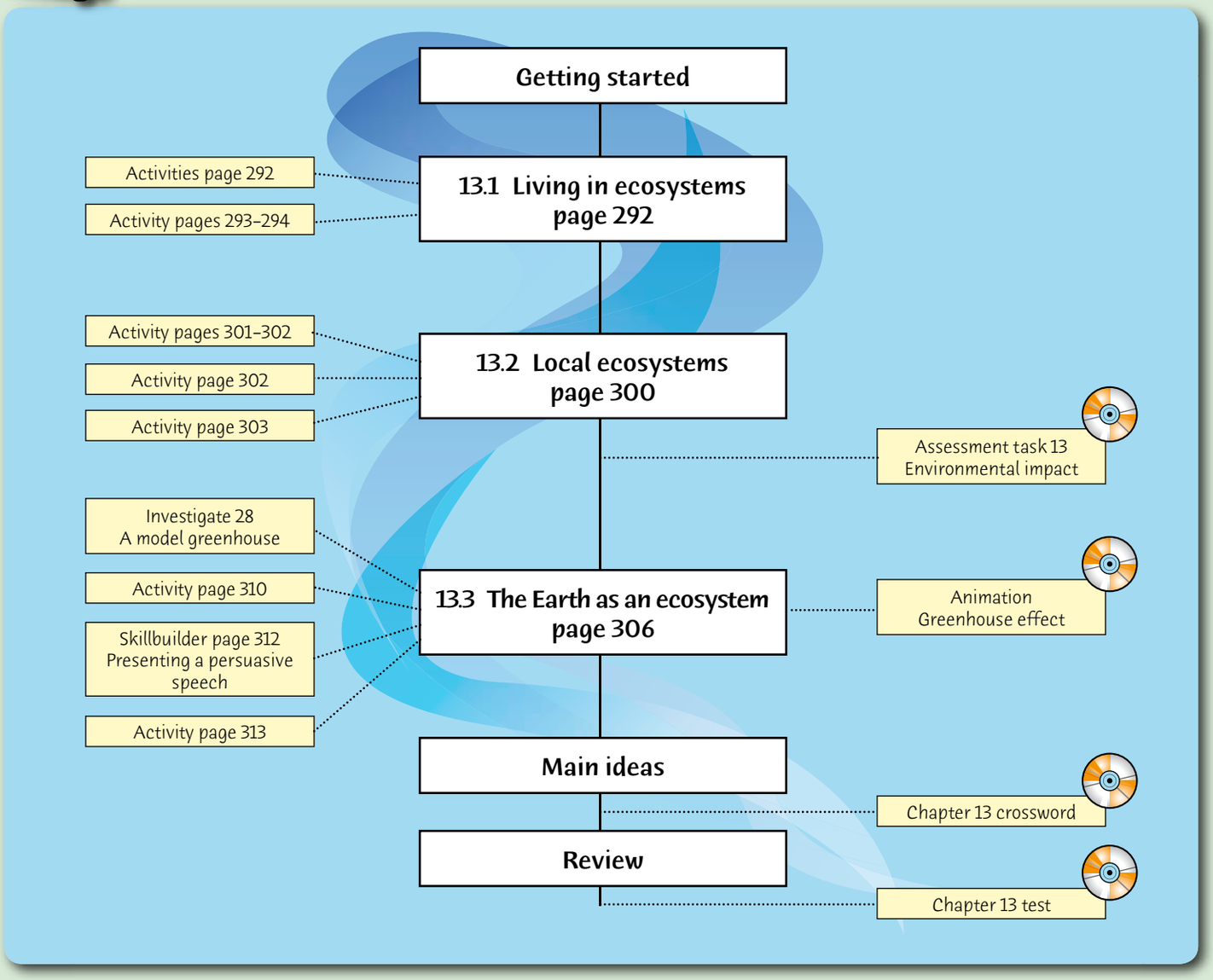
13 Ecosystem Earth

Planning page



Essential Learnings for Chapter 13

Essential Learnings	References		
	Student book (page number)	Workbook (page number)	Teacher Edition CD (Assessment task)
Knowledge and understanding ***Life and living*** In ecosystems, organisms interact with each other and their surroundings	pp. 292–299	pp. 103–104, 106	
Changes in ecosystems have causes and consequences that may be predicted	pp. 300–304		Assessment task 13 Environmental impact
Earth and beyond Global patterns of change on earth and in its atmosphere can be predicted and modelled	pp. 306–314	pp. 104–105	
Science as a human endeavour Responsible, ethical and informed decisions about social priorities often require the application of scientific understanding	pp. 300, 303–305 Activity pp. 301–302	p. 101	Assessment task 13 Environmental impact
Ways of working Communicate scientific ideas, explanations, conclusions, decisions and data, using scientific argument and terminology, in appropriate formats	Activity p. 310 Skillbuilder p. 312	p. 107	Assessment task 13 Environmental impact
Reflect on different perspectives and evaluate the influence of people's values and culture on the applications of science	p. 304 Activities pp. 301–302, 310, 313	p. 101	
Reflect on learning, apply new understandings and justify future applications	Activity p. 313		

QSA Science Essential Learnings by the end of Year 9

Vocabulary

bacteria
competitors
decomposers
global
ionosphere
nitrates
ozone
persuasive
pyramid
recycled
scenario
stratosphere
troposphere
urban

Focus for learning

Brainstorm ideas to explain recent extreme weather conditions (page 291).

Equipment and chemicals (per group)

Investigate 28 page 308 2 microscope slides, adhesive tape, 2 small cardboard boxes or plastic containers (eg margarine or takeaway containers), 2 thermometers


Floods in Europe

13 Ecosystem Earth

Getting Started

The photos show some of the extreme weather conditions that many countries have experienced over the last few years. These disasters and other atmospheric problems have been blamed on such things as:

- the destruction of forests
- emissions from power stations and car engines
- the hole in the ozone layer
- global warming.

- Form a small group and brainstorm ideas about how each of these factors could be responsible for the extreme weather conditions and other problems such as an increase in skin cancers.
- Keep your answers for later on in this chapter (page 314).


Cyclonic weather in Australia

Drought in northern Africa

Starting point

1 You might like to introduce this chapter by asking the students to do an online ecological footprint. Construct a class chart to see how many 'Earths' they need to sustain their lifestyle. Put a scale from 1 to 10 on the board and get the students to indicate, with a cross, the number of 'Earths' they need. Alternatively, a sheet of paper could be used to construct the chart so that it can be kept and referred to at a later date. For further information see the Webwatch on page 299.

2 You could use some of the questions asked in the ecological footprint quiz as discussion points. Find out how students in your class travel to school and construct a pie chart of the transportation methods. What is the percentage of the students who walk, ride a bike, catch public transport or car pool to school? Could any of the students change their method of getting to school and use a method that is more energy-efficient?

3 Even though ICT can be a good interactive tool, be careful not to overuse it. Students generally still prefer 'hands-on' tasks or experiments rather than computer-simulated ones. Be choosy with the types of ICT activities the students do. Some good interactive applications include investigating ecosystems or constructing food webs. Other ways of using ICT in science is as a tool for presenting work. This can range from writing notes or practical investigation reports, doing internet research, preparing assessment tasks in a multimedia format (Flash, PowerPoint, etc) or making a podcast or vodcast. Be creative when setting tasks but make sure the software and technology are easily available to the students.

13.1 Living in ecosystems

The island in the photo above is a few kilometres from the mainland. Over the years it has been colonised by many types of plants, as well as animals such as lizards, native mice, small wallabies and many types of insects and birds. This island can be described as an ecosystem because there is a complex system of relationships between the organisms and with the non-living part of the environment.

The matter in the bodies of the organisms on the island is recycled by bacteria and fungi when the organisms die. Dead animals and plants are attacked by decomposers, and the matter in their bodies is released into the atmosphere. It dissolves in water and increases soil fertility. Plants use the dissolved matter in the soil. Hence the matter is reused over and over.

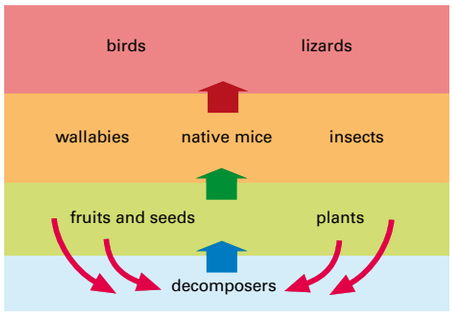


Fig 4 The matter in the bodies of organisms on the island is recycled by decomposers and reused by plants and other organisms.

Activities

A How much do know about food webs?

1. Which of the organisms in Fig 4 are producers? Write a definition for producer.
2. Which organisms in Fig 4 are second-order consumers? Explain your answer.
3. Draw two food chains for the organisms in Fig 4. Now draw a food web.

Check your answers with someone else.

B Form a group of three or four people and discuss these questions about the island.

1. The island probably formed as the sea level changed many thousands of years ago. Suggest how the island might have been colonised by organisms.
2. Why can the island be described as an isolated ecosystem? How is this different from other ecosystems?
3. Most of the food chains you could draw for the organisms on the island would contain a producer and no more than one or two consumers. Suggest why the food chains are short.

Hints and tips

- Food webs and food chains are different. Revise how they differ, with examples of each.
- Activity A asks the students to draw a food web, so make sure they know how to do this. Remind the students that the source of energy of a food web or food chain is the sun. Plants get their energy from the sun. Animals eat plants or other animals, so the energy is transferred from one organism to another. The arrows in a food chain or food web point in the direction the energy (food) is being transferred.

Activity notes

The following definitions may be helpful for students.

- An ecosystem is a system of feeding relationships among organisms, and the way they interact with non-living parts of the environment.
- A habitat is the living place of an organism.
- Producers are organisms which make their own food using the energy in sunlight. Plants are producers.
- Consumers are organisms that eat other organisms. Animals are consumers.
- Decomposers are organisms that break down the bodies of dead organisms into simpler substances. Some bacteria and fungi are decomposers.

Homework

Ask students to investigate any organisms that get their energy from sources other than the sun. (A few specialised bacteria use chemicals and volcanic heat as their energy source. Some places deep in the Pacific Ocean have octopods, tubeworms and crustaceans which get their energy from chemosynthetic bacteria.)

Learning experience

Establish what the students know about ecosystems by giving them a simple test. See what they can remember from *ScienceWorld 1* Chapter 7. Revise any key concepts that are needed for this chapter.

The flow of matter and energy

In any ecosystem matter in the form of solids, liquids and gases is used and recycled through food webs.

What happens to the matter as it passes through an ecosystem? How does an organism use the food it consumes? The story of Lucy and her kitten will help to explain this.

Activity

Your task

Work in a group of three or four people and read carefully the three parts of this task. Answer the questions in each part, and be prepared to discuss them with others in the class.

Information

Lucy wanted to compare the growth of her kitten with the amount of food and water she gave it. To do this, she measured the mass of the kitten as well as the mass of the food and water it consumed each month. She also measured the mass of the wastes.

The cartoon below shows the results of Lucy's investigation.

Part A

Copy and complete the data list below using the information in the cartoon. One entry has been done for you.

Initial mass of kitten	..... g
Mass of kitten after a month	..... g
Change in the mass of kitten	..... g
Mass of food and water taken in	..... g
Mass of wastes	..... g
Mass of food and water used in body processes	..... g
Mass of new tissue of kitten	620 g
Mass of food and water used by the body but not for growth	..... g

Hints and tips

Remind the students that energy is the ability to do work and is available in many forms. All organisms require energy for life. It is needed for growth, respiration, reproduction, digestion and repair of body tissues. Energy is measured in joules (J).

Activity notes

Students shouldn't need a calculator for this exercise. However, check on any students who experience difficulties with mathematics.

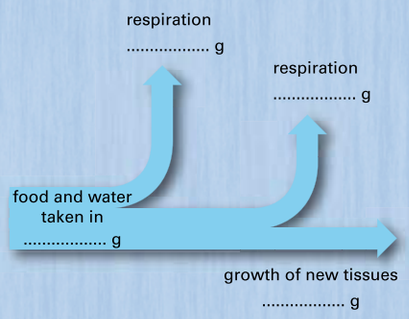
Learning experience

As each student enters the room give them a printed card with a word or term on it. Ask them to write a definition of the term on their card. Choose students to read out their definitions and make sure each word has been properly defined. Suggested terms might include *ecosystem*, *habitat*, *producer*, *consumer*, *decomposer*, *food web*, *food chain*, *photosynthesis* and *energy*.

- What does 'mass of food and water used by the body but not for growth' mean? What main process in the body would this refer to? What other substance is used in this process? What substances are produced?
- Of all the food and water eaten by the kitten, what mass was used for the growth of new tissues? What mass was not used for growth?
- What are the two main processes for which organisms use food?

Part B

Copy the matter flow diagram below into your notebook. Then use the data in the table on the previous page to fill in the missing quantities.



- The matter flow diagram shows three possible destinations for the food eaten by an organism. What are they?
- What percentage of the food eaten by the kitten is used for growth?

Part C

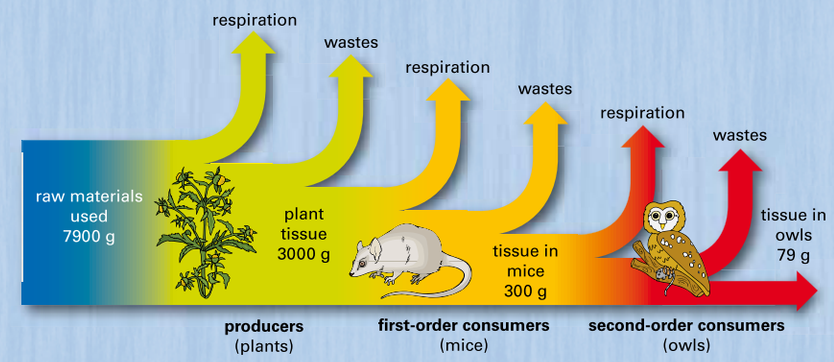
The way food is used by Lucy's kitten is an example of how food moves through a food chain. Look at the food chain below.

GRASS SEEDS ➡ MICE ➡ OWLS

Matter flow diagrams can be combined for the three types of organisms in the food chain. The diagram at the bottom of the page is an example.

- Matter enters the food chain through the producers. What is this matter?
- What percentage of the matter in the raw materials is used to make new plant tissue?
- What percentage of the plant tissue eaten by the mice is used for the growth of new tissues?
- Explain what happens to the matter that is not used to make the tissues of the organisms.
- Suggest what role decomposers play in a food chain like this one.

If you feel creative try this: modify the matter flow diagram below to include decomposers.



Activity notes

It is a good idea to set time limits for each part of the activity. Go through the questions in each part with the class before students attempt the next part.

Homework

Ask students to answer the following questions.

1. The diagram at the bottom of the page shows first-order consumers and second-order consumers. Are there more than two types of consumers?
2. Are there other names given to first-, second- and third-order consumers?
3. Which order consumer would a dingo or seal be, for example?
4. Draw a food chain for the dingo.

Flow of matter in food webs

The activity on the previous pages showed that only a small percentage of the food eaten by an organism is actually used for growth. The remaining matter is either given off as products of respiration or as solid and liquid wastes (faeces and urine).

The diagram below shows the flow of matter through a food web. The size of each yellow box represents the total *mass* of organisms in each of the three feeding levels. For example, the size of the producers' box represents the mass of *all* the plants in the food web.

The diagram shows two main things about the flow of matter through a food web. Firstly, the mass of the organisms in a feeding level decreases as you pass up through the food web from the producers to the highest order consumers. This means that the mass of food available to consumers becomes less and less at each level. Consequently, a particular mass of organisms in one level will only support a smaller mass in the next level. Secondly, the wastes and dead bodies are broken down by decomposers, who return the matter to the soil, air or water. This means that decomposers are vital to the functioning of the food web. The products from respiration are also recycled through the soil, air and water.

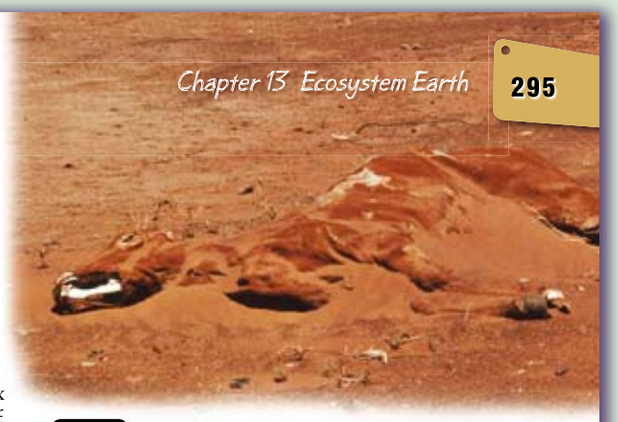


Fig 10 Drought reduces the mass of producers (grass), which then cannot support the mass of consumers. Animals like this cow die from starvation.

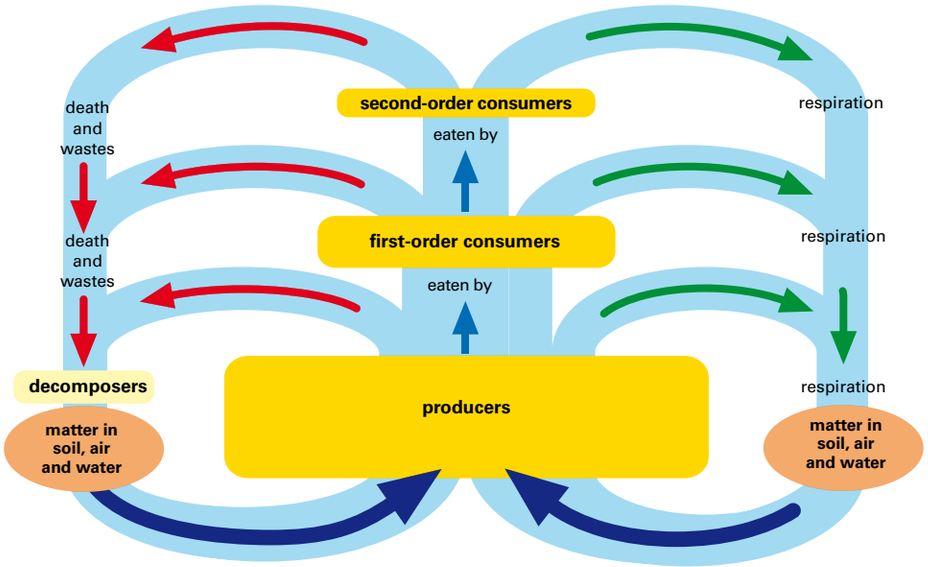


Fig 9 The flow of matter through a food web

Hints and tips

- Make sure the students make the distinction between the 'mass of organisms' and the 'mass of *an* organism'.
- If an ecosystem is not affected by external factors such as climate, introduced organisms or other environmental factors, it should be self-sustaining. In other words, there should be a continuous flow of matter through the food web. Energy is considered to move only in one direction through an ecosystem.

Learning experience

Why are there so few very large high-order consumers (top predators) on Earth? How is the law of conservation of energy applied to an ecosystem—does it still hold true? Turn these questions into a Think/Pair/Share activity and get the students to answer them.

Learning experience

Using Fig 9, ask the students to choose an Australian animal which is a predator, then draw a flow diagram, including this animal, showing the flow of matter through the food web. The students could begin by listing the animals the predator eats and work backwards through the food web.

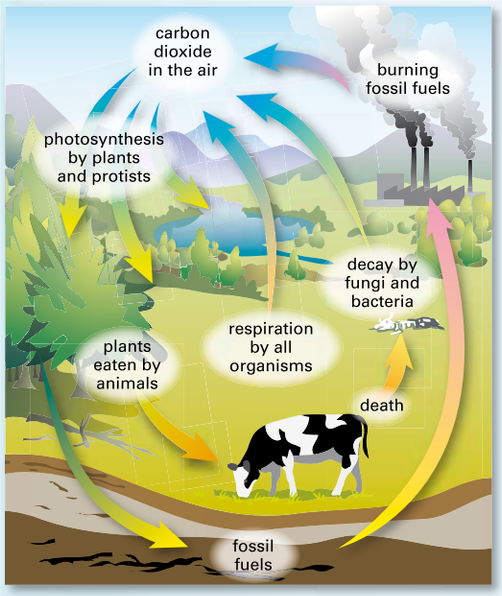
Matter cycles

The carbon cycle

The element carbon is one of the main materials in sugars, proteins and fats in living things, and in waste products like carbon dioxide and urea. Carbon is also found in fossil fuels—coal and oil, which are formed from decaying plants.

Sugars, proteins and fats make up the tissues of all living things. Animals obtain the raw materials to make these substances by eating other organisms. Plants and algae make these substances from carbon dioxide and water in photosynthesis.

Carbon is returned to the air or soil when decomposer organisms break down the bodies of dead organisms into carbon dioxide. Carbon dioxide is also produced when coal and oil are burnt, and during bushfires.



The nitrogen cycle

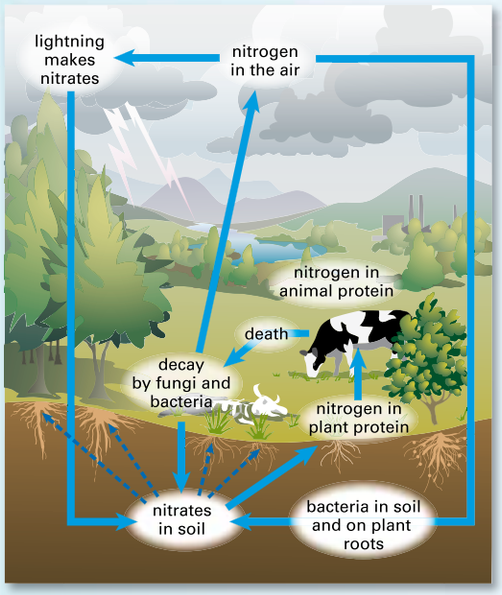
Nitrogen makes up about 78% of the Earth's atmosphere. It is also found combined with oxygen in nitrates in rocks and soil, and it is one of the elements in proteins.

Animals obtain their nitrogen from the protein in plants or other animals. The protein in their food is broken down into amino acids, which are then built into proteins in the animal's cells.

Plants and algae take in nitrogen in the form of nitrates. These compounds are soluble in water and are found dissolved in the water in aquatic habitats and in the soil of land habitats.

Nitrates are formed from the decay of dead organisms. Decomposers break down the proteins in the cells of the dead organism into amino acids and then into nitrates.

Nitrogen is returned to the air through the action of other bacteria that live in soil and in swamps.



Hints and tips

If you set the task in the Learning experience below, make sure you and the students are familiar with the basics of podcasting and vodcasting. *Podcasting* is the term used to describe the process of creating and publishing a digital broadcast on the internet. The broadcast is then downloaded to an external media player (MP3 or MP4 player, iPod, mobile phone, etc). *Vodcasting* (video podcasting) is more or less the same as podcasting but images are used in conjunction with audio (eg pictures, video, PowerPoint presentations—anything that is visual).

Research

Ask students to find out the difference between nitrogen and nitrate. Why is nitrogen considered to be good for the soil? Are there any particular plants that 'fix' nitrogen in the soil? If so, list some of them.

Learning experience

Ask the students to make their own podcast or vodcast about matter cycles. Encourage them to be creative. They could write and sing their own jingle about one of the cycles. Fancy equipment is not needed to make a podcast—all that is required is a computer with a microphone, and software that converts the broadcast into a media file. This software can be obtained free on the internet. If students have an MP3 or MP4 player they may be able to record audio on it, download it to a computer and then convert it to a media file.

Learning experience

Get the students to make posters of the carbon and nitrogen cycles to display around the classroom.

Flow of energy in food webs

In a food web, producers use solar energy to manufacture large molecules of carbohydrates, proteins and fats from carbon dioxide, water and other substances from the soil. When animals eat producers, some of the chemical energy in the plants is used for new tissues, and the remainder is released as heat energy during respiration, muscle movement and other body processes.

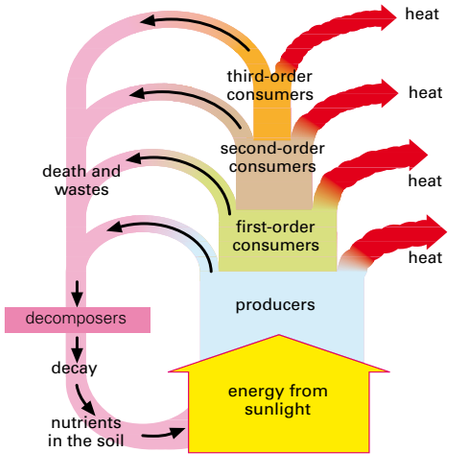


Fig 13 The flow of energy through a food web. Notice that only a very small amount of energy is recycled. The rest is given off as heat.

The diagram above shows the flow of energy through a food web. The size of the boxes represents the amount of chemical energy in the tissues of the organisms. Notice the large amount of energy that is given off as heat. This energy cannot be used by the organisms in the ecosystem. It is absorbed by the air and eventually radiated out into space.

Only a small amount of energy is recycled through the soil, air and water. This is in the form of chemical energy bound up in small molecules such as carbon dioxide, nitrates and phosphates that result from the action of decomposers. When you compare the energy flow diagram with the matter flow diagram on page 295 you can see that matter is recycled in the ecosystem but most energy is not. The energy that is lost by organisms is replaced by the energy from sunlight which is absorbed by producers.

Energy pyramids

If you stacked the energy boxes in Fig 13 on top of each other, an **energy pyramid** would be formed. In the diagram below an energy pyramid has been constructed for the food web shown.

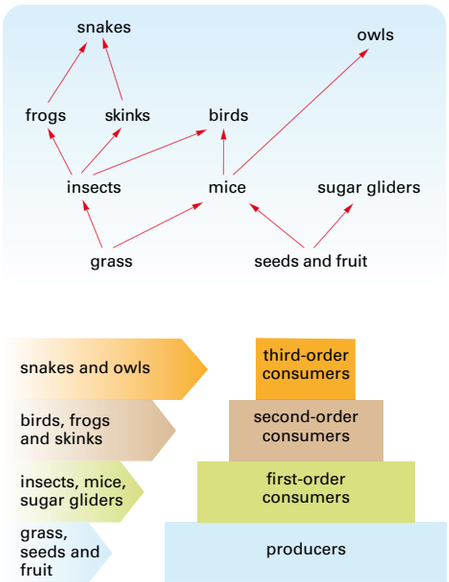


Fig 14 An energy pyramid of the organisms in a forest ecosystem

Since there is a large loss of energy from one feeding level to the next, the food web cannot have an unlimited number of levels. For this reason, most food webs consist of producers, first-order, second-order and perhaps third-order consumers. Very rarely will a food web support fourth-order consumers or higher.

Hints and tips

Remind the students that although very little energy in a food web is recycled, this doesn't mean energy has not been conserved. It simply means that the apparent loss in energy in the food web is the energy that has been converted into other energy forms such as heat. Conservation of energy still occurs.

Learning experience

1 Make sets of food web cards with photos of different producers and consumers on them. (To help preserve the cards for future use, they could be laminated.)

2 Get the students to arrange the cards into an appropriate food web.

3 Using sheets of butcher's paper, ask the students to draw the flow of matter through the food web, then do the same for the flow of energy. Small groups of about three work best. Preparing a set of cards with arrows so the students can connect their food webs is also a good idea.

4 Alternatively, students could place the organism cards onto a sheet of butcher's paper and draw in connecting arrows. If you use more than one sheet of butcher's paper, number them according to the particular food web, so that it doesn't matter if they get mixed up. A fun activity is to do a giant food web on the board and get the entire class involved in its formation. Make a list of the producers, the first-order consumers and so on.

5 Using the cards, the students can now make energy pyramids for the food webs they made. This is a great way for students to visualise the shape of ecosystems. Make sure you test the sets of cards out beforehand so that the food web connections are obvious to the students and that the energy pyramids are in fact a pyramid shape.

There are many examples of food webs in textbooks or on the internet. Try to find Australian ecosystems, as students tend to relate more easily to them.

Hints and tips

Revise this section by asking the students to write a paragraph about what they have learned so far and share it with the person next to them. Then choose a few students to read aloud their paragraphs to share with the class.

Inferring from energy pyramids

By studying energy pyramids, a number of inferences can be made about the way humans feed themselves. Look at the two energy pyramids on the right.

Both food webs begin with producers, containing the same amount of total energy. However, in Fig 16, there are more feeding levels in the food web and consequently more energy lost between producers and humans. This food web supports fewer people than the vegetarian diet. This means that a mainly fish diet is less energy-efficient than a vegetarian diet.

In most cultures, the human diet is varied and includes a high proportion of foods that have come from plants. In countries where the population density is high, people have to rely on plants to supply most of their energy. In these countries the eating of animal foods is more a luxury than an everyday occurrence.

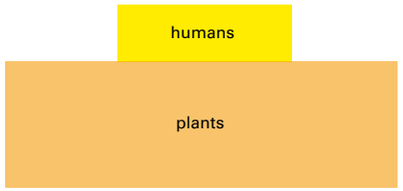


Fig 15 A human vegetarian diet

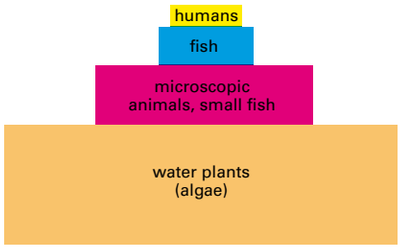
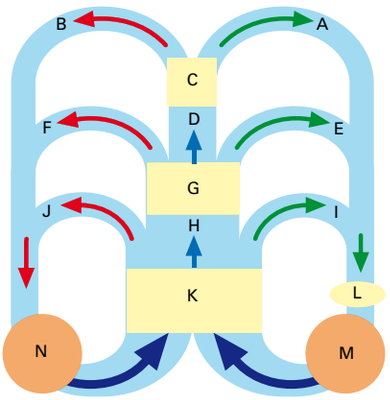


Fig 16 A human diet consisting mainly of fish

Check!

1. Explain in your own words what an ecosystem is.
2. Ecosystems are not limited by size. The Earth can be considered an ecosystem, as can a river. What do all ecosystems have in common?
3. The diagram on the right shows the flow of matter in a rocky shore ecosystem. Match the following descriptions with the letters in the diagram. (You will have to use some descriptions more than once.)

   producers
   decomposers
   first-order consumers
   food eaten
   matter lost as wastes
   matter lost through respiration
   matter in air, water and soil
   second-order consumers



4. Natural ecosystems are self-sustaining.
   a. What does this statement mean? If necessary check a dictionary.
   b. Why are decomposers important in a food web? Can an ecosystem be self-sustaining without decomposers?

Homework

Draw an energy pyramid for non-vegetarian humans, but in the pyramid list examples of organisms which are consumed. This might be a very big task, so consider limiting it to what one person eats.

Check! solutions

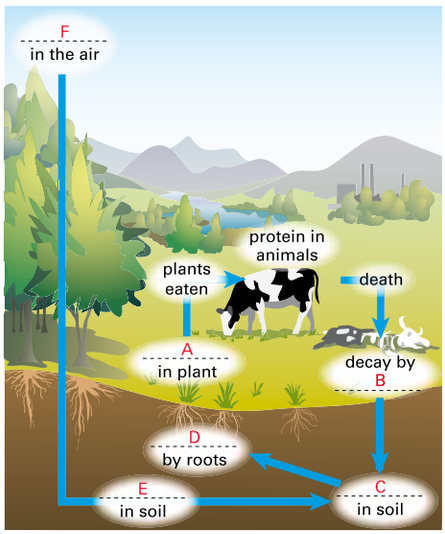
1. An ecosystem is a collection of living and non-living things existing together and relying on each other.
2. All ecosystems involve a complex series of interactions between different organisms and the non-living parts of their environment. This allows the flow of matter and energy. Almost all ecosystems rely on energy from the Sun and are able to recycle nutrients.
3. A matter lost as wastes
   B matter lost through respiration
   C second-order consumers
   D food eaten
   E matter lost as wastes
   F matter lost through respiration
   G first-order consumers
   H food eaten
   I matter lost as wastes
   J matter lost through respiration
   K producers
   L decomposers
   M matter in air, water and soil
   N matter in air, water and soil
4. a 'Self-sustaining' means maintaining itself or keeping going without extra help. While this is largely true of the matter in a natural ecosystem it does rely on energy from outside and this usually comes from the sun.
   b The importance of decomposers is to break down dead material and recycle the nutrients in the ecosystem. Without this an ecosystem could not be self-sustaining.

5 Is it possible that a carbon atom in your body could be the same one that was part of a protein in the body of a dinosaur 180 million years ago? Give reasons for your answer.

6 In what form is energy lost from an ecosystem? Why doesn't an ecosystem run out of energy?

7 The ooze and mud at the bottom of oceans and seas contain an abundance of bacteria.
- **a** Why are so many bacteria found there?
- **b** Why are these organisms an important part of the marine food web?

8 Some parts of the labels in the cycle on the right have been left off and letters have been used in their place. For each of the letters in the cycle, choose the appropriate word.
- nitrates
- nitrogen
- absorbed
- protein
- decomposers
- bacteria



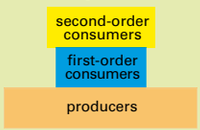
challenge

1 An ecosystem is considered productive if it contains a large mass of producers (plants and algae). Suggest why the following statements are true.
- **a** A rainforest is a more productive ecosystem than a desert.
- **b** Ecosystems in warm climates are more productive than ones in colder climates.

2 **a** Why does a large molecule, eg sugar ($C_{12}H_{22}O_{11}$), contain more energy than a molecule of carbon dioxide or water?
- **b** You mow the lawn and dump the lawn clippings in a pile on the compost heap. A day later you notice that the pile is quite warm. Explain in detail how this heat was generated. Where does the heat energy go?

3 How is it possible to increase the nitrogen content in the soil of your vegetable garden without using synthetic fertilisers?

4 Is it possible to have an energy pyramid like this one? Explain your answer.



5 Mass pyramids are similar to energy pyramids except that the boxes in the mass pyramid represent the mass of the organisms at each feeding level. Is it possible to have a mass pyramid the shape of the pyramid in Question 4? Explain your answer.

6 An area of open eucalypt forest is cleared and burnt. In its place sugar cane is planted. Write inferences to explain the following.
- **a** The sugar cane is more productive over time than the native forest.
- **b** The sugar cane is not a self-sustaining ecosystem, whereas the eucalypt forest is.
- **c** There is a smaller mass of decomposers in the sugar cane ecosystem.

WEBwatch

Go to www.scienceworld.net.au and follow the links to the website below.

Ecological Footprint Quiz

This quiz estimates how much productive land and water you require for everyday living. It compares your data with the requirements of other people and what is available on Earth.

5 Chemicals are continually being recycled in nature. For example a dinosaur would be decomposed when it died and some of the carbon atoms would be converted to carbon dioxide and released into the air. These carbon dioxide molecules could then be used by a plant for photosynthesis and be changed into food molecules. These could then be eaten either by a person or by another animal and this process could be repeated many times, finishing up with the atoms in your body.

6 Most energy is lost from an ecosystem as heat which is radiated into the atmosphere and then into space. An ecosystem does not run out of energy because it is continually being replenished with energy from the Sun.

7 **a** Many bacteria are found in the mud because it contains many dead organisms and is a rich source of nutrients and energy.
- **b** Bacteria are extremely important as decomposers because they recycle nutrients which can then be used by other organisms in the marine ecosystem.

8 **A** protein
B decomposers
C nitrates
D absorbed
E bacteria
F nitrogen

Challenge solutions

1 **a** Rainforests are more productive ecosystems because generally plants will grow more quickly if they have a good supply of water.
- **b** Generally plants grow more quickly in warmer climates. This means that there will be more plants and therefore more animals and it will be a more productive ecosystem.

2 **a** Chemical energy is contained in the bonds which hold the atoms together. In general, bigger molecules have more bonds and therefore contain more energy. Glucose ($C_{12}H_{22}O_{11}$) molecules have many more chemical bonds and will therefore store more energy than carbon dioxide (CO_2) and water (H_2O) molecules.
- **b** The pile of lawn clippings contains waste matter and water which is an ideal environment for the growth of decomposer micro-organisms. These micro-organisms produce enzymes which break down the lawn clippings into smaller pieces and then into smaller molecules. These processes are very similar to the digestion which occurs in your gut and produce heat as a by-product. This heat first of all increases the temperature of the pile of clippings, and then is radiated into the air and eventually into space.

3 It is possible to increase the nitrogen content in your garden soil by growing certain plants such as clover, peas and beans. These plants have small lumps or nodules on their roots containing bacteria which can change nitrogen in the air to nitrate in the soil so that plants can use it.

4 No, this is not possible because the only place that the second-order consumers can get their energy is from the first-order consumers. Therefore the energy of the first-order consumers must be greater then the second-order consumers.

5 No, in most cases the mass pyramids will be narrower at successive levels because the majority of the food eaten by an organism is burned to produce energy for heat and movement rather than the growth or increase in mass of the organism. The only exception will be where some organisms (eg plankton) reproduce very quickly while those that eat

continued

them (eg whales) reproduce very slowly, but this is uncommon.

6 'Productivity' can be defined as the amount of solar energy which is captured and stored in the bodies of organisms.
   - **a** A sugar cane crop grows quickly, is artificially fertilised and stores a lot of energy in the form of sugar in the stems of the plant.
   - **b** Every year the farmer will remove the sugar cane and send it off to be processed. He will then add fertiliser to the soil to replace the lost nutrients. This means it is not self-sustaining like the native forest.
   - **c** With the sugar cane crop very little of the plant material is returned to the soil and therefore there will be few decomposers present.

Hints and tips

Check out the local news to see if there are any proposed building constructions which are likely to affect your local ecosystem. It might be worth contacting the local council or newspapers. If there appears to be nothing, find out if there is a state issue. Present your findings to the class and ask them to investigate the possible environmental impact the building project/s may have. In Brisbane, for example, there has been opposition to the inner-city tunnels, and there is continuing opposition to the Traveston Dam proposal to supply water to south-east Queensland. Several rare species are threatened: the Mary River Cod, the Mary River Turtle and Queensland Lungfish.

13.2 Local ecosystems

No matter where humans live, they are a part of an ecosystem. City dwellers are part of an urban ecosystem, while people who live on farms are part of rural ecosystems.

Humans often forget that their needs, like those of any other animal, are closely linked to the health of the environment. Look at the cartoon below. Humans clear land for farming, for recreation and for houses, and in doing so destroy most of the food web in these areas. In this case, the mangroves have been cleared for houses, and the fish breeding grounds have been destroyed. Then the people who come to live where the mangroves used to be expect to catch fish when they go fishing.

Of all organisms, humans can be the most destructive. For example, the following may have been the story of a forest which was cleared many years ago for crops. When the forest was cleared, the natural food web in the area was destroyed. After the crops were planted, predators of the crops, mainly insects, invaded the area. However, because the original food web had been destroyed, the predators of these insects (mainly spiders, birds and frogs) had moved away from the area.

Fig 21 Residents protest about a proposal to destroy a row of trees to widen a road

The farmer, faced with losing the crops, used pesticides to kill the insect pests. These poisons affected many of the animals in the area, as well as the life in the nearby creeks.

Can humans balance their activities and needs as well as conserving, protecting and maintaining the quality of the environment? The activity on the next page looks at this challenge.

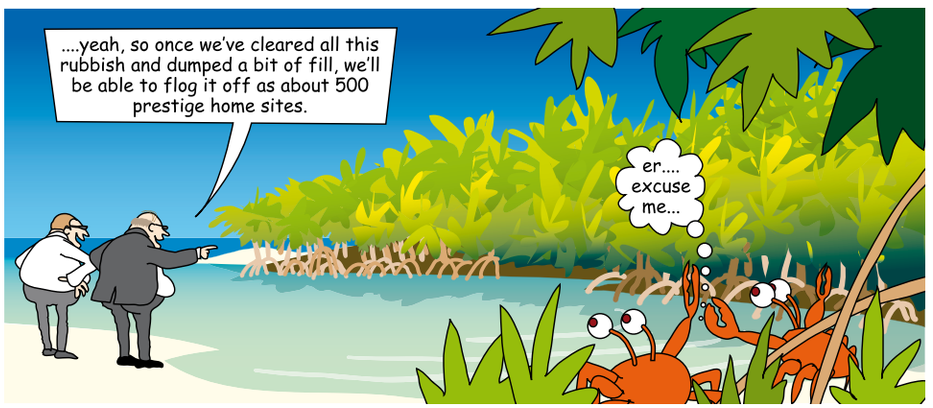


Fig 20 Mangroves contain many complex food webs. They are the breeding grounds for fish and crabs, and their destruction affects the food webs in the ocean.

Learning experience

Using the information given to them about a proposed building construction (see Hints and tips above), ask the students to investigate what environmental impact plan has been done. They could then write a letter to the local council or government MP expressing their viewpoint and outlining what they believe the environmental impact is. If the students wish to send their letters, make sure to check they are appropriately written.

Learning experience

Often protest marches are held in the major cities with the aim of saving wildlife or habitats. What do the students think about protest marches? Ask them to write down their thoughts about the following issues.

- What are the people who protest trying to do?
- Do you think this is the most appropriate method of drawing attention to the cause?
- Are there any alternatives to protest marches?
- If you felt strongly about the issue behind the protest, would you join in or find another way of supporting the protest?

Activity

Koala habitat

This activity involves group decision making to try to find a solution to the problem of freeway construction and koala habitat destruction.

Work in a group of 3 or 4, and read through the following instructions for group decision making.

Group decision making

- Be courteous and reasonable in your discussions. Make sure all members contribute.
- Listen to the opinions of others; remember that differences of opinion are useful in clarifying issues.
- If possible, all members must agree with the final decision; avoid taking a vote.
- Do not change your mind simply to avoid conflict or friendship tensions.

The problem

A large city of nearly 2 million people is 80 km away from a seaside and popular tourist resort city of 300 000 people. The cities are presently connected by a four-lane freeway and a double rail line. The area between the two cities is the fastest growing region in Australia, and the government estimates that by the year 2050 an extra 1 million people will be living in the region. However, the present road and rail network will not be able to cope with the increased population.

On the eastern side of the present freeway and suburbs is a large area of natural forest containing the food trees for one of the largest koala colonies in Australia.

The government planners have designed two routes for a second four-lane freeway. See the map. Many of the residents do not want the freeway anywhere near the forest or parklands and say there are other alternatives.

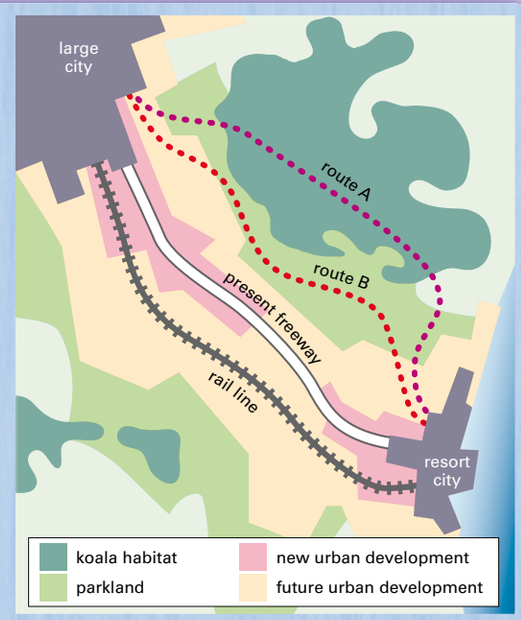


Fig 22 Map of the area showing the koala habitat and the proposed freeways

Your task

Your task is to make a recommendation about the future of the area. Use the ideas and questions below as a guide.

1. Make a list of the main aspects of the problem.
2. What do you think are the present threats to the koalas in the area? Why is the freeway a threat to the koalas? How will the extra people in the area be a threat to the koalas?
3. Proposed Route A is the cheaper route to construct. Planners say that some of the freeway will be elevated and will not restrict the movement of the koalas. Is Route A a better alternative than Route B? Why do you think most residents reject both Routes A and B?

>

Hints and tips

For this Activity, as with most group tasks, small groups of 3–5 students work best. (This does depend on the nature of the task, however.) Small groups like these minimise doubling up of roles and encourage all the members to participate.

Activity notes

- If there is a local problem causing, or likely to cause, destruction of a habitat you might like to modify this Activity to reflect the local issue. For example, the Traveston Dam project is likely to destroy the lungfish habitat. Using a local issue will mean more work for you as the teacher to organise, but the activity will be much more meaningful to the students.
- This task lends itself very well to being presented orally. Get the group to assign a team leader who will act as their group's voice. Alternatively, you could assign roles such as ministers for housing, transport and the environment, and local residents for and against the development. Each student then presents their findings to the class. Set a time limit of 3–5 minutes per student for the oral presentation.

4 The present freeway is the only major road connecting the two cities. Should more lanes be added to it?

5 If the new freeway is not built and the old one is not upgraded, are there any other transportation alternatives?

6 Some groups say that the preservation of the koalas is the number one priority. Do you think this is a realistic idea?

7 Should residents and other people be able to influence the decision-making processes of a government?

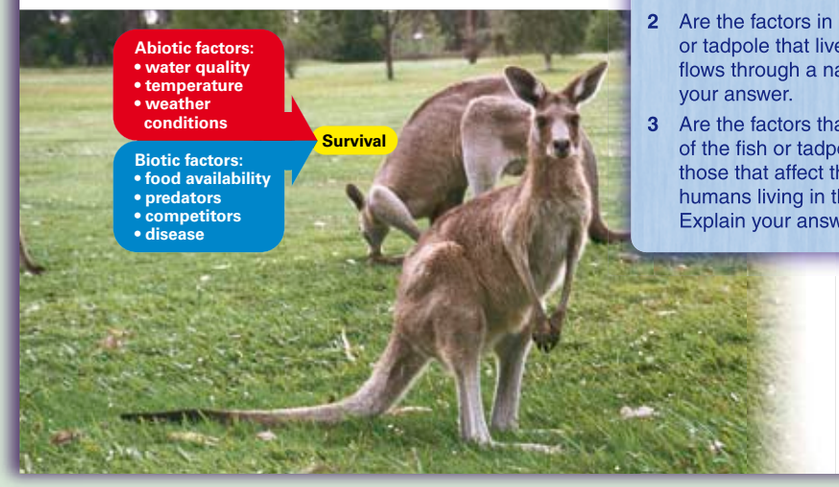
Now make your recommendations about the future planning of this area to include housing, transportation and wildlife. You may be asked to present this to the class.

The factors which affect survival

The survival of an organism depends on a number of environmental factors. These factors can be classified into two main groups:

- **biotic factors** or biological factors include food availability, predators, competitors and disease
- **abiotic factors** or physical factors include soil type and fertility, availablity of clean water and air, temperature and weather conditions.

The biotic and abiotic factors in the ecosystem determine the survival of an organism.



Activity

Form a small group to discuss the following questions. Choose someone to report back to the class at the end of the discussion.

1 List some of the biotic and abiotic factors which would affect the survival of a fish or tadpole that lives in a creek that flows through a suburb of a large town.

2 Are the factors in **1** different for a fish or tadpole that lives in a creek which flows through a national park? Explain your answer.

3 Are the factors that affect the survival of the fish or tadpole the same as those that affect the survival of humans living in the same area? Explain your answer.

Hints and tips

Many of the activities in this chapter involve group work. Make sure the students are not always in the same group with their friends. You might choose to:

- select students and assign them to a group
- number them so that all the students numbered 1 are together, all numbered 2 are together, and so on
- ask the students to choose their own groups, making sure two members are different from the last group they were in.

Activity notes

Give the students a time limit to complete this activity: 20 minutes is probably sufficient time.

Learning experience

Pose a higher-order thinking task. For example, ask students to imagine that a huge volcano eruption has spewed clouds of ash into the atmosphere, blocking out the sun's rays. Ask them to suggest what will happen on Earth if the rays are blocked for a day, a week or a year. The following questions could be explored to help them with their conclusions:

- Why is sunlight necessary for life?
- What is likely to happen to the producers in an ecosystem for the time involved?
- What could be the consequences of this?
- How do you think the human population would be affected?
- Do you think this scenario would affect climate? How?
- What possible solutions/strategies could be put in place to fix the problem?

It is important to allow thinking time for students to develop ideas, especially for the more creative learners. You might choose to get the students to work in pairs or small groups for this exercise. Gifted and talented students may like to complete this task individually. The students could present their information in a variety of formats, eg a poster, booklet, multimedia presentation, podcast or vodcast.

Urban ecosystems

Urban ecosystems include cities and towns where humans live and work. An urban ecosystem is different from other ecosystems for three reasons.

Firstly, humans are the dominant organism, not necessarily because there are more of them, but because their activities affect almost every other organism in the food webs within this ecosystem. For example, a house is sprayed with insecticide to kill cockroaches and other pests. This poison also kills spiders and predatory wasps, which control many insect populations.

Secondly, almost all the energy inputs in an urban ecosystem come from other ecosystems. Food, electricity and fossil fuels have to be supplied to an urban ecosystem for its survival. You notice how much your household relies on external energy supplies when there is an electrical blackout for a number of hours!

Thirdly, an urban ecosystem produces enormous amounts of wastes which are usually not recycled. Unlike the matter cycle in Fig 9 on page 295, the matter is often taken outside the urban ecosystem for decomposition. In addition, some of the wastes in an urban ecosystem are toxic. For example, oil discharged into creeks and rivers around industrial plants can affect other organisms.

Activity

Form a small group to discuss some of the following problems. Choose someone to report back to the class at the end of the discussion.

1. Most animals have predators and competitors in their habitats. Do you, as an animal, also have predators and competitors? How do you deal with these problems? Explain your answers.
2. Most animals in natural ecosystems move around to find food. How do humans usually find food? Does the supply of food to cities create problems for the environment? Explain your answer.
3. In a natural ecosystem, the wastes from the organisms that live there are usually broken down and recycled in that ecosystem. How do urban ecosystems deal with human wastes? What other wastes are created in urban ecosystems? What is done with them?
4. A natural ecosystem has to be self-sustainable to be able to survive. How could an urban ecosystem become self-sustaining? Have your group brainstorm some ideas. You might like to write your ideas on a large piece of paper to present to the class.
5. Some rural homes use a Remote Area Power Supply (RAPS) system instead of being connected to the electricity grid. Could RAPS be used in small urban ecosystems as well? The website below has more information on RAPS.

WEBwatch

Go to www.scienceworld.net.au and link to:

Remote Area Power Supply (RAPS)

This Australian government website contains information on setting up a RAPS system, and several case studies.

Hints and tips

- This chapter involves a lot of discussion work and written tasks. Make sure to check that ESL students or those with language difficulties are coping. Keep track of them throughout the chapter and modify tasks if and where appropriate.
- Make sure students understand the meaning of the words *urban*, *insecticide*, *predator*, *fossil fuels* and *decomposition*.

Activity notes

Allow time for the students to try the Webwatch. You may find it helpful to write a worksheet for the class to fill in about Remote Area Power Supply (RAPS).

Homework

Ask students to plan a city which considers the needs of both humans and wildlife.

- List the human needs.
- Decide which type of habitat the city's wildlife lives in, and list its needs.
- What should humans do to preserve these habitats?
- How can humans and wildlife coexist?

The written report should include an action plan or proposal, and a map of the city with key features highlighted.

Learning experience

Get the students to make a word list for the chapter. This is particularly useful for ESL students as they can write the words in their native language. Next to each word ask the students to write sentences using the word in its correct context. Auditory learners could use technology to make an audio recording of their words and turn it into a glossary. ESL students would also benefit from this as they would be able to hear the correct pronunciation of words.

Assessment task

This would be a good place to set *Assessment task 13: Environmental impact*, found on the CD.

Hints and tips

Ask students to collect magazine articles or newspaper clippings that focus on particular habitats or wildlife, and preservation of the environment. Develop a noticeboard where the articles can be displayed. You may like to use them as discussion starting points. Doing an activity like this helps the students build an appreciation of our natural world.

Research

The students could investigate *bioaccumulation*, which is the process of organisms accumulating chemicals in their bodies. The chemicals become more concentrated in organisms higher up the food chain. Do pesticides and herbicides contribute to bioaccumulation? How do scientists test chemical levels in wildlife?

Learning experience

Consider getting the students to do an ecotourism project as an assessment item for this chapter. They could design their own ecotour or travel resort targeting environmentally aware people. They should make their tour or resort appealing to all age groups, including families. Attach a copy of the marking criteria or design a self-evaluation sheet for the students to complete. For the teacher this is invaluable information as it gives insights into how the students feel they performed.

Learning experience

See if you can obtain some data on declining wildlife populations in Australian ecosystems, and have the students graph the data. A task like this helps to unify the studies of science and mathematics.

The Gippsland Lakes ecosystem

On a number of occasions over the past few years, mass fish kills have choked areas of the Gippsland Lakes with the rotting bodies of dead fish, especially the black bream. The lakes have been described as 'an ecosystem in rapid decline'.

The Gippsland Lakes make up a large freshwater ecosystem. The two large lakes, Wellington to the west, and Victoria, are home to numerous species of fish and waterbirds, and other animals and plants in food webs which support the fish and birds.

However, the human impact on the lakes has been severe over the last 30 years. The following are some of the changes humans have made to the ecosystem.

- Lake Victoria is dredged at Lakes Entrance to keep the channel to the sea open. This action is making the lakes increasingly saline.
- The Thomson Dam, built on the upper reaches of the Thomson River, reduces the flow of fresh water that used to flush out the lakes system. The dam is used mainly to supply water to Melbourne.
- Laboratory tests on the water in the lakes have shown that in excess of 100 tonnes per year of phosphates is poured into the lakes, mainly from fertilisers used on nearby farms.
- Vegetation clearing from the land in the catchment areas of the lakes has resulted in soil run-off and silting of the waterways.
- The temperature of the water in the lake system has increased over the last few years.
- The black bream population in the lakes has decreased markedly since 1980. The fish need a mixture of fresh and salty water to breed.

Questions

1 Suggest inferences to explain the following observations.
   a The water in the lakes is becoming increasingly saline.
   b The temperature of the water in the lakes system is increasing.
   c There is very little water entering Lake Victoria. This is especially so during dry weather.
   d There have been a number of algal blooms in the lake system.
   e Some of the creeks that feed into the lakes have silted up.
   f Commercial catch rates of black bream have fallen from 250 tonnes per year in 1980 to 25 tonnes in 2006.

2 In recent years hundreds of fish have died in the lakes system. Scientists examining the dead fish have found changes to the cells in their gills.
   a Why would these changes kill the fish?
   b If you were a scientist investigating the fish kill, where would you start and how would you go about the investigation?

Check! solutions

1 This statement means that humans eat other plants and animals but are not eaten by them. This statement is true in almost all cases. The only exceptions are:
   - those natural ecosystems where humans are not present very often, for example in some remote wilderness regions (eg Antarctic).
   - when humans are occasionally eaten by other animals. Such predators would include bears and crocodiles that would therefore be above humans in the food webs.

2 a Biotic factors are those caused by living things. These include diseases, predators and competitors. Abiotic factors are those that are not directly caused by non-living things and include such things as sunlight, water and temperature.
   b It will be useful to compare these factors using a table.

	Biotic	*Abiotic*
Dingo	Live prey (kangaroos) Human hunters Parasitic worms	Water Temperature Weather
Pet dog or sheep dog	Human owners Other pets Fleas	Shelter (kennel) Provision of food Medicines

3 Humans and domesticated animals are not usually threatened by other living things and do not usually hunt for food whereas this is the case in nature. Humans and pets also usually have access to medical or veterinary help and medicines if they are suffering a disease which is caused by other organisms

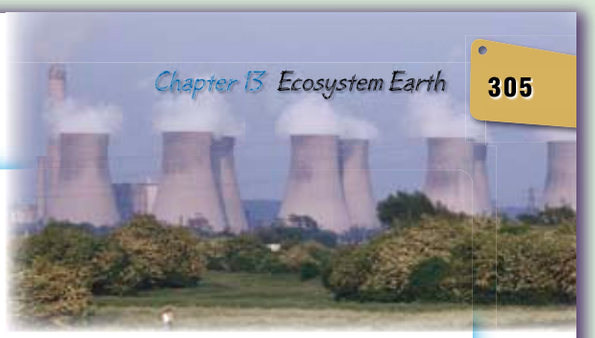
Check!

1 Humans are at the top of all food webs. Do you agree with this statement? Explain why or why not.

2 a What are biotic and abiotic environmental factors? Give examples of each.
b Make a list of the biotic and abiotic factors which might affect the survival of a dingo in its natural habitat. Are these factors the same for a pet dog in a city suburb, or a working dog on a sheep farm? Explain your answer.

3 The biotic factors of the environment do not affect humans and domesticated animals such as dogs and cats as much as they affect other animals in natural ecosystems. Suggest why.

4 List the ways an urban ecosystem is different from a natural ecosystem, for example a eucalypt forest ecosystem.



5 The photo above shows the cooling towers of a power station. The water from these cooling towers is returned to the rivers or oceans after it is used. However, the temperature of the used water can be up to 20°C warmer than the original water. Suggest what effect this would have on the organisms in the surrounding ecosystem.

6 On a farm that had been cleared of most of its trees many years ago, a farmer planted thousands of trees and shrubs in wide bands around her paddocks. After some years, she noticed that the number of insect pests on the farm had dramatically decreased, without the use of pesticides. Suggest reasons for this.

challenge

1 Freeways like the one in the photo slice through ecosystems and form a barrier which stops the movements of animals from one side of the freeway to the other.

a What changes might occur to an ecosystem over a number of years after a freeway is built through it?
b Suggest ways to reduce the impact of freeways forming a barrier through ecosystems.

2 The table below shows the amount of wastes from a suburban household each week.

Type of waste	Amount (kg)
plastic bottles & containers	2.3 kg
metal cans	2.1 kg
newspapers & cardboard	7.5 kg
kitchen scraps & peelings	15.5 kg
glass containers	1.9 kg
other wastes	2.5 kg

a What is the total amount of wastes discarded by the household each week?
b What do you think 'other wastes' might be?
c What happens to the wastes that are thrown out? What problems do these wastes cause in the environment?
d Suggest actions that the household could take in reducing wastes.
e What would be a realistic amount of waste produced by the household after the actions in **d** were taken? Justify your answer.

Challenge solutions

1 a In an ecosystem it is usual for plants to cross-pollinate and also usual for animals to move around and mate with different individuals. Construction of a freeway like this will form a barrier and reduce this interbreeding. Over a number of years this may reduce the numbers of organisms and also the variety of living things (biodiversity).
b There are several ways that the impact of freeways can be reduced. Firstly the route of the freeway can be chosen to avoid any remaining natural ecosystems (see Activity on pages 301–302). When freeways are built it is possible to provide warning signs for motorists to slow down so that they don't collide with and kill animals that are crossing the road. Better still, safe crossings for animals such as wombats can be provided, eg using a tunnel under the road.

2 Using the information in the table:
a The total amount of waste produced by the household each week is 31.8 kg.
b Other wastes would include cuttings from the garden and plastic bags.
c Wastes that are thrown out are normally collected by the local government and taken to a dump or possibly a recycling centre. Some materials are biodegradable, some can be recycled, some are burned but some are buried in the soil and become landfill. Apart from looking untidy some of these materials can find their way into the soil, water and air, and cause pollution.
d Many households and communities in Australia are becoming more aware of these problems of managing waste and are doing various things about it. These include collecting and recycling plastic, glass and metal containers. Newspaper can be collected and used as fuel in open fires and also used to make cardboard and other packaging. Kitchen scraps and peelings can be fed to pets or composted with garden clippings to make mulch which can be used to improve soil fertility in the garden.
e Using some of the methods mentioned above, a household can reduce the waste they have to discard to about $\frac{1}{5}$ or 20% of the amounts given. In this case it would be about 6 kg per week. For example the kitchen scraps which make up about half the total waste will all be reused, as well as most of the containers.

whereas animals in nature do not and often die if they contract a disease.

4 An urban ecosystem relies on an input of matter and energy from outside. This includes food, electricity and raw materials for industry. Other features are that a lot of matter is wasted as rubbish and a large amount of energy is wasted as heat. This is why an urban ecosystem is said to be 'open'. In contrast, a natural system like a eucalypt forest is 'closed'. Matter is recycled and energy from the sun is used efficiently by plants to make food which is then eaten by animals.

5 The heated water from the power station will mix with the water in the river and will raise its temperature by several degrees. This is sometimes called 'thermal' pollution. This warm water will dissolve more solids but fewer gases and this will affect the plants and algae that live in it. In turn this will affect the other organisms in this ecosystem and may cause 'algal blooms'.

6 Farms are ecosystems and any changes will have many effects. In this case, planting trees will provide food and nesting places for birds. These birds in turn will eat some of the insects and the farmer will not need to use as may chemical insecticides. This is sometimes called 'biological control'. Trees may also help to stabilise the soil and allow a more balanced and stable ecosystem to develop.

13.3 The Earth as an ecosystem

The Earth is a large self-sustaining ecosystem. Apart from the odd spacecraft and a small amount of hydrogen gas which escapes into space, all the matter on the Earth is recycled and reused over and over.

Earth's atmosphere

If the Earth was a sphere one metre in diameter, 90% of the atmosphere would make a layer about 1 millimetre thick. So the atmosphere, which is essential to life and which protects us from meteors, UV light and deadly cosmic rays, is only a relatively very thin layer.

The force of gravity holds the atmosphere close to the Earth's surface. As you move away from the Earth, the atmosphere becomes less dense, and at a height of around 1000 km you reach the vacuum of space. Scientists describe the atmosphere as consisting of three main layers. Each layer fades into the next, so that it is difficult to say where one layer ends and the next begins.

Troposphere

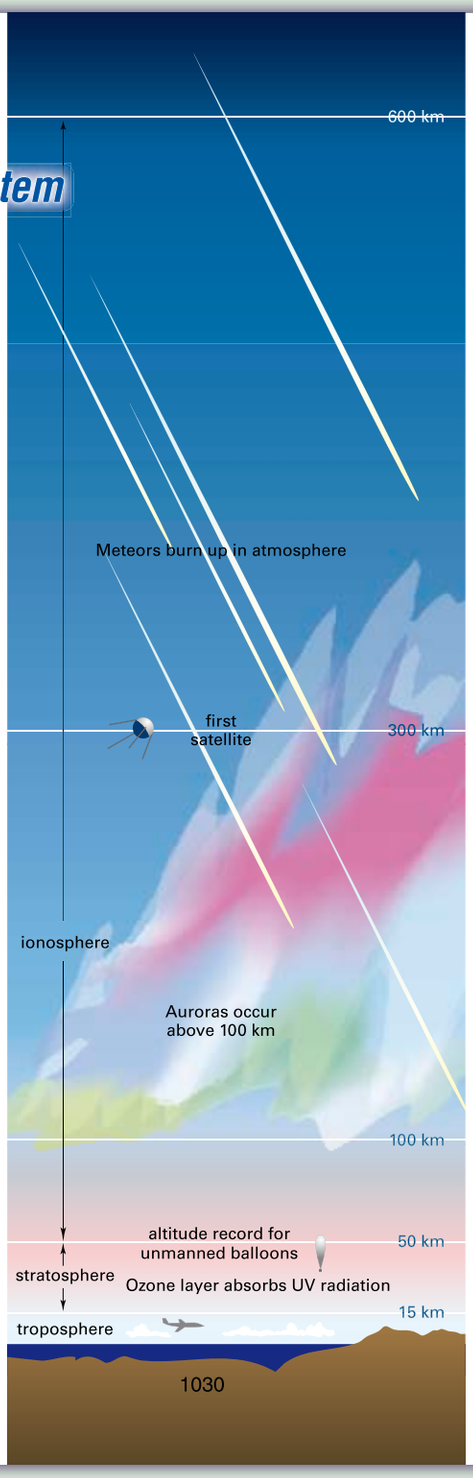
The layer closest to the Earth is called the **troposphere** (TROP-os-fear). It is about 15 km thick and contains about 75% of the air in the atmosphere. It also contains most of the water vapour, dust and clouds, and is the main influence on our weather. The temperature decreases with height in this layer.

Stratosphere

The **stratosphere** begins at a height of about 15 km. As you move upwards, the temperature increases due to the absorption of ultraviolet radiation from the Sun by molecules of ozone gas.

Ionosphere

The **ionosphere** (eye-ON-os-fear) is the layer furthest from the Earth, and it gets very hot—about 1200°C at a height of 500 km. The Sun constantly emits electrically charged particles. When these particles collide with the gases in the ionosphere, the gas molecules are changed into ions—hence the name ionosphere.



Hints and tips

Some students find it difficult to visualise shapes and learn best if they can see a model. The students need to recognise that the Earth's atmosphere surrounds the spherical Earth. If you have a globe of the world, take it into class and explain the different atmospheric layers using it as an aid.

Learning experience

Ask the students to spend five minutes writing down as many points as they can to summarise what they have learnt so far in this chapter. Also ask them to write down one question relating to the chapter that they would like to know the answer to. Let the students share their points with the person next to them and discuss the questions. Encourage them to write a personal reflection on how they *feel* about an issue discussed.

Learning experience

The students could create a mural using environmental images from their own photos, magazines or newspapers. It could be displayed in the classroom or a hallway.

Learning experience

Posters, PowerPoint slideshows or Flash animations could form part of the students' assessment for the chapter. Ask them to use the information in this section to make a presentation.

The greenhouse effect

Of the planets in our solar system, only Earth has the correct temperature range to support life as we know it. On one side of us is the planet Venus, which is too hot for life, and on the other side is Mars, which is too cold. But it is not only our distance from the Sun that is important. Our moon, which is the same distance from the Sun as Earth, cannot support life. It is extremely hot during the day and extremely cold at night. It lacks a blanket of air to even out the temperature.

There are similarities in the way a greenhouse and the Earth's atmosphere work. Sunlight passes through the glass greenhouse. Inside the greenhouse the soil and plants absorb this radiation and heat up. Heat is then radiated from everything in the greenhouse. However, this heat or infra-red radiation has a longer wavelength than light and cannot pass through glass, and is trapped inside. So the temperature inside a greenhouse can be quite high, even on a cold day.

The Earth constantly receives radiation from the Sun, mostly as light. Some of this radiation is reflected back into space by the atmosphere (including clouds) before it reaches the surface. The rest of the solar radiation is absorbed, causing the land and oceans to warm up. The infra-red radiation is then emitted from the Earth's surface out to space.

Unlike the glass, which traps the infra-red radiation inside the greenhouse, water vapour, carbon dioxide and other gases in the atmosphere absorb some of this infra-red radiation given off from the Earth's surface. These *greenhouse gases* re-emit this radiation in all directions, some back to the Earth. As a result, the Earth's surface loses less heat to space than it would if these gases were not there. The whole process is called the **greenhouse effect**.

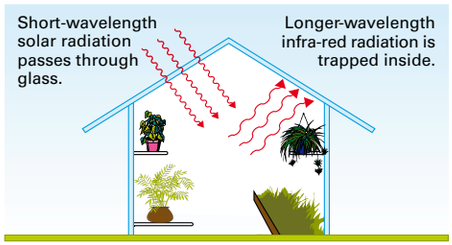


Fig 31 How a greenhouse works

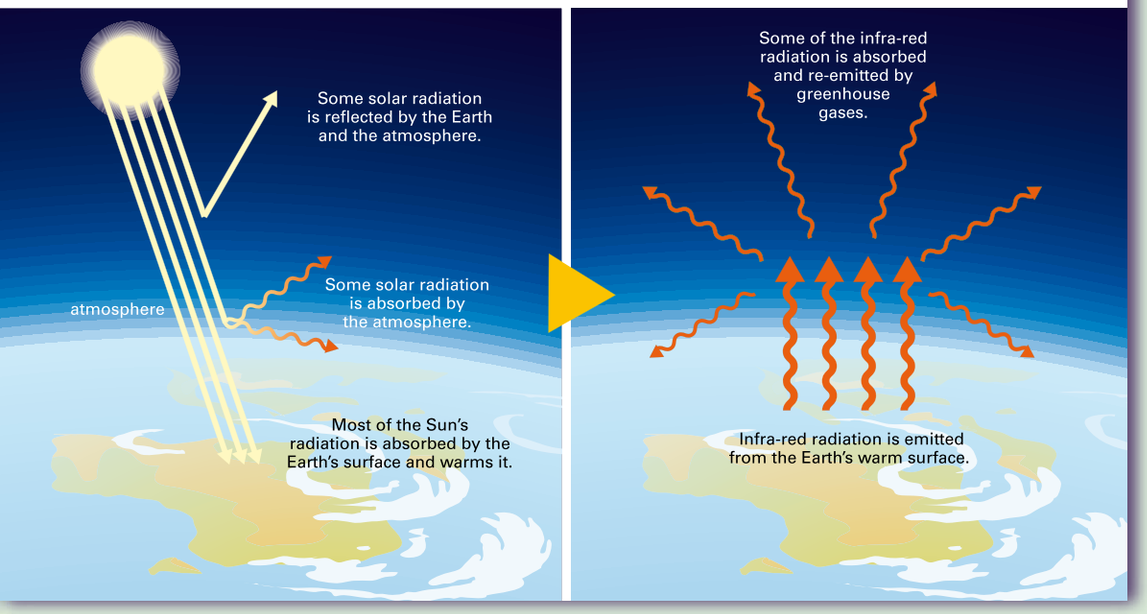


Fig 32 Greenhouse gases in the atmosphere absorb infra-red radiation and re-emit it back to Earth.

Hints and tips

Consider organising a Science Dinner Party as an end-of-year science celebration. Get a team of willing students to organise it. Good preparation and planning are important if it is to run smoothly. The students could dress up as a famous scientist, astronaut or an animal. Be creative—have food such as 'bug juice' (green cordial), jelly snakes and other animal lollies, butterfly cakes, and a 'frog bog' (green jelly with chocolate frogs in it). Make sure to have a balance of healthy food too, and cater for the herbivores!

Homework

- Ask students to find a current media article relating to the Earth's greenhouse effect and write a review about it. They should include the source and date of the publication, the main points (in dot-point form) and their own viewpoint.
- Alternatively, the Webwatch on the next page could be given as a homework exercise.

Learning experience

Why do fossil fuels affect the greenhouse effect? How is the carbon cycle (page 296) related to the Earth's 'greenhouse'? Ask the students to generate their own list of questions about the greenhouse effect and then, in pairs, try to answer them. Collect the questions and answers for review. They could be used as part of a formal test.

Investigate

28 A MODEL GREENHOUSE

Aim

To set up a model greenhouse.

Materials

- 2 microscope slides
- adhesive tape
- 2 small cardboard boxes or plastic containers, eg margarine or take-away containers
- 2 thermometers

Planning and Safety Check

- Read through the Method carefully. You will need to leave your equipment for at least 20 minutes in the sun or, if overcast, set up lights.
- Prepare a data table for your results.

Working with technology: You could use a temperature probe and a datalogger instead of thermometers.

Method

1 Lay the two slides side by side and tape them together. Cut a hole in both boxes as shown.

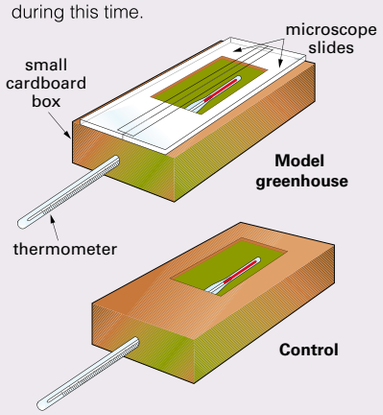
2 Lay the slides over the hole in one of the boxes. Punch a hole in one end of the box to insert a thermometer. This is your model greenhouse.

3 To see how effective your greenhouse is, set up a control box. It is the same as the other box, without the glass roof.

Record the temperatures in both boxes before you take them out into the sunlight.

4 Leave the greenhouse and the control in the sun for about 20 minutes.

Record the temperatures every 2 minutes during this time.



Discussion

1 Plot temperature against time for the greenhouse and the control on the one sheet of graph paper.

2 Interpret the graphs. That is, write a sentence or two saying what they tell you.

3 Use the model greenhouse to explain how the atmosphere affects the temperature of the Earth.

Working with technology: To see how the greenhouse effect works, open the Greenhouse effect animation on the CD.

WEBwatch

Go to www.scienceworld.net.au and follow the links to the websites below.

Greenhouse? What's that?

This site contains useful information on the greenhouse effect, climate change and alternative energies.

Forests and the environment

Information is presented in cartoon and text form on how forests help to reduce greenhouse gases.

Lab notes

- You will need quite a few cardboard boxes, so it is a good idea to collect these in advance.
- You may have to arrange for the class to use a more sunny area, eg a balcony or courtyard.
- This investigation is a good opportunity for students to develop their graphing skills.

Learning experience

A very interesting long-term activity for the class or groups is to set up a 'Winogradsky column'. This can be used to demonstrate succession of microbial populations and changes in the environment brought about by certain microbial groups.

Materials (per group)

- a sealable plastic container (a 1 L PET soft-drink bottle is ideal)
- a selection of soils (eg silt, mud, sand, fine gravel)
- muddy water (from a pond or creek)
- a source of cellulose (eg lawn clippings, straw, sawdust or wood shavings)
- a source of sulfur (eg calcium sulfate, magnesium sulfate or egg yolk)
- a source of carbon (eg calcium carbonate)

Method

1 Mix about 2 teaspoonfuls of calcium sulfate and 2 teaspoonfuls of calcium carbonate with about 200 mL of soil and place it in the bottom of the container.

2 Add about 200 mL of the cellulose source and pack it down with a long rod.

3 Add another layer of about 200 mL of soil.

4 Add enough water so that there is about 100 mL of air in the top of the container. Again use the rod to pack it all together and expel air.

5 Place the column in a safe, warm (about 20°C) place with good sunlight—a window sill is ideal.

6 Observe regularly over at least 8 weeks.

Alternatively, you may wish to set up several columns or set up groups to test the effect of varying the composition of the columns or the conditions, eg salt water will favour halophiles, higher temperatures will favour thermophiles.

Results

- Note any changes in colour and odour over the period of your observations. This needs to extend over 2–3 months.
- When checking for the production of gas it is best to open the column outside.
- You are looking for the development of coloured layers as succession occurs.
- Choose the best way to record your observations, eg a table, photographs or diagrams.
- For more information, see <www.woodrow.org/teachers/bi/2000/Winogradsky_Column/winogradsky_column.html>.

Human impact on the atmosphere

The amounts of gases in our atmosphere are just right to support life, and they remain fairly constant. For example, the amount of carbon dioxide in the air is kept fairly constant by the carbon cycle. (See the diagram on page 296.)

The world's population now is five times what it was in 1800. Since then, the number of factories and farms has increased, and scientists have become concerned about the increasing amounts of carbon dioxide in the atmosphere. Fossil fuels contain carbon, and when they are burnt carbon dioxide is released into the atmosphere. On average, about 4 tonnes of this gas is released each year for every person on the planet! About half of this carbon dioxide is absorbed by the oceans and by plants, but the rest stays in the atmosphere.

Carbon dioxide is one of the gases in the atmosphere called greenhouse gases. These are the gases which absorb the radiated heat from the Earth's surface and hence keep the Earth warm. Other natural greenhouse gases include methane and nitrous oxide. However, a number of manufactured gases also act as greenhouse gases, particularly a group called CFCs or chloro-fluorocarbons. These CFCs were discovered in the 1920s and since then they have been widely used in refrigerators, airconditioners, aerosols, plastic foam, dry cleaning and for cleaning computer parts. Until 1990 Australians used more CFCs per person than any other country in the world. CFCs are now banned in most countries.

Global warming

Global warming refers to the rise in the Earth's temperature due to increased levels of carbon dioxide and other greenhouse gases in the atmosphere.

Greenhouse gas levels are shown in the table below. The global warming effect in the right-hand column shows how much warming one tonne of the gas causes in 100 years, compared with the warming produced by one tonne of carbon dioxide.

To investigate the relationship between CO_2 levels and temperature, scientists have drilled through Antarctic ice to a depth of over 2 km. When the snow fell thousands of years ago, tiny pockets of air were trapped in it. Hence, ice which is deep below the surface has older air trapped in it than ice at the surface. From these ice cores, CO_2 levels and changes in temperature for the last

Greenhouse gas and sources	Atmospheric concentration before 1750 (ppm)	Atmospheric concentration in 2006 (ppm)	Yearly increase (%)	Atmospheric lifetime (years)	Global warming effect
carbon dioxide (CO_2) burning fossil fuels and forests	280	377	0.79	5–200	1
methane (CH_4) cows & sheep, swamps, rice paddy fields, natural gas leakage, rubbish dumps	0.73	1.85	0.6	12	23
CFCs fridges, foams, aerosol sprays, solvents	zero	0.0003	0* * CFC atmospheric concentrations are now declining	35–100	4600–10600
nitrous oxide (N_2O) burning fossil fuels and forests	0.27	0.32	0.25	114	296

Source: Carbon Dioxide Information Analysis Centre (CDIAC), updated Jul 2006. Website: http://cdiac.esd.ornl.gov/pns/current_ghg.html

Hints and tips

Present to the class some interesting facts, tips or viewpoints about global warming. For example, consider replacing incandescent light bulbs with compact fluorescent light bulbs (CFL) because they use about 60% less energy. About 3% of the emissions of the greenhouse gas methane is released by decomposing biodegradable waste. Recycling organic waste or composting it can help reduce this problem.

Research

Ask the students to use the internet to find a map of Australia showing its likely form in the event of rising sea levels. What time frame does the map cover? Is where students live at the moment predicted to be on dry land?

Learning experience

There have been many debates about greenhouse gases causing global warming. Ask the students to draw a cartoon strip explaining the impact humans have had on the atmosphere. You might like to collate the cartoons into a book and put it on display for other people to read.

160 000 years have been calculated. The graph on the right shows clearly that there is a link between the temperature and the concentration of CO_2 in the atmosphere. When the CO_2 concentration is high, so is the temperature.

There has been an increase of 0.5–0.7°C in global surface air temperatures over the last 100 years, with 1995 and 2005 being the hottest years ever recorded. With this slight warming, the oceans have expanded and ice has melted, resulting in a rise in sea level of 11–12 centimetres.

In 2005 the Kyoto Protocol came into force. This agreement commits 163 industrialised countries to reducing CO_2 and other greenhouse gas emissions. Australia and the USA have not signed the agreement.

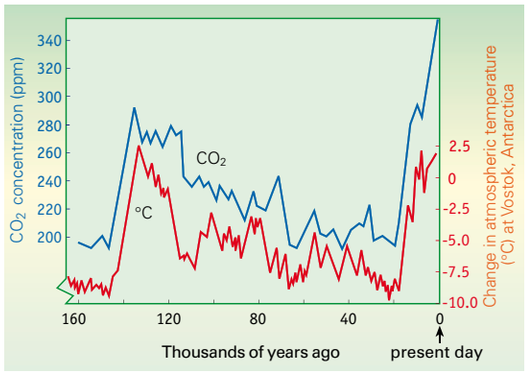


Fig 35 How the carbon dioxide content of the atmosphere and the global temperature have changed over the past 160 000 years

Activity

Predicting the future

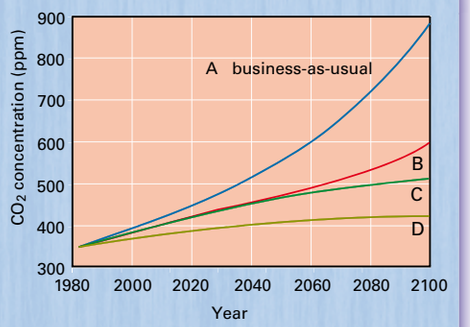
Future greenhouse gas emissions will depend on future human activity, and this is not easy to predict.

One of the most useful ways of looking at what might happen is to construct scenarios of the future, using complex computer models. The graph shows four different scenarios for the concentration of carbon dioxide. Scenario A is called the business-as-usual scenario because it assumes that things will continue as they presently are, eg we will continue to burn coal to generate electricity.

Scenarios B, C and D represent futures where there are more and more controls on the emission of greenhouse gases.

Which scenario would have the strictest controls? Explain your answer.

Suggest what the differences between the four scenarios A, B, C and D might be.



What are the predicted CO_2 levels for the year 2100 for each of the four scenarios?

If we do nothing to reduce emissions, in which year will the 2000 level double?

Hints and tips

Ask the students to try to explain how the graph in Fig 35 was plotted. You may need to point out to them that CO_2 concentration (blue) is plotted on the left-hand vertical axis, and change in temperature (red) is on the right-hand axis. How might the scientists have inferred what the carbon dioxide levels were thousands of years ago? What evidence do they have?

Activity notes

Reinforce that 'ppm' is an abbreviation for parts per million.

Issues

Get the students to hold their own 'World Climate Summit'. Appoint leaders and their assistants from different countries. Each country must come up with their own climate policy and then, as a class, the world leaders collaborate and form one policy to combat climate change.

Learning experience

Prepare a set of flash cards on the chapter which can be used as a revision tool. Use the cards at the beginning or end of a lesson to reinforce concepts.

The ozone layer

What is the **ozone layer** and why has it got a hole in it? Ozone is found naturally with other gases in the atmosphere, and its concentration is greatest in the lower stratosphere. Even here, only about 1 molecule in every 100 000 is ozone. These ozone molecules are formed when UV radiation from the Sun strikes an oxygen molecule. In a series of three reactions ozone is formed and splits apart again, absorbing UV radiation in the process.

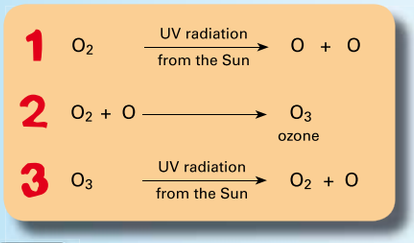


Fig 37 Ozone is formed when oxygen molecules in the stratosphere absorb UV radiation from the Sun.

The natural balance between oxygen and ozone in the atmosphere was upset when CFCs began to be widely used.

CFCs contain chlorine and fluorine atoms bonded to carbon atoms. In the stratosphere, radiation from the Sun causes the chlorine atoms from the CFCs to react with ozone molecules, breaking them apart. One molecule of CFC can destroy many thousands of ozone molecules.

In 1982 British scientists recorded a very low concentration of ozone in the stratosphere over Antarctica. Similar amounts were recorded during 1983 and 1984. The ozone layer had depleted by 30% since 1970. By 2004 this depletion had increased to 60%. Thus the term 'hole in the ozone layer'.

The 'ozone hole' over the Antarctic is greater in the winter months. The warmer air during summer brings in more ozone and the 'hole' almost disappears.

CFCs stay in the atmosphere for many years. So even though CFCs are banned in most countries, the CFCs in the atmosphere are still affecting ozone concentration.

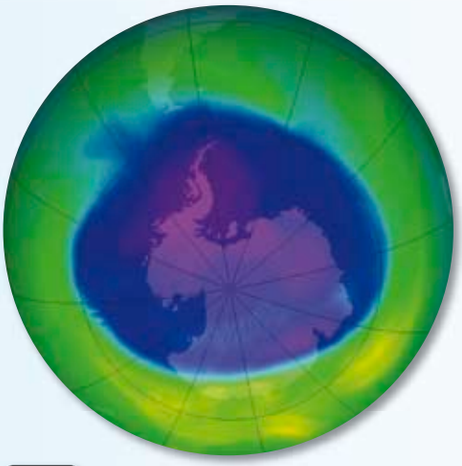


Fig 38 This satellite photo shows the ozone hole over Antarctica in September 2005. The blue area is where the ozone has thinned most.

Effects of ozone depletion

Ultraviolet radiation from the Sun is responsible for almost all skin cancers. For each 1% decrease in ozone, there is a corresponding 2% increase in harmful UV radiation reaching the Earth's surface, and a 4% increase in skin cancer rates. Australians already have the highest rate of skin cancer in the world, so ozone depletion means that you will need to take extra precautions in the Sun.

Exposure to UV radiation can also affect the human immune system so that you are more likely to contract diseases such as the herpes virus and hepatitis. Increased exposure to UV can also lead to eye problems, for example cataracts, where the lens of the eye becomes clouded.

Increased UV radiation can damage crops, leading to decreased yields. And photosynthetic plankton, which are the basis of most aquatic food webs, particularly in the ocean, are very sensitive to extra UV radiation. So ozone depletion is a serious threat to marine ecosystems.

Learning experience

Is the 'hole' in the ozone layer increasing, decreasing or stabilising? Are there peak times of the year when the hole is largest? How extensive is the 'hole'? In which region of Australia would people be most affected by the ozone depletion? Have a class discussion on one or all of these questions.

Learning experience

The students could write an advertisement or TV commercial raising awareness of ozone layer depletion and informing the general public. It needs to be short, creative and scientifically factual.

Skillbuilder

Presenting a persuasive speech

The purpose of a persuasive speech is to convince your audience through carefully reasoned and logical argument that they should agree with your point of view. This Skillbuilder will show you some of the techniques used to make an effective persuasive speech.

Your task

Suppose you are to present a persuasive speech on the topic *Our future depends on household recycling*.

Researching the topic

Before you can write your persuasive speech, it is essential you research the topic following these steps:

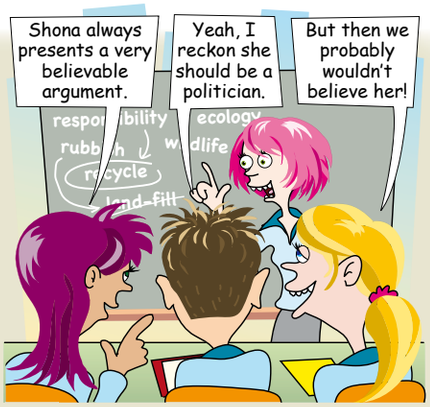
1. Search the internet using the words *household recycling*, or just *recycling,* in your search engine. You can also use library books, magazines and brochures.
2. Scan the information and decide how useful it is.
3. If the information is relevant to the topic, read it carefully and make notes. Do this by summarising in your own words. Do not copy straight from the source.

Preparing the persuasive speech

1. In the **introduction** of your speech:
   - state your point of view firmly and clearly
   - summarise the case you are going to present.
2. In the **body** of the speech:
   - develop the argument in clear steps
   - support each main point with evidence
   - take one side of the argument only.
3. In the **conclusion** of your speech:
   - in strong, stirring language state your conclusion
   - do not introduce any new ideas.

Presenting your persuasive speech

As well as preparing a logical, factual and well-developed argument, there are some techniques



you might like to consider to enhance your presentation.

1. **Using emotive language**: Appeal to the personal and emotional side of your audience so that they feel involved. For example, *Every one of us has the responsiblity to ensure that the Earth's fragile ecosystems are not destroyed by...*
2. **Using rhetorical questions**: Involve the audience by asking questions and answering them. For example, *What can we do? First of all, each one of us...*
3. **Using repetition**: For example, *On this continent, over 100 species are lost by extinction each day. These 100 species...*
4. **Using alliteration**: Use words starting with the same letter. For example, *putrid, poisonous pollution.*
5. **Using short sentences**: The listener cannot return to what has been said, unlike the reader of an essay.

Have a go!

Work in a small group and practise preparing a short persuasive speech of no more than two minutes using the topic given in Your task above. Then take it in turns to present the speech to your group.

Choose one of the topics in the Activity on the next page, research it and prepare a persuasive speech to present to the class.

Skillbuilder notes

- Small groups work best for this task, and make sure you set clear time limits.
- It is a good idea to read this task together as a class. Before students start, give them the opportunity to ask questions so that they all understand what they have to do.
- Extra assistance will be needed for ESL students or those with language difficulties.
- It might be helpful to give the students a copy of your marking criteria so they know how they will be assessed. Be sure to include criteria about how well prepared they were and how much research they did. This way, students who are not such confident presenters will feel more comfortable about doing the task.

Check! solutions

1 The Earth is surrounded by a layer of air called the atmosphere which is about 30 km thick. This layer of air behaves like a very large blanket and keeps the surface of the Earth at a fairly constant temperature. If the blanket works 'too well' then the Earth will slowly heat up. We know this is happening and it is called global warming.

2 The glass in a greenhouse allows short-wave radiation (eg light) in but traps longer wavelength radiation (infra-red) inside. The Earth's atmosphere is similar to this which means that the earth

Activity

Choose one of the topics below and prepare a persuasive speech.

Your purpose is to present your speech to an audience (your class) and try to persuade them through logical arguments and presentation skills that your point of view is correct.

The websites on the right contain useful information for some of the topics. For more information type the key words into the search engine of your internet browser.

Topics

1. Deforestation and land clearing means increased global warming.
2. Sun power—the only way to go!
3. Fossil fuels or renewable resources? The choice is simple!
4. Protecting our environment doesn't mean going without. It means using resources wisely.

WEBwatch

Go to www.scienceworld.net.au and follow the links to the websites below.

Tropical deforestation
Detailed information on effects of deforestation.

Sustainable energy—using energy wisely
Information on this site could be used as a guide to the preparation of a persuasive speech. There are links to fact sheets and other sites.

Global warming – frequently asked questions
This site has easy-to-read information on the greenhouse effect and global warming.

Global warming facts and our future
This site presents useful information and activities on the causes and effects of global warming.

Fossil fuels
This easy-to-read site has information on fossil fuels. It has links to alternative forms of energies.

Check!

1. The surface temperature of the Earth depends on the atmosphere. Explain what this statement means.
2. Explain the similarities and differences between how a greenhouse works and how the atmosphere moderates the Earth's temperature.
3. Use the table on page 309 to answer these questions about greenhouse gases.
   - a What are the sources of methane?
   - b Which gas was increasing in concentration most rapidly in 2006?
   - c Suggest why the CO_2 concentration has increased greatly since 1750.
   - d Which gas has the most dramatic effect on the heating of the Earth's atmosphere? Explain your answer.
   - e Why is it that carbon dioxide is the major source of concern even though other gases have a greater global warming effect?
   - f The concentration of CO_2 in the atmosphere in 2006 was 377 ppm. What percentage of the atmosphere is this?
4. Explain in your own words the connection between fossil fuels and global warming.
5. Give two ways in which the clearing of rainforests might contribute to an increase in global warming.
6. How is carbon dioxide removed naturally from the atmosphere?
7. Why does ozone depletion result in higher levels of UV radiation on the Earth?
8. In a group, discuss how each of the following could help to slow down global warming.
   - a recycling
   - b banning CFCs
   - c replanting of cleared forest areas
   - d driving smaller cars
   - e using energy-efficient appliances
   - f using public transport

Activity notes

Check the Webwatch websites first and prepare some instruction sheets for the students to navigate their way through.

stays warm at night when the sun is not shining on it.

3. Referring to the table on page 309:
   - a The sources of methane are cows and sheep, rice paddy fields, natural gas leakage and rubbish dumps.
   - b Methane was increasing by 0.6% per year which is the most rapid.
   - c The main reasons for the increase in CO_2 levels include the burning of fossil fuels and the destruction of most of the world's forests.
   - d The gases which have the most dramatic effect on the atmosphere are the CFCs.
   - e Carbon dioxide is of major concern because of the enormous amount which is now being produced and the prediction that there will be much more in the future.
   - f Carbon dioxide was $\frac{369}{1\,000\,000} \times 100$ = 0.0369% of the atmosphere in 2000.
4. When fossil fuels are burned, carbon dioxide, water and some other gases are produced. These gases accumulate in the atmosphere and enhance the greenhouse effect, causing global warming.
5. When rainforests are cleared the trees are usually burned which adds CO_2 and smoke to the atmosphere. With fewer trees there is less CO_2 being used in photosynthesis so more stays in the atmosphere.
6. CO_2 is removed from the atmosphere by the process of photosynthesis.
7. Ozone provides protection because its molecules absorb ultraviolet rays and are changed to oxygen. When the level of ozone decreases in the atmosphere there is an increase in the amount of UV radiation reaching the surface of the Earth.
8. Your group may think of other ideas but these will be a start for you.
   - a Recycling, eg drink containers, will mean that less energy is needed to make new ones.
   - b Banning CFCs will mean that less of these gases end up in the atmosphere and will help to decrease global warming.
   - c Replanting cleared forest areas means that the amount of photosynthesis will increase, which will help to use up some of the carbon dioxide in the atmosphere.
   - d Driving smaller cars will mean that less petrol is used and less carbon dioxide will be produced.
   - e Energy-efficient appliances use less electricity which means less CO_2 is produced by power stations.
   - f Even though buses, trains and trams use more fuel than cars, they can carry many more people. This means that they are much more efficient with the use of fuel and will also produce less greenhouse gases compared to cars.

9 A scientist measured the amount of UV radiation on a typical cloud-free summer day using a radiometer.

Daylight saving time	Radiometer count
8 am	60
9 am	210
10 am	400
11 am	620
12 noon	850
1 pm	960
2 pm	910
3 pm	690
4 pm	450
5 pm	250
6 pm	130
7 pm	50

a Draw a graph of this data.
b At what time of the day did the UV radiation reach a maximum?
c During what times was the UV radiation count greater than 600?
d A slogan that was used by the Anti-Cancer Council was: between 11 and 3 slip under a tree. The best sunscreen of all is absolutely free. Does your graph agree with this slogan?
e Predict what the graph would look like on a cloudy day. Draw it.

10 Form the same group as you did for the Getting Started on page 291 and look at your discussion answers. As a result of what you have learnt in this chapter, what changes would you make to your answers?

challenge

1 Suppose you are trying to explain to some adults who do not understand chemical equations how ozone protects us from UV radiation. Use the equations in Fig 37 on page 311 to write an explanation. (You may have to explain what UV radiation is, and the differences between O, O_2 and O_3.)

2 How is it possible to find out what the world's atmosphere was like thousands of years ago?

3 Maize plants were grown under two different conditions:
- normal atmosphere (377 ppm CO_2)
- double CO_2 levels (754 ppm CO_2)

Leaf area was measured every 5 days and recorded.

Days	Leaf area (cm²)	
	377 ppm CO_2	754 ppm CO_2
5	27	28
10	110	117
15	358	460
20	690	879
25	660	882
30	491	761
35	386	588
40	280	412

a Plot the data on graph paper.
b Write a conclusion for the experiment.

4 Hamish made this comment: *I don't know what all the fuss is about global warming. In the last 100 years the temperature has increased less than 1°C.* How would you answer him?

5 Environmentalists often use the slogan *Think globally—act locally.* Explain what this means, using global warming or ozone depletion as an example.

6 The following equations show how CFCs destroy ozone.

1 $CCl_3F \xrightarrow{\text{UV radiation from the sun}} CCl_2F + Cl$ (chlorine atom)

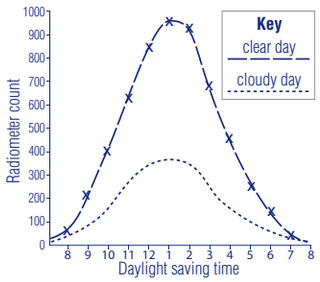
2 $O_3 + Cl \longrightarrow ClO + O_2$

3 $ClO + O \longrightarrow O_2 + Cl$

Use the equations above to write an explanation of how CFCs destroy the ozone layer and allow more UV radiation to hit the Earth's surface.

You might like to make models of the various molecules using a molecular models kit.

9 a



b The UV radiation reached a maximum at 1 pm.
c The radiation count was greater than 600 between 11 am and 3 pm.
d Yes, this graph supports the slogan because this is the period of greatest risk.
e Clouds reflect some of the UV radiation away from the Earth which reduces the amount reaching the surface. An estimate is shown by the dotted line on the graph in **a**.

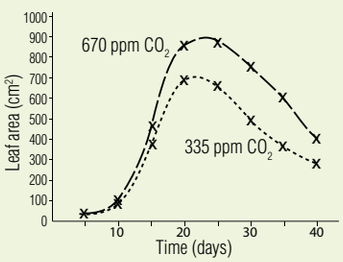
10 Your answers here will depend very much on what your group wrote down. Briefly, the destruction of forests and emissions cause an increase in 'greenhouse' gases. These in turn cause global warming, climatic change and natural disasters. The hole in the ozone layer causes more ultraviolet radiation and cancer but does not change the temperature or the weather.

Challenge solutions

1 You would need to explain that ultraviolet light is dangerous and can cause skin cancer. You would also need to explain that most ultraviolet light is absorbed in the upper atmosphere by ozone gas (O_3) which is converted to oxygen gas (O_2) and then back to ozone again.

2 Scientists are able to collect and analyse small air samples which have been trapped in ice. From these observations they are able to infer what the atmosphere was like thousands of years ago.

3 a



b From this experiment it can be concluded that double the amount of CO_2 will increase the growth of the maize plants by about 30%.

4 To answer Hamish you could mention any of the following points.
- A change of 1°C does not simply mean that it will be slightly hotter throughout the year. The major change is in weather patterns and El Niño is a good example.
- The trend is disturbing—not only is the temperature increasing but it is doing so at an increasing rate. Perhaps more obvious effects will be experienced by Hamish's grandchildren.
- Drastic effects such as a rise in sea levels may occur relatively suddenly when the polar temperatures reach a certain level and ice starts to melt very quickly.

MAIN IDEAS

Copy and complete these statements to make a summary of this chapter. The missing words are on the right.

absorbed
atmosphere
biotic factors
carbon cycle
CFCs
decomposers
ecosystem
global warming
greenhouse effect
UV radiation
ozone layer
photosynthesis
producer
protecting

1 An _____ is a system of relationships between organisms and the non-living part of their environment.

2 Matter is used and reused as it cycles through an ecosystem. For example, in the _____, carbon atoms are used in _____ and respiration and are recycled by _____.

3 Energy from the Sun is _____ and used by _____ organisms. It is then continually given off as heat by all organisms in a food web.

4 The survival of organisms in an ecosystem depends on _____ (eg predators) and abiotic factors (eg availability of clean water).

5 Conserving and _____ the quality of the environment should be balanced with the needs and activities of humans.

6 The _____ is the warming of the _____ by carbon dioxide and other gases when they absorb energy radiated from the Earth's surface.

7 An increase in greenhouse gases may cause _____ which results in changes in the climate and a rise in sea levels.

8 The _____ protects the Earth from _____ from the Sun. Chemicals such as _____ destroy ozone and have created a thinning of the layer.

Try doing the Chapter 13 crossword on the CD. Working with technology

REVIEW

1 Which one of the following statements is incorrect?
- **A** The energy stored in plants is called chemical energy.
- **B** Solar energy is converted to chemical energy during respiration.
- **C** Some chemical energy is lost as heat energy in a food web.
- **D** During photosynthesis, carbon dioxide is converted into larger molecules, eg sugars and starch.

2 The energy pyramid on the right shows the organisms in a forest ecosystem. According to the pyramid, which of the following is correct?
- **A** Snakes, birds and possums are all second-order consumers.
- **B** Not all the energy in one feeding level is transferred to the one above it.
- **C** The energy in one feeding level is equal to the energy in the feeding level below it.
- **D** Insects, possums, worms and mice supply the energy for the feeding level below them.

Main ideas solutions

1 ecosystem
2 carbon cycle, photosynthesis, decomposers
3 absorbed, producer
4 biotic factors
5 protecting
6 greenhouse effect, atmosphere
7 global warming
8 ozone layer, UV radiation, CFCs

Review solutions

1 **B**—Solar energy is converted to chemical energy during *photosynthesis*.
2 **B**

5 The whole point is that thinking globally, by itself, does not actually solve these problems. It is only when individual people change their choices and act locally that there are changes. This means that we change what we do, for example conserving electricity in our homes or what we buy, eg not buying certain sports shoes which contain pockets of the most damaging greenhouse gas (sulfur hexafluoride) in their soles.

6
- Equation 1 shows that a CFC will break down with ultraviolet light to form a chloride atom.
- Equation 2 shows that this chloride atom will react with an ozone molecule to change it to an oxygen molecule. This is the most important step because it results in less ozone in the atmosphere and we know that ozone will absorb the harmful ultraviolet light from the sun.
- Equation 3 shows that a further reaction can occur to release the chloride atom again (ie it is recycled) and this means that more ozone will be destroyed by reaction 2.

You could use models to help you explain these reactions.

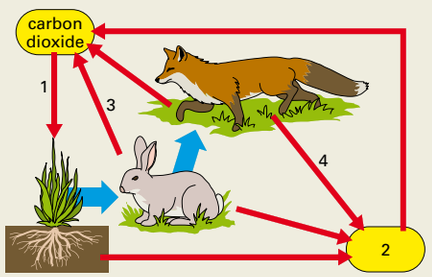
REVIEW

3 In the nitrogen cycle, nitrogen in the air is:
- **A** converted to nitrates by soil bacteria and by lightning.
- **B** converted to amino acids by bacteria in the gut of some animals.
- **C** absorbed directly by plants and algae.
- **D** very reactive and reacts with oxygen to form nitrates.

4 Why is it that the Earth stays relatively warm at night but other bodies in the solar system such as the Moon and Mars become very cold when the Sun is not shining on their surfaces?

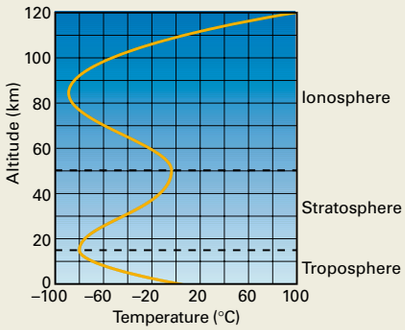
5 The photo below shows a river ecosystem. List the ways this ecosystem is different from an urban ecosystem in a large town.

6 Use the diagram of the carbon cycle to answer the questions below.



- **a** What is the process labelled 3?
- **b** What are the organisms labelled 2?
- **c** What happens to the carbon that results from the action of 2?
- **d** What do the arrows labelled 1 and 4 mean?

7 The graph below shows how the temperature changes with the distance from the Earth's surface (altitude).



- **a** Where is the lowest temperature reached?
- **b** In which layers does the temperature increase steadily with altitude?
- **c** The region between the altitudes of 50 km and 80 km is often referred to as the mesosphere. Describe the temperature changes in this layer.
- **d** O_2 molecules in the atmosphere absorb UV radiation from the Sun and form ozone, O_3. In the process heat energy is released. In which layer does this occur? Justify your answer.

8 Consider the list of CFCs below.

CFC number	Greenhouse warming potential	Ozone depletion potential	Lifetime in years
11	0.4	1.0	50
12	1.0	1.0	102
113	0.3-0.8	0.8	85
114	0.5-1.5	0.8	185
115	1–3	0.4	380

- **a** Which CFC can cause the most warming?
- **b** If all five CFCs were released into the atmosphere now, which would still be present in 200 years time?
- **c** Which is the most damaging to the ozone layer?

Check your answers on page 325.

3 **A**—See page 296.

4 The Earth's atmosphere traps some of the heat that is radiated from the surface during the day. This heat is then re-radiated back to Earth and this keeps the night temperature relatively high. Mars and the Moon, however, have no atmosphere to trap the radiated heat during the day, so the temperature falls rapidly at night.

5 The table shows some of the differences between the two ecosystems; you may have others. Check with your teacher if you are unsure.

River ecosystem	Urban ecosystem
• humans not the dominant organism • matter is usually recycled in the ecosystem • apart from solar energy, very few other energy inputs	• humans the dominant organism • matter is usually taken out of the ecosystem • large energy inputs from outside the ecosystem

6 **a** respiration
b decomposers
c The carbon in the bodies of the dead organisms is used as food by the decomposers and is returned to the air as carbon dioxide.
d 1 represents photosynthesis and 4 represents death.

7 **a** The lowest temperature is in the ionosphere (about –90°C).
b The temperature increases steadily in the stratosphere and in the upper region of the ionosphere.
c The temperature in the mesosphere decreases with altitude.
d The formation of O_3 and the release of heat occurs at the top of the stratosphere. This is indicated by the increase in temperature from the lower stratosphere.

8 **a** CFC-115
b CFC-115
c CFC-11, CFC-12 and perhaps CFC-115 because of its long lifetime.