4. Beauty

Our idea of beauty is based on what we see in living things and in the surroundings. For example, the beauty and peacefulness of the mountains, the sea and the grassland attracts people for recreation, rest and may encourage an interest in them to do something creative.

Natural environments are beautiful and we can enjoy them when we visit them.

If we destroy or spoil these things then the result is an ugly world. We need to preserve our environment on the basis of beauty for the enjoyment of future generations.



A beautiful scene of Wassi Falls in Southern Highlands

5. Science

Our country Papua New Guinea has a great variety of plants and animals found nowhere else in the world. Proper studies have not been carried out on many of these plants and animals to fully understand their special place in the ecology of our environment.

A group of scientists from Britain, the United States and Papua New Guinea climbed Mount Bosavi in Papua New Guinea and discovered 16 frogs which have never before been recorded by science. At least three new fish, a new bat and a giant rat, which may turn out to be the biggest in the world were also discovered.

The world's first night flowering orchid was also recently discovered in Papua New Guinea on New Britain Island.



Night flowering orchid



A giant woolly rat never seen before by science

Our study of ecology in science will help us to take actions and not destroy the natural environment which contains many species which are yet to be discovered and written about.

Conservation and Management of Natural Environments

We have so many different kinds of plants and animals in Papua New Guinea but because our population is increasing so fast, there is a great need for land to use for farming, industry, reservoirs and houses. Many of the animals and plants which we still have are under threat and we must do all we can to conserve them.

The environment provides us with the resources that are essential to our survival. We must look after or manage our environment well so that it can continue to provide the resources.

Today, conservation is described as the wise use of the Earth's resources such that they will be able to support, or sustain, all life for generations ahead. Conservation is practiced in different ways in different situations. Below are some of the ways of conserving and managing natural environments.

Water conservation

Something that is useful or valuable is known as a **Commodity**. Clean water is a precious resource and commodity.

- Rivers must not be regarded as dumping sites for domestic and toxic wastes. These actions can pollute the water
- Water conservation can be achieved by reducing pollution from agriculture. Runoff from fertilizers, pesticides and animal wastes are the main causes of water pollution.

Species Protection

In Papua New Guinea natural environments including endangered species are protected and managed through the establishment of National Parks, such as Varirata in Central Province and McAdam in the Morobe Province. People are not allowed to hunt in these parks and rangers are employed to make sure this law is strictly followed and enforced.



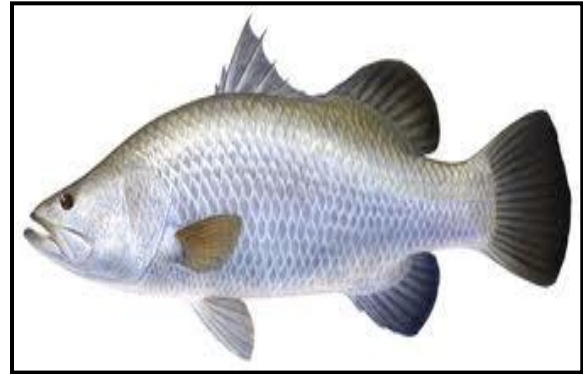
Varirata National Park in Central Province

Marine reserves

The seas are an important resource as they are full of a large numbers of sea creatures. Some of these sea creatures are a valuable source of food while others are economically important.



The banana prawn is economically important



The barramundi is a valuable source of food

As more and more of these sea creatures are caught, this valuable source of food and income could be lost forever.



It is therefore important that this resource is managed well for the future.

Overfishing occurs when so many fish are caught that the population cannot reproduce enough to replace them. When overfishing takes place the population declines and may eventually die out.

Overfishing can lead to depletion of or extinction of species



A large modern fishing vessel and its massive net.

The picture on the left shows a large modern fishing vessel and its giant net. This net is deep enough to scrape along the bottom of the sea bed. These types of modern fishing have had devastating impact on marine life.

Large commercial boats are now catching large quantities of fish and careful management will be essential. Some methods of management are described below.

- The total number of fish caught can be limited.
- Regulations can be made to prevent overfishing.
- Young fish should not be caught. They should be left as breeding stock. Older fish can be selectively caught using nets with a larger mesh size which allow the smaller, younger fish to swim through.

- Breeding grounds and migratory routes need special protection from disturbances and pollution to ensure that a maximum number of fish can be born.

With the use of modern fishing equipment, fishing companies are able to catch more and more fish. Strict control over the activities of fishing companies is necessary to safeguard our marine resources for the future.

Land Reserves

The tropical rainforests are important for their biodiversity because 50% of the world's plant and animal species can be found there. Forest resources also need to be managed properly otherwise this valuable resource will also be lost. The problem is that the forests are now being cut down faster than they are regrowing or regenerating. The population of trees in PNG's tropical forests is declining very fast as a result of this.

If deforestation proceeds faster than **afforestation** which is the conservation of forest areas, many of these species could become extinct before they can be documented or written about.



An example of deforestation in a once lush tropical rainforest

This picture shows an example of a deforested land.

- a. Where do you think all the animals would have gone to?
- b. What has happened to all the plant species?

If we do not manage and conserve our forests well, we may lose this valuable resource with all the plant and animal species found in it as shown in the picture above.



Therefore, it is important to balance the needs and demands for forests with the need to conserve and maintain the environmental services of forests.

The following are some sustainable methods that are used to control the over-exploitation of the forests in PNG.

- The total number of trees cut down or felled at a time can be controlled. When all the trees are cut down this is called **clear-felling**. Clear-felling often results in bad soil erosion, making regeneration impossible.

- Young trees should not be felled; they should be left to grow so that they can be harvested in the future. This is called **selective logging** and means only mature trees are removed.
- Instead of leaving the natural young trees to grow, an area can be replanted with nursery-grown trees. In West New Britain, a forestry project is replanting as the trees are cut down.

Recycling

Recycling involves the reprocessing of used materials or wastes into new products. 76% of what we throw away could be recycled. Paper can be pulped and made into new paper goods. Glass and metals can be melted down and reused. Certain types of plastics can be used again and kitchen refuse can be composted and used as garden fertilizer.

Recycling is very important in reducing waste and is the third component of the three R's, **Reduce**, **Reuse** and **Recycle**.

Recycling does not simply control pollution by reducing the size of rubbish tips, it slows the rate at which raw materials are used up, and so saves energy and money.



These posters are telling us to be friends of the Earth by Recycling

Is there any other information that you can get by looking at the posters?

Some Traditional Methods Used in Managing Resources

Traditionally people have managed their environment very wisely in Papua New Guinea. Traditional gardeners were like ecologists. Traditional gardeners did not misuse the land. They looked after it and manage it carefully.



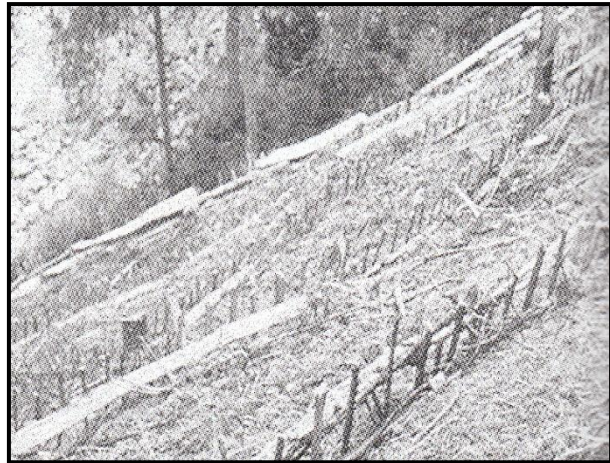
Clearing of bushes for new garden sites

The elders knew where and when to make gardens. They could judge the stage of succession of a bush. They used their knowledge of the appearance of a certain plant or a characteristic such as its flowering to do this.

These traditional ecologists also knew when to abandon a garden. When harvests dropped, they knew that the soil had lost its fertility and it was time to abandon the

garden and move to a new garden site. Forest trees were often encouraged to grow by clearing around their seedlings.

Traditional gardeners knew how to control erosion by placing logs across steep slopes. For example, in the Chimbu Province, gardens were built on very steep slopes. Special barriers called gui (wooden fences) were built to trap soil washed down the steep slopes



Small wooden fences called giu are used to prevent soil erosion in parts of Chimbu Province

Traditionally the bush is also managed wisely in order to obtain a regular supply of wild plants and animals. Traditional hunters only kill one or two animals for food and the populations of animals remain stable but the introduction of shotguns has now lead to overhunting. As a result, populations of many animals such as cassowary, wallaby and birds of paradise are declining.



A hunter returning home with a wallaby

Wild plants that are useful are selectively cared for in the bush.

For example, in many areas of the highlands pandanus nuts or karuka are an important part of the diet. These nuts are obtained from trees that are managed by clearing around the trunks and protecting them from rats.



Other useful plants, such as those that provide building materials and medicine, are selectively cared for.

People sometimes mark these trees to show ownership and this is respected by the community.





A father teaching his son traditional hunting techniques

Traditional ways of managing the environment are now in danger of being lost. This is because some young people are growing up in isolation from their community and consequently are losing respect for traditional knowledge.

Traditional ways of managing the environment are now in danger of being lost but you can learn these ways from your elders



Summary

You have come to the end of Lesson 20. In this lesson you have learnt that:

- in order to survive, we must manage and conserve our natural resources.
- environmental management is the process by which the balance in nature is regulated or controlled.
- conservation is the wise use of the Earth's resources such that they will be able to support, or sustain all life for generations ahead.
- the reasons for managing and conserving natural resources are economics, cultural, responsibility, beauty and science.
- people have traditionally managed their environments very wisely in Papua New Guinea.
- it is important to preserve land and marine resources for the future.
- wildlife management areas should be set up to protect endangered species.
- over harvesting of forests in PNG can be controlled by selective logging and replanting of new trees.
- recycling is important in reducing waste and also slows down the rate at which raw materials are used up.

NOW DO PRACTICE EXERCISE 20 ON THE NEXT PAGE.



Practice Exercise 20

Answer the following questions.

1. What is conservation?

2. Why is it important to manage the environment wisely?

3. Name one sea creature in Papua New Guinea that is economically important.

4. What is meant by:

- a. clear felling?

- b. selective logging?

5. Write down four reasons why we should study ecology.

- (i)

- (ii)

- (iii)

- (iv)

NOW CHECK YOUR WORK. ANSWERS ARE AT THE END OF TOPIC 4.
--

Answers to Practice Exercises 17 – 20

Practice Exercise 17

A.

1. Limiting factors are any conditions that affect the survival of an organism or population of organisms
 2. A limiting factor either slows the growth of an animal population or causes the population to decline.
 3. Predators are often a major limiting factor on the growth rate of a prey population.
 4. Competition occurs between individuals of the same species when individuals become crowded as the population grows. Since individuals within a population require the same resources, crowding causes resources to become more limited. Some individuals, especially the old, sick and weak do not acquire enough resources and die or do not reproduce. This reduces population size and slows population growth
 5. Limiting factors like natural disasters, competition, parasitism, diseases and natural predation reduces population.
-

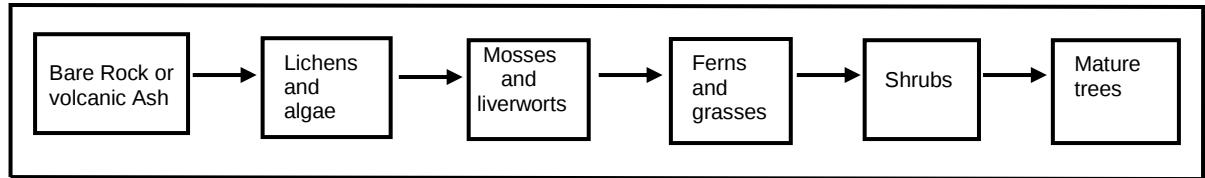
B.

6. **False** Limiting factors determine the ~~immigration~~ **carrying** capacity of a population.
 7. **True** A limiting factor controls the growth of a population.
 8. **True** Populations grow too large in the absence of limiting factors.
 9. **True** Competition is an example of a limiting factor.
 10. **True** Population size can be limited by factors such as predation.
-

Practice Exercise 18

1.
 - (a) Primary succession occurs when organisms start to live in a barren environment for the first time.
 - (b) Secondary succession is the series of community changes which take place on a previously colonised, but disturbed or damaged habitat.
2. This is because lichens can produce acids that can break down the rock and they trap organic material and form humus.

3.



A Flow Chart Showing the Stages of Ecological Succession

Each stage changes the habitat in such a way that it prepares the way for the next invasion of species.

The different stages are:

7. newly deposited volcanic rock and ash.
8. the first organisms to appear are the lichens.
9. mosses soon appear, and grasses take root in the thin layer of soil.
10. eventually, tree seedlings and shrubs sprout among the plant community.

Practice Exercise 19

1. A renewable resource can be replaced naturally and a non-renewable resource cannot be replaced once they are consumed.
2. Fossil fuels such as coal, oil and natural gas are considered non-renewable resources because of the length of time it would take to replace. These resources take thousands of years to form naturally and cannot be replaced as fast as they are being consumed.
3. Resource depletion is the term used to describe the resources in a country or area that are being used up and there is no more of that resource. The use of natural resources like trees, fish, oil and fossil fuels beyond their rate of replacement is considered to be resource depletion.
4. In order to obtain these natural resources, humans carry out activities such as logging, fishing, land clearing and mining.
5. Proper management is necessary to control the activities of humans so that they do not deplete the natural resources.

Practice Exercise 20

1. Conservation is the wise use of the Earth's resources such that they will be able to support, or sustain, all life for generations ahead.
2. The environment provides us with the resources that are essential to our survival. We must look after or manage our environment well so that it can continue to provide these resources.
3. Banana Prawn

4. (a) Clear felling is when all the trees are cut down.
- (b) Selective logging is when young trees are not felled or cut but left to grow so they can be harvested in the future and only mature trees are removed.
5. The reasons for managing and conserving natural resources are:
- i. economics,
 - ii. cultural
 - iii. responsibility
 - iv. beauty and science
-

REVISE TOPIC 4 USING THE MAIN POINTS ON THE NEXT PAGE.

REVIEW OF TOPIC 4: Maintaining Balance

Now, revise all lessons in this Topic and then do **ASSIGNMENT 2**.
Here are the main points to help you revise.

Lesson 17: Limiting Factors

- Limiting factors are any conditions that affect the survival of an organism or population of organisms
- Limiting factors can be abiotic or biotic and they include food, water, shelter, space availability, natural disasters, competition, parasitism, diseases and predation
- Carrying capacity is the maximum number of organisms the resources of an ecosystem can support
- A population will decrease due to limited resources if it exceeds its carrying capacity
- Limiting factors like natural disasters, competition, parasitism, diseases and natural predation reduces population.

Lesson 18: Ecological Succession

- Ecological succession is a sequence of different communities in an ecosystem over a period of time.
- Primary succession occurs when organisms start to live in a barren environment for the first time.
- Secondary succession occurs when living things are already established.
- A pioneering community refers to the first or initial living things to colonise an uninhabited area.
- When ecological succession no longer occurs the community is stable and is called a climax community.

Lesson 19: Renewable and Non-Renewable Resources

- A natural resource is anything of value people get which comes from nature. Examples include air, water, sunlight, wood, soil, minerals, plants and animals.
- Natural resources can be renewable or non-renewable. Renewable resources can be replaced naturally and non-renewable resources cannot be replaced once they are consumed.
- Resource depletion is the use of natural resources beyond their rate of replacement.
- Natural resources will run out if they are not used properly. Therefore, they need to be conserved. Proper management is necessary to control the activities of humans so that they do not deplete the natural resources.

Lesson 20: Conservation and Management

- In order to survive, we must manage and conserve our natural resources.
- Environmental management is the process by which the balance in nature is regulated or controlled.
- Conservation is the wise use of the Earth's resources such that they will be able to support, or sustain all life for generations ahead.
- The reasons for managing and conserving natural resources are economics, cultural, responsibility, beauty and science.
- People have traditionally managed their environments very wisely in Papua New Guinea.

- It is important to preserve land and marine resources for the future.
 - Wildlife management areas should be set up to protect endangered species.
 - Over harvesting of forests in PNG can be controlled by selective logging and replanting of new trees.
 - Recycling is important in reducing waste and also slows down the rate at which raw materials are used up.
-

NOW DO TOPIC TEST 4 IN YOUR ASSIGNMENT 2.

**NOW YOU MUST COMPLETE ASSIGNMENT 2.
RETURN IT TO THE PROVINCIAL CO-ORDINATOR.**

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4	ALOTAU	P. O. Box 822, Alotau	6411343 / 6419195	72228130	The Coordinator	Senior Clerk	72229051
5	POPONDETTA	P. O. Box 71, Popondetta	6297160 / 6297678	72228138	The Coordinator	Senior Clerk	72229052
6	MENDI	P. O. Box 237, Mendi	5491264 / 72895095	72228142	The Coordinator	Senior Clerk	72229053
7	GOROKA	P. O. Box 990, Goroka	5322085 / 5322321	72228116	The Coordinator	Senior Clerk	72229054
8	KUNDIAWA	P. O. Box 95, Kundiawa	5351612	72228144	The Coordinator	Senior Clerk	72229056
9	MT HAGEN	P. O. Box 418, Mt. Hagen	5421194 / 5423332	72228148	The Coordinator	Senior Clerk	72229057
10	VANIMO	P. O. Box 38, Vanimo	4571175 / 4571438	72228140	The Coordinator	Senior Clerk	72229060
11	WEWAK	P. O. Box 583, Wewak	4562231/ 4561114	72228122	The Coordinator	Senior Clerk	72229062
12	MADANG	P. O. Box 2071, Madang	4222418	72228126	The Coordinator	Senior Clerk	72229063
13	LAE	P. O. Box 4969, Lae	4725508 / 4721162	72228132	The Coordinator	Senior Clerk	72229064
14	KIMBE	P. O. Box 328, Kimbe	9835110	72228150	The Coordinator	Senior Clerk	72229065
15	RABAU	P. O. Box 83, Kokopo	9400314	72228118	The Coordinator	Senior Clerk	72229067
16	KAVIENG	P. O. Box 284, Kavieng	9842183	72228136	The Coordinator	Senior Clerk	72229069
17	BUKA	P. O. Box 154, Buka	9739838	72228108	The Coordinator	Senior Clerk	72229073
18	MANUS	P. O. Box 41, Lorengau	9709251	72228128	The Coordinator	Senior Clerk	72229080
19	NCD	C/- FODE HQ	3230299 Ext 26	72228134	The Coordinator	Senior Clerk	72229081
20	WABAG	P. O. Box 259, Wabag	5471114	72228120	The Coordinator	Senior Clerk	72229082
21	HELA	P. O. Box 63, Tari	73197115	72228141	The Coordinator	Senior Clerk	72229083
22	JIWAKA	c/- FODE Hagen		72228143	The Coordinator	Senior Clerk	72229085

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.

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

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.

CERTIFICATE IN MATRICULATION STUDIES

No	Compulsory Courses	Optional Courses
1	English 1	Science Stream: Biology, Chemistry, Physics Social Science Stream: Geography, Intro to Economics and Asia and the Modern World
2	English 2	
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

REMEMBER:

You must successfully complete 8 courses: 5 compulsory and 3 optional.