BIOLOGY

Looking at Plants and Ecosystems

Ideas you have met before

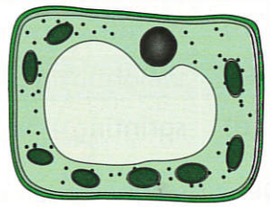
Plants

Green plants need water and nutrients from the soil in order to grow. They make food in their leaves by photosynthesis using light energy.

Flowers contain pollen. Pollination is the first stage in fertilisation. It occurs when pollen is transferred from the anther to the stigma.

Insects have an important role in pollination.

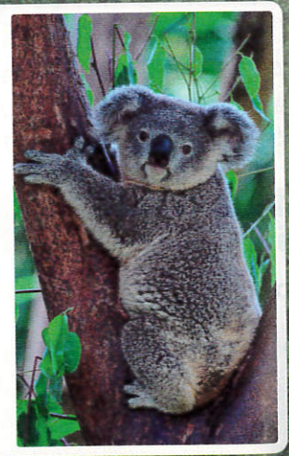
Cells



Cells are the basic building blocks of all plants and animals.

Plant cells have all the parts that animal cells have, but they also have chloroplasts containing chlorophyll, which capture light energy from the Sun for photosynthesis.

The environment



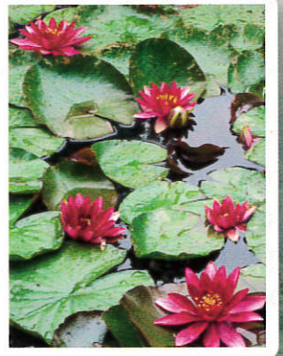
Animals and plants are adapted to the conditions of the habitats in which they live. Their adaptations help them to survive.

All living things also depend on one another to survive. A food chain shows how each living thing gets food and energy.

Humans can affect the environment both in positive ways, (for example, by creating nature reserves) and in negative ways (for example, by depositing huge quantities of rubbish and litter).

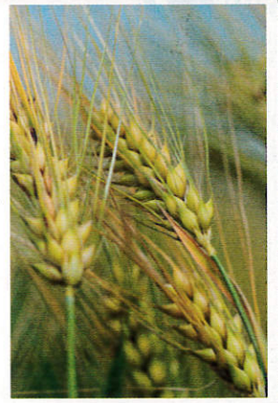
In this chapter you will find out

Healthy plants



- Plants have adaptations that allow them to survive and grow, for example stomata in the leaves.
- Plants have a network of vessels that transport water and minerals to their leaves and flowers.
- Healthy plants need certain essential minerals. Without these minerals they show symptoms of mineral deficiency.

Producers



- Food chains usually start with a green plant, called a producer.
- The amount of photosynthesis that takes place in a plant is affected by various factors, including the levels of carbon dioxide, light, water and temperature.
- Some organisms that have no chlorophyll are also able to make their own food. They do this by chemosynthesis, using different chemicals in their environment.

Relationships in the environment

- All organisms are affected by the conditions in their environment and are dependent on one another.
- The relationships between organisms take different forms. In some relationships, both organisms benefit; in others, only one benefits or one even suffers harm.
- In any environment there are many interlinked food chains. These can be disrupted by factors such as toxins entering the food chain or disease.
- Some feeding relationships are very important to human survival, and we need to protect the organisms involved.
- Almost every human activity affects organisms in their habitats, very often in a negative way.

Understanding the importance of plants

We are learning how to:

- Identify the importance of plants to life on Earth.
- Use evidence to explain that plants do not use soil to grow.
- Evaluate secondary data to start to explain how plants make food.

A huge variety of plants grow on land and in water. Throughout the world humans plant, cut down and replant trees. They also cultivate many types of plant. Why do we grow plants? Why are plants so important to us?

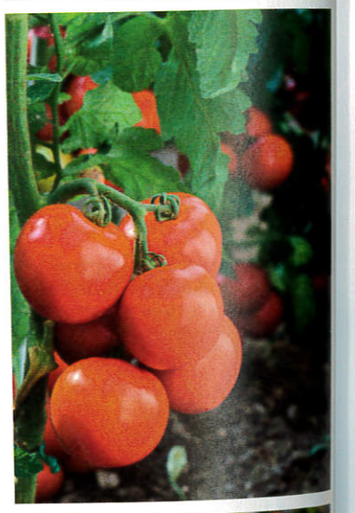


FIGURE 2.2.2a: How do we use these plants?

Useful plants

Plants allow us to survive. We use plants every day for food. All food is either a plant or comes from an animal that has eaten plants. Some plants give us raw materials for fabrics, building and fuel; others are used in medicine. We even use plants as decoration in our gardens, homes and parks.

Plants:

- remove **carbon dioxide** from the atmosphere
- release **oxygen** into the atmosphere.

1. List the ways that we use plants.
2. Describe the ways that we use plants. Give at least one example for each use.
3. Explain why plants are essential to the survival of life on our planet.

Plants and soil

Small seeds grow over many years into very large trees. Up until the 1600s, most scientists thought that plants grew by taking in solid materials from the soil. The Belgian scientist Jan Baptist van Helmont (1580–1644) devised a plan to test this idea. He did an experiment that involved growing a willow tree in a large pot of soil.

Before the experiment, van Helmont measured the mass of the soil and the tree. He covered the soil with a transparent lid, but watered the plant regularly. After five years he again measured the mass of the soil and the tree. The results he obtained were similar to those in Figure 2.2.2b.

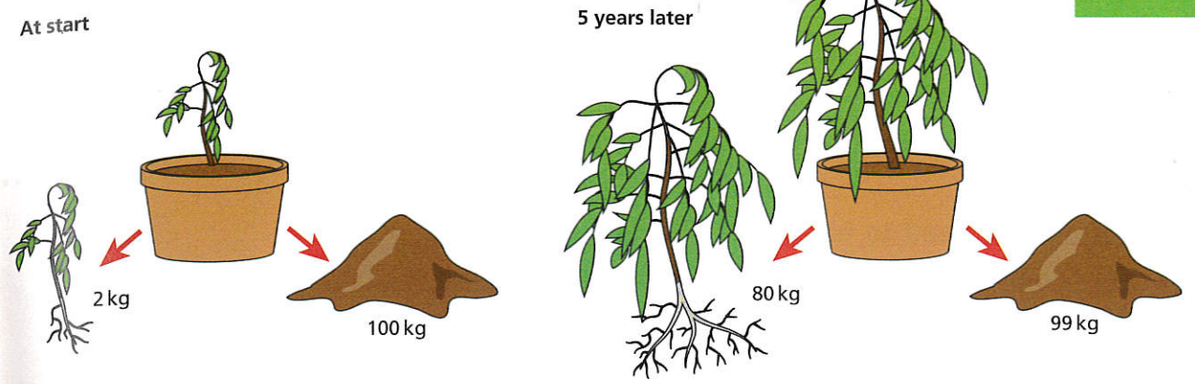


FIGURE 2.2.2b: Van Helmont's experiment

4. List five variables that might affect this experiment.
5. **a)** What was the change in the mass of the tree?
   b) What was the change in the mass of the soil?
6. Explain how this experiment suggested that plants did not grow by taking in solid materials from the soil.
7. **a)** What other explanations could there be for the results van Helmont found?
   b) How could van Helmont's experiment be improved?

Special plants

J.B. van Helmont concluded that all of the wood, bark and roots that had grown during the experiment must have come by the plant using only water.

We now know much more about how plants grow. Look at the plants shown in Figure 2.2.2c, the water hyacinth. Its roots are not anchored in soil but are free-floating.

8. What conclusions can you draw from this information?
9. Is this sufficient information to support van Helmont's conclusion that plants do not use soil to grow?
10. Why did van Helmont cover the pot with a lid?

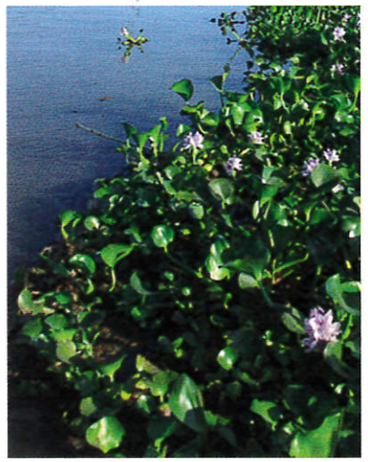


FIGURE 2.2.2c: Water hyacinths grow in fresh water.

Did you know...?

'Hydroponics' is a method of growing plants in water using mineral nutrient solutions. The roots are not kept in soil.

Key vocabulary

carbon dioxide

oxygen

Exploring how plants make food

We are learning how to:

- Identify the reactants and products of photosynthesis.
- Plan and predict the results of investigations.
- Evaluate the risks of a procedure.

Plants do not need to eat other plants or animals to get their food. They make food using materials around them. What do they use to make food? How do they do it?

Making food

Green plants use water from the environment and carbon dioxide from the air to make the sugar **glucose**. Light from the Sun provides the energy needed for the reaction. This process is called **photosynthesis**. The reaction also produces oxygen, which is released into the air during the daytime.

$$\text{carbon dioxide} + \text{water} \xrightarrow{\text{light}} \text{glucose} + \text{oxygen}$$

The plant uses the glucose for new growth and respiration and also stores unused glucose as a carbohydrate called **starch**.

1. **a)** Name the reactants in photosynthesis.
   b) Name the products of photosynthesis.
2. Why does photosynthesis not happen at night?
3. What will happen to the amount of carbon dioxide in the air during daylight?
4. Why is light not a reactant or a product in the reaction?

FIGURE 2.2.3a: These trees are giving out oxygen. Why is it important to conserve our trees?

Checking the evidence

You can show that a plant has photosynthesised by testing its leaves for starch. This is done using a chemical called **iodine**. Iodine is an orange colour, but it turns blue-black when added to starch.

First, the leaf needs to be boiled in ethanol and then rinsed in warm water. This kills the cells and removes the green colour. Iodine is then added. If the leaf become blue-black, then starch is present, showing that photosynthesis has taken place.

Did you know...?

'Biomass' is the total mass of an organism. As plants photosynthesise and grow, their biomass increases.

leaf after extracting green colour

leaf after iodine is added

FIGURE 2.2.3b: Testing a leaf for starch: when a green leaf is boiled in alcohol the green colour is extracted. When iodine is added the leaf will turn blue-black if starch is present.

5. **a)** A leaf has been kept in the light for five days. What colour will it be when tested with iodine?
   b) The leaf is then kept in the dark for five days. Now what colour will it be when tested when with iodine? Explain your answer.
6. A leaf has been kept in a sealed jar without carbon dioxide for five days. What colour will it be when tested with iodine?

The importance of green leaves

Leaves have a green colour because they contain a pigment called **chlorophyll** that absorbs light energy. Chlorophyll is found in the chloroplasts in plant cells. Look at the plant in Figure 2.2.3c. Some parts of its leaves are green and some parts are white.

Think about the process for testing a leaf for starch. Like most activities, this process is not entirely free of risk. You have to judge which risks are greatest and reduce these to a level that can be managed by sensible, safe behaviour.

7. What do think would happen if you tested a leaf from the plant in Figure 2.2.3c for starch? Explain your answer.
8. What are the risks in the test for starch and how can they be controlled?

FIGURE 2.2.3c: This plant has variegated leaves.

Key vocabulary

glucose
photosynthesis
starch
iodine
chlorophyll

Looking at leaves

We are learning how to:

- Relate the size of a leaf to the availability of light.
- Relate the function of the leaf to its structure and the types of cell.
- Evaluate the structure of a cell related to its function.

Leaves are one of the major organs in a plant. They have a complex structure that allows them to photosynthesise and make glucose. What is special about leaves? How are they able to capture the Sun's energy to make food for the plant?

FIGURE 2.2.4a: Leaves have many different shapes and sizes, but they all have some features in common with each other.

How are leaves adapted?

Leaves have features that allow them to photosynthesise efficiently. Typically, leaves are thin, flat, broad, green and have a network of veins. They all contain a pigment called chlorophyll, which absorbs the Sun's energy and enables the plant to photosynthesise. Scientists use a technique called chromatography to look at chemicals in the pigment. The leaves are ground up, and the pigments are separated using a solvent. The pigments in chlorophyll are green and different shades of yellow.

1. What features do leaves have in common?
2. Why do leaves have these features?
3. What cells have you studied that are found in leaves?

Observing leaves

Look at the photograph in Figure 2.2.4a. It shows different types of plants growing to different heights.

Water lilies (Figure 2.2.4b) grow in fresh water. Their leaves float on the surface of the water.

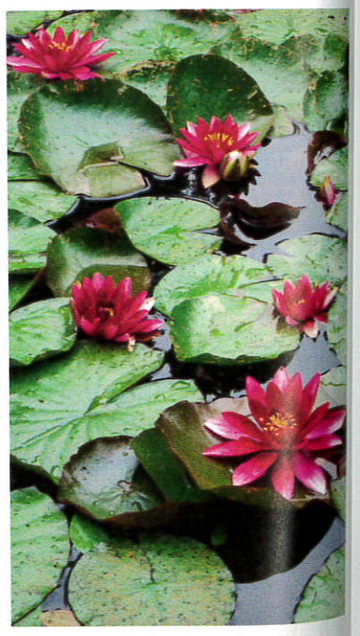


FIGURE 2.2.4b: Look at these leaves. How are they adapted to carry out their function?

The internal structure of a leaf is also adapted to allow it to photosynthesise efficiently. Look carefully at Figure 2.2.4c.

Leaves have:

- a waxy waterproof **cuticle**
- a transparent **epidermis**
- long, narrow **palisade cells** packed with chloroplasts, mainly at the top of the cells
- **spongy cells** that have a large surface area and large spaces between them.

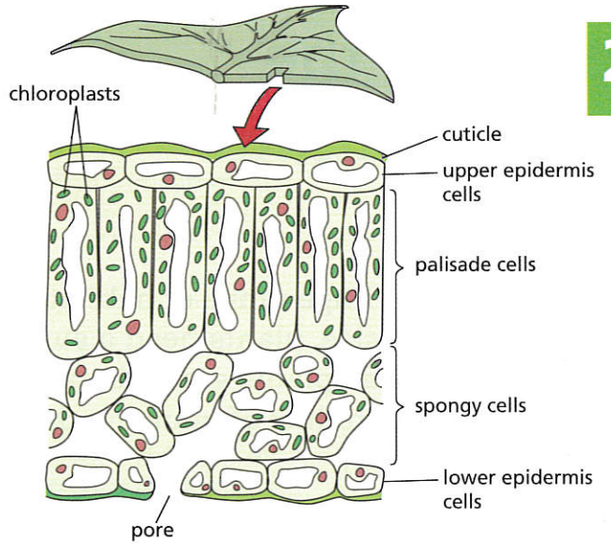


FIGURE 2.2.4c: Section through a leaf showing the different types of cell

4. What do you notice about the size of the leaves growing at different heights in the forest?
5. Why is this important to the plants that grow to these heights?
6. What does this tell you about the leaves?
7. How do gases move in and out of a leaf?
8. Name the different types of cells in a leaf and describe their features.

Evaluating leaf adaptations

Look closely at the different types of cells in the leaf section shown in Figure 2.2.4c. Each cell type has special adaptations to help it perform its function and maximise the amount of photosynthesis taking place.

- Light passes through the cuticle and epidermis until it reaches the palisade cells.
- The palisade cells absorb as much light as possible, to ensure that the rate of photosynthesis is as high as possible.
- The spongy cells capture the remaining light.
- Their surface area and the air spaces allow gases to diffuse through the leaf.

9. Evaluate the adaptations of each type of cell. How do these adaptations ensure that the cells perform their function efficiently?

Did you know... ?

Diatoms are microscopic plants that live in water all over the Earth. They are responsible for providing 20 per cent of the oxygen added to the atmosphere by plants.

Key vocabulary

cuticle
epidermis
palisade cell
spongy cell

SEARCH: leaf adaptations for photosynthesis

Exploring the role of stomata

We are learning how to:

- Describe how stomata control gas exchange.
- Explain how gas exchange occurs in leaves.
- Analyse how stomata density is affected by different conditions.

Plants are found in a huge range of habitats. In order to photosynthesise, plants need a supply of carbon dioxide. How do plants get carbon dioxide? Why does oxygen, a product of photosynthesis, not build up in the leaf?

How do plants get the carbon dioxide they need?

Look again at Figure 2.2.4c. Land plants have **pores** (holes) on the underneath surface of their leaves. These pores can open and close to control materials that flow in and out of the leaf. You can see these in Figure 2.1.13c of Topic 1.13. These special structures are called **stomata** (the plural of **stoma**). When a plant needs carbon dioxide, the stomata open, allowing the gas into the leaf. Two **guard cells**, one on either side of each stoma, control the opening and closing of the stoma.

1. What are stomata and where are they found?
2. Describe how gases pass in and out of a leaf.
3. What is the name of the cells that control the size of the stomata?

FIGURE 2.2.5a: Look at this picture. What shape are the guard cells?

Observing stomata

Guard cells have chloroplasts and can photosynthesise. When the guard cells are full of water, they open the stomata.

As the plant takes in carbon dioxide (CO_2) from the air, oxygen (O_2), a waste product of photosynthesis, is removed through the stomata. At the same time, water escapes from the plant. A stoma cannot stay open because the guard cells shrink back as the water escapes, and so the stoma closes.

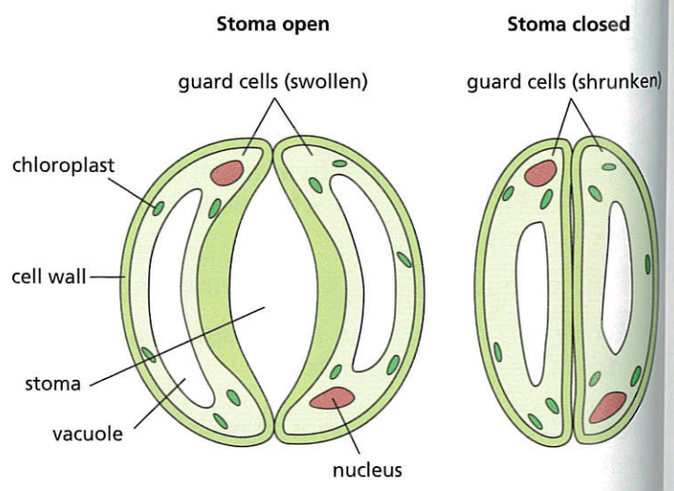


FIGURE 2.2.5b: Open and closed stomata

4. Why must guard cells come in pairs?
5. Draw an annotated diagram to explain how stomata control the flow of substances in and out of the leaf.
6. Explain why stomata are found on the underside of leaves.

Density of stomata

Look closely at the photographs of stomata from different plants in Figure 2.2.5c. The number of stomata varies depending on environmental factors, such as the concentration of carbon dioxide and the humidity of the air.

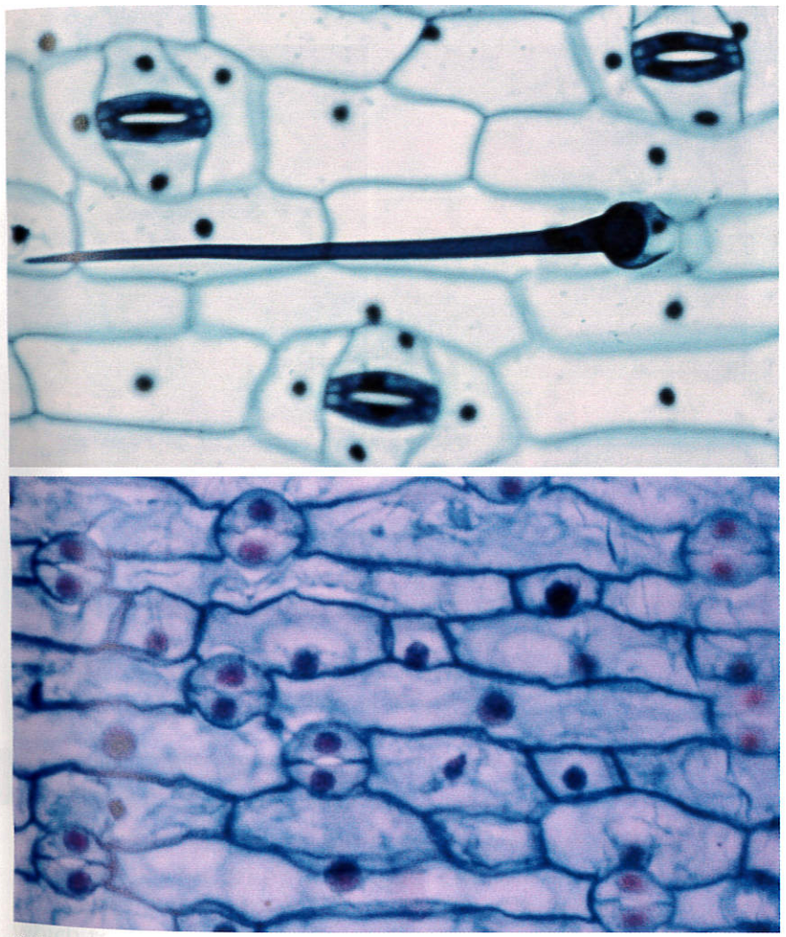


FIGURE 2.2.5c: Stomata from different plants: one with low stomatal density and one with high stomatal density

7. Suggest two other environmental factors that will affect the number of stomata
8. Describe how environmental factors would affect the number of stomata.

2.5

Did you know... ?

Plants respire just as animals do. They respire all day and all night, but only photosynthesise during the hours of daylight.

Key vocabulary

pore

stomata

stoma

guard cell

Investigating photosynthesis

We are learning how to:

- Identify the factors that can affect photosynthesis.
- Predict results of investigations.
- Interpret secondary data about photosynthesis.

Photosynthesis happens in all green plants. In this process the plant uses raw materials in the environment to make glucose. What factors can affect how fast a plant photosynthesises? How will these factors affect photosynthesis?

Photosynthesis

Green plants all over the world use carbon dioxide and water from the environment to make glucose and then carbohydrates. Glucose is needed for the plants to grow and increase their biomass. Plants in some habitats grow at a much faster **rate** than others. For example, mosses growing in cold tundra habitats grow very slowly, whereas plants in the rainforest grow much more quickly.

FIGURE 2.2.6a: Will these trees photosynthesise at the same rate?

1. Write the word equation for photosynthesis.
2. What factors will affect how much photosynthesis takes place in a plant?
3. Look at Figure 2.2.6a. Will these trees photosynthesise at the same rate? Explain your answer.

Factors affecting photosynthesis

The **concentration** of carbon dioxide in the air will affect the rate of photosynthesis. Carbon dioxide and water are the reactants in the reaction – the higher the amount of the reactants, the greater the amount of photosynthesis, as shown in Figure 2.2.6b.

Choloropyhll in the chloroplasts absorbs light energy. The more choroplasts a leaf has, the more light it can absorb to carry out more photosynthesis.

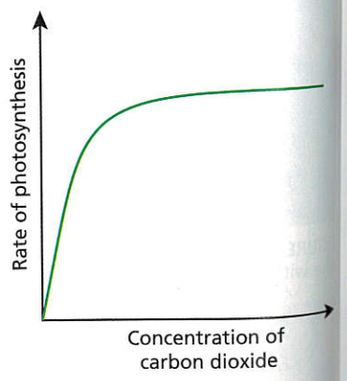


FIGURE 2.2.6b: How does the concentration of carbon dioxide affect photosynthesis?

A student is carrying out an investigation to see how the amount of light a plant receives affects the rate of photosynthesis. She uses some pondweed with the apparatus shown in Figure 2.2.6c. She counts how many bubbles of oxygen are given off by the pondweed in one minute, at different distances from a lamp.

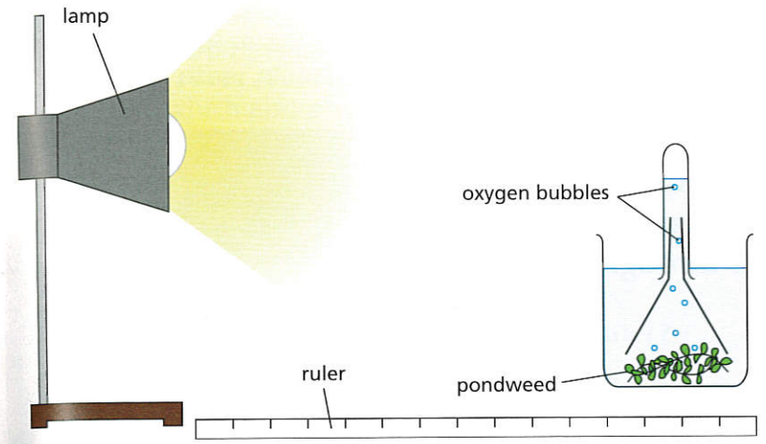


FIGURE 2.2.6c: Apparatus used in an investigation to see the effect of light on photosynthesis

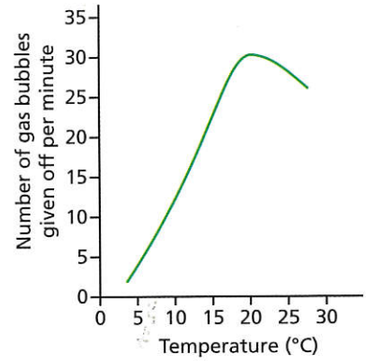


FIGURE 2.2.6d: Results of the investigation

4. How do we know that plants photosynthesise less in winter than in summer?
5. How does the amount of light available to a plant affect the rate of photosynthesis?
6. How does temperature affect the rate of photosynthesis?
7. **a)** Why does the student think that counting bubbles is a good way to measure photosynthesis?
   b) What variables does the student need to control?
   c) What errors might occur in the investigation?

Interpreting data

A student's grandfather wants to grow tomatoes as quickly as possible in his greenhouse over the winter. The student carries out an investigation to find the temperature at which tomatoes photosynthesise the most.

8. Using the investigation results to help you, explain how the rate of photosynthesis changes from dawn to nightfall.
9. What is the best temperature for the student's grandfather to use in his greenhouse? Explain why.

Did you know...?

Rainforests produce over 20 per cent of the Earth's oxygen. This is why it is so important to look after them and stop the trees being destroyed.

Key vocabulary

rate

concentration

Exploring the movement of water and minerals in plants

We are learning how to:

- Identify how water and minerals move through a plant.
- Explain how water and minerals move through a plant.
- Evaluate the cell structures that allow the movement of water and minerals through a plant.

Water is needed in cells to support the plant and to photosynthesise. Minerals in the soil dissolve in water. How do plants get the water and minerals they need? How do they move through the plant?

Taking water in

Plants take in water and dissolved minerals through their roots. The roots grow downwards and can also spread out underground to absorb water and minerals from a large area. Roots anchor plants firmly in the ground.

Water and minerals move from the roots, up the stem or tree trunk to the leaves and flowers. Water in plant cells causes them to swell and become rigid.

1. Name two functions of the roots.
2. Look at Figure 2.2.7b. Why do these plants have differently shaped roots?
3. Why does water move to the leaves?

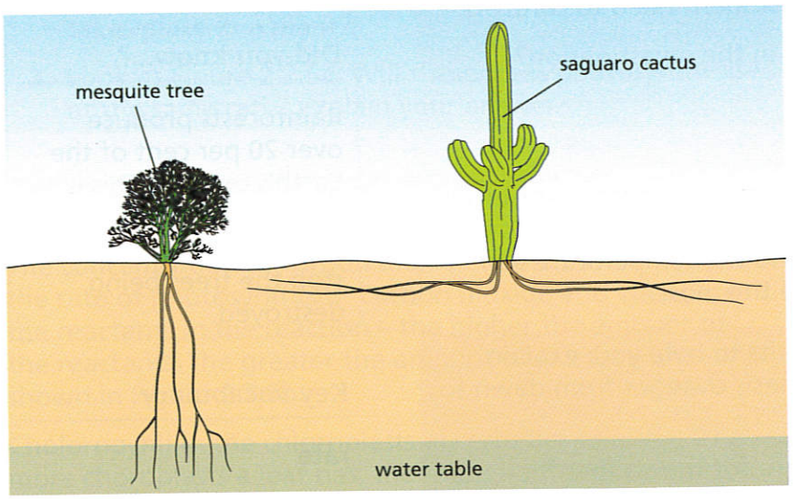


FIGURE 2.2.7b: Plants native to the Sonoran Desert in the Western USA. Why do these plants have differently shaped root systems?

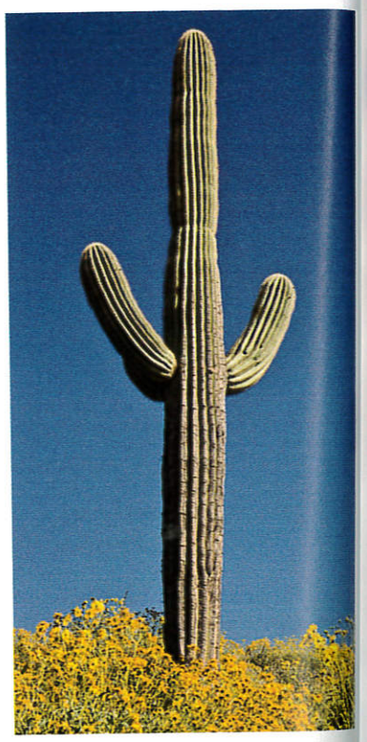


FIGURE 2.2.7a: The saguaro cactus

FIGURE 2.2.7c: How is the saguaro cactus adapted to prevent water loss?

Keeping the water

Plants can lose water from the leaves through the stomata, which let in carbon dioxide. Stomata close in hot conditions.

The loss of water from a leaf is called **transpiration**. Plants lose most water when it is dry, hot and windy. Leaves have a waxy cuticle to prevent water loss (see Figure 2.2.4c). The cuticles of desert plants are much thicker and waxier compared to other plants. Their leaves are often small or needle-like, which also prevents too much water loss.

Some plants have curled or folded leaves. The curl reduces the surface area of the leaf. It also traps moist air to help reduce transpiration further.

4. What is transpiration?
5. In what conditions will plants lose least water?
6. Describe how plants can reduce water loss.
7. Draw a diagram to show the movement of water through a plant.

Looking at cells

Water and minerals move from the roots up the plant, in a series of cells in the stem. These **xylem cells** form a pipeline through the plant.

The roots of the plant have special cells called **root hair cells**. These have long, hair-like extensions that penetrate between the soil particles. They have a large surface area through which they can absorb water.

The guard cells are also important for controlling water loss (see Topic 2.5). When the guard cells are swollen with water, they open the stomata to let excess water leave the leaf. When the guard cells contain little water, they close the stomata.

FIGURE 2.2.7e: How are these xylem cells adapted to their function?

8. How effective are the adaptations of xylem, stomata and root cells for transpiration?

2.7

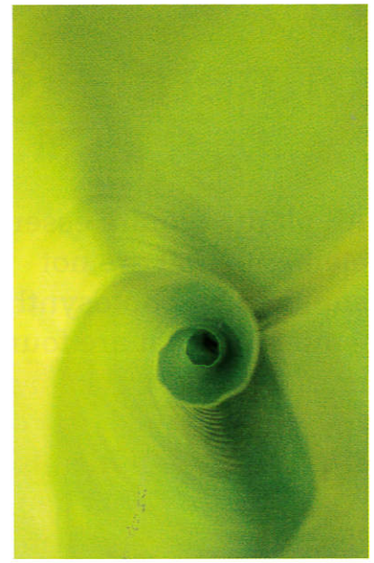


FIGURE 2.2.7d: Some plants have curled or folded leaves to reduce water loss.

Did you know...?

The tallest plants in the world are the giant redwood trees in California. They can reach over 100 m in height. Water travels in the xylem cells from their roots right up to the highest leaves.

Key vocabulary

transpiration

xylem cells

root hair cell

Investigating the importance of minerals to plants

We are learning how to:

- Identify the minerals essential to healthy plant growth.
- Explain the effects of a deficiency in essential minerals.
- Evaluate the limitations of evidence.

All plants require essential elements that are not supplied by photosynthesis – minerals that are found in soil and absorbed by the plant through its root system. What minerals do plants need? What happens if they do not get them? How can we help plants that we grow to get the minerals they need?

FIGURE 2.2.8a: Are these plants healthy? How do you know?

Mineral deficiency

Poor plant growth may be due to a deficiency, or shortage, of one or more minerals.

- Plants that do not have enough nitrates have poor growth and yellow leaves.
- Plants with too little magnesium cannot make chlorophyll.
- Phosphorus **deficiency** causes poor root growth and discoloured leaves.

1. What is a mineral deficiency?
2. Predict how a plant would grow if it had a lack of magnesium.

Essential minerals

When plants photosynthesise, they make glucose from carbon, hydrogen and oxygen. To convert these to protein, the element nitrogen must be added. Most plants obtain their nitrogen from the soil in the form of nitrates.

FIGURE 2.2.8b: What do plants need to be healthy?

Minerals are needed to make proteins, chlorophyll and energy-storage molecules. Not all minerals have the same importance for the plant. The major minerals that plants use in large quantities are called 'macroelements'. Phosphorous, potassium and nitrogen are the main macroelements. Others are sulfur, calcium and magnesium.

3. Explain how plants get the minerals they need.
4. What are macroelements?
5. Name the three main macroelements.

Putting it right

Farmers grow many plants in specially selected fields. As the plants grow, they extract nutrients from the soil. Because the farmer harvests the crops from the fields, the soil becomes depleted of nutrients.

Tests can be done to establish which minerals are deficient, or a general purpose NPK **fertiliser** or **manure** can be added to the soil. (N, P and K are the symbols for the three macroelements:
N = nitrogen;
P = phosphorus;
K = potassium.)

FIGURE 2.2.8c: Fertilisers contain NPK.

FIGURE 2.2.8d: Why do farmers use fertilisers?

Commercial fertilisers release minerals quickly into the soil for the plants. However, they can get into waterways and cause algae in the water to grow very quickly. Many farmers prefer to use manure because it is natural, improves soil quality and releases the minerals much more slowly than commercial fertilisers. This means that manure has longer-term effects.

6. What is a fertiliser?
7. What is in an NPK fertiliser?
8. If farmers have fertile healthy soil, why do they need to use fertilisers?
9. Why do you think some farmers use manure and some use commercial fertilisers?

Did you know... ?

Many zoos sell elephant dung as manure. The nutrient-rich manure improves nutrient-depleted soils, helping farmers to ensure good soil for planting crops in.

Key vocabulary

deficiency

fertiliser

manure

Investigating chemosynthesis

We are learning how to:

- Describe how ocean vent communities survive.
- Describe the adaptations of tube worms.
- Compare and contrast chemosynthesis and photosynthesis.
- Evaluate models of chemosynthesis and photosynthesis.

Most living organisms depend on sunlight as their ultimate source of energy. Green plants use sunlight to make food by photosynthesis. In the darkness of the ocean depths there is no sunlight, but many organisms live there. How do living organisms survive in this environment?

Chemosynthesis

Scientists once thought that green plants were the only organisms able to make their own food (known as producers). Green plants use light energy to make food by photosynthesis.

Scientists now know that some bacteria are also able to make their own food. They can use energy from chemicals to make food by a process called **chemosynthesis**. Both methods involve an energy source, carbon dioxide and water and both produce sugars. Photosynthesis gives off oxygen gas as a byproduct, while chemosynthesis produces sulfur.

Chemosynthesis is the life-sustaining process in deep-sea communities where sunlight does not penetrate.

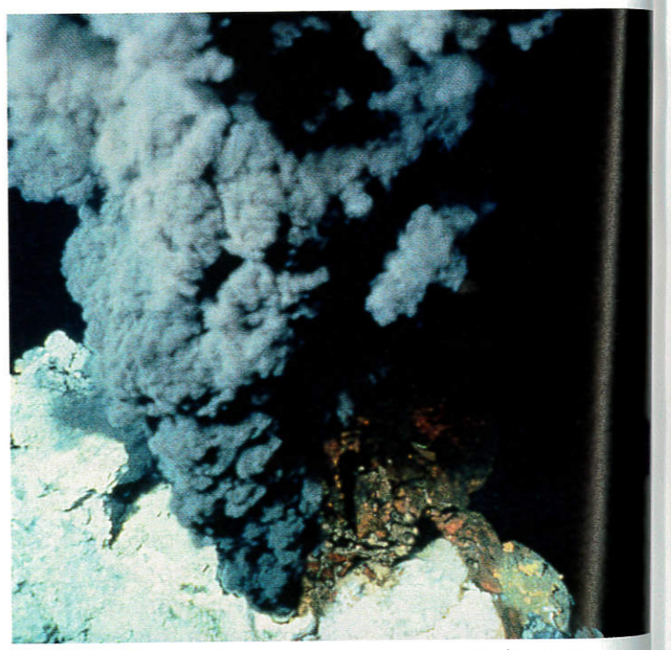


FIGURE 2.2.9a: In a hydrothermal vent, very deep in the ocean, communities of organisms survive without sunlight.

Photosynthesis:
carbon dioxide + water → glucose + oxygen

Chemosynthesis:
carbon dioxide + water + oxygen + hydrogen sulfide → glucose + sulfuric acid

1. Explain how chemosynthesis and photosynthesis are similar.
2. Explain how chemosynthesis and photosynthesis are different.

Chemosynthesis vs photosynthesis

Hydrothermal vents form where there is volcanic activity on the ocean floor. Cold seawater (2 °C) seeps through cracks in the floor and is heated by molten rock (up to 400 °C). The hot fluid gushes out of the vent, carrying dissolved metals combined with sulfur to make metal sulfides.

The fluid also contains many bacteria adapted to live in very high temperatures. The bacteria absorb hydrogen sulfide, oxygen and carbon dioxide from the water. They break down the hydrogen sulfide to get energy, which they use to convert carbon dioxide into sugars. The bacteria are the producers – they are the food source on which all the other vent animals ultimately depend. Food chains and food webs are covered more fully in Topic 2.11.

Billions of chemosynthetic bacteria can be found living inside giant tubeworms. The tubeworms use some of the sugars produced by the bacteria as food, and they provide the bacteria with hydrogen sulfide and oxygen that they take up from the water. Both organisms benefit. The tubeworms have a coat made from chitin (a tough, protective substance derived from glucose).

3. Describe how bacteria near hydrothermal vents get the food and energy they need.
4. Why are these bacteria so important?
5. Explain how tubeworms and bacteria help each other to survive.

Life on Mars?

Some scientists believe that life on Earth may have started in the sulfurous environment around the hydrothermal vents. They have proposed that many of the basic molecules needed to start life could have formed in vents just below the surface of the ocean floor (by the interaction of the rock and the circulating hot water).

This hypothesis has also helped space scientists to develop their ideas. They hope that they might find life elsewhere in the Solar System.

6. Explain why chemosynthesis may be more likely to support life on distant worlds than photosynthesis.
7. Explain how some scientists believe life on Earth may have started.

FIGURE 2.2.9b: A tubeworm.

Did you know...?

Our knowledge of chemosynthetic communities is relatively new. They were found during ocean exploration and first observed in 1977.

FIGURE 2.2.9c: What kind of life could exist on Mars?

Key vocabulary

chemosynthesis

hydrothermal vent

Applying key ideas

You have now met a number of important ideas in this chapter. This activity gives an opportunity for you to apply them, just as scientists do. Read the text first, then have a go at the tasks. The first few are fairly easy – then they get a bit more challenging.

Down at the allotment

Ben has an allotment. An allotment is a plot of land that can be rented by a person to grow fruit and vegetables for their own use. Allotment plots come in many different shapes and sizes. Ben's allotment has a greenhouse.

Ben grows many different types of vegetables outside: carrots, potatoes, onions, leeks, cabbages, beans, lettuces and tomatoes. He also grows cucumbers, courgettes and tomatoes in his greenhouse.

Ben has had his allotment for a long time and grows his crops every year. He cannot use the farming practice of growing crops in different places every year, but he tries not to grow the same crop in the same place more than two years in a row. During spring he digs in well-rotted manure that he buys from the local farm. Not only does the manure fertilise the soil, it also conditions it.

Ben's friend, Joe, has an allotment too. He grows his vegetables in the same place every year, but the plants are not as healthy as Ben's – even though the allotments are next to each other. His plants never produce as many vegetables and they are always much smaller than Ben's. Joe cannot understand why this happens.

Ben has noticed that his outdoor tomato plants never produce as many tomatoes as his greenhouse plants, and they also take much longer to grow outside. Some years he gets no tomatoes from the plants that are outside. Tomatoes grown outside cannot be planted until the temperatures are warm enough, especially at night. Also, when it rains less water is taken up by the roots.

FIGURE 2.2.10a: An allotment

FIGURE 2.2.10b: A polythene tunnel

Task 1: Exploring how plants make food

Describe how the plants in the allotment make food to grow. Write the equation for this process.

Task 2: Investigating photosynthesis

Why do the tomatoes in Ben's greenhouse have a longer growing period and produce more fruit than the ones grown outside?

Task 3: Investigating photosynthesis

What else can Ben do to make sure that the greenhouse plants produce as many large tomatoes, cucumbers and courgettes as possible?

Task 4: Investigating the importance of minerals to plants

Explain why Joe's plants are not as healthy as Ben's.

Task 5: Exploring the movement of water and minerals and the role of stomata

When Ben arrives at the allotment, there is condensation inside the greenhouse, so he opens the doors. Explain where this water comes from. Why is this process important?

Task 6: Investigating the importance of minerals to plants

What advice would you give to Joe to improve the crops he gets from his allotment? Explain the advice.

Understanding food webs

We are learning how to:

- Describe how food webs are made up of a number of food chains.
- Make predictions about factors affecting plant and animal populations.
- Analyse and evaluate changes in a food web.

Food chains show the feeding relationships between living organisms. If something happens to disrupt part of the chain, it can have serious knock-on effects through the whole chain.

The ups and downs of food chains

The organisms in a **food chain** are dependent on each other. For example, in Figure 2.2.11a, grass is eaten by rabbits, which in turn are hunted and eaten by foxes. The grass captures the energy from sunlight to photosynthesise and make glucose. The glucose provides energy for the plant to grow. When a rabbit eats grass, the energy left in the grass is transferred to the rabbit. The rabbit uses some of this energy to move and grow. When a fox eats a rabbit, the remaining energy in the rabbit is transferred to the fox.

Changes in the number of one organism in a food chain affects other organisms in the food chain.

- The number of plants in an ecosystem can be affected by the amount of rain, sunlight, minerals and space available to grow.
- The number of animals can be affected by the amount of food, habitats, mates, water and disease.

Look at Figure 2.2.11a again and then answer these questions.

1. What would happen to the numbers of rabbits and foxes if all the grass died out?
2. What would happen to the amount of grass and foxes if all the rabbits died out?
3. Why is it a good idea for an organism to have different sources of food?

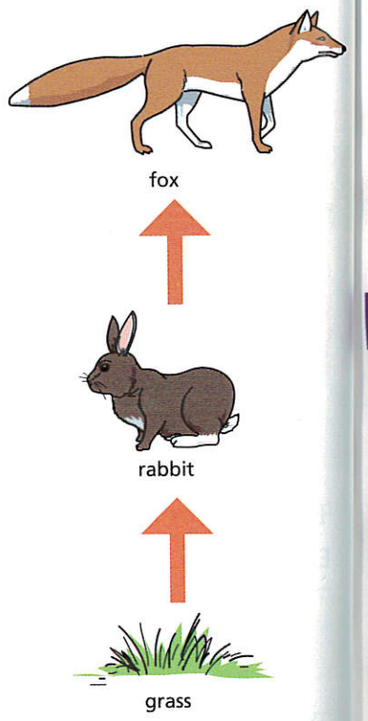


FIGURE 2.2.11a: A simple food chain

Did you know...?

Dugongs are marine mammals with important populations in the Arabian Gulf. They only eat seagrass. Building in the area has destroyed the seagrass beds, and the dugong is now endangered.

Food webs and trophic levels

2.11

Most animals eat many different things and are involved in many different food chains. These food chains can be put together in a **food web**, which shows how the food chains are connected. Food webs can be complex.

In a food web:

- producers make their own food
- **primary consumers** eat producers
- **secondary consumers** eat primary consumers
- **tertiary consumers** eat secondary consumers.

These rankings are called **trophic levels**. The trophic level of an organism is the position it occupies in a food chain.

4. What is a trophic level? Give an example of a trophic level.
5. Looking at Figure 2.2.11b, give an example of an animal in each of the four trophic levels listed above.
6. If the mice died, what could happen to the rabbits in the food web?

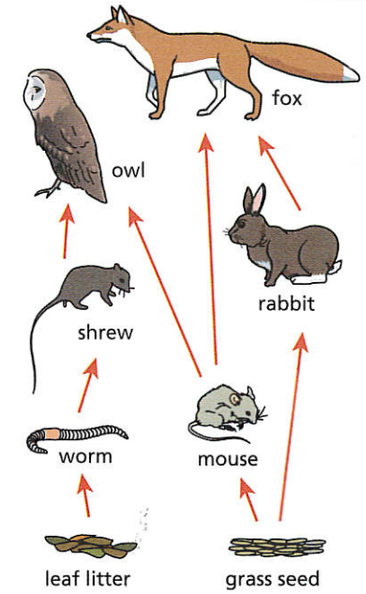


FIGURE 2.2.11b A simple food web. What do the arrows in the food web mean?

Knock-on effects

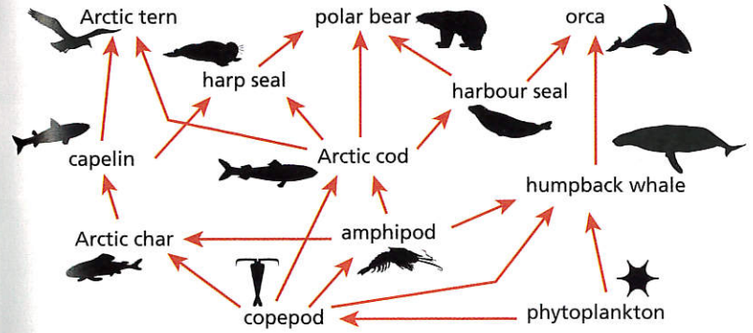


FIGURE 2.2.11c: An Arctic food web

Look at Figure 2.2.11c. Harbour seals, harp seals and Arctic terns all feed on Arctic cod. If the Arctic cod catch a disease and die, the Arctic tern and harp seals will eat more of their other prey. The harbour seal only eats Arctic cod, so they will die too. This means that the cod will not eat amphipods and copepods, so there will be more food for the humpback whale and Arctic char, and their populations will increase.

7. Harp seal populations are controlled by killing them – this is called 'culling'. Analyse and evaluate the impact of culling the majority of harp seals.
8. Explain how this food web shows that energy is transferred from the copepod to the Arctic tern.

Key vocabulary

food chain
food web
primary consumer
secondary consumer
tertiary consumer
trophic level

Exploring the importance of insects

We are learning how to:

- Describe the impact of low pollination on fruit production.
- Explain why artificial pollination is used for some crops.
- Evaluate the risks of monoculture on world food security.

Food security refers to the availability of food and the ability to obtain it. What is the role of bees and insects in our food security? How does agricultural practice impact on food security?

Fruit production and bees

Bees are vital in pollinating fruit crops. Pollination is successful when flowers receive healthy pollen at the best time. The better the pollination of apples and pears, the larger the fruits.

Anything that interferes with bee activity, such as disease or adverse weather, will reduce pollination. Bee colony numbers in Britain have fallen dramatically. The reduced pollination has lowered both fruit **yields** and the earnings of fruit growers – the apple harvest in 2012 was 50% lower than expected. This resulted in a higher cost of apples in the shops.

Recent research has found that the fall in wild bee populations, caused by habitat destruction, is having a greater impact than the fall in honeybee numbers. This is because wild bees are twice as effective as honeybees in pollinating orchards.

1. Why do fruit growers put beehives in their orchards?
2. How can we help wild bee colonies to survive and grow?

Ensuring pollination

In south west China, wild bees have become extinct because of overuse of **pesticides** and the destruction of their natural habitats. Apple and pear farmers now hand-pollinate their trees, using pots of pollen and paintbrushes to pollinate each flower individually.

Crops of cucumbers, tomatoes and peppers are also often hand-pollinated. Date palms have male and female plants; natural pollination therefore requires trees of both types.

FIGURE 2.2.12a: Honeybee hives are placed in orchards to ensure pollination.

FIGURE 2.2.12b: These women are hand-pollinating blossom on pepper plants.

By using hand-pollination, date farmers need only grow female trees and so avoid wasting space by growing male plants.

There are not enough humans in the world to pollinate all of our crops by hand. In addition, hand-pollinated fruits are often smaller than those pollinated by bees. Scientists are building a robotic bee that could one day be used to pollinate plants artificially and support the work of real bees.

3. Why is artificial pollination vital to fruit growers in China?
4. What are the advantages and disadvantages of artificial pollination?

Tackling food security

Evidence from around the world shows that yields of insect-pollinated crops are falling and are becoming ever more unpredictable. This is especially true in the areas with the most intensive farming. Where single crops are grown in vast fields – a practice called **monoculture** – there are not enough insects to go around.

FIGURE 2.2.12c: Monoculture is a modern agricultural practice that destroys the pollinators' natural habitats.

Almond orchards cover hundreds of square miles in California. Bees cannot survive naturally in these areas because the flowering time is too short and there are no other plants for them to feed on.

Some poor countries use monoculture to grow huge quantities of crops that they sell to richer countries, such as coffee, cocoa and bananas. Little fertile land is left to grow food crops for the local people who then suffer food insecurity.

5. Evaluate the practice of monoculture in agriculture.
6. Suggest how farmers can ensure pollination in monocultural systems.

Did you know...?

It has been suggested that 'travel stress' caused by bees being shipped from pollination site to pollination site is partly to blame for disorders in bee colonies that hugely reduce their population.

Key vocabulary

food security
yield
pesticide
monoculture

Looking at other examples of interdependence

We are learning how to:

- Describe examples of the interdependence of organisms.
- Explain how organisms help other organisms to survive.
- Explain ideas about habitat destruction.

Wherever you look in the world, you see habitats that support many different populations. The different species living in a particular habitat will all depend on others for their survival. What types of relationships occur? Are they always beneficial?

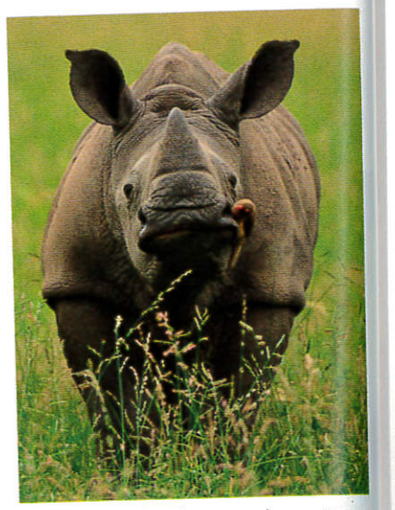


FIGURE 2.2.13a: The oxpecker eats bugs on the rhinoceros.

Niches and relationships

A **niche** is the role of an organism within a particular ecosystem. This includes what it eats; what eats it; its habitat; its nesting site, range and habits; what effect it has on the other populations; what effect it has on the environment.

The interdependence between organisms is called **symbiosis**. Types of symbiosis include:

- **commensalism** – one organism benefits, whereas the other does not. For example, clownfish live among the tentacles of sea anemones and are protected from their predators. The anemones do not benefit from this relationship.
- **mutualism** – both organisms benefit. For example, oxpeckers eat bugs that live on a rhinoceros.
- **parasitism** – one organism benefits, but the other is harmed. For example, fleas live on the skin of a dog. They feed on blood from the dog, which makes the dog weaker.

Other examples of interdependence are predator–prey relationships and decomposers (such as fungi and worms) that recycle nutrients from dead or decaying organisms.

1. Describe examples of the interdependence of organisms.
2. In the example of the oxpecker and the rhinoceros, how does the relationship benefit each animal?
3. What is an organism's 'niche'?

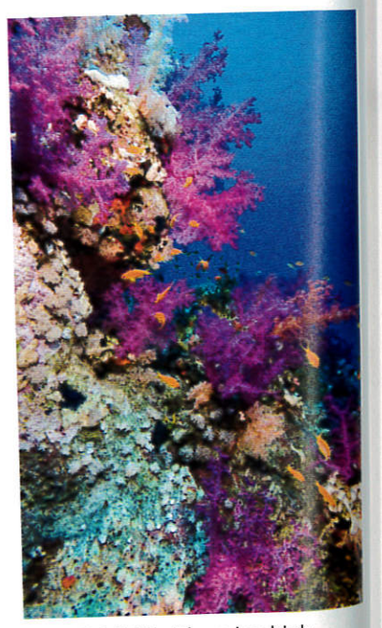


FIGURE 2.2.13b: There is a high level of interdependence between different organisms on a coral reef.

Competition

Competition is another example of interdependence. Organisms in every ecosystem are continually competing for the same resources. For example, if there are only ten trees with fruit and one animal is better at reaching the fruit than a shorter animal, then the shorter animal will not get any and may starve. However, if the tall animal kills all the trees with the high fruit and only low fruit is left, the shorter animal will survive at the expense of the larger.

Competition usually happens when there are limited resources. Sometimes, if everything is even, it can be a stalemate – both species compete, but both survive.

Some organisms co-exist by 'specialisation' – for example, plant roots may access water at different depths in the soil.

4. Give an example of:
   - **a)** competition
   - **b)** mutualism
   - **c)** parasitism
   - **d)** commensalism.

Problems in the rainforest

Rainforests are the oldest ecosystems on Earth. Nearly half of all animal species live in them. The high temperatures and abundance of water create an ideal environment for many organisms. The animals' long-term survival depends on a number of factors, such as their ability to adapt, their interdependence with other species and the actions of humans, e.g. hunting.

Loss of habitat is the biggest threat to animals inhabiting the rainforest. If animals lose their homes in a sudden way, they are likely to die. Large mammals, such as gorillas and leopards, rely on having large areas of suitable habitat in which to roam, hunt and find mates. It is difficult for them to survive if their habitat is cut back in size or is reduced to smaller, separated pockets.

5. Why are rainforests such important ecosystems?
6. What are the advantages and disadvantages of habitat destruction? Design a poster to communicate your ideas.

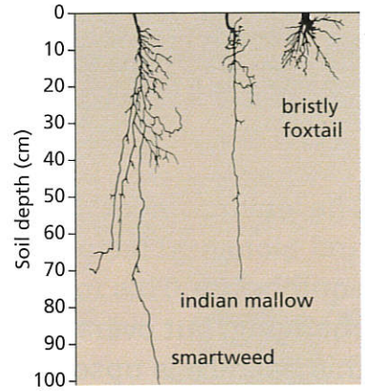


FIGURE 2.2.13c: Specialisation in plant roots

Did you know...?

Mountain gorillas are endangered. Fewer than 650 remain in the wild. A male mountain gorilla may stand as tall as six feet (two metres).

FIGURE 2.2.13d: Why are rainforest habitats being destroyed?

Key vocabulary

niche
symbiosis
commensalism
mutualism
parasitism
competition

Understanding interactions in the environment

We are learning how to:

- Describe some effects of human activity on the environment.
- Explain why many species are endangered.
- Analyse and evaluate secondary data and recommend solutions for species survival.

The 'environment' is a system of physical, chemical and biological factors that are in a dynamic equilibrium. This means that they are constantly changing, but overall the system stays in balance. If this balance is upset, species become endangered.

How humans affect the environment

Human actions and behaviours are major factors contributing to environmental change. We hunt animals for food, sport, medicines and to keep as pets. We use their fur, skin, horns and tusks for making clothing, bags, shoes and ornaments. We construct buildings, roads and other structures such as dams and reservoirs that destroy the habitats needed by plants and animals.

The human population is increasing rapidly as a result of factors such as better medical care and higher standards of living. This puts our planet at greater risk:

- More land is needed for farming, so natural habitats are being lost.
- More factories and power stations cause more pollution.
- Long-distance travel is easy, so plant and animal species can be transported around the world, sometimes with disastrous results.
- Many plants and animals all over the world are now becoming **endangered**.

Some people and communities make changes to their lifestyles that will reduce their impact on the environment. This helps to preserve **biodiversity** – the variety of living organisms found in an ecosystem.

1. Describe how humans interact with their environment.
2. Describe examples of human impact on the environment.
3. How can you help in protecting the environment?

FIGURE 2.2.14a: An example of our impact on the environment

Did you know...?

In December 2013, the US government's Fish and Wildlife Services reported 2143 species worldwide that are endangered or threatened, ranging from mammals and birds to flowering plants and ferns.

FIGURE 2.2.14b: Why is the Malagasy rainbow frog endangered?

Endangered organisms

A species is endangered when there are so few of its kind left that it could become **extinct**. Some animals are more threatened than others. Scientists categorise the level of risk to species. From most to least threatened, these levels are:

- critically endangered
- endangered
- **vulnerable**
- not threatened.

Some animals exist only in captivity, in wildlife parks. These animals are extinct in the wild – an example is the scimitar-horned oryx, which was once widespread across northern Africa.

Many countries have laws that protect endangered species from being captured, injured or killed.

4. Explain what an 'endangered species' is.
5. Explain why some species are more endangered than others.

Putting it right

Conservationists use various methods to identify species at risk and to measure their population size. Some of the methods include:

- observation
- surveys of nests and vegetation
- analysis of air, land and water
- identification of habitats
- collection of data, for example on pellets, fecal matter, feathers or scales.

These scientists also use methods to increase the numbers of animals, including **captive breeding**, re-introduction of animals, habitat creation and pest control. International agreements and the creation of protected areas also help to protect species and their habitats.

6. Explain the job of a conservationist.
7. Why do conservationists use captive breeding programmes?

FIGURE 2.2.14c: The scimitar-horned oryx is extinct in the wild.

FIGURE 2.2.14d: Environmentalists at work

Key vocabulary

endangered
biodiversity
extinct
vulnerable
captive breeding

Learning about ecological balance

We are learning how to:

- Describe ways in which organisms affect their environment.
- Explain why prey populations affect predator populations.
- Evaluate a model of predator–prey populations and explain the importance of predators.

Organisms are not isolated in their environment. They interact with other individuals of their own species, with other species and with their physical environment. The study of the interactions between organisms and their environment is called **ecology**. In what ways do organisms interact? How does one organism affect others?

FIGURE 2.2.15a: How can cows affect grass when they graze?

How organisms affect the environment

All organisms cause changes in the environment where they live. An organism's behaviour depends on the nature of its environment. This includes factors such as:

- the types and numbers of other organisms present
- the availability of food and resources
- physical characteristics of the environment.

Cattle that stay in one place for a long time will eat the plant life to death. Without plants to hold it, topsoil runs off into streams causing habitat loss for other organisms (in both the fields and the streams). Eventually there is a drop in the water supply, which can cause pollution of water resources. This then affects all the habitats that the water flows through, including surface water (such as lakes and rivers), groundwater and water found underground.

1. What is 'ecology'?
2. Describe examples of how organisms affect their environment.

Did you know...?

Big cats are examples of predators adapted for efficient hunting. One of the cheetah's best hunting skills is its ability to run at high speed. It can run faster than any other land animal, accelerating from 0 to 100 km/h (62 mph) in about three seconds.

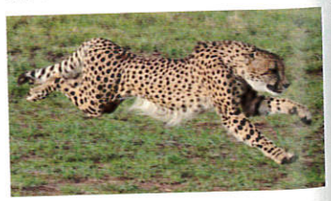


FIGURE 2.2.15b

Predators and prey

The relationship between **predator** and **prey** is probably the most important interaction between organisms and their environment. Predators need to be adapted for efficient hunting to catch enough food to survive. Prey species must be well adapted to escape their predators to ensure their survival.

If the prey population grows, predator numbers will respond to the increased food supply and grow too. Increased predator numbers will reduce the food supply so that it can no longer supply the predator population.

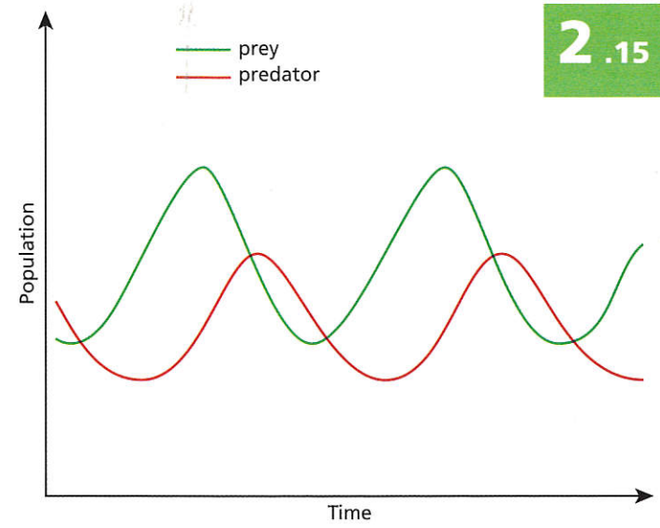


FIGURE 2.2.15c: The relationship between predator and prey numbers

3. What variables affect the numbers of predators and prey in a population?
4. Explain how prey populations affect predator populations.

The importance of predators

The role of predators has been misunderstood by humans throughout time, and many predator species are now endangered.

Predators are an important part of the food web. They keep in check the negative impacts other animals have on the environment if they are too abundant. Predators keep prey moving around, which prevents population explosions and this gives plants time to grow. Predators also contribute to preserving biodiversity in environments.

Predators therefore play a vital role in maintaining the **equilibrium** in an environment. Humans need to understand this, or else they will remain in trouble. Ecologists now put more emphasis on studying and maintaining predator populations and their habitats.

Predators can be introduced to an ecosystem to control prey that are pests. For example, ladybirds (predator) can be used in greenhouses to control aphids (prey and pest).

5. How can predators be used to control a prey population? Why would you want to do that?
6. Explain why predators are important.

FIGURE 2.2.15d: Ladybirds are used to control aphid populations.

Key vocabulary

ecology
predator
prey
equilibrium

Understanding the effects of toxins in the environment

We are learning how to:

- Describe how toxins pass along the food chain.
- Explain how toxins enter and accumulate in food chains.
- Evaluate the advantages and disadvantages of using pesticides.

Otters nearly became extinct in the south of England in the 1960s. What caused this? Why were otters more affected than other animals? Why do we use chemicals in agriculture?

Why are chemicals used in agriculture?

In recent times, the global population has increased dramatically – food needs to be grown more quickly to feed the growing number of people. Soils are quickly depleted of the nutrients needed to grow healthy crops. Nowadays, farmers rarely mix keeping animals with growing crops, so they do not have the supplies of cattle manure to replace the nutrients naturally. Instead, artificial **fertilisers** and nutrients are used to replenish the soil.

Pesticides and **insecticides** are chemicals used to kill insect pests and small creatures that damage crops.

1. Why do farmers use chemicals in agriculture?
2. Why do most modern farms not use manure on their fields?

FIGURE 2.2.16a: Why is the farmer adding artificial fertiliser, not manure?

Chemicals entering the food chain

Toxins can enter the food chain in several ways.

- Fertilisers dissolve in water and are washed off the fields by rain into rivers and reservoirs.
- Pesticides, used by farmers to kill weeds or insects, contaminate small creatures that are eaten, or the chemicals are washed or blown into waterways.
- Water runs off urban streets into waterways.
- Soft mud acts like a sponge that slowly soaks up the toxins. Plants absorb these through their roots.
- Some chemicals fall from the air, such as mercury released by coal-burning power plants.

FIGURE 2.2.16b: Insects covered in insecticide are eaten by other animals.

Primary consumers eat the plants containing the toxins; secondary consumers eat the primary consumer; and so on up the food chain.

3. Give examples of a primary consumer and a secondary consumer that could be affected by pesticides used on farmland.
4. Explain how toxins enter the food chain.

Accumulation of toxins in the food chain

Organisms at the start of a food chain can take up small amounts of toxins. The higher up the organism is in the food chain, the more concentrated the toxin will become – eventually it is so concentrated that it can kill the top predator.

A pesticide called DDT was used in the 1960s. It killed insects that were damaging crops, but it ran off into rivers and contaminated plants. The small animals and fish further up the food chain collected more and more of the toxin because it stayed in their bodies. This process is called **bioaccumulation**.

Otters that ate the fish were killed and almost became extinct in the south of England.

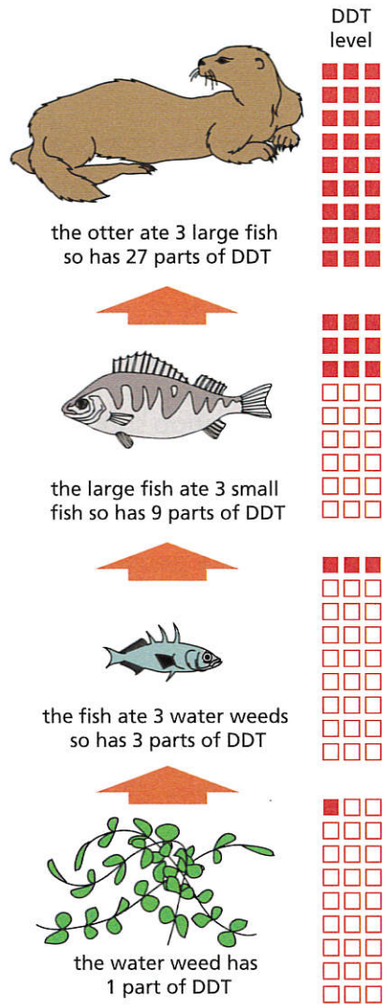


FIGURE 2.2.16d: Bioaccumulation of DDT in a food chain

5. Explain why otters were in danger of extinction because of DDT.
6. If the otter population declined, how would this affect the river ecosystem?

FIGURE 2.2.16c: How does mercury released into the air get from here into an organism?

Did you know...?

In 2001, DDT was banned worldwide. The only remaining legal use of DDT is to control malaria-carrying mosquitoes. Modern insecticides do not accumulate in food chains.

Key vocabulary

fertiliser

insecticide

toxin

bioaccumulation

Exploring how organisms co-exist

We are learning how to:

- Describe the role of niches.
- Explain the concept of resource partitioning.
- Analyse and evaluate the role of variation in enabling organisms to co-exist.

Living organisms all have basic needs that are vital to their survival. The world has finite resources. How do organisms ensure that they get what they need to survive?

Exploring niches

The ecological niche of an organism is the role it plays in a particular habitat. For example, a bee's niche is producing honey, pollinating flowers and drinking nectar, in its habitat of field or garden.

- **Specialists** have a narrow niche. They only survive in very specific environmental conditions and they have a very limited diet. For example, the giant panda lives only in the bamboo forests of China; bamboo shoots and leaves make up 99% of its diet.
- **Generalists** have a broad niche. They can live in a wide range of environmental conditions and eat many different types of food. Human beings are generalists.

Species with overlapping niches compete for resources – the greater the overlap, the greater the competition between the species.

1. Name two other examples of specialists.
2. Name two other examples of generalists.
3. Explain why competition arises.

Competition in detail

Animals and plants are constantly competing for resources. Animals compete for prey, water, mates, nest sites and so on. Plants compete for water, light, nutrients and space.

There are two main types of competition:

- Competition between organisms of the *same* species – for example, stags fighting for a mate
- Competition between organisms of *different* species – for example, lions and hyenas feeding on the same dead animal.

Did you know...?

Giant pandas have a 'sixth' finger – a small extension of the panda's wrist bone that helps them grasp the bamboo and pull the leaves and shoots off the stem easily. They have large jaws with smoother, wider and flatter premolars and molars to break down the hard bamboo.

FIGURE 2.2.17a: The niche of the panda is a herbivore active in the day in the bamboo forest.

Different species with similar needs use resources in different ways. They do not compete directly for the limited resource. This is called **resource partitioning**.

Anole lizards live in the Florida forests (USA). Seven species of anole live in the same community. They all feed on insects and other small invertebrates. These species **co-exist** because each one lives in a particular space in the forest and so has a different niche. Some anole lizards live in the tree canopy, some on the tree trunks and some live close to the ground or in the leaf litter.

4. Explain what resource partitioning is in your own words.
5. Explain how the different species of anole can co-exist.

Resource partitioning

Variation helps the anoles survive in their chosen niche.

- Species living on tree trunks near the ground have long hind limbs for running and jumping.
- Species living on narrow twigs higher in the trees have very short legs and crawl slowly to capture prey and escape from predators.
- Species living in the vegetation high in the tree have very large toepads and are green for camouflage.

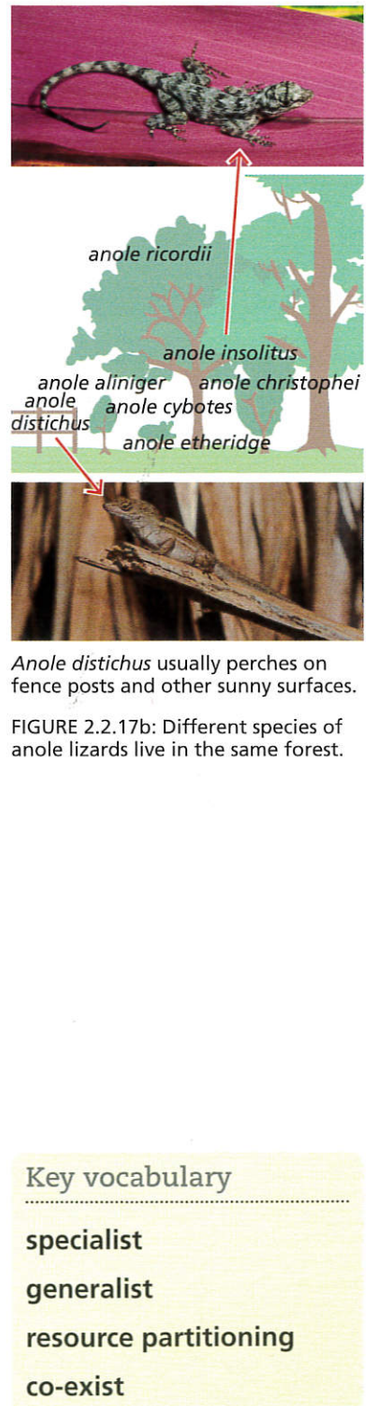
Animals can partition their niches by:

- feeding on different types of food
- feeding on different sizes of food – some feed on large seeds, others on small seeds
- feeding in different places
- feeding at different times – nocturnal foragers eat insects active at night; diurnal foragers feed on insects active during the day.

Robert MacArthur was an ecologist who studied how five species of warbler could live in one conifer tree without direct competition. He found that the birds occupied different niches in the habitat. They all fed on insects, but in different parts of the tree, at different times and with different preferences. By using these different behaviours they avoided competition and were able to co-exist.

6. Explain how warblers avoid competing for resources.
7. Using the information about how organisms partition their niches, explain how rabbits and cows can co-exist in the same field.

Anole insolitus usually perches on shady branches.



Anole distichus usually perches on fence posts and other sunny surfaces.

FIGURE 2.2.17b: Different species of anole lizards live in the same forest.

Key vocabulary

specialist
generalist
resource partitioning
co-exist
variation

Checking your progress

To make good progress in understanding science you need to focus on these ideas and skills.

- ☐ State that green plants need sunlight to grow and to make food.
- ☐ Identify water and carbon dioxide as the raw materials for photosynthesis, and glucose and oxygen as the products.
- ☐ Explain the chemical changes involved in photosynthesis and the roles of light and chlorophyll.
- ☐ Describe how gases enter and leave a leaf and how light energy for photosynthesis is captured.
- ☐ Describe how cells in the leaf and root are adapted for their functions.
- ☐ Relate and explain how the structure of palisade, mesophyll and guard cells allows them to perform their function.
- ☐ Describe how levels of light, temperature and carbon dioxide affect the rate of photosynthesis.
- ☐ Explain how levels of light, temperature and carbon dioxide affect the rate of photosynthesis.
- ☐ Apply learning about the factors affecting photosynthesis to solve problems.
- ☐ Name some of the nutrients needed by plants and supplied by fertilisers; state how they enter the plant dissolved in soil water.
- ☐ Explain why nutrients are needed by plants, how spreading manure adds them to the soil and how water passes through the plant.
- ☐ Explain how mineral deficiencies affect plants and how different factors affect the rate of transpiration.

- ☐ Describe how some bacteria produce food by chemosynthesis.
- ☐ Compare chemosynthesis with photosynthesis.
- ☐ Explain why some bacteria use chemosynthesis and how they support food chains.
- ☐ Describe an example of a simple food web.
- ☐ Explain how energy flows through a food web and explain factors that can affect food webs, such as loss of a species or toxin accumulation.
- ☐ Explain the importance of predators in an environment and evaluate changes in a food web.
- ☐ Describe an example of interdependence of organisms in an ecosystem – for example the pollination of crops by insects.
- ☐ Explain examples of interdependence of organisms in an ecosystem – for example through symbiosis, commensalism and parasitism.
- ☐ Analyse an example of interdependence of organisms in an ecosystem – for example, the effects of the destruction of rainforests.
- ☐ Identify some ways in which organisms affect, and are affected by, their environment – for example through pollution or destruction of habitats.
- ☐ Explain some ways in which organisms affect, and are affected by, their environment – for example, predator–prey relationships.
- ☐ Analyse and evaluate the factors affecting endangered species and recommend solutions.

Questions

Questions 1–7

See how well you have understood the ideas in the chapter.

1. Where do plants get their food from? [1]

a) Plants absorb food from the soil.
b) Plants absorb nutrients from rain through their leaves.
c) Plants make food in their leaves using carbon dioxide and water.
d) Plants absorb nutrients from the soil and food is made from these in the roots.

2. Which of these does NOT affect the rate of photosynthesis? [1]

a) temperature **b)** light **c)** chlorophyll **d)** oxygen concentration.

3. Which of these is an important element needed for healthy plant growth? [1]

a) cobalt **b)** potassium **c)** iodine **d)** aluminium

4. Which of these organisms can make their own food without using sunlight? [1]

a) tube worm **b)** bacteria **c)** seaweed **d)** algae

5. Describe how palisade mesophyll cells are adapted to photosynthesise. [2]

6. Give two examples of the way that humans impact on the environment. [2]

7. What are the differences and similarities between photosynthesis and chemosynthesis? [4]

Questions 8–14

See how well you can apply the ideas in this chapter to new situations.

8. Stomata close when water is in short supply. Name a disadvantage of closed stomata. [1]

a) Water is not lost. **b)** Nutrient uptake is reduced.
c) Photosynthesis increases. **d)** Water is lost.

9. Look at this simple food web in a rainforest. What will happen to the number of red-eyed tree frogs if all the chimpanzees die from a disease? [1]

a) They stay the same.
b) They go up.
c) They go down.
d) They will die out too.

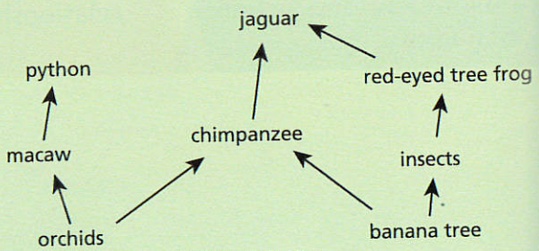


FIGURE 2.2.19a

10. What is the niche of the jaguar in the food web in Figure 2.2.19a? [2]

11. Look at the food web in Figure 2.2.19a. The jaguar and the python are predators. What will happen if both predators die out? [4]

12. What effect will increasing the light intensity have on transpiration? [1]

a) It will stay the same. **b)** It will drop. **c)** It will rise. **d)** It will stop completely.

13. Harmful algal blooms (HABs) produce toxins in the sea. Oysters are animals that filter food particles like plankton from the water. How could dining on oysters during an HAB affect a person's health? [1]

14. Look at Figure 2.2.19b. This single-celled organism lives in pond water. How does it get food? Explain how you know this. [2]

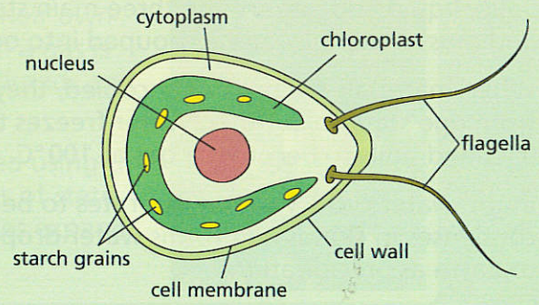


FIGURE 2.2.19b: Chlamydomonas – a unicellular organism

Questions 15–16

See how well you can understand and explain new ideas and evidence.

15. Marram grass grows on sand dunes. It has rolled leaves. Why do you think it has:

a) sunken stomata and rolled leaves?
b) a thick, waxy cuticle? [2]

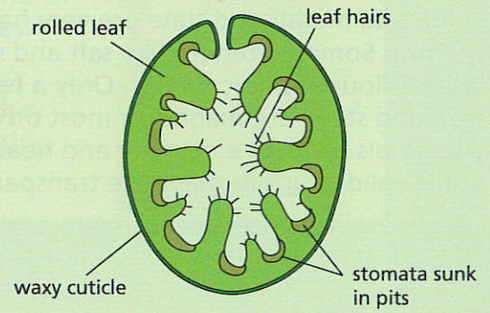


FIGURE 2.2.19c: The leaf blade of the marram grass is rolled towards the mid vein.

16. Figure 2.2.19d shows how the populations of lynx and hares change over time. Analyse and evaluate the data to explain why the populations rise and fall when they do. Do you think this pattern is still happening today? Explain your answer. [4]

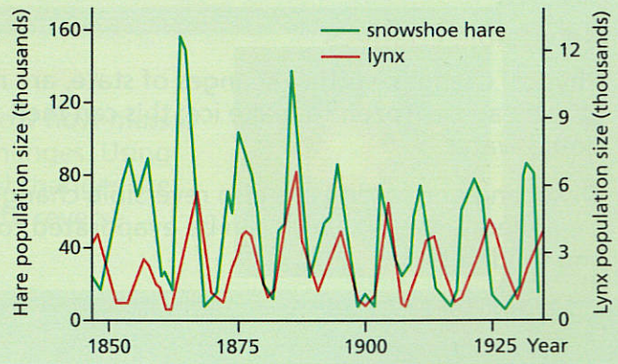


FIGURE 2.2.19d: Lynx and hare population data