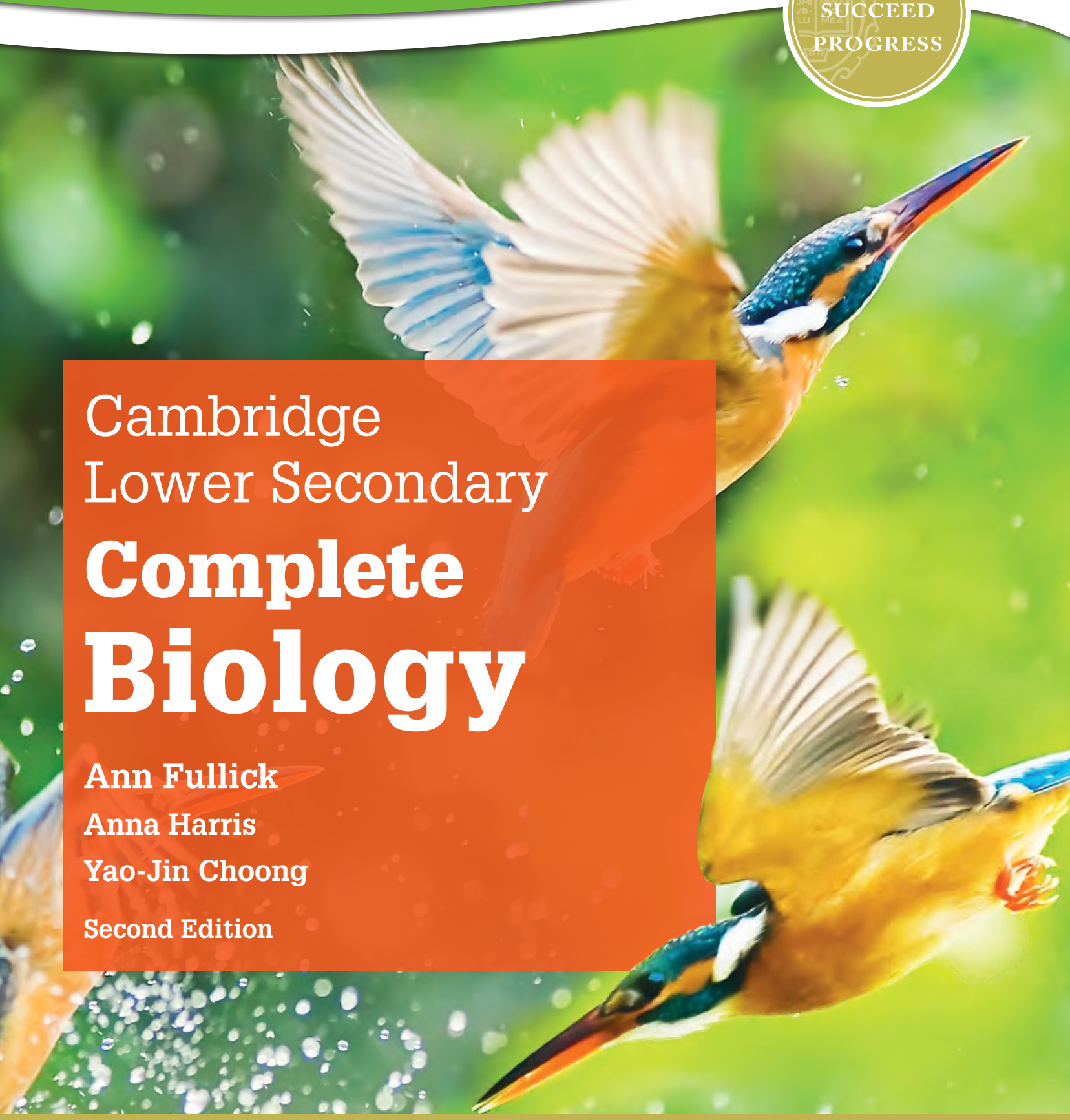
OXFORD
UNIVERSITY PRESS

ASPIRE
SUCCEED
PROGRESS



Cambridge Lower Secondary Complete Biology

Ann Fullick
Anna Harris
Yao-Jin Choong

Second Edition

Oxford excellence for Cambridge Lower Secondary

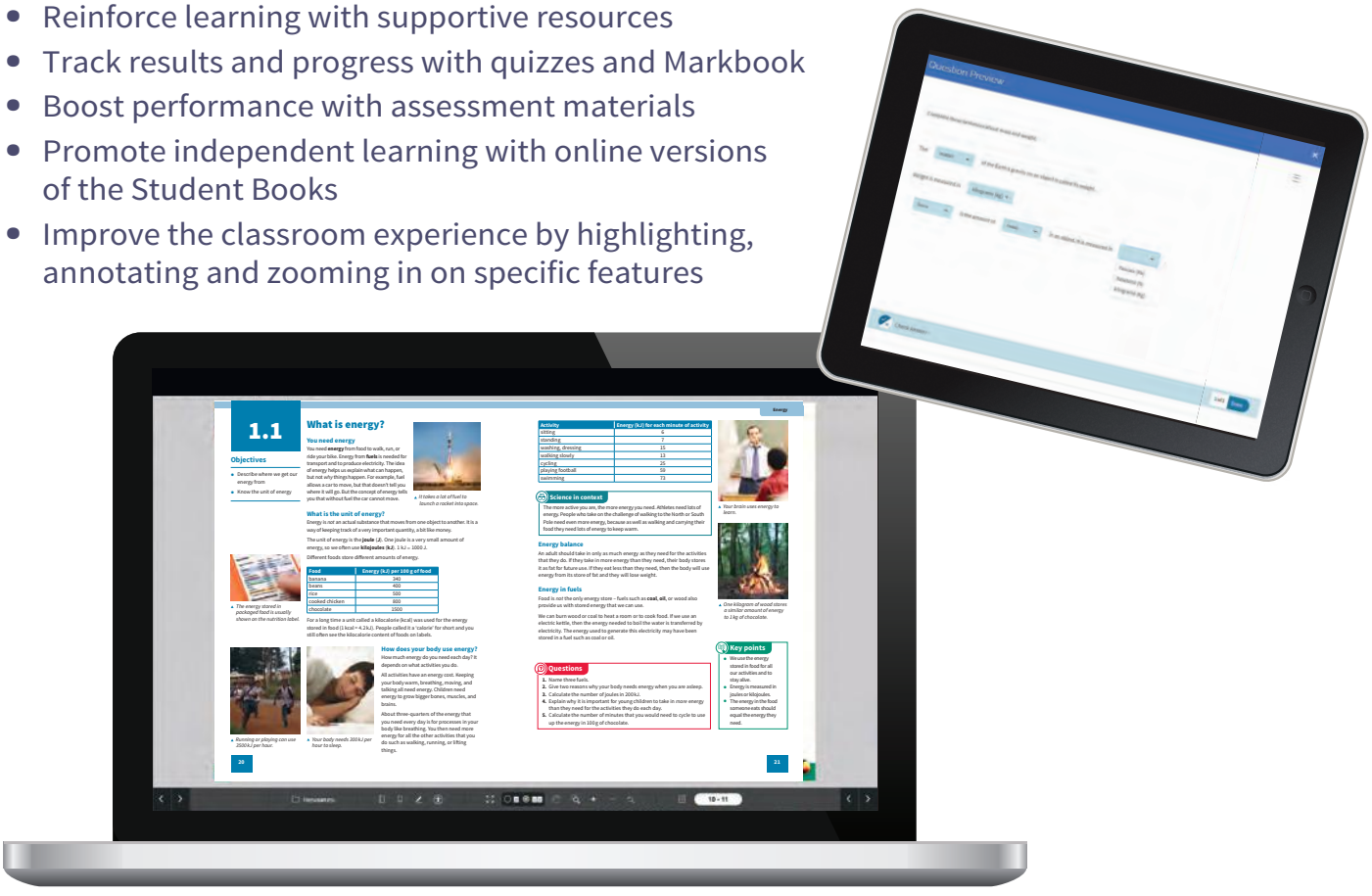
OXFORD

Sign up to access your Cambridge Lower Secondary Complete Science online Kerboodle course

What is Kerboodle?

Kerboodle is a digital platform that works alongside your course textbooks to create a truly blended learning solution. Available for purchase by your school as an annual subscription, it can help you to:

- Reinforce learning with supportive resources
- Track results and progress with quizzes and Markbook
- Boost performance with assessment materials
- Promote independent learning with online versions of the Student Books
- Improve the classroom experience by highlighting, annotating and zooming in on specific features



For more information, visit:
www.oxfordsecondary.com/cambridge-lowersecondary-science

Need help?
Contact your local educational consultant: www.oxfordsecondary.com/contact-us

Contents

Introduction 4

Thinking and working scientifically

1 Asking questions 8
2 Planning and carrying out investigations 10
3 Collecting and recording data 12
4 Drawing graphs 14
5 Analysis 16
6 Evaluation 18

Stage 7

1 Classifying life

1.1 What is life? 20
1.2 Investigating living organisms: yeast 22
1.3 Classification and species 24
1.4 Classifying invertebrate animals 26
1.5 Simple keys 28
1.6 Classifying vertebrates 30
1.7 Classifying plants 32
1.8 Making your own identification keys 34
1.9 Are viruses living? 36
1.10 Moving classification forwards 38
1.11 **Review** 40

2 Cells

2.1 The building blocks of life 42
2.2 The cell story 44
2.3 Animal and plant cells 46
2.4 Using a microscope 48
2.5 Specialised animal cells 50
2.6 Specialised plant cells 52
2.7 Modelling cells 54
2.8 Tissues and organs in animals 56
2.9 Tissues and organs in plants 58
2.10 **Review** 60

3 Microorganisms

3.1 Microorganisms 62
3.2 Microorganisms are our friends 64
3.3 Microorganisms and disease 66
3.4 Using science to prevent disease 68
3.5 The decomposers 70
3.6 Investigating rotting rates 72
3.7 Food chains, food webs and decomposers 74
3.8 **Review** 76

4 Water and life

4.1 The physical environment 78
4.2 The water cycle 80
4.3 Global warming and the water cycle 82
4.4 **Review** 84

Stage 7 review 86

Stage 8

5 Respiration and the respiratory system

5.1 Diffusion in biology 88
5.2 Aerobic respiration in animals and plants 90
5.3 Anaerobic respiration 92
5.4 Investigating respiration 94
5.5 The lungs and gas exchange 96
5.6 Breathing 98
5.7 The effect of exercise on the breathing rate 100
5.8 The structure of the alveoli 102
5.9 Asthma 104
5.10 Transport in the blood 106
5.11 Coping with extremes 108
5.12 **Review** 110

6 Lifestyle and health

6.1 The food we eat 112
6.2 Carbohydrates, fats and energy 114
6.3 Measuring the energy in food – managing variables 116
6.4 A balanced diet 118
6.5 Diet, growth and development 120
6.6 Starvation, obesity and health 122
6.7 Smoking and health 124
6.8 Building the evidence 126
6.9 The human skeleton 128
6.10 Muscles and movement 130
6.11 Health and inequality 132
6.12 **Review** 134

7 The health of the environment

7.1 Ecosystems of the earth 136
7.2 Habitats within an ecosystem 138
7.3 The interdependence of organisms 140
7.4 Pesticides and bioaccumulation 142
7.5 Invasive species 144
7.6 Invasive species and ecosystems 146
7.7 Sampling your ecosystems 148
7.8 **Review** 150

8 Our changing climate

8.1 What is weather? 152
8.2 Climate and climate change 154
8.3 Climate changes past and present 156
8.4 Gathering evidence of climate change 158
8.5 **Review** 160
Stage 8 review 162

Stage 9

9 Plant biology

9.1 What do we know about plants? 164
9.2 Photosynthesis 166
9.3 Evidence for photosynthesis: testing for starch 168
9.4 Evidence of photosynthesis: oxygen bubbles 170
9.5 The need for minerals 172
9.6 The use of fertilisers 174
9.7 Water and mineral transport in plants 176
9.8 Xylem, phloem and plant pests 178
9.9 **Review** 180

10 Excretion and the kidney

10.1 What is excretion? 182
10.2 The human excretory system 184
10.3 Who made the best model? 186
10.4 When kidneys go wrong 188
10.5 Kidneys work everywhere! 190
10.6 **Review** 192

11 Human genetics and development

11.1 Reproduction: a characteristic of life 194
11.2 Fertilisation: new life begins 196
11.3 Boy or girl? Sex inheritance in humans 198
11.4 Variation between individuals 200
11.5 The development of a fetus 202
11.6 Health of the mother, health of the child 204
11.7 Understanding science, saving lives 206
11.8 Smoking and pregnancy: the evidence 208
11.9 **Review** 210

12 The carbon cycle and climate change

12.1 The carbon cycle 212
12.2 People and the carbon cycle 214
12.3 Historical impacts of climate change 216
12.4 Predicting the future 218
12.5 Evaluating evidence for climate change 220
12.6 **Review** 222

13 Variation, natural selection and extinction

13.1 Variation in animals and plants 224
13.2 Natural selection in action 226
13.3 Environmental change and natural selection 228
13.4 Extinction! 230
13.5 Investigating the peppered moth: past and present 232
13.6 What can we do? 234
13.7 **Review** 236
Stage 9 Review 238

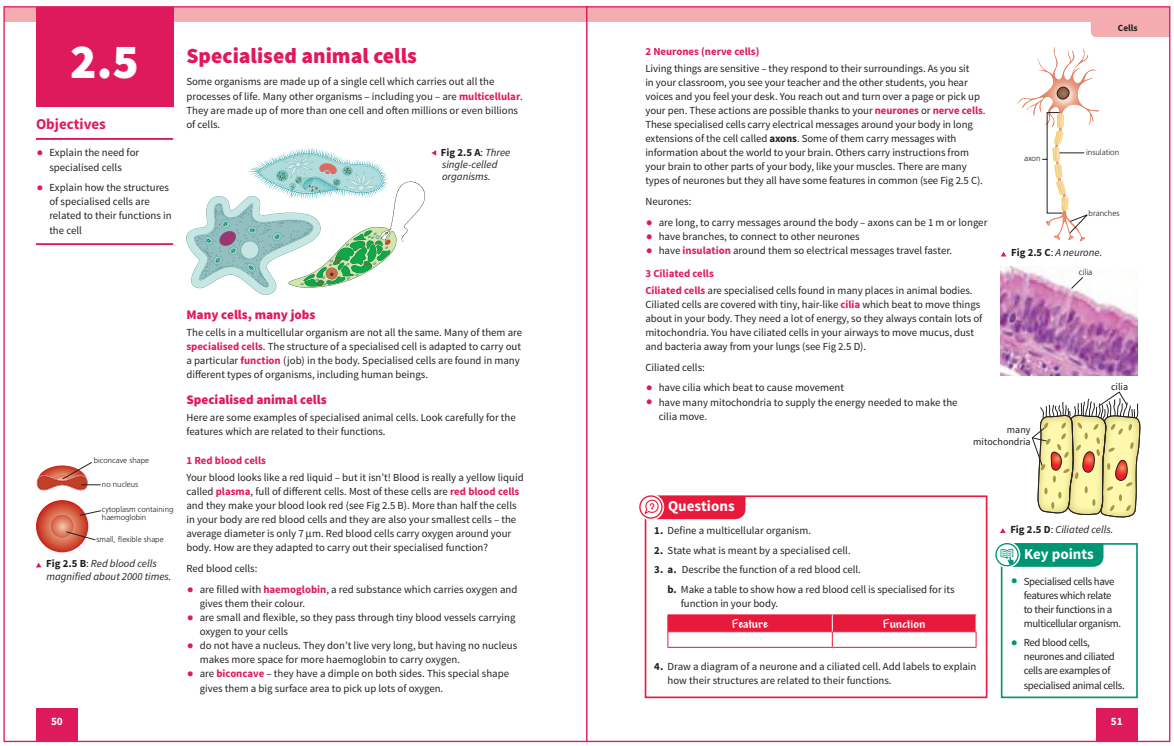
Reference **240**
1 Choosing apparatus 240
2 Working accurately and safely 242
Glossary **244**
Index **250**

Introduction

How to use your Student Book

Welcome to your Cambridge Lower Secondary Complete Biology Student book. This book has been written to help you study Biology at all three stages of the Cambridge Lower Secondary Science curriculum framework.

Most of the units in this book work like this:



2.5

Specialised animal cells

Objectives

- Explain the need for specialised cells
- Explain how the structures of specialised cells are related to their functions in the cell

Some organisms are made up of a single cell which carries out all the processes of life. Many other organisms – including you – are **multicellular**. They are made up of more than one cell and often millions or even billions of cells.

Fig 2.5 A: *Three single-celled organisms.*

Many cells, many jobs

The cells in a multicellular organism are not all the same. Many of them are **specialised cells**. The structure of a specialised cell is adapted to carry out a particular **function** (job) in the body. Specialised cells are found in many different types of organisms, including human beings.

Specialised animal cells

Here are some examples of specialised animal cells. Look carefully for the features which are related to their functions.

biconcave shape
no nucleus
cytoplasm containing haemoglobin
small, flexible shape

Fig 2.5 B: *Red blood cells magnified about 2000 times.*

1 Red blood cells

Your blood looks like a red liquid – but it isn't! Blood is really a yellow liquid called **plasma**, full of different cells. Most of these cells are **red blood cells** and they make your blood look red (see Fig 2.5 B). More than half the cells in your body are red blood cells and they are also your smallest cells – the average diameter is only 7 µm. Red blood cells carry oxygen around your body. How are they adapted to carry out their specialised function?

Red blood cells:

- are filled with **haemoglobin**, a red substance which carries oxygen and gives them their colour.
- are small and flexible, so they pass through tiny blood vessels carrying oxygen to your cells
- do not have a nucleus. They don't live very long, but having no nucleus makes more space for more haemoglobin to carry oxygen.
- are **biconcave** – they have a dimple on both sides. This special shape gives them a big surface area to pick up lots of oxygen.

50

Cells

2 Neurones (nerve cells)

Living things are sensitive – they respond to their surroundings. As you sit in your classroom, you see your teacher and the other students, you hear voices and you feel your desk. You reach out and turn over a page or pick up your pen. These actions are possible thanks to your **neurones** or **nerve cells**. These specialised cells carry electrical messages around your body in long extensions of the cell called **axons**. Some of them carry messages with information about the world to your brain. Others carry instructions from your brain to other parts of your body, like your muscles. There are many types of neurones but they all have some features in common (see Fig 2.5 C).

Neurones:

- are long, to carry messages around the body – axons can be 1 m or longer
- have branches, to connect to other neurones
- have **insulation** around them so electrical messages travel faster.

axon
insulation
branches

Fig 2.5 C: *A neurone.*

3 Ciliated cells

Ciliated cells are specialised cells found in many places in animal bodies. Ciliated cells are covered with tiny, hair-like **cilia** which beat to move things about in your body. They need a lot of energy, so they always contain lots of mitochondria. You have ciliated cells in your airways to move mucus, dust and bacteria away from your lungs (see Fig 2.5 D).

Ciliated cells:

- have cilia which beat to cause movement
- have many mitochondria to supply the energy needed to make the cilia move.

cilia

cilia
many mitochondria

Fig 2.5 D: *Ciliated cells.*

Questions

1. Define a multicellular organism.
2. State what is meant by a specialised cell.
3. a. Describe the function of a red blood cell.
   b. Make a table to show how a red blood cell is specialised for its function in your body.

Feature	Function

4. Draw a diagram of a neurone and a ciliated cell. Add labels to explain how their structures are related to their functions.

Key points

- Specialised cells have features which relate to their functions in a multicellular organism.
- Red blood cells, neurones and ciliated cells are examples of specialised animal cells.

51

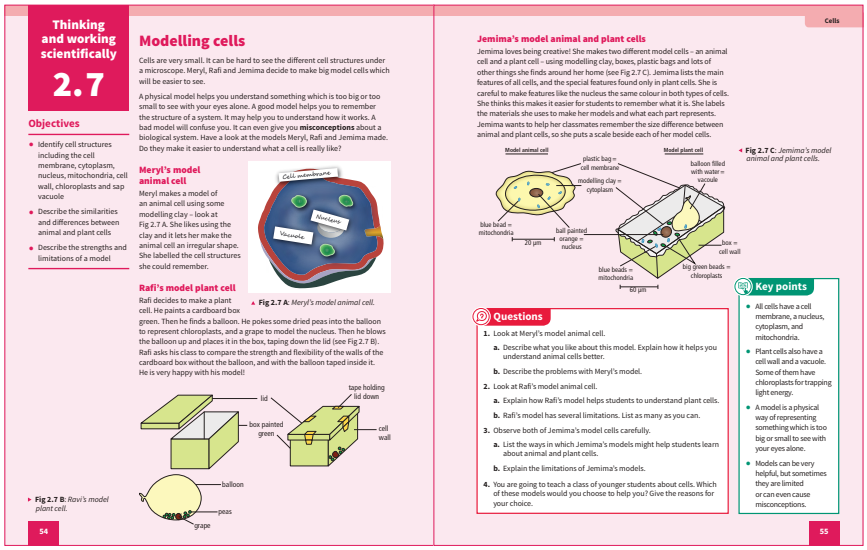
- Every page starts with the learning objectives for the unit. The learning objectives are linked to the Cambridge Lower Secondary Science curriculum framework.
- Key words are marked in **bold**. You can check the meaning of these words in the glossary at the back of the book.
- At the end of each unit there are questions to test that you understand what you have learned. The first question is straightforward and later questions are more challenging. The questions are written in the style of the Cambridge Checkpoint test, to help you prepare. Answers are available in the Teacher Handbook which is available in print and digitally via Kerboodle.
- The key points to remember from the unit are also summarised here.

These units cover the Biology topics in the Cambridge Lower Secondary Science curriculum framework.

In addition, many of the units help you think and work scientifically, put science in context, prepare for the next level, and test your knowledge.

Thinking and working scientifically

Thinking and working scientifically is an important component of the curriculum framework.



Thinking and working scientifically 2.7

Objectives
- Identify cell structures including the cell membrane, cytoplasm, nucleus, mitochondria, cell wall, chloroplasts and sap vacuole
- Describe the similarities and differences between animal and plant cells
- Describe the strengths and limitations of a model

Modelling cells

Cells are very small. It can be hard to see the different cell structures under a microscope. Meryl, Rafi and Jemima decide to make big model cells which will be easier to see.

A physical model helps you understand something which is too big or too small to see with your eyes alone. A good model helps you to remember the structure of a system. It may help you to understand how it works. A bad model will confuse you. It can even give you **misconceptions** about a biological system. Have a look at the models Meryl, Rafi and Jemima made. Do they make it easier to understand what a cell is really like?

Meryl's model animal cell

Meryl makes a model of an animal cell using some modelling clay – look at Fig 2.7 A. She likes using the clay and it lets her make the animal cell an irregular shape. She labelled the cell structures she could remember.

Fig 2.7 A: *Meryl's model animal cell.*

Rafi's model plant cell

Rafi decides to make a plant cell. He paints a cardboard box green. Then he finds a balloon. He pokes some dried peas into the balloon to represent chloroplasts, and a grape to model the nucleus. Then he blows the balloon up and places it in the box, taping down the lid (see Fig 2.7 B). Rafi asks his class to compare the strength and flexibility of the walls of the cardboard box without the balloon, and with the balloon taped inside it. He is very happy with his model!

Fig 2.7 B: *Ravi's model plant cell.*

54

Cells

Jemima's model animal and plant cells

Jemima loves being creative! She makes two different model cells – an animal cell and a plant cell – using modelling clay, boxes, plastic bags and lots of other things she finds around her home (see Fig 2.7 C). Jemima lists the main features of all cells, and the special features found only in plant cells. She is careful to make features like the nucleus the same colour in both types of cells. She thinks this makes it easier for students to remember what it is. She labels the materials she uses to make her models and what each part represents. Jemima wants to help her classmates remember the size difference between animal and plant cells, so she puts a scale beside each of her model cells.

Fig 2.7 C: *Jemima's model animal and plant cells.*

Questions

1. Look at Meryl's model animal cell.
   a. Describe what you like about this model. Explain how it helps you understand animal cells better.
   b. Describe the problems with Meryl's model.
2. Look at Rafi's model animal cell.
   a. Explain how Rafi's model helps students to understand plant cells.
   b. Rafi's model has several limitations. List as many as you can.
3. Observe both of Jemima's model cells carefully.
   a. List the ways in which Jemima's models might help students learn about animal and plant cells.
   b. Explain the limitations of Jemima's models.
4. You are going to teach a class of younger students about cells. Which of these models would you choose to help you? Give the reasons for your choice.

Key points

- All cells have a cell membrane, a nucleus, cytoplasm, and mitochondria.
- Plant cells also have a cell wall and a vacuole. Some of them have chloroplasts for trapping light energy.
- A model is a physical way of representing something which is too big or small to see with your eyes alone.
- Models can be very helpful, but sometimes they are limited or can even cause misconceptions.

55

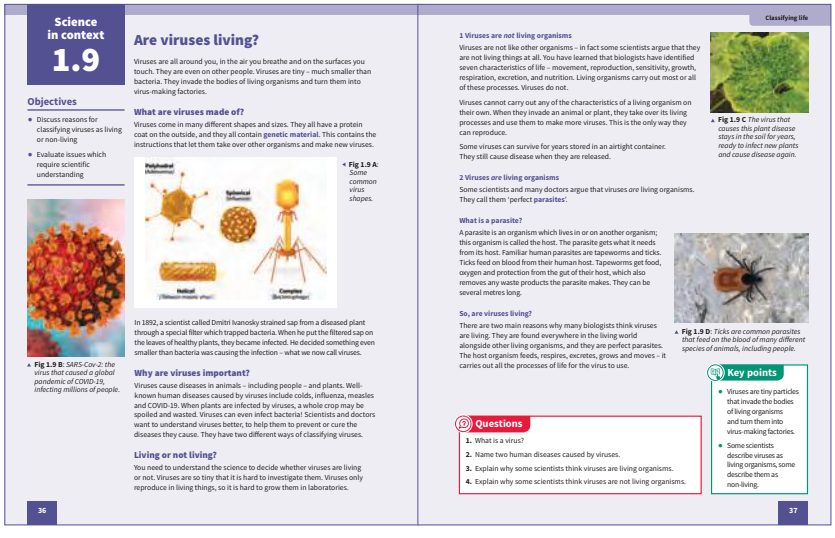
The Thinking and working scientifically units and features will help you learn:

- how to understand and apply models and representations
- the importance of asking scientific questions and planning how to answer them
- how to carry out enquiries such as fair test investigations and field work
- how to analyse data, draw conclusions, and evaluate your enquiry.

TWS Questions which test your Thinking and working scientifically skills and knowledge are marked with this icon.

On pages 8-19 you will find a dedicated Thinking and working scientifically chapter which introduces essential skills which will be useful throughout every stage of the curriculum framework.

Science in context



Science in context 1.9

Objectives
- Discuss reasons for classifying viruses as living or non-living
- Evaluate issues which require scientific understanding

Are viruses living?

Viruses are all around you, in the air you breathe and on the surfaces you touch. They are even on other people. Viruses are tiny – much smaller than bacteria. They invade the bodies of living organisms and turn them into virus-making factories.

What are viruses made of?

Viruses come in many different shapes and sizes. They all have a protein coat on the outside, and they all contain **genetic material**. This contains the instructions that let them take over other organisms and make new viruses.

Fig 1.9 A: *Some common virus shapes.*

Fig 1.9 B: *SARS-Cov-2: the virus that caused a global pandemic of COVID-19, infecting millions of people.*

In 1892, a scientist called Dmitri Ivanosky strained sap from a diseased plant through a special filter which trapped bacteria. When he put the filtered sap on the leaves of healthy plants, they became infected. He decided something even smaller than bacteria was causing the infection – what we now call viruses.

Why are viruses important?

Viruses cause diseases in animals – including people – and plants. Well-known human diseases caused by viruses include colds, influenza, measles and COVID-19. When plants are infected by viruses, a whole crop may be spoiled and wasted. Viruses can even infect bacteria! Scientists and doctors want to understand viruses better, to help them to prevent or cure the diseases they cause. They have two different ways of classifying viruses.

Living or not living?

You need to understand the science to decide whether viruses are living or not. Viruses are so tiny that it is hard to investigate them. Viruses only reproduce in living things, so it is hard to grow them in laboratories.

36

Classifying life

1 Viruses are not living organisms

Viruses are not like other organisms – in fact some scientists argue that they are not living things at all. You have learned that biologists have identified seven characteristics of life – movement, reproduction, sensitivity, growth, respiration, excretion, and nutrition. Living organisms carry out most or all of these processes. Viruses do not.

Viruses cannot carry out any of the characteristics of a living organism on their own. When they invade an animal or plant, they take over its living processes and use them to make more viruses. This is the only way they can reproduce.

Some viruses can survive for years stored in an airtight container. They still cause disease when they are released.

Fig 1.9 C: *The virus that causes this plant disease stays in the soil for years, ready to infect new plants and cause disease again.*

2 Viruses are living organisms

Some scientists and many doctors argue that viruses *are* living organisms. They call them 'perfect **parasites**'.

What is a parasite?

A parasite is an organism which lives in or on another organism; this organism is called the host. The parasite gets what it needs from its host. Familiar human parasites are tapeworms and ticks. Ticks feed on blood from their human host. Tapeworms get food, oxygen and protection from the gut of their host, which also removes any waste products the parasite makes. They can be several metres long.

So, are viruses living?

There are two main reasons why many biologists think viruses are living. They are found everywhere in the living world alongside other living organisms, and they are perfect parasites. The host organism feeds, respires, excretes, grows and moves – it carries out all the processes of life for the virus to use.

Fig 1.9 D: *Ticks are common parasites that feed on the blood of many different species of animals, including people.*

Questions

1. What is a virus?
2. Name two human diseases caused by viruses.
3. Explain why some scientists think viruses are living organisms.
4. Explain why some scientists think viruses are not living organisms.

Key points

- Viruses are tiny particles that invade the bodies of living organisms and turn them into virus-making factories.
- Some scientists describe viruses as living organisms, some describe them as non-living.

37

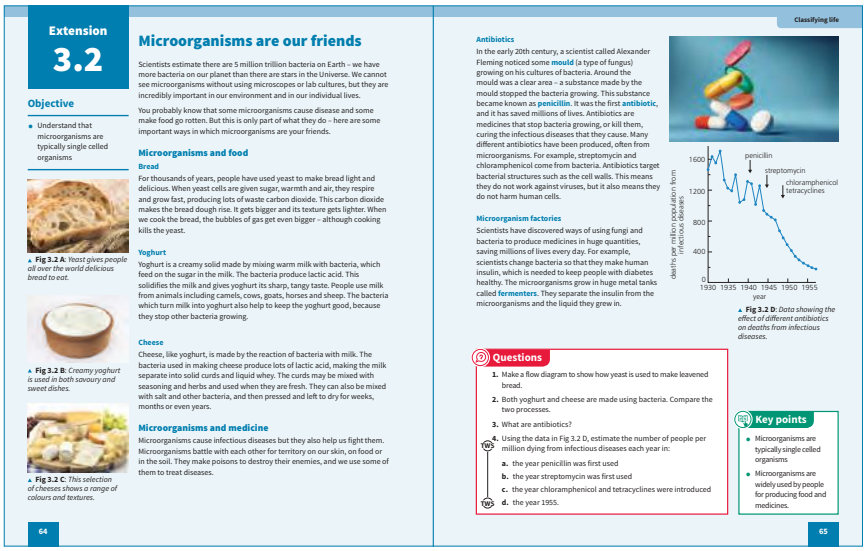
Science in context units will also help you learn:

- how scientists throughout history and from around the globe developed theories, carried out research, and drew conclusions about the world around them
- how science is applied in everyday life
- how issues involving biology are evaluated
- the global impact of the use of biology.

Extension

Throughout this book there are lots of opportunities to learn even more about biology, beyond the curriculum framework. These units are called Extension because they extend and develop your science skills further.

You can tell when a question or part of a unit is Extension because it is marked with a dashed line, like the one on the left.



Extension 3.2

Microorganisms are our friends

Objective

- Understand that microorganisms are typically single celled organisms

Scientists estimate there are 5 million trillion bacteria on Earth – we have more bacteria on our planet than there are stars in the Universe. We cannot see microorganisms without using microscopes or lab cultures, but they are incredibly important in our environment and in our individual lives.

You probably know that some microorganisms cause disease and some make food go rotten. But this is only part of what they do – here are some important ways in which microorganisms are your friends.

Microorganisms and food

Bread

For thousands of years, people have used yeast to make bread light and delicious. When yeast cells are given sugar, warmth and air, they respire and grow fast, producing lots of waste carbon dioxide. This carbon dioxide makes the bread dough rise. It gets bigger and its texture gets lighter. When we cook the bread, the bubbles of gas get even bigger – although cooking kills the yeast.

Fig 3.2 A: *Yeast gives people all over the world delicious bread to eat.*

Yoghurt

Yoghurt is a creamy solid made by mixing warm milk with bacteria, which feed on the sugar in the milk. The bacteria produce lactic acid. This solidifies the milk and gives yoghurt its sharp, tangy taste. People use milk from animals including camels, cows, goats, horses and sheep. The bacteria which turn milk into yoghurt also help to keep the yoghurt good, because they stop other bacteria growing.

Fig 3.2 B: *Creamy yoghurt is used in both savoury and sweet dishes.*

Cheese

Cheese, like yoghurt, is made by the reaction of bacteria with milk. The bacteria used in making cheese produce lots of lactic acid, making the milk separate into solid curds and liquid whey. The curds may be mixed with seasoning and herbs and used when they are fresh. They can also be mixed with salt and other bacteria, and then pressed and left to dry for weeks, months or even years.

Fig 3.2 C: *This selection of cheeses shows a range of colours and textures.*

Microorganisms and medicine

Microorganisms cause infectious diseases but they also help us fight them. Microorganisms battle with each other for territory on our skin, on food or in the soil. They make poisons to destroy their enemies, and we use some of them to treat diseases.

64

Classifying life

Antibiotics

In the early 20th century, a scientist called Alexander Fleming noticed some **mould** (a type of fungus) growing on his cultures of bacteria. Around the mould was a clear area – a substance made by the mould stopped the bacteria growing. This substance became known as **penicillin**. It was the first **antibiotic**, and it has saved millions of lives. Antibiotics are medicines that stop bacteria growing, or kill them, curing the infectious diseases that they cause. Many different antibiotics have been produced, often from microorganisms. For example, streptomycin and chloramphenicol come from bacteria. Antibiotics target bacterial structures such as the cell walls. This means they do not work against viruses, but it also means they do not harm human cells.

Microorganism factories

Scientists have discovered ways of using fungi and bacteria to produce medicines in huge quantities, saving millions of lives every day. For example, scientists change bacteria so that they make human insulin, which is needed to keep people with diabetes healthy. The microorganisms grow in huge metal tanks called **fermenters**. They separate the insulin from the microorganisms and the liquid they grew in.

Fig 3.2 D: *Data showing the effect of different antibiotics on deaths from infectious diseases.*

Questions

1. Make a flow diagram to show how yeast is used to make leavened bread.
2. Both yoghurt and cheese are made using bacteria. Compare the two processes.
3. What are antibiotics?
4. Using the data in Fig 3.2 D, estimate the number of people per million dying from infectious diseases each year in:
   - a. the year penicillin was first used
   - b. the year streptomycin was first used
   - c. the year chloramphenicol and tetracyclines were introduced
   - d. the year 1955.

Key points

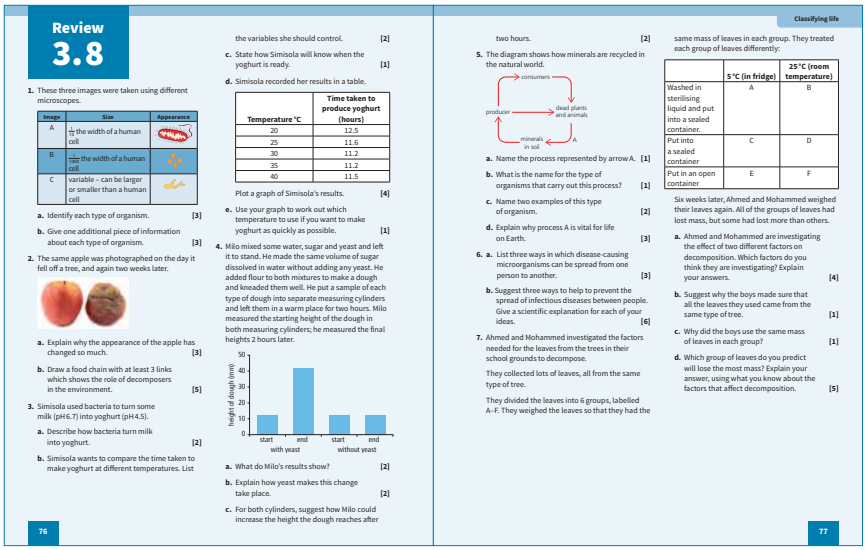
- Microorganisms are typically single-celled organisms
- Microorganisms are widely used by people for producing food and medicines.

65

Extension units will not be part of your assessment, but they will help you prepare for moving onto the next stage of the curriculum and eventually for Cambridge IGCSE Biology.

Review

At the end of every chapter and every stage there are review questions.



Review 3.8

1. These three images were taken using different microscopes.

Image	Size	Appearance
A	$\frac{1}{10}$ the width of a human cell	
B	$\frac{1}{100}$ the width of a human cell	
C	variable – can be larger or smaller than a human cell	

   a. Identify each type of organism. [3]
   b. Give one additional piece of information about each type of organism. [3]

2. The same apple was photographed on the day it fell off a tree, and again two weeks later.

   a. Explain why the appearance of the apple has changed so much. [3]
   b. Draw a food chain with at least 3 links which shows the role of decomposers in the environment. [5]

3. Simisola used bacteria to turn some milk (pH6.7) into yoghurt (pH4.5).
   a. Describe how bacteria turn milk into yoghurt. [2]
   b. Simisola wants to compare the time taken to make yoghurt at different temperatures. List the variables she should control. [2]
   c. State how Simisola will know when the yoghurt is ready. [1]
   d. Simisola recorded her results in a table.

Temperature °C	Time taken to produce yoghurt (hours)
20	12.5
25	11.6
30	11.2
35	11.2
40	11.5

   Plot a graph of Simisola's results. [4]
   e. Use your graph to work out which temperature to use if you want to make yoghurt as quickly as possible. [1]

4. Milo mixed some water, sugar and yeast and left it to stand. He made the same volume of sugar dissolved in water without adding any yeast. He added flour to both mixtures to make a dough and kneaded them well. He put a sample of each type of dough into separate measuring cylinders and left them in a warm place for two hours. Milo measured the starting height of the dough in both measuring cylinders; he measured the final heights 2 hours later.

   a. What do Milo's results show? [2]
   b. Explain how yeast makes this change take place. [2]
   c. For both cylinders, suggest how Milo could increase the height the dough reaches after two hours. [2]

5. The diagram shows how minerals are recycled in the natural world.

   a. Name the process represented by arrow A. [1]
   b. What is the name for the type of organisms that carry out this process? [1]
   c. Name two examples of this type of organism. [2]
   d. Explain why process A is vital for life on Earth. [3]

6. a. List three ways in which disease-causing microorganisms can be spread from one person to another. [3]
   b. Suggest three ways to help to prevent the spread of infectious diseases between people. Give a scientific explanation for each of your ideas. [6]

7. Ahmed and Mohammed investigated the factors needed for the leaves from the trees in their school grounds to decompose.

   They collected lots of leaves, all from the same type of tree.

   They divided the leaves into 6 groups, labelled A–F. They weighed the leaves so that they had the same mass of leaves in each group. They treated each group of leaves differently:

	5 °C (in fridge)	25 °C (room temperature)
Washed in sterilising liquid and put into a sealed container.	A	B
Put into a sealed container	C	D
Put in an open container	E	F

   Six weeks later, Ahmed and Mohammed weighed their leaves again. All of the groups of leaves had lost mass, but some had lost more than others.
   a. Ahmed and Mohammed are investigating the effect of two different factors on decomposition. Which factors do you think they are investigating? Explain your answers. [4]
   b. Suggest why the boys made sure that all the leaves they used came from the same type of tree. [1]
   c. Why did the boys use the same mass of leaves in each group? [1]
   d. Which group of leaves do you predict will lose the most mass? Explain your answer, using what you know about the factors that affect decomposition. [5]

76

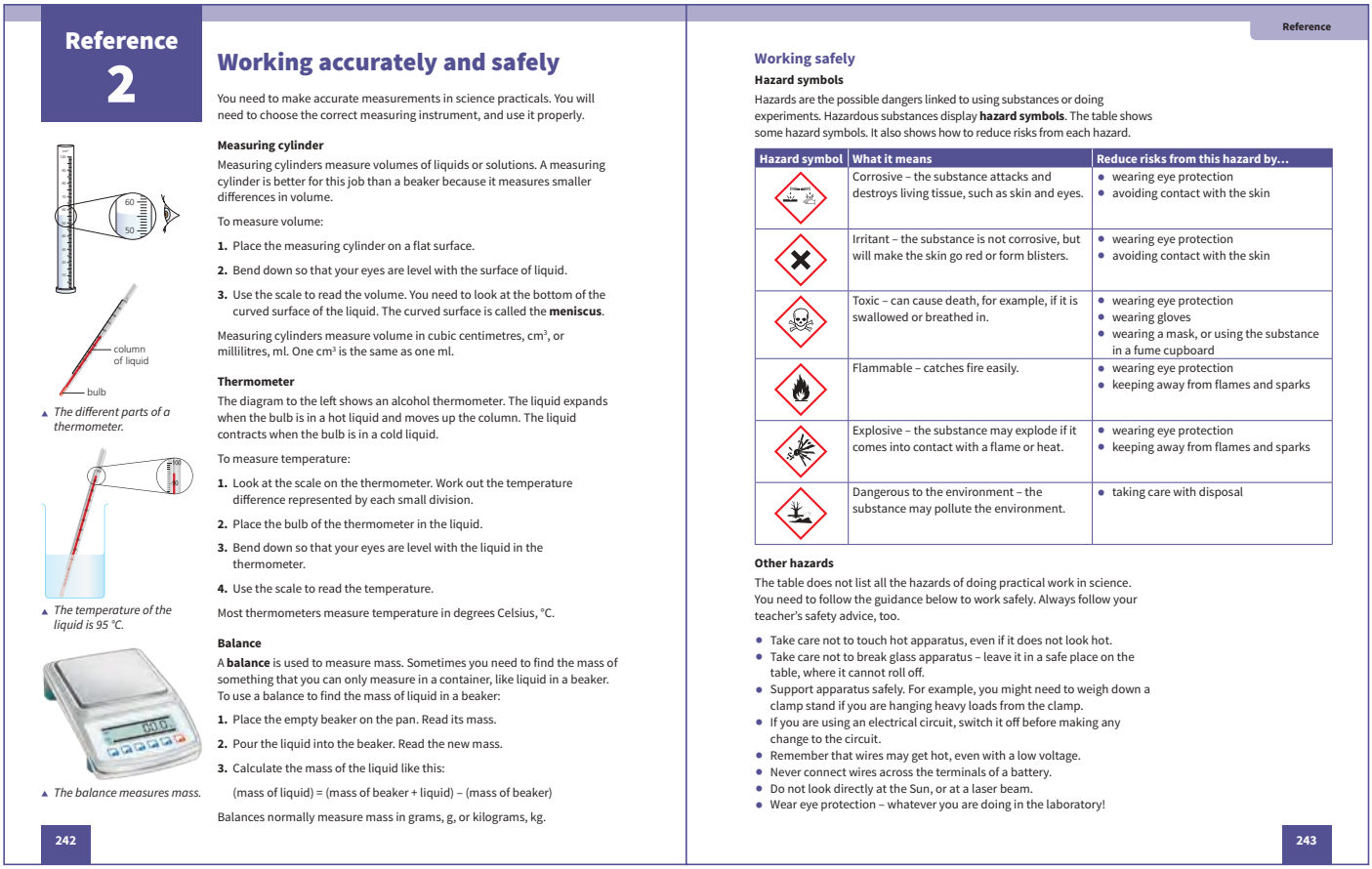
Classifying life

77

These questions are written in the style of the Cambridge Checkpoint test. They are there to help you review what you have learned in that chapter or stage. Answers to these questions are available in the Teacher Handbook. The Teacher Handbook is available in print or digitally via Kerboodle.

Reference

At the back of this book, on pages 240-243, there are reference pages providing further information that will help you while you study.



Reference 2

Working accurately and safely

You need to make accurate measurements in science practicals. You will need to choose the correct measuring instrument, and use it properly.

Measuring cylinder

Measuring cylinders measure volumes of liquids or solutions. A measuring cylinder is better for this job than a beaker because it measures smaller differences in volume.

To measure volume:

1. Place the measuring cylinder on a flat surface.
2. Bend down so that your eyes are level with the surface of liquid.
3. Use the scale to read the volume. You need to look at the bottom of the curved surface of the liquid. The curved surface is called the **meniscus**.

Measuring cylinders measure volume in cubic centimetres, cm^3, or millilitres, ml. One cm^3 is the same as one ml.

▲ *The different parts of a thermometer.*

Thermometer

The diagram to the left shows an alcohol thermometer. The liquid expands when the bulb is in a hot liquid and moves up the column. The liquid contracts when the bulb is in a cold liquid.

▲ *The temperature of the liquid is 95 °C.*

To measure temperature:

1. Look at the scale on the thermometer. Work out the temperature difference represented by each small division.
2. Place the bulb of the thermometer in the liquid.
3. Bend down so that your eyes are level with the liquid in the thermometer.
4. Use the scale to read the temperature.

Most thermometers measure temperature in degrees Celsius, °C.

Balance

A **balance** is used to measure mass. Sometimes you need to find the mass of something that you can only measure in a container, like liquid in a beaker. To use a balance to find the mass of liquid in a beaker:

▲ *The balance measures mass.*

1. Place the empty beaker on the pan. Read its mass.
2. Pour the liquid into the beaker. Read the new mass.
3. Calculate the mass of the liquid like this:

   (mass of liquid) = (mass of beaker + liquid) – (mass of beaker)

Balances normally measure mass in grams, g, or kilograms, kg.

242

Working safely

Hazard symbols

Hazards are the possible dangers linked to using substances or doing experiments. Hazardous substances display **hazard symbols**. The table shows some hazard symbols. It also shows how to reduce risks from each hazard.

Hazard symbol	What it means	Reduce risks from this hazard by…
	Corrosive – the substance attacks and destroys living tissue, such as skin and eyes.	• wearing eye protection • avoiding contact with the skin
	Irritant – the substance is not corrosive, but will make the skin go red or form blisters.	• wearing eye protection • avoiding contact with the skin
	Toxic – can cause death, for example, if it is swallowed or breathed in.	• wearing eye protection • wearing gloves • wearing a mask, or using the substance in a fume cupboard
	Flammable – catches fire easily.	• wearing eye protection • keeping away from flames and sparks
	Explosive – the substance may explode if it comes into contact with a flame or heat.	• wearing eye protection • keeping away from flames and sparks
	Dangerous to the environment – the substance may pollute the environment.	• taking care with disposal

Other hazards

The table does not list all the hazards of doing practical work in science. You need to follow the guidance below to work safely. Always follow your teacher's safety advice, too.

- Take care not to touch hot apparatus, even if it does not look hot.
- Take care not to break glass apparatus – leave it in a safe place on the table, where it cannot roll off.
- Support apparatus safely. For example, you might need to weigh down a clamp stand if you are hanging heavy loads from the clamp.
- If you are using an electrical circuit, switch it off before making any change to the circuit.
- Remember that wires may get hot, even with a low voltage.
- Never connect wires across the terminals of a battery.
- Do not look directly at the Sun, or at a laser beam.
- Wear eye protection – whatever you are doing in the laboratory!

243

They include information on:

- how to choose suitable apparatus
- how to work accurately and safely.

13.1

Variation in animals and plants

Objectives

- Describe the variation in a species
- Relate this variation to genetic differences between individuals

It is easy to tell the difference between a palm tree and a sunflower plant. They are different species, and they have many different characteristics. There is a lot of genetic variation between them. It is not always so easy to see the differences between two animals or two plants of the same species.

Variation in animals

In Chapter 11 you learned that variation has two causes:

- inherited or genetic variation, carried in the genes passed on from parents to offspring
- environmental variation, resulting from the world in which an organism lives.

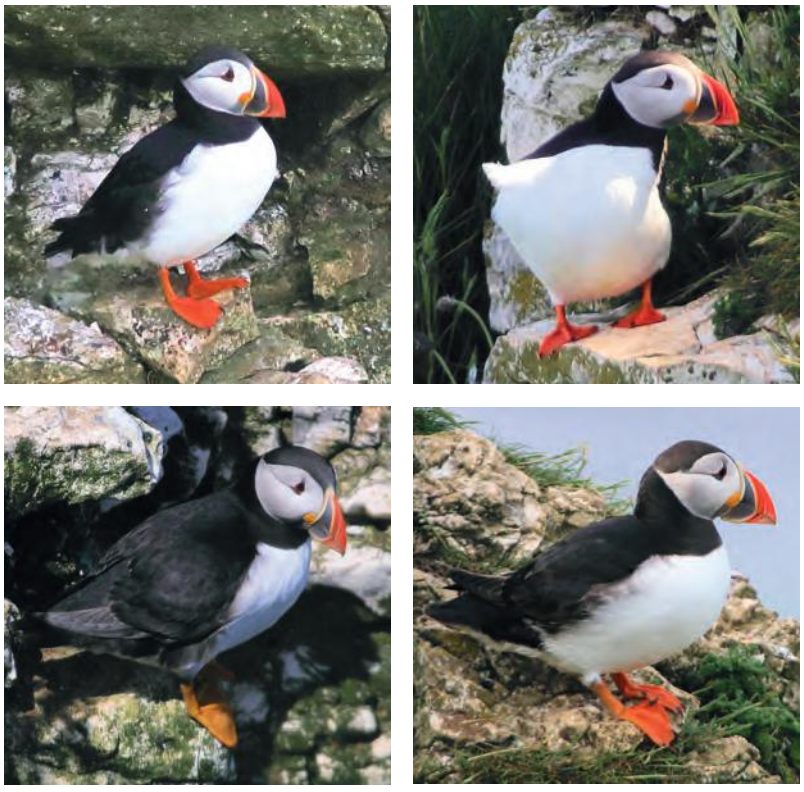
Animals of the same species have many shared genetic characteristics. This is why they breed successfully. They also have differences, which is why you do not look the same as your parents, your siblings or your cousins. The variation you observe between members of a species may be the result of genetic differences, environmental differences or the interaction of the two.

Within a species, some differences are easy to identify. For example, some horses have longer legs than others and some butterflies have longer tongues than their relatives. Look at the puffins in Fig 13.1 B. The similarities are clear – but what variation can you see?





▲ **Fig 13.1 A**: *You don't have to be a biologist to see the differences between a butterfly and a lizard.*



▲ **Fig 13.1 B**: *At first sight these puffins all look the same. Can you find some variation in their beaks, their eye markings or their feet?*

If you look carefully, you will observe that some puffins have paler feet than the others, and the shape and pattern of each beak is slightly different. This variation lets us identify each bird.

Some variation is less easy to see, involving characteristics that only appear some of the time, or systems inside an animal. For example, some frogs call louder than others in the breeding season, and some people have lower blood pressure than others.

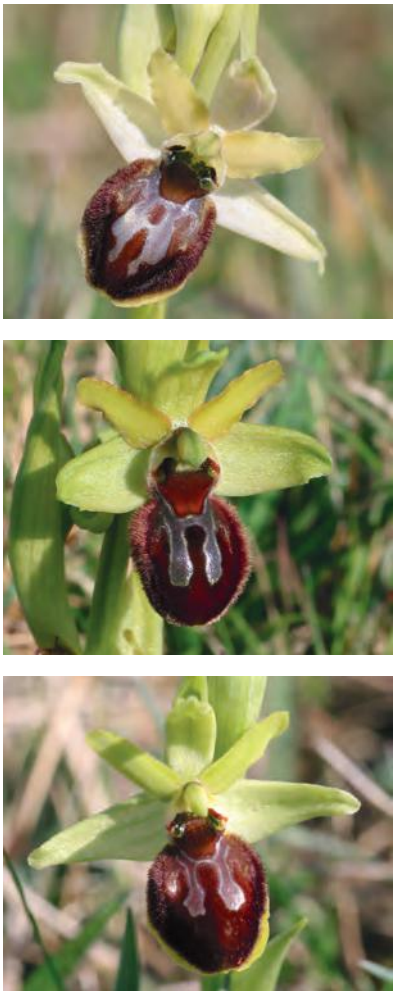
Human blood groups

One clear example of genetic variation in humans is the inheritance of blood groups. If you hurt yourself and bleed, your blood will look like anyone else's, but it may be a completely different ABO group to any of your friends. Everyone inherits an ABO blood group from their parents and this remains the same throughout your life. The four possible blood groups are A, B, AB, and O. It is very important that you get the right type of blood if you need a blood transfusion. If you are given the wrong blood group, it will make you very ill.

Variation in plants

Like animals, plants of the same species inherit many characteristics that are the same, but they also have differences. Olive trees produce olives, date palms have dates, but the fruit of some trees will be bigger, sweeter, and tastier than others, even when they grow in the same conditions.

All the flowers of a species of plant will have the same basic shape and pattern but, like the puffins, there will be some variation. See what variation you can observe in the early spider orchids in Fig 13.1 D. The features that members of the same species have in common show how they are adapted to the environment in which they live. The differences between them show the variation that will allow the species to adapt when the environment changes.



▲ **Fig 13.1 C**: *Early spider orchids show clear similarities and variations in their flowers.*

Questions

1. Describe the causes of variation between
   - **a.** different species
   - **b.** individuals within a species.
2. **a.** Describe the general appearance of the puffins in Fig 13.1 B.
   - **b.** List three ways in which the appearance of the birds shows variation.
3. **a.** State the type of variation seen in human blood groups.
   - **b.** Explain how you are sure of the type of variation involved.
4. **a.** List three ways in which the early spider orchids in Fig 13.1 C show variation.
   - **b.** Discuss how features of a plant might be affected by genetic variation only, or by a combination of genetic and environmental variation.

Key points

- Members of the same species share many genetic characteristics and have many features in common, but they do not all look the same.
- Variation within a species is the result of both genetic and environmental variation.

13.2

Natural selection in action

Objectives

- Describe the scientific theory of natural selection
- Relate natural selection to genetic changes over time

Look at the enormous herd of wildebeest in Fig 13.2 A. Millions of these animals migrate across Africa every year. When the young are born, they each get a different combination of genes from their parents. Some of them have slightly longer legs. Others have stronger hearts or bigger muscles or better teeth. They each have slightly different markings. Some have bigger horns or higher nostrils or better eyesight. Some of the females will make more milk than others.

Does any of this variation matter?



▶ **Fig 13.2 A**: *Wildebeest on their great migration – imagine the variation in this herd.*

Natural selection

Organisms in a species show variation – this is caused by differences in their genes.

↓

The organisms with the characteristics that are best adapted to the environment survive and reproduce. Less well adapted organisms die. This process is known as 'survival of the fittest'.

↓

Genes from successful organisms are passed to the offspring in the next generation. This means that the offspring are likely to possess the characteristics that made their parents successful.

↓

This process is then repeated many times. Over a period of time, this may lead to the development of a new species.

▲ **Fig 13.2 B**: *The process of natural selection.*

Natural selection

Living organisms produce many offspring. Think of the seeds in a pomegranate or the baby birds in a nest. Most of these offspring do not survive. What affects which organisms live, and which die?

The answer is **natural selection**. Natural selection is the result of variation between individuals. It is the process by which the organisms with the characteristics best adapted to their environment live and reproduce, passing on the useful characteristics to their offspring. There are several steps in the process of natural selection:

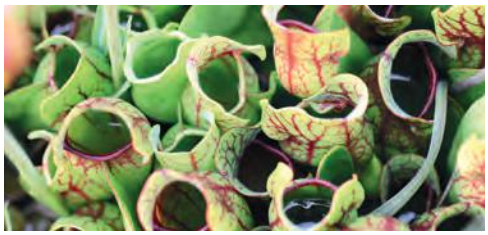
- Each individual inherits genetic variation from their parents and is different from all other members of their species.
- The individuals with characteristics that give them an advantage are the ones most likely to survive. Think again about the wildebeest. The animals with the longest legs, strongest hearts and muscles or best eyesight are most likely to escape being eaten by hungry lions or hyenas. The females who make the most milk increase the chances that their calves will survive. The animals with the best teeth will eat more efficiently and get more food.
- The successful individuals survive long enough to reproduce and pass on their useful characteristics.
- This process is repeated many times until these characteristics become more common in the population. Over a long period of time, it may lead to the development of a new species.

This is natural selection in action. It is sometimes called 'survival of the fittest'.

Examples of natural selection

Natural selection does *not* change individuals. Whole populations or even species change as a result of natural selection. Think about the puffins in Fig 13.1 B. The birds with the brightest colours are most likely to attract a mate. The puffins with the biggest beaks catch more fish to feed their offspring, so they are most likely to survive. Eventually all puffins will have bigger beaks or brighter colours. In Fig 13.1 D, the early spider orchid which attracts the most insects to pollinate it has the best chance of producing lots of fertile seeds. Gradually most of the population will have these successful characteristics. Table 13.2.1 shows some more examples of natural selection.

Table 13.2.1

Organism	Example of natural selection	
Rats	Since 1950, warfarin has been used to poison rats. As part of the natural variation in the rat population, some rats inherit a gene that makes them resistant to the poison. Whenever the poison is used, only the resistant rats survive and breed. In some rat populations, all the rats are resistant to the poison.	
Pitcher plants	Several variations allowed the ancestors of these pitcher plants to collect water, trap insects, and make use of the digested bodies. This gave them a huge advantage in the mineral-poor ecosystems where they live. Now all pitcher plants get added nitrates from insect prey in the same way.	
Lizards	The variation that makes this lizard the same colour as his environment makes it very difficult for predators to find him. This is a big survival advantage and as a result of natural selection, lizards of this species are now all leaf green in colour.	 

Questions

1. Plants and animals keep producing offspring but the total number of each species stays approximately the same. Suggest a reason for this.
2. **a.** State what the term 'natural selection' means.
   b. Explain how the process of natural selection takes place.
3. Give two examples of the effects of natural selection in animal species local to your country.
4. Give two examples of the effects of natural selection in plant species local to your country.

Key points

- Natural selection is the result of variation between individuals. It is the natural process by which the organisms best able to survive are the ones which live and reproduce, passing on advantageous characteristics to their offspring.
- Living organisms produce many offspring, many of which don't survive. Some of the offspring have genes that give them useful characteristics that increase their chances of surviving and reproducing successfully. These genes and the variations they produce will become common in the population. Over a long period of time, a new species may develop.

13.3

Environmental change and natural selection

Objective

- Describe what happens to the population of a species when there is an environmental change





▲ **Fig 13.3 A**: *A cactus grows better in a desert than in a UK garden.*

▶ **Fig 13.3 B**: *The effect of natural selection on a population when the environment changes.*

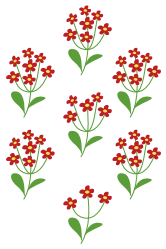
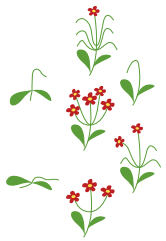
Natural selection results in **adaptation**, producing populations that survive successfully in their environment. Changes in that environment will affect the organisms living there. Date palms and olive trees may survive in low temperatures, but they will not bear fruit.

What happens when the environment changes?

In Chapter 12 you looked at how the climate is changing, affecting environments all over the world. Many are getting hotter and drier, while some get wetter. Winters may be colder or end sooner. Rains are failing. Environmental changes mean that organisms are no longer well adapted to their environment.

Every population contains variation. The individuals which are different may struggle to survive and breed. But if conditions change, they are there with characteristics more suited to the new conditions, so their population can survive (see Fig 13.3 B).

Living organisms must adapt to changes in their environment or they will not survive. Natural selection changes populations to fit their environment.

A population of plants grow, flower and set seeds successfully every year with 25 mm of rain every growing season. Most plants produce 7 flowers and an average of 28 seeds, but there are variations. Some produce 5 flowers with an average of 15 seeds, others produce 3 flowers with an average of 6 seeds.	Rainfall in growing season: 25 mm 
When the climate changes as a result of global warming, only 15 mm of rain falls during the growing season. Many plants die, or fail to produce flowers and seeds. The variants that produce fewer flowers and seeds cope better with less water. They reproduce successfully.	Rainfall in growing season: 15 mm 
As the dry conditions continue, natural selection takes place until most of the population are the drought-adapted variation. They produce fewer flowers and seeds but survive and reproduce successfully in the changed environment.	Rainfall in growing season: 15 mm 

Natural selection, environment change and interdependence

Environmental changes also impact the interdependence of organisms in an ecosystem. Plant and animal life cycles are often linked through feeding relationships. If the environment changes, patterns of reproduction change, and the food supply fails. For example, many organisms in hot, dry regions depend on the rains to reproduce. If the rains are delayed or fail, whole populations are threatened. If one population or species changes over time by natural selection in response to a change in the environment, other interdependent species must also adapt to the new conditions or die out.



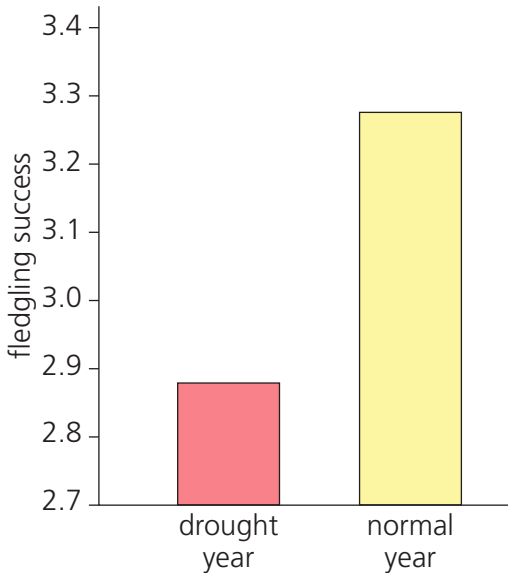
▲ **Fig 13.3 C**: *A young kestrel.*

Gradual change v. extreme events

Kestrels are small birds of prey (see Fig 13.3 C), widespread in Africa, Asia and Europe. Their diet varies depending on where they live and the time of year.

Scientists observe that kestrels reproduce successfully even when the average environmental temperature increases due to climate change, but kestrel populations are damaged by extreme weather events such as droughts (see Fig 13.3 D). Natural selection means that the birds best able to cope with rising temperatures will breed successfully, which reduces the impact of environmental warming. There are no adaptations which prepare kestrels for severe, unpredictable droughts.

Natural selection has always allowed species to adapt to new environmental conditions. The problem is that climate change is now happening very fast and causing many extreme weather events. Will natural selection keep up with the changes?



▲ **Fig 13.3 D**: *Kestrel breeding success per nest over different seasons.*

Questions

1. Explain how environmental changes drive natural selection and affect populations.
2. Use information from Fig 13.3 B to answer these questions.
   - **a.** Explain why 7-flowered plants are most common in the original environment.
   - **b.** Suggest reasons why 5-flowered plants, not 3- flowered plants, become more common when the climate becomes drier.
   - **c.** Predict, giving an example, how the population might change if the climate changes again.
3. **a.** Describe using Fig 13.3 D how kestrels are affected by changes in their environment.
   - **b.** How do you know this data is the average from many nests?
   - **c.** Explain the role of natural selection in the adaptation of kestrels to changes in their environment.

TWS TWS

Key point

- When there is an environmental change, populations change and become better adapted to their new environment as a result of natural selection.

13.4

Objective

- Describe how populations and species become extinct as a result of environmental change

Extinction!

Millions of years ago, our planet was home to dinosaurs such as *Stegosaurus* (see Fig 13.4 A). Where are they all now?

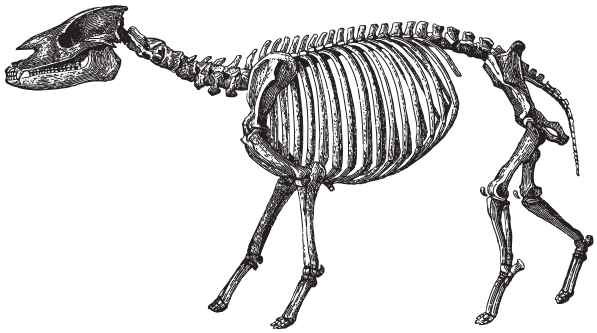
What is extinction?

A species becomes **extinct** when there are no more individuals of that species alive. Extinction may be local, involving a population in a particular place, or it may be global, so that an organism no longer exists anywhere on Earth – like the dinosaurs.

Once a species becomes globally extinct, it has gone forever. This is not always a bad thing. Some extinct species only exist as fossils. Others have descendants living today, better adapted to their environment (see Fig 13.4B). Extinction is part of life on Earth, and is needed to make resources available for better adapted organisms.

▼ **Fig 13.4A**: *All we have left of the dinosaurs are fossil remains.*







▲ **Fig 13.4 B**: *This extinct fossil mammal is a relative of modern horses.*

Why do species go extinct?

Species go extinct because their environment changes, and the climate of the earth has changed many times through history, as you learned in Unit 8.3. For example, tropical organisms become extinct in an ice age through lack of food, or being too cold.

A new species moving into an environment also changes it. The newcomers may be predators, like the brown tree snakes on Guam, or competitors better adapted to the environment, for example invasive plants like Himalayan balsam or water hyacinth. You learned about this in chapter 7.

Environmental changes also produce the conditions for new diseases to appear, sometimes wiping out whole species (see Fig 13.4 C).

Changes in land use are driving many animals and plants to extinction – for example draining land for agriculture destroys ecosystems such as mangroves, marshes, and bogs.

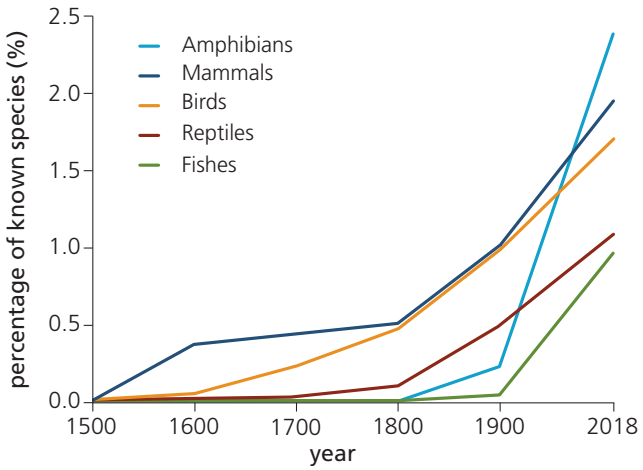
▼ **Fig 13.4 C**: *Amphibian species around the world are threatened with extinction by a deadly new fungal disease.*



So far, there have been five mass extinctions on a global scale, when many species died out over a relatively short time period. In the past, these extinctions were the result of huge environmental changes, often coming from a single catastrophic event such as a massive volcanic eruption or a giant meteorite strike.

Humans and extinction

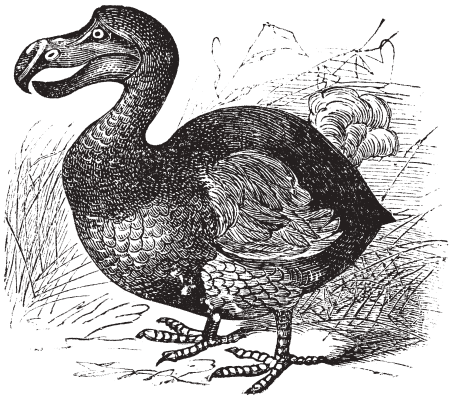
In the last 150 years, the rate of extinctions has been increasing. Species of animals and plants are dying out faster than ever before (see Fig 13.4 D).



▲ **Fig 13.4 D**: *The impact of human activities on extinction rates begins in the Industrial Age.*

We are living in the sixth mass extinction and the evidence suggests many of these extinctions are the result of our human actions on the environment. These include:

- **Hunting/fishing:** the human population has grown enormously and we have guns. From mammoths to dodos and whales, human hunters have killed and eaten many species to extinction. We have also overfished the seas.
- **Habitat destruction:** humans are destroying habitats such as rainforests for farmland, at a rate of about 8000 km^2 per year. Climate change from our actions is also destroying coral reefs, and pollution from our factories and our sewage is destroying rivers and ocean environments – 16 species of freshwater fish became extinct in 2020 alone.
- **Climate change:** climate change resulting from human activities is happening all over the world (see Chapter 12). When plants and animals cannot adapt quickly, or lose their natural environment, they become extinct.



▲ **Fig 13.4 E**: *Dodos were big, flightless birds on the island of Mauritius. They had no predators until people arrived in the 17th century. In less than 100 years, dodos were extinct.*

Questions

1. **a.** What is extinction?
   b. Explain why some extinction is important for life on earth.
2. **a.** Describe four different changes in the environment that may result in the extinction of a population or species.
   b. Explain how extinction happens.
3. Use the data in Fig 13.4 D to answer these questions.
   a. In which year did extinction rates begin to speed up?
   b. Which type of animals are becoming extinct most rapidly? Suggest two reasons for this.
   c. Explain how the data in Fig 13.4 D suggests that environmental changes are leading to the extinction of many species.

TWS TWS

Key point

- Populations and species may become extinct as a result of environmental changes such as temperature, habitat loss, new diseases or competitors moving in, hunting by humans, etc.

Thinking and working scientifically

13.5

Investigating the peppered moth: past and present

Scientists thought natural selection took place over long periods of time. Some unexpected observations of British moths made them change their minds.

Objectives

- Describe a model for natural selection
- Describe examples where scientists' unexpected results have led to improved scientific understanding
- Describe how people develop and use scientific understanding

Natural selection in action: the peppered moth

Peppered moths (*Biston betularia*) are found in countries from China, Russia and Kazakhstan to Europe and North America. They vary in colour from almost white to almost black. Some well-known studies on these moths were carried out in the 1950s by Professor Kettlewell of Oxford University, UK.

Kettlewell's theory

If natural selection causes changes in moth populations, clean woodlands will contain mainly pale moths. Pale moths are more likely to survive and reproduce, camouflaged against the tree trunks where they rest. Darker moths produced by natural variation will be more easily seen and eaten by birds (Fig 13.5 A).

After the Industrial Revolution, many UK trees were blackened by factory pollution. Kettlewell suggested this made it easy for birds to find pale moths, so moths with genes for lighter colours would be eaten. In polluted woodlands, he predicted there would be many more dark moths than light ones in the population, as a result of natural selection.

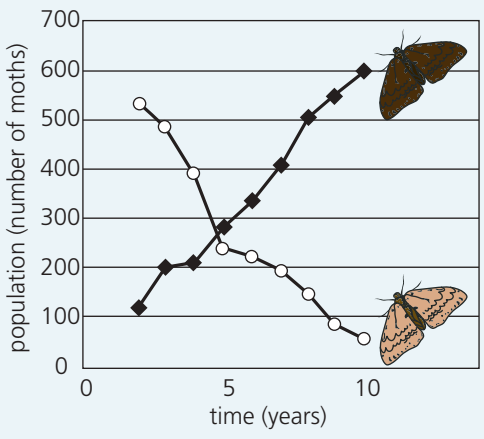
Kettlewell's findings

Professor Kettlewell analysed specimens of peppered moths from old collections made before the Industrial Revolution and observations from amateur moth collectors all over the country. He carried out field experiments, placing light and dark moths on different coloured tree trunks and observing which were eaten by birds. The evidence he collected supported his theory (Fig 13.5 B). This was natural selection in action – fast.



▲ **Fig 13.5 A**: *Light and dark coloured peppered moths on a clean tree.*

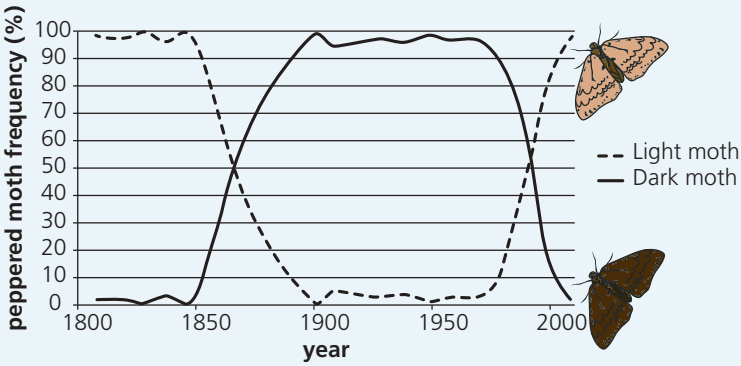




▶ **Fig 13.5 B**: *The changing populations of light and dark coloured peppered moths in industrial areas.*

Moving forwards

Environments keep changing. From 1970, factories in the UK became cleaner, followed by the air and the trees. Birds could easily see the dark moths again. The changing environment caused more natural selection. Most peppered moths in the UK and northern Europe are now the pale form again.



▲ **Fig 13.5 C**: *Changes in the colours of peppered moths in the UK over time.*

Proving the point

At one stage, some people questioned Professor Kettlewell's original experiments. They said that moths did not rest on tree trunks. They doubted whether birds ate the moths. They even accused him of cheating.

Between 2001 and 2008, Professor Michael Majerus from Cambridge University set out to verify the story of the peppered moth. He observed them in their natural habitat. He released 4864 moths over six years at an unpolluted site and recorded where they rested, what ate them, and which colours were eaten. He found the original work was correct. Birds see and eat dark moths more easily on clean trees, so natural selection favours the pale moths.

Professor Majerus's results

- 35% of the moths rested on tree trunks. Most of the rest were on branches.
- The moths were eaten by nine different bird species including, robins, great tits, blue tits, blackbirds, starlings, and wrens.
- Over a 6-year period, a greater percentage of the dark moths released were seen and eaten by birds than light moths.

▼ **Table 13.5.1**

Year	% of released pale moths eaten	% of released dark moths eaten
2001	23	31
2002	28	29
2003	17	32
2004	22	31
2005	19	18
2006	20	29

Questions

1. **a.** Describe Professor Kettlewell's theory about peppered moths.
   b. Describe three ways in which he proved his theory correct.
   c. Explain how each of these methods supported his theory.
2. **a.** Describe what the data in Fig 13.5 C shows you.
   b. Explain these observations in terms of natural selection.
3. **a.** Display the data in Table 13.5.1 as a bar chart.
   b. Discuss the work of Professor Majerus and explain how it supports Kettlewell's original findings about natural selection and peppered moths.

Key points

- An investigation into the effect of environmental change on peppered moths led to improved scientific understanding of natural selection.
- People develop scientific understanding through investigations, analysing evidence and building models that can be tested.

Science in context

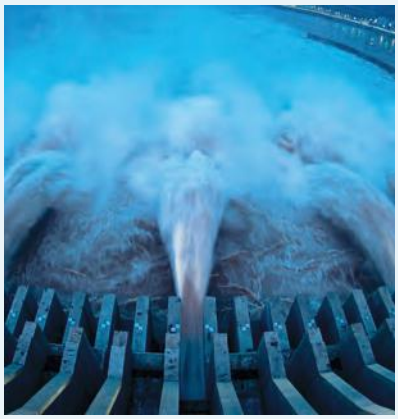
13.6

Objectives

- Describe what can happen to a species when there is an environmental change
- Describe how people develop and use scientific understanding
- Discuss how the uses of science can have a global impact



▲ **Fig 13.6 A**: *The world at night is lit up by electric lights.*



▲ **Fig 13.6 B**: *Hydroelectric power produces clean electricity.*

What can we do?

The global environment is changing fast. Species are becoming extinct at an alarming rate. Scientists and citizens around the world want to solve these problems. Some of the ideas are simple, cheap, and effective. Often there is a human price to be paid. In every case we must ask:

- Can we do it?
- Should we do it?

Sometimes a solution to one problem produces another. The advantages and disadvantages must be weighed in the balance. These reports were written by IGCSE students. Read them carefully.

Article 1: Stop global warming now!

Global warming and the climate change it causes are accepted scientific facts. They are happening as a result of human activities and climate change is driving the extinction of organisms of all sorts (see Unit 13.4).

People all over the world want cheap electricity. Electricity lights our homes, powers our technology, refrigerates our food and our medicines, gives us warmth or air conditioning in our buildings, powers our factories … . Unfortunately, about two thirds of all the electricity used around the world is generated by burning fossil fuels, adding carbon dioxide to our atmosphere, increasing global warming and affecting climate change.

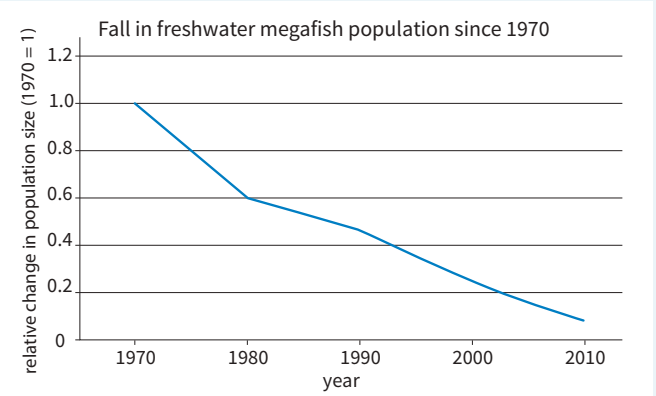
There is another way. We can produce electricity without producing carbon dioxide using the energy in the Sun, in the wind and in our mighty rivers. Hydroelectric power uses water, a natural renewable resource, trapping it behind huge dams so it can be used. Four hydroelectric dams on the Mekong river in China produce more than 8800 megawatts of electricity each day, or around 3 million megawatts per year. That's equivalent to burning over 7 million barrels of oil. Hydroelectric power does not produce greenhouse gases. and provides people with relatively cheap electricity. In Latin America, 70% of the electricity is now generated by hydroelectric power. Many scientists and governments see hydroelectric power as part of the solution to global warming for the future. We can use the power of water to generate electricity and help prevent climate change at the same time.

Article 2: Saving our freshwater fish

Humans have lived by rivers and lakes and eaten freshwater fish since the earliest times. But times are changing. A recent scientific report called *The World's Forgotten Fishes* shows that fresh water fish are threatened all over the world. Here are some of the statistics:

- Nearly one third of all freshwater fish species are threatened by extinction.
- 16 freshwater fish species became globally extinct in 2020 alone.

- Populations of migratory fish like salmon and eels have fallen by 75% in the last 50 years.
- Megafish – enormous freshwater fish that weigh over 30 kg and live for many years, for example, the Mekong giant catfish – are seriously threatened.



▲ **Fig 13.6 C**: *The fall in populations of megafish since 1970 is catastrophic.*



▲ **Fig 13.6 D**: *The Mekong giant catfish is considered critically endangered.*

What has gone wrong?

Human activities are affecting the survival of freshwater fish around the world. Where fish go extinct, other species are threatened as well. Many of the changes to the environment that threaten freshwater fish are linked to human activities. They include:

- Hydroelectric dams: producing electricity for people and industry changes river flows and may cause drought in some areas. It floods land in the reservoirs created by the dam which can remove indigenous people and destroys ecosystems. Hydroelectric power stations prevent fish moving up and down rivers to breed.
- Pollution of rivers by human sewage, farming and industry: this may destroy all life, including plants, invertebrates and fish, or it may result in bioaccumulation.
- Draining rivers and wetlands: done to make farmland or build housing, it removes the river habitat and may deprive people downstream of water.
- Overfishing: depletes the populations of fish which may never recover. This deprives people of a long-term food source and source of income.

We must put a stop to the decline in our freshwater fish before it is too late!

Questions

1. a. Make a table to compare the advantages and any disadvantages of hydroelectric power mentioned in Article 1.

b. Make a table to compare the advantages and disadvantages of hydroelectric power mentioned in Article 2.

TWS **c.** Use the data from Fig 13.6 C to help you to explain why scientists are so concerned about global freshwater fish.

2. a. Discuss the specific issues of hydroelectric power highlighted in both these articles.

b. Suggest how people could have as many of the benefits of hydroelectric power as possible whilst minimising the damage.

Key points

- When there is an environmental change, it may reduce the numbers of one or more species or threaten them with extinction.
- People develop and use scientific understanding to try to solve global problems such as climate change and extinctions.
- The uses of science can have global impacts.

Review 13.7

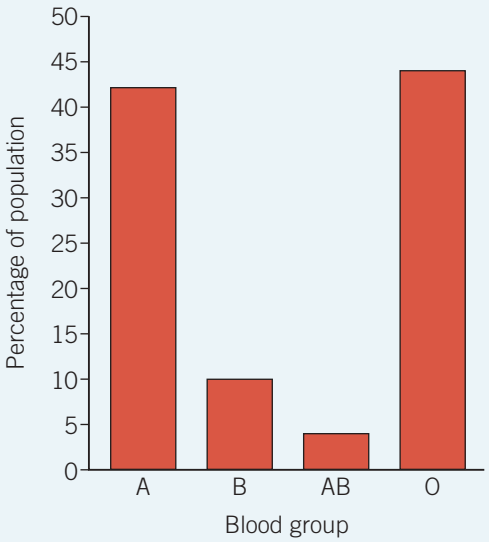
1. Zarah is a scientist. She is investigating the variation in the weights of a herd of goats.

a. What is meant by variation? **[1]**

b. Zarah found that every goat had a different body mass. Name the type of graph Zarah should use to display her results. **[1]**

c. Suggest two different explanations for the differences in the body masses of the goats that Zarah observed. **[2]**

2. This graph shows you the distribution of human blood groups in a population.



a. Which blood group is most common? **[1]**

b. Which blood group is least common? **[1]**

c. Abdul has lost weight by eating healthily. He has changed his body mass. Now he wants to give blood to help others. Abdul is blood group A. He plans to eat different food to change his blood group to a rarer one. His doctor says this will not work. His blood group will always be the same.
Explain to Abdul why he could change his body mass but cannot change his blood group. **[4]**

3. Cheetahs are members of the cat family. They are the fastest land animals. They have very long legs, which use a lot of energy. Animals with short legs do not run as fast, but they use less energy. Animals with extra long legs easily break their bones. Scientists measured the length of the front legs of 10 female cheetahs in Namibia.

Cheetah number	Length of front leg (cm)
1	73
2	73
3	73
4	69
5	72
6	77
7	70
8	74
9	74
10	72

a. What is natural selection? **[2]**

b. Draw a bar chart of the variation in the front legs of the cheetahs. **[5]**

c. Describe the type of variation seen. **[2]**

d. Explain how the process of natural selection has affected the leg length of the female cheetahs. **[6]**

e. A new type of plant-eating animal moves into the environment of the cheetahs. It is relatively slow moving, but it breeds very fast. Discuss the changes you might expect to see in the cheetah population in future. **[6]**

4. a Draw a flow diagram of the process of natural selection. **[6]**

b. Explain how the process of natural selection helps a species overcome the problems of climate change. **[6]**

5. Peppered moths rest on tree trunks during the day. Their main predators are birds. The moths come in two forms – light and dark. The light forms are well camouflaged on light tree trunks.



The percentages of dark and light moths were measured in the years 1700, 1840 and 1980.

Moth colour	% of total moth population		
	1700	1840	1980
dark	1	90	5
light	99	10	95

a. Draw a bar chart of these results. **[5]**

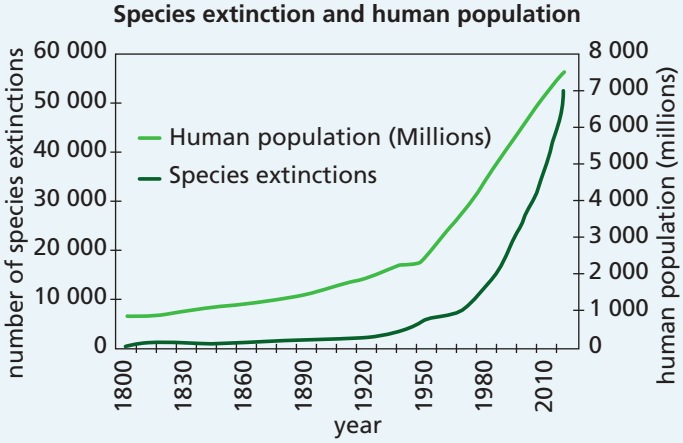
b. Briefly describe how the populations of moths changed between 1700 and 1840. **[2]**

c. Between these dates the use of coal increased. Smoke from the burning coal turned tree trunks black. Which type of moth would birds see more clearly on the dark tree trunks? **[1]**

d. Describe the change in the moth populations between 1840 and 1980. **[3]**

e. Explain how and why these changes in the colour of the peppered moth population happened. **[12]**

6. a. State what is meant by extinction and give an example of an organism that is extinct. **[4]**



b. Describe the data in this graph. **[4]**

c. Suggest an explanation for the pattern in the data. **[3]**

d. Describe and explain four ways in which humans impact the rate of extinction of other organisms. **[8]**

Cambridge Lower Secondary

Complete Biology

Second Edition

Cambridge Lower Secondary Complete Biology ensures that learners fully cover, and excel in, the biology requirements of the Lower Secondary Science curriculum. The stretching and contextual approach to thinking and working scientifically is engaging, progressively strengthens student ability, and helps build the vital skills needed to progress to biology IGCSE and O Level.

- **Build scientific knowledge and understanding** – comprehensive coverage of the course
- **Develop advanced skills** – dedicated scientific enquiry extends performance
- **Progress to the next stage** – differentiated extension material eases the transition to 14–16 study

Workbooks, Teacher Handbooks and Kerboodle online support also available as part of the Cambridge Lower Secondary Complete Science series.

kerboodle



Empowering every learner to succeed and progress

- ✓ Full Cambridge curriculum coverage
- ✓ Reviewed by subject specialists
- ✓ Stretching extension activities
- ✓ Embedded critical thinking skills
- ✓ Progression to the next educational stage

ASPIRE
SUCCEED
PROGRESS

eBook
Available

OXFORD
UNIVERSITY PRESS

How to get in contact:
web www.oxfordsecondary.com/cambridge
email schools.enquiries.uk@oup.com
tel +44 (0)1536 452620
fax +44 (0)1865 313472

ISBN 978-1-382-01834-0





Digital Evaluation

for Cambridge resources

Digital evaluation copies are available for Cambridge resources. Access online evaluation titles for up to 30 days, free of charge.

www.oxfordsecondary.com/evaluate-cambridge

OXFORD UNIVERSITY PRESS