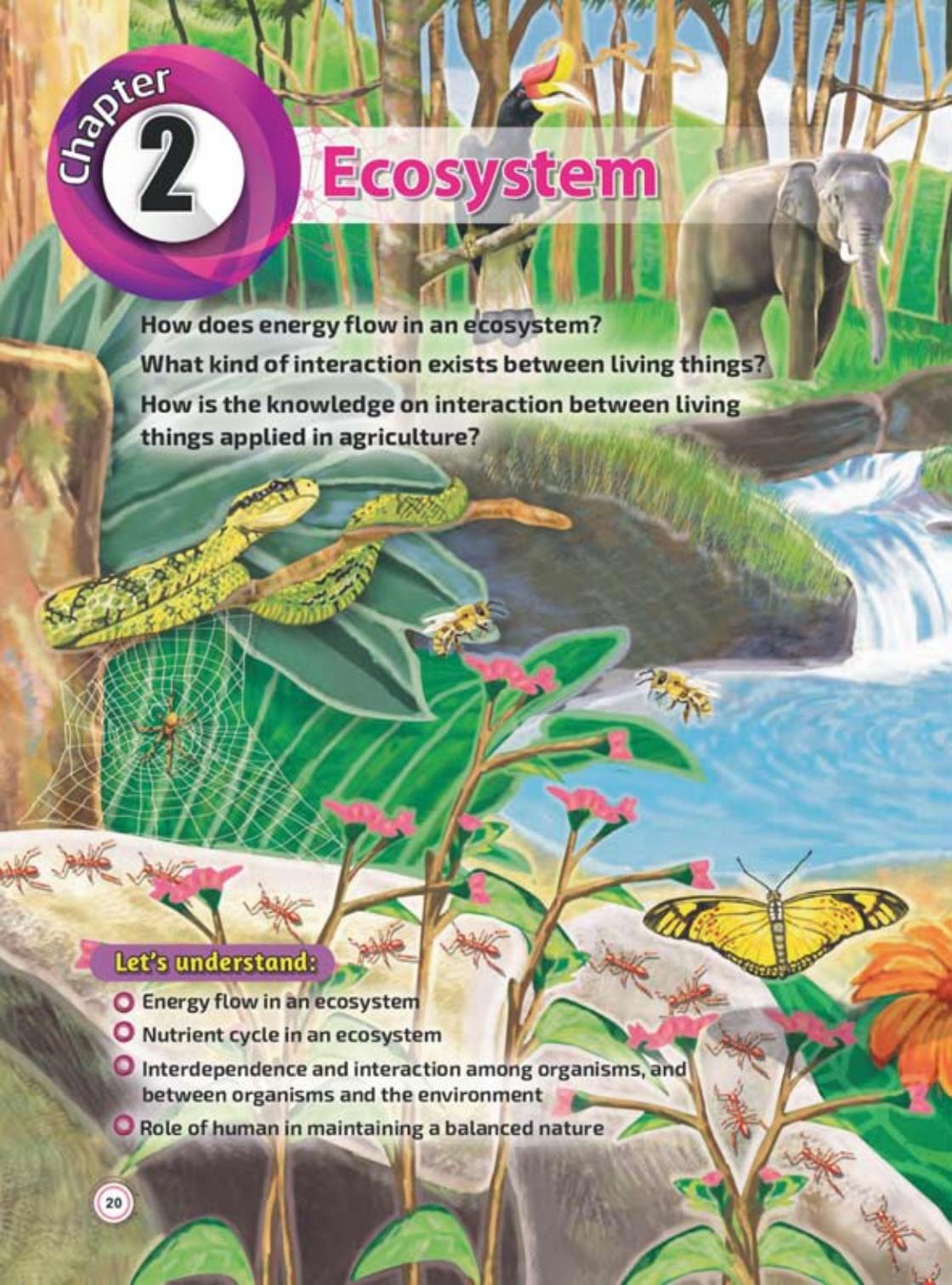


Ecosystem



How does energy flow in an ecosystem?

What kind of interaction exists between living things?

How is the knowledge on interaction between living things applied in agriculture?

Let's understand:

- Energy flow in an ecosystem
- Nutrient cycle in an ecosystem
- Interdependence and interaction among organisms, and between organisms and the environment
- Role of human in maintaining a balanced nature

SCIENCE BLOG

Programme to Control Monkey Population

The Department of Wildlife and National Parks (PERHILITAN) carried out a programme to control the monkey population in Taman Tasik Perdana in the year 2010. This programme was an alternative method to solve the conflict between humans and monkeys.

The method used in this programme was sterilisation. It was performed on male monkeys. Then, these sterilised monkeys were released into their original habitat. The monkey population growth rate was studied to observe the effectiveness of this programme.

Keywords

- ▶ Ecosystem
- ▶ Producer
- ▶ Consumer
- ▶ Decomposer
- ▶ Food chain
- ▶ Food web
- ▶ Species
- ▶ Population
- ▶ Community
- ▶ Mutualism
- ▶ Commensalism
- ▶ Parasitism
- ▶ Saprophytism

2.1 Energy Flow in an Ecosystem

Do you know that the source of energy in all ecosystems originates from the Sun? Green plants convert **light energy** from the Sun into **chemical energy** through the process of photosynthesis. The chemical energy is transferred to primary consumers and then to secondary and tertiary consumers in the **food chain** and **food web**.

Producers, Consumers and Decomposers

In an ecosystem, organisms can be classified as **producers**, **consumers** and **decomposers**.

Producer

A **producer** is an organism that produces its own food through photosynthesis. Most plants are producers.

Primary consumer

A **consumer** is an organism that eats another organism. **Primary consumers** are **herbivores** and **omnivores** that eat producers. For example, caterpillars.



Plant



Caterpillar

Dead

Brain

Teaser

What are the materials that cannot be broken down by a decomposer?

Decomposer

A **decomposer** is an organism that breaks down dead animals and plants into simpler materials or nutrients. This interaction is known as **saprophytism**.

Figure 2.1 Examples of producer, consumer and decomposer in a forest ecosystem

Secondary consumer

A **secondary consumer** is an **omnivore** and **carnivore** that eats the primary consumer. For example, the Himalayan bluetail, *Tarsiger rufilatus*, is an omnivore because it eats caterpillars and fruits. However, the kingfisher, *Alcedo atthis*, is a primary carnivore because it eats primary consumers such as snails, fish, tadpoles and shrimps.



Himalayan
bluetail



Fox



Mushroom

Brain Teaser

Are human beings primary, secondary or tertiary consumers? Explain.



Info

Construct Food Chains
<http://www.vtaide.com/png/foodchains.htm#create>

**Tertiary consumer**

A **tertiary consumer** is a secondary carnivore that eats a secondary consumer. The size of a tertiary consumer is usually bigger than a primary or secondary consumer.

Science Info

Some examples of decomposers are mushrooms that grow on decaying wood, mould that grows on food as well as *E.coli* bacteria that break down food molecules in the large intestine of humans.

Food Chain

A **food chain** can be used to show the feeding relationship between organisms. Figure 2.2 shows an example of a food chain.



Figure 2.2 Example of a food chain

Food Web

The interconnection of a few food chains is called a **food web**. Figure 2.3 shows an example of a simple **food web** in a vegetable garden. Can you write four food chains that create the food web shown?

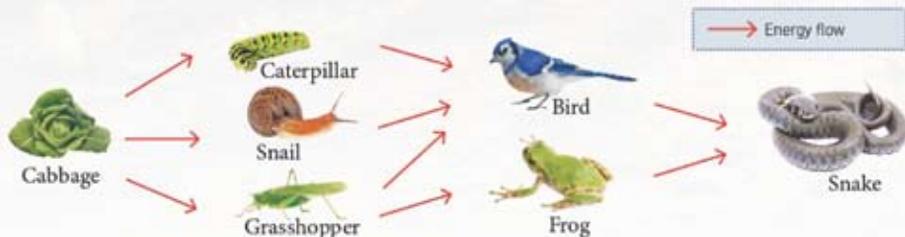


Figure 2.3 Example of a food web

Energy Flow in a Food Web

As seen in the food chain, energy is also transferred from one organism to another organism in the food web. In reality, some of the energy is lost because it is used by the organism to move and carry out the life process of respiration. Apart from this, energy is also lost in the form of heat energy or chemical energy through undigested food, or faeces.

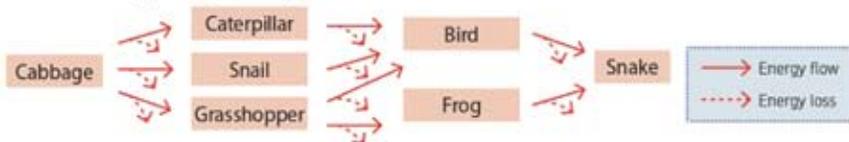


Figure 2.4 Energy flow in a food web

Activity 2.1

Aim: To construct a food web.

Instruction

1. Visit any ecosystem in your school compound or your housing area.
2. Construct as many food chains as possible from the plants and animals you find.
3. Interconnect the food chains to make a food web. Then, identify the producers, consumers and decomposers in the food web.
4. Discuss the energy flow in the food web.

Formative Practice 2.1

1. The following is an example of a food chain. Identify the producer, primary consumer, secondary consumer and tertiary consumer.

Cabbage → Caterpillar → Chicken → Snake

2. Based on the following organisms:

Paddy plant

Grasshopper

Sparrow

Owl

Rat

Caterpillar

(a) construct a food web.

(b) predict what will happen if the paddy plant dies because of a long drought.

2.2 Nutrient Cycle in an Ecosystem

The transfer of nutrients and energy is continuous in an ecosystem. Nutrients are obtained from a balanced ecosystem and used by living things. Then, the nutrients are returned to the environment to be used again. This cycle is called a **nutrient cycle**. Do you still remember the examples of nutrient cycles, such as the water cycle, carbon cycle and oxygen cycle that you learned in Form One? What is the role of living things in those cycles?

Water Cycle

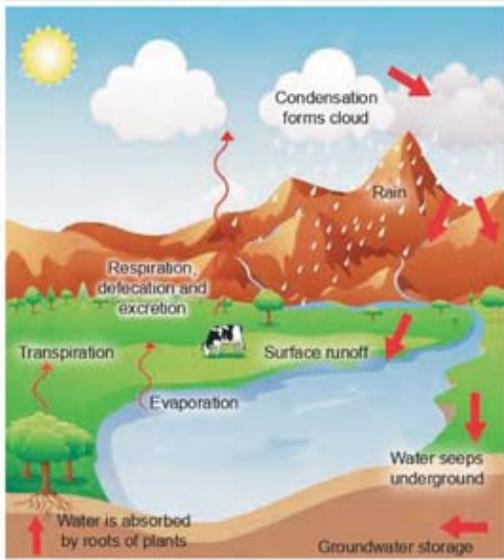


Figure 2.5 Water cycle

The role of living things in the water cycle

- Water is absorbed by roots of plants in the ground and released into the atmosphere through **transpiration**. Animals carry out respiration, defecation and excretion (sweating and urination). All of these **increase the water content** in the atmosphere.
- Roots of plants hold the soil tightly and make the structure of the soil more compact. This slows down the flow of water underground and **prevents soil erosion**.
- Leaves that fall from trees and cover the surface of the earth will reduce the rate of evaporation and **prevent the soil from becoming dry**.

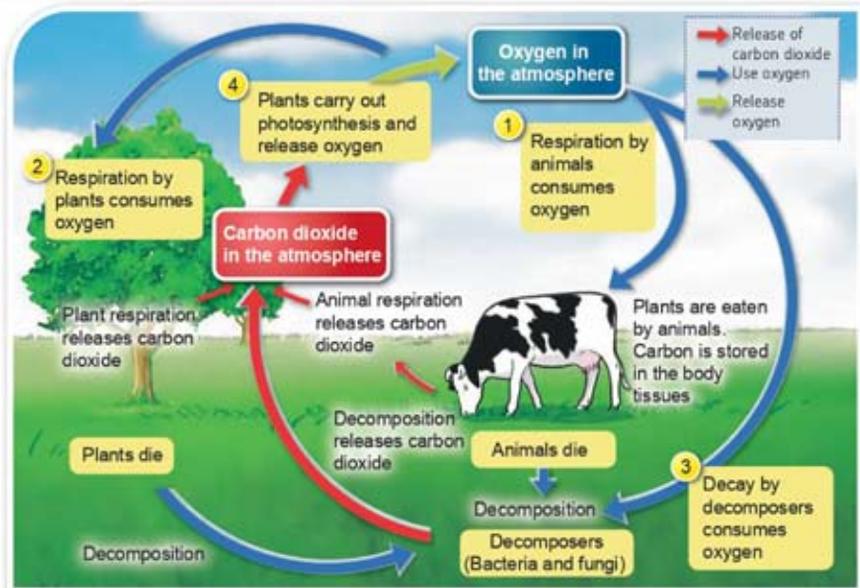


Figure 2.6 Carbon and oxygen cycles are inter-connected

The role of living things in the carbon cycle and oxygen cycle

- 1 2 Plants and animals carry out respiration which uses oxygen and releases carbon dioxide.
- 3 The decay of dead plants and animals by bacteria and fungi in the soil uses oxygen and releases carbon dioxide.
- 4 Green plants maintain the content of carbon dioxide and oxygen in the air through photosynthesis which absorbs carbon dioxide and releases oxygen.

Activity 2.2

21st Century

Aim: To create a multimedia presentation that connects the role of living things in the water cycle, oxygen cycle and carbon cycle.

Instruction

1. Work in groups.
2. Design a water cycle, a carbon cycle and an oxygen cycle using multimedia.
3. Predict the effects to the nutrient cycle if the water cycle, oxygen cycle or carbon cycle are affected.
4. Present the multimedia presentation in class.

Steps to Solve Problems when there is an Interference to the Nutrient Cycle

You have learned the role of plants in maintaining the balance of oxygen and carbon dioxide in the atmosphere. Nevertheless, human activities such as **unrestricted logging**, **burning of fossil fuels** and **overconsumption of water resources** for agricultural and domestic purposes have negatively affected the nutrient cycle. Can you think of steps to solve these problems?

Human activities that disrupt the nutrient cycle



Unrestricted logging



Burning of fossil fuels



Overconsumption of water resources

Steps to solve interference to the nutrient cycle



Create planned agricultural systems



Use public transport



Store rain water for daily use



Replant trees



Tighten laws

Photograph 2.1 Human activities that disrupt the nutrient cycle and steps to solve the problem

Formative Practice 2.2

1. Name three types of nutrient cycles.
2. Give two processes that change the state of matter in the water cycle.
3. Explain the role of organisms in the carbon cycle and oxygen cycle.
4. Suggest two steps to save water. 🌱

Before we study the interdependence and interaction among organisms, and between organisms and the environment, let us understand a few important terms first.

1 Habitat

A habitat is the **natural surroundings** or **home** of an organism.

2 Species

A species is a **group of organisms** that have common characteristics and can reproduce to breed offsprings.

3 Population

A population is a **group of organisms** of the **same species** that live in the same habitat.

4 Community

A community is a **few populations** of different organisms that live together in one habitat and have mutual interaction with one another.



Dragonfly

Species



A population of dragon flies



Pond community

5 Ecosystem

An ecosystem is a **few communities** that live together in one habitat and have mutual interaction with one another, including all the non-living components such as water, air and soil.

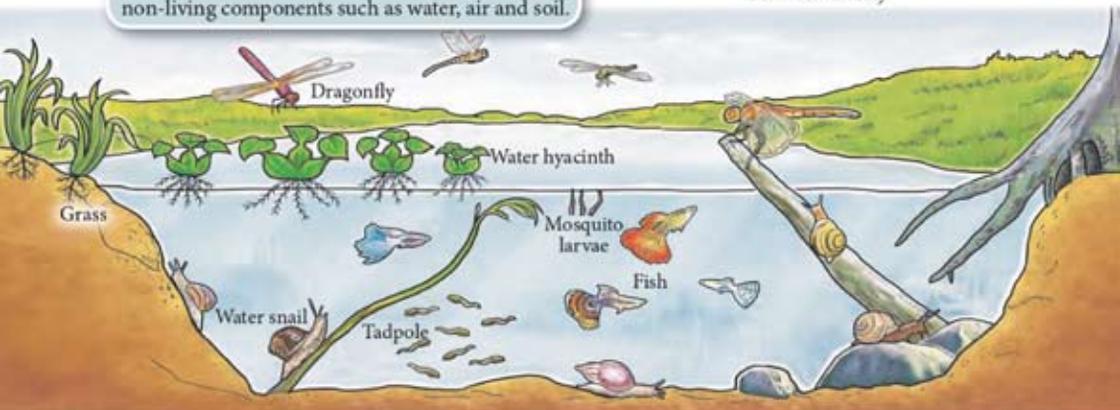


Figure 2.7 Pond ecosystem

A Balanced Ecosystem

Organisms in an ecosystem are interdependent on each other to ensure the survival of the species. These organisms are also interdependent on non-living components in the environment such as **water, light, air and soil**.

The interdependence that exists between organisms and their natural surroundings creates a **balanced** ecosystem. An ecosystem is said to be balanced if the living organisms and non-living components in the environment are in a state of harmony without any external interference. Imagine the state of a forest ecosystem if the trees were cut down. Would this ecosystem still be balanced?



Activity 2.3

STEM

Aim: To study the habitats, populations and communities in an ecosystem.

Instruction

1. Work in groups.
2. Find a natural ecosystem in your area.
3. Conduct an observation of that ecosystem.
4. Take photos and list the species, populations and communities of animals and plants that can be found in that ecosystem.
5. Prepare a folio of the information that you have obtained.

Questions

1. How do different populations obtain food?
2. How do living organisms interact with their surroundings?
3. What are the benefits that exist from the interaction of organisms and their surroundings?
4. Name an organism and predict what will happen if the population of that organism dies.

Career in STEM

A person who is an expert in the study of ecosystems is called an ecologist.

Most natural ecosystems are balanced if there is no external interference. Are man-made ecosystems such as aquariums also balanced?

Brain Teaser

Can you name a few other man-made ecosystems?

Photograph 2.2 Example of a man-made ecosystem (aquarium)

You have already learned that living organisms are interdependent on one another and also on non-living components to create a balanced ecosystem. What is the effect of these non-living components on the distribution of animals and plants? Let us carry out Experiment 2.1.

Experiment 2.1

Aim: To study the influence of temperature, light and humidity on the distribution of organisms.

A The effect of temperature on the distribution of organisms

Problem statement: What is the effect of temperature on the distribution of woodlice?

Hypothesis: Woodlice are more likely to gather in a place with medium temperature.

Variables:

- Constant variables: The number of woodlice, light and humidity
- Manipulated variable: Temperature
- Responding variable: Distribution of woodlice

Materials: Woodlice, hot water and room temperature water ($26^{\circ}\text{C} - 30^{\circ}\text{C}$)

Apparatus: Petri dish with partition, Petri dish lid, wire gauze, pliers and stopwatch

Procedure:

- Pour 20 ml of hot water (50°C) into partition P of a Petri dish and 20 ml of room temperature water ($26^{\circ}\text{C} - 30^{\circ}\text{C}$) into partition Q of the same Petri dish.
- Use a pair of pliers to make a wire gauze mould.
- Place the wire gauze mould on the Petri dish.
- Put 10 woodlice on the wire gauze above the Petri dish and cover with the lid (Figure 2.8).
- Leave the apparatus in an open area in the laboratory for five minutes.
- Record the number of woodlice found in each partition.

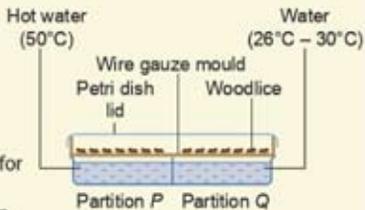


Figure 2.8

Conclusion:

Is the hypothesis accepted? Give your reasons.

B The effect of light on the distribution of organisms

Problem statement: What is the effect of light on the distribution of woodlice?

Hypothesis: Woodlice are more likely to gather in a dark place.

Variables:

- Constant variables: The number of woodlice, room temperature and humidity
- Manipulated variable: Light
- Responding variable: Distribution of woodlice

Material: Woodlice

Apparatus: Petri dish with partition, wire gauze mould, Petri dish lid, black cloth and stopwatch

Procedure:

1. Pour 20 ml of room temperature water into partition R and S of a Petri dish with partition.
2. Use the wire gauze mould made in Experiment A.
3. Place the wire gauze mould on the Petri dish.
4. Put 10 woodlice on the wire gauze mould.
5. Cover the Petri dish lid of partition R with a black cloth (Figure 2.9).
6. Leave the apparatus in an open area in the laboratory for five minutes.
7. Record the number of woodlice found in each partition.

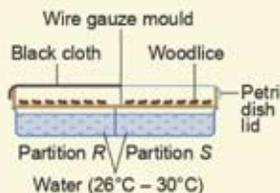


Figure 2.9

Conclusion:

Is the hypothesis accepted? Give your reasons.



The effect of humidity on the distribution of organisms

Problem statement: What is the effect of humidity on the distribution of woodlice?

Hypothesis: Woodlice are more likely to gather in a damp place.

Variables:

- (a) Constant variables: The number of woodlice, room temperature and light
- (b) Manipulated variable: Humidity
- (c) Responding variable: Distribution of woodlice

Material: Woodlice

Apparatus: Petri dish with partition, wire gauze mould, Petri dish lid, anhydrous calcium chloride and stopwatch

Procedure

1. Pour 20 ml of room temperature water (26°C – 30°C) into partition T of a Petri dish.
2. Place anhydrous calcium chloride into partition U of the same Petri dish.
3. Place the wire gauze mould on the Petri dish.
4. Put 10 woodlice on the wire gauze mould.
5. Cover the Petri dish with the lid (Figure 2.10).
6. Leave the apparatus in an open area in the laboratory for five minutes.
7. Record the number of woodlice found in each partition.

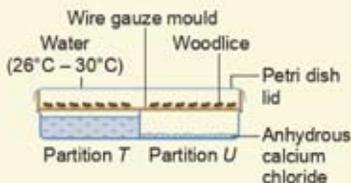


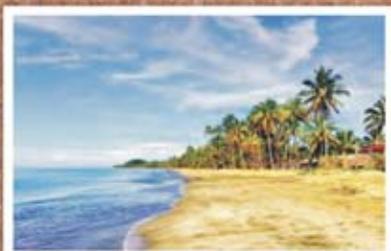
Figure 2.10

Conclusion:

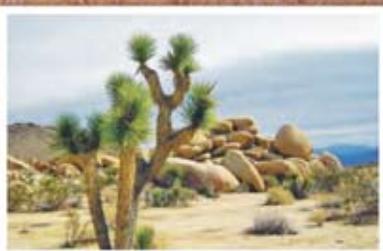
Is the hypothesis accepted? Give your reasons.

Importance of Adaptation of Living Things to the Environment

Tropical areas receive high distribution of rainfall and sunlight throughout the year. Desert areas experience extreme hot and dry weather. Tundra areas experience long winters and short summers. How does wildlife adapt to the climate of their habitat in tropical, desert and tundra areas?



Tropical



Desert



Tundra

Photograph 2.3 Tropical, desert and tundra areas

Activity 2.4

21
Century

Aim: To carry out multimedia presentation on how animals and plants adapt to the climate of their habitats; in desert, tundra and tropics.

Instruction

1. Work in groups.
2. Each group represents one of the three different areas of habitats; desert, tundra and tropics.
3. Collect materials from a variety of media about the habitat.
4. Discuss the adaptation of animals and plants to the climate in their habitats.
5. Present your results using a multimedia presentation.

Interaction between Organisms

Interaction between organisms comprises **symbiosis**, **prey-predator** and **competition**.

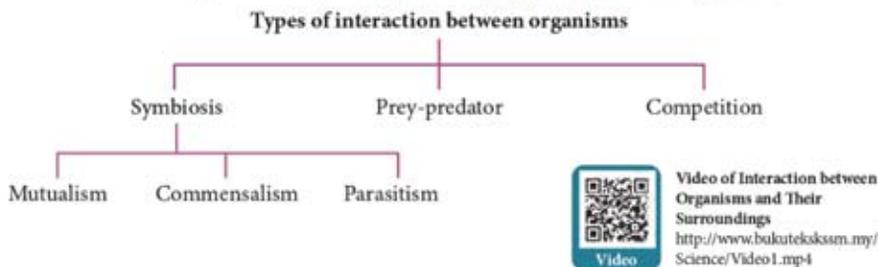


Figure 2.11 Types of interaction between organisms

Symbiosis

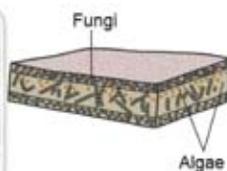
Symbiosis happens when two or more organisms of different species live closely together and interact with one another. Symbiosis includes **mutualism**, **commensalism** and **parasitism**.

Mutualism

- An interaction that **benefits both organisms**. Photograph 2.4 shows a few examples of mutualism.



- The **sea anemone** protects the clown fish from predators and supplies food to it.
- The **clown fish** cleans the sea anemone and provides nutrients to the sea anemone in the form of waste.



- Lichens** are algae and fungi that live together.
- The **fungi** supply water and minerals to the algae.
 - The **algae** carry out photosynthesis and supply food to the fungi.

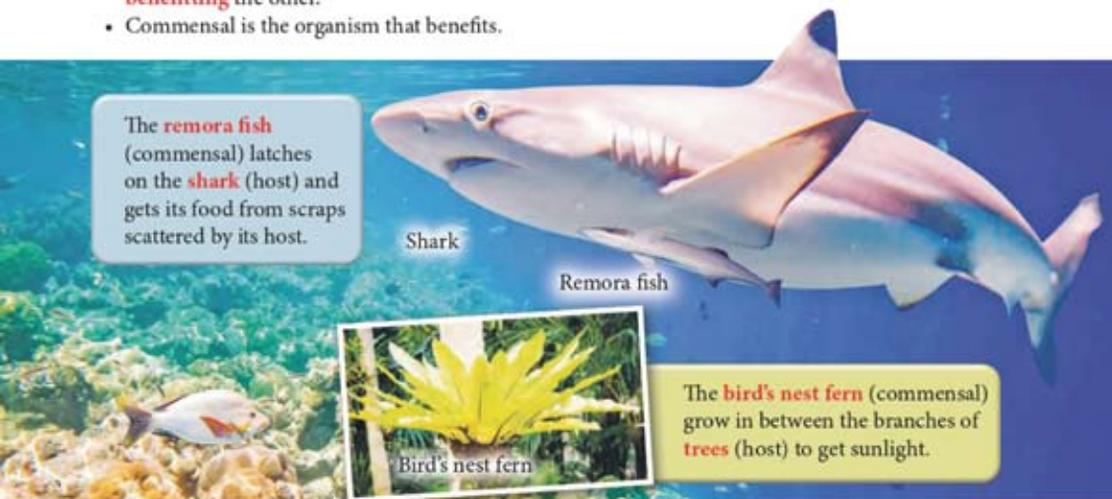


- The **mynah** gets food from the buffalo by eating the lice that stick to the body of the buffalo.
- The body of the buffalo is free of lice.

Photograph 2.4 Examples of mutualism

Commensalism

- The interaction between two organisms which only benefits **one organism without harming or benefitting** the other.
- Commensal is the organism that benefits.



Photograph 2.5 Examples of commensalism

Parasitism

- An interaction that benefits **one organism** only and **harms** the other.
- Parasite is the organism that benefits.
- Host is the organism that is harmed.



The **tapeworm** (parasite) that lives in the **human intestine** (host) absorbs nutrients.

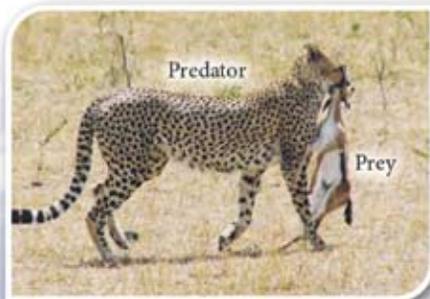


Lice (parasite) suck the blood of **humans** and **animals** (host).

Photograph 2.6 Examples of parasitism

Prey-predator

- Involves one organism that **eats** another organism.
- Prey is the organism that is eaten by the predator.
- Predator is the organism that hunts another organism for food.



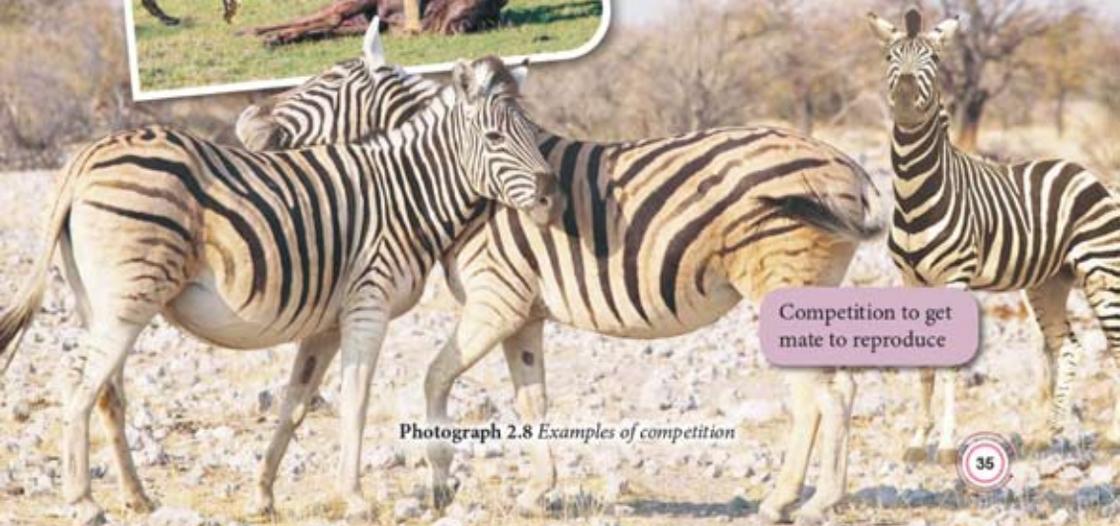
Photograph 2.7 Examples of prey-predator

Competition

- Competition happens when organisms in one habitat **compete** for **limited supply of basic needs** such as light, space, water, food and mates.



Competition to
get food



Competition to get
mate to reproduce

Photograph 2.8 Examples of competition

Biological Control

Biological control is a method that uses organisms that are natural predators, parasites or pathogens to reduce the number of pests in an area. Photograph 2.9 shows examples of biological control that are used in the agricultural sector in Malaysia.



Photograph 2.9 Examples of biological control in Malaysia

Biological control is **more environmental friendly** because it does not use pesticides or chemicals. Apart from this, this method is usually **cheaper** and **does not affect humans' health**. Nevertheless, this method has a few weaknesses such as:

- it **takes a long time** before any effect is seen.
- the **balance of the ecosystem** might be **disrupted** because a new species is introduced into that ecosystem.

Factors that Influence Population Size in an Ecosystem

How does population size change in an ecosystem? Among the factors that cause population size to change is **disease, the presence of predators, source of food and change of weather.**

Disease

The population of animals and plants decreases when a disease strikes. For example, avian flu in poultry-rearing areas and tobacco mosaic virus in tobacco crops.



Photograph 2.10 Poultry affected by a disease



Photograph 2.11 Tobacco crops struck by a disease

Presence of predators

The population size of a living organism is influenced by the population size of its predator. For example, the size of the zebra population in the savanna ecosystem decreases with the presence of its predators such as the lion.



Photograph 2.12 Zebra being eaten by a lion

Source of food

If a food source decreases, animals can be threatened by extinction. For example, panda depends on bamboo as its primary food source. Clearing of forests has caused the destruction of its food source and habitat.

In Malaysia, the crow population has increased due to the abundance of food scraps.



Photograph 2.13 Panda



Photograph 2.14 Crow

Change of weather

Droughts cause soil to become dry and infertile and increase the risk of forest fires. As a result, the population of plants and animals decreases.



Photograph 2.15 Soil becomes dry and infertile

Photograph 2.16 Forest fires resulting from a long drought



Changes in the Ecosystem

Changes in the ecosystem such as limited water supply, animal migration and decrease or increase in population size can upset the balance between populations.

Limited water supply

- Paddy is a plant that requires a lot of water.
- If there is a long drought season, this change in the ecosystem will **upset the balance between populations** in the paddy field.
- The food web will be affected because the population of the producer, which is paddy, decreases.



Photograph 2.17 Insufficient water supply disrupts the ecosystem of a paddy field

Migration



Photograph 2.18 Cattle egret which migrates to Kuala Gula, Perak

- The ecosystem can also change because of animal **migration**, moving from one place to another due to a change of season.
- For example, the **cattle egret** (*Bubulcus ibis*) migrates to Kuala Gula, Perak from September to April every year. As a result, the number of insects such as grasshoppers, crickets, spiders, flies and worms decreases as they are eaten by the egrets.

Change in population size



Photograph 2.19 Overpopulation of beetles destroys crops

- The **size of a population** can decrease or increase because of changes in another population.
- For example, the increase of pests such as beetles and caterpillars causes the population of plants to decrease.



In 2015, the southern region of Russia was attacked by locusts which destroyed crops. Cornfields as wide as 800 hectares were destroyed in just a few hours.



Formative Practice 2.3

1. Fill in the boxes using the choice of answers given.

Habitat

Population

Ecosystem

Community

- (a) A group of goats in a grass field.
- (b) A small pond that has lotus plants, grass, a group of tadpoles, a few fish, ducks and frogs.
- (c) A grass field that becomes the living place of a group of goats.
- (d) A tropical rainforest where there are a variety of plants and animals that are interdependent on one another.

2. Based on the situation below, state the kind of interaction that happens between these living organisms.

Situation	Type of interaction
(a) Two roosters fight to get a mate to reproduce	
(b) A cucumber plant wraps around the branch of a papaya tree	
(c) A rafflesia flower grows on the branch of a live tree	

2.4

Role of Humans in Maintaining a Balanced Nature

Nature is threatened by destruction because of human activities. As such, humans are responsible for conserving and maintaining the balance of nature.

Table 2.1 Effects of human activities on the environment

Activity	Effects
Forest logging	<ul style="list-style-type: none"> Extinction of flora and fauna species Greenhouse effect Soil erosion
Industrialisation	<ul style="list-style-type: none"> Pollution of air, water and soil Greenhouse effect Acid rain
Agriculture	<ul style="list-style-type: none"> Pollution of water due to overuse of pesticides and fertilisers Soil loses minerals due to non-sustainable agriculture
Waste disposal	<ul style="list-style-type: none"> Pollution of water and ground Flash floods Foul odour due to decaying organic waste matter

Steps to solve the effects of human activities on the environment

- Enforce laws

The Forestry Department is always conducting law enforcement activities in all states. For example, carrying out patrols in the forest area, using helicopters and having road blocks to monitor the movement of timber-carrying lorries.

- **Increase public awareness**

In schools, students are instilled with good values through Moral Education to appreciate the balance of nature. These good values are also instilled through mass media such as newspapers, radio and television.

- **Practise Refuse, Reduce, Reuse, Recycle, Repurpose (5R)**

The practice of **refuse** (not to use non-recyclable materials), **reduce** (reduce the number of materials to use), **reuse** (reuse the materials), **recycle** (recycle materials) and **repurpose** (use the materials for other uses) can reduce the waste materials.

- **Use biological control**

Avoid the use of pesticides that pollute the air and soil by carrying out biological control in agriculture.



Activity 2.5

STEM

21st Century

Aim: To carry out a role play to discuss the importance of humans to manage and ensure the sustainability of life.

Instruction

1. Work in groups.
2. Each group has to choose one of the following environmental issues in Malaysia:
 - (a) waste management system
 - (b) flood dam project
 - (c) forest management
 - (d) haze
3. Identify several agencies or stakeholders and public to solve the selected environmental issue.
4. Organise a forum to discuss:
 - (a) the cause of the environmental issue
 - (b) the effect of the environmental issue on the local community
 - (c) solutions for the issue
5. Each group member must represent the roles of agencies, stakeholders and the public in the forum.

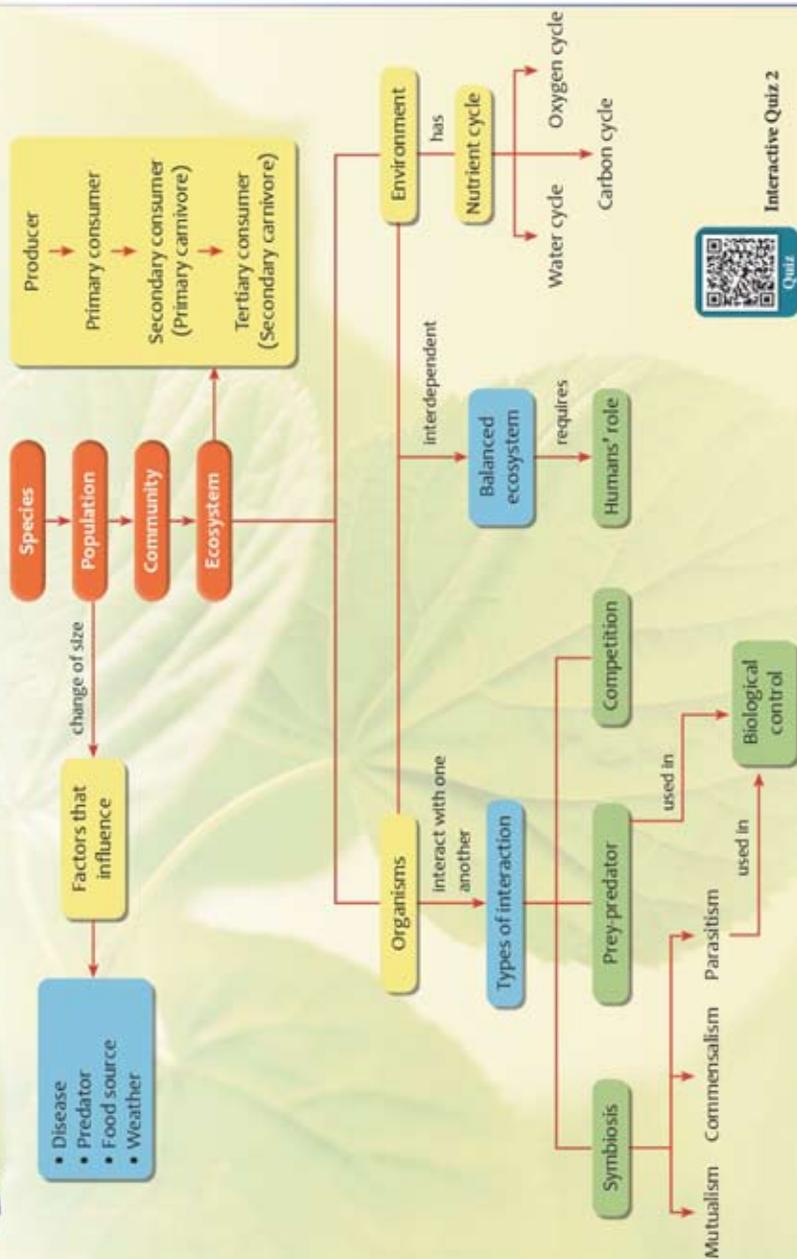
Career in STEM

An environmental consultant cares for the environment from a science and technology aspect to make it sustainable.

Formative Practice 2.4

1. List four human activities that can destroy the ecosystem.
2. State two effects for each of the following activities to the balance of nature.
 - (a) Deforestation
 - (b) Industrialisation
 - (c) Agriculture
 - (d) Waste disposal
3. Mr. Lim wants to start a sustainable oil palm plantation. In your opinion, how can Mr. Lim control the rat population that frequently destroys crops?
4. Haze happens more frequently in our country. State:
 - (a) the cause of haze
 - (b) the effects of haze on people and the environment
 - (c) the steps to be taken to avoid haze from happening
5. Give two reasons why humans need a balanced ecosystem.

Summary



Interactive Quiz 2



SELF-REFLECTION

After learning this chapter, you are able to:

2.1 Energy Flow in an Ecosystem

- Explain through examples; producer, consumer and decomposer.
- Interpreting food chains and food webs.

2.2 Nutrient Cycle in an Ecosystem

- Elaborate and communicate the role of living things in oxygen and carbon cycles in an ecosystem.
- Justify the role of organisms in water cycle in an ecosystem.
- Solve problems when there is an interference to the cycles due to human activities.

2.3 Interdependence and Interaction among Organisms, and between Organisms and the Environment

- Explain through examples interdependence among living things and the environment in maintaining a balanced ecosystem.
- Justify the importance of adaptation of living things to the environment.
- Communicate through examples the interaction between organisms and apply these interactions in daily life.
- Separate the factors that affect the size of population in an ecosystem.
- Predict how the changes in ecosystem affect resources and balance of population.

2.4 Role of Humans in Maintaining a Balanced Nature

- Justify and communicate why humans need a stable and productive ecosystem for the sustainability of life.

Summative Practice 2

1. Based on the food web in Figure 1, answer the following questions.



Figure 1

