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Pearson Edexcel Qualifications

PEARSON EDEXCEL INTERNATIONAL GCSE (9–1)

SCIENCE SINGLE AWARD

Student Book

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eBook included

BIOLOGY

CHEMISTRY

PHYSICS

ABOUT THIS BOOK

This book is written for students following the Edexcel International GCSE (9–1) Science Single Award specification. You will need to study all of the content in this book for your examinations, apart from content in Extension boxes.

The units of this book reflect specification topics. Each unit contains concise explanations and worked examples, plus numerous exercises that will help you build up confidence. The book also describes the methods for carrying out all of the required practicals.

Science-specific terminology for each topic is highlighted in the text and definitions are provided in the glossaries on the eBook. A list of command words at the back of this book will help you to learn the language you will need in your examinations and understand better how to answer different types of question.

Learning objectives show what you will learn in each chapter.

Unit boxes tell you which units (e.g. metres, grams and seconds) you will need to know and use for the study of a topic.

Specification references indicate the exact specification points covered in the chapter.

Exam hints give tips about how to answer exam-style questions and guidance for exam preparation, including requirements indicated by particular **command words**.

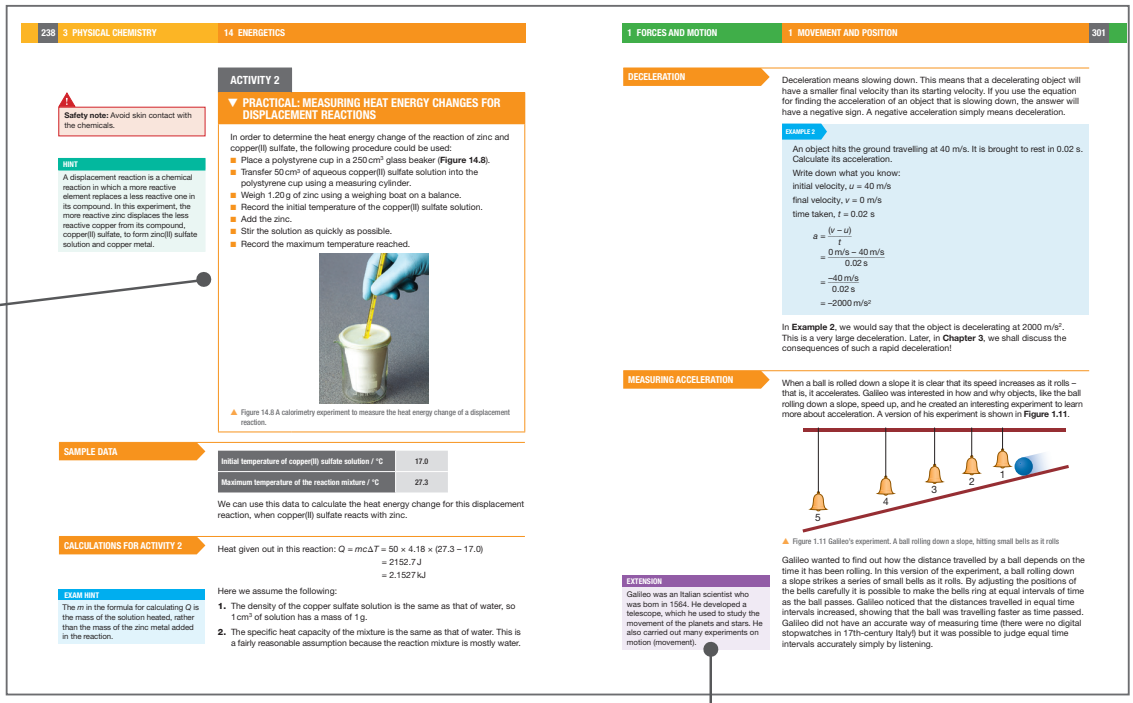
Subject vocabulary Key terms are highlighted in blue in the text. Clear definitions are provided in glossaries on the student eBook (use the scratch-off code in the inside front cover of this book).

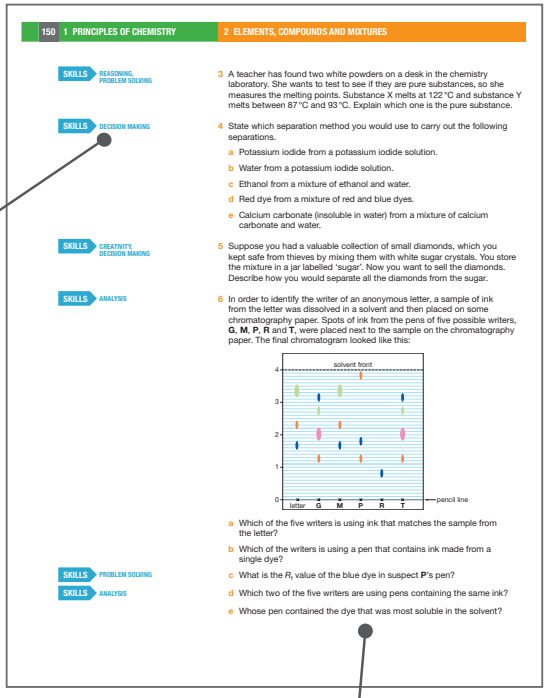
Did you know? Interesting facts help you remember the key concepts.

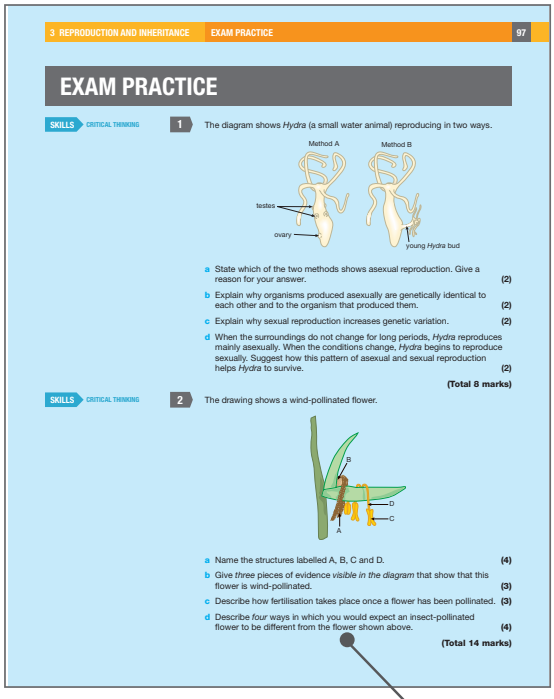
Activity boxes describe the methods for carrying out all of the practicals you will need to know for your examination.

Extension boxes include content that you will not need to revise for your examination because it is not included in the IG Single Award specification. However, content covered will help to extend your understanding of the topic.

Questions indicate which key *transferable skills* you will need to practise in answering the question, so you can see which skills you are developing. These skills are an important basis for key academic qualities, and will also be valuable for further study and in the workplace. You can find details of these skills on the Edexcel qualification website under 'teaching and learning resources'.







Chapter questions test your knowledge of the topic in that chapter.

Exam practice questions test your knowledge of the whole unit and provide quick, effective feedback on your progress as well as giving you practice in answering questions in an exam style format (e.g. use of command words, breakdown of marks and structure of questions).

ASSESSMENT OVERVIEW

The following tables give an overview of the assessment for this course.

We recommend that you study this information closely to help ensure that you are fully prepared for this course and know exactly what to expect in the assessment.

BIOLOGY PAPER 1	SPECIFICATION	PERCENTAGE	MARK	TIME	AVAILABILITY
Written examination paper Paper code 4SS0/1B Externally set and assessed by Edexcel	Science Single Award	33.3%	60	1 hour 10 minutes	January and June examination series First assessment June 2019
CHEMISTRY PAPER 1	**SPECIFICATION**	**PERCENTAGE**	**MARK**	**TIME**	**AVAILABILITY**
Written examination paper Paper code 4SS0/1C Externally set and assessed by Edexcel	Science Single Award	33.3%	60	1 hour 10 minutes	January and June examination series First assessment June 2019
PHYSICS PAPER 1	**SPECIFICATION**	**PERCENTAGE**	**MARK**	**TIME**	**AVAILABILITY**
Written examination paper Paper code 4SS0/1P Externally set and assessed by Edexcel	Science Single Award	33.3%	60	1 hour 10 minutes	January and June examination series First assessment June 2019

ASSESSMENT OBJECTIVES AND WEIGHTINGS

ASSESSMENT OBJECTIVE	DESCRIPTION	% IN INTERNATIONAL GCSE
AO1	Knowledge and understanding of science	38%–42%
AO2	Application of knowledge and understanding, analysis and evaluation of science	38%–42%
AO3	Experimental skills, analysis and evaluation of data and methods in science	19%–21%

EXPERIMENTAL SKILLS

In the assessment of experimental skills, students may be tested on their ability to:

- solve problems set in a practical context
- apply scientific knowledge and understanding in questions with a practical context
- devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- identify independent, dependent and control variables
- use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- assess the reliability of an experimental activity
- evaluate data and methods taking into account factors that affect accuracy and validity.

CALCULATORS

Students are permitted to take a suitable calculator into the examinations. Calculators with QWERTY keyboards or that can retrieve text or formulae will not be permitted.

BIOLOGY UNIT 1 THE NATURE AND VARIETY OF LIVING ORGANISMS

Any living thing, whether it is an animal, a plant or a bacterium, is called an organism. There is an enormous variety of organisms. Unit 1 looks at the similarities and differences between living things and how we put them into groups based on the features that they show. All organisms are made of microscopic 'building blocks' called cells. You will find out a little about cells in this unit, but you will learn much more about them in Unit 2.

1 THE CHARACTERISTICS OF LIVING ORGANISMS AND THEIR VARIETY

SPECIFICATION REFERENCES: 1.1–1.4

'Characteristics' are features which allow us to recognise something for what it is. We recognise that an object is a car by its body, wheels, engine and seats. These are the characteristics of a car. Characteristics also allow us to tell the difference between things. For example the characteristics of a bus are different from those of a car: a bus has a bigger body and bigger wheels, a larger engine and more seats. This chapter will cover the characteristics of different groups of living organisms.

LEARNING OBJECTIVES

- Understand the characteristics shared by living organisms.
- Understand the difference between eukaryotic and prokaryotic organisms.
- Describe the features common to plants and recognise examples of flowering plants such as maize, peas and beans.
- Describe the features common to animals and recognise examples such as mammals and insects.
- Describe the features common to fungi and recognise examples such as *Mucor* and yeast.
- Describe the features common to protoctists and recognise examples such as *Amoeba*, *Chlorella* and *Plasmodium*.
- Describe the features common to bacteria and recognise examples such as *Lactobacillus bulgaricus* and *Pneumococcus*.
- Describe the features common to viruses and recognise examples such as the influenza virus, HIV and the tobacco mosaic virus.
- Understand the term 'pathogen' and know that pathogens may include fungi, bacteria, protoctists or viruses.

THE CHARACTERISTICS OF LIVING ORGANISMS

There are eight 'life processes' which take place in most living things. These processes allow us to recognise whether something is living or dead. They are the characteristics of living organisms. Organisms:

- Need nutrition – plants make their own food, animals eat other organisms
- Respire – release energy from their food
- Excrete – get rid of waste products
- Respond to stimuli – are sensitive to changes in their surroundings
- Move – by the action of muscles in animals and slow growth movements in plants
- Control their internal conditions – maintain a steady state inside the body
- Reproduce – produce offspring
- Grow and develop – increase in size and complexity, using materials from their food.

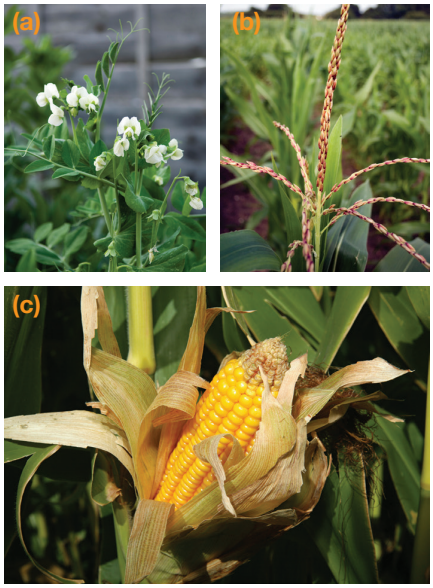
THE VARIETY OF LIVING ORGANISMS

There are more than 10 million species of organisms alive on the Earth today, and many more once lived on Earth but are now extinct. In order to make sense of this enormous variety, biologists classify organisms, putting them into groups. Members of each group are related – they are descended from a common ancestor by the process of evolution (see **Chapter 10**). That is why the members of a group look similar, for example different species of frogs all look and behave like frogs, because they all evolved from a common frog-like ancestor.

The five main groups of living organisms are plants, animals, fungi, protoctists and bacteria.

PLANTS

You will be familiar with flowering plants, such as those shown in **Figure 1.1**. The plant group also contains simpler non-flowering plants, such as mosses and ferns. All plants are **multicellular**, which means that they are made up of many cells. A key feature of plants is that many of their cells contain **chloroplasts** and they carry out **photosynthesis**. Photosynthesis is the process that uses light energy to convert the simple molecules water and carbon dioxide into complex organic substances (see **Chapter 5**). One of these substances is a carbohydrate called **cellulose** – all plants have **cell walls** made of this material.



▲ Figure 1.1 (a) A pea plant. Its leaves contain chloroplasts, giving them their green colour. (b) Maize plants are pollinated by wind. These are the male flowers, which make the pollen. (c) The female maize flowers produce seeds after pollination.

Plants can make many other organic compounds through photosynthesis. One of the first to be made is the storage carbohydrate **starch**, which is often found inside plant cells. Another is the sugar **sucrose**, which is transported around the plant and is sometimes stored in fruits and other parts of the plant.

ANIMALS

You will be even more familiar with this group, since it contains the species *Homo sapiens* – humans! The variety of animals is enormous, ranging from organisms such as sponges, molluscs, worms, starfish, insects and crustaceans through to larger animals such as fish, amphibians, reptiles, birds and mammals (**Figure 1.2**). The last five groups are all **vertebrates**, which means they have a backbone (vertebral column). All other animals have no backbone and are called **invertebrates**.

▲ Figure 1.2 (a) A housefly. (b) A mosquito, feeding on human blood. Houseflies and mosquitoes are both insects, which make up the largest sub-group of all the animals. About 60% of all animal species are insects. (c) This high jumper's movement is co-ordinated by a complex nervous system.

Animals are also multicellular organisms. Their cells never contain chloroplasts, so they are unable to carry out photosynthesis. Instead, they gain their nutrition by feeding on other animals or on plants. Animal cells also lack cell walls, which allows their cells to change shape. This is an important feature for organisms that need to move from place to place. Movement in animals is achieved in various ways – for example, running, swimming or crawling, which often involves co-ordination by a nervous system. Another feature common to most animals is that most animals store carbohydrate in their bodies as a substance called **glycogen**.

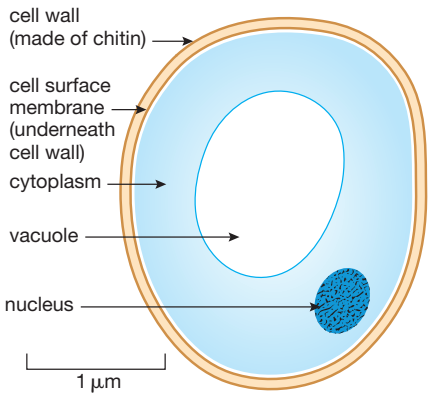
FUNGI

Fungi include mushrooms and toadstools, as well as moulds. These sub-groups of fungi are multicellular. Another sub-group of fungi is the yeasts, which are **unicellular** (made of single cells). Different species of yeasts live everywhere – on the surface of fruits, in soil, water, and even on dust in the air. The yeast powder used for baking contains millions of yeast cells (**Figure 1.3**). The cells of fungi never contain chloroplasts, so they cannot photosynthesise. Their cells have cell walls, but they are not composed of cellulose. Instead they are made of a substance called **chitin** (**Figure 1.4**).

EXTENSION

Because fungi have cell walls, they were once thought to be plants that had lost their chlorophyll. However, their cell walls are made of chitin, not of cellulose like plants. There are many ways that fungi are very different from plants – the most obvious is that fungi do not carry out photosynthesis. We know now that they are not closely related to plants at all.

▲ Figure 1.3 Yeast cells, highly magnified

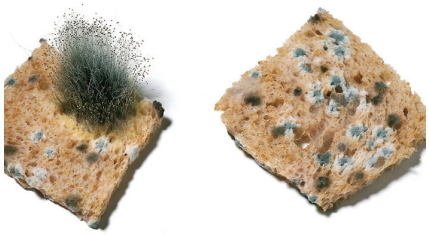


▲ Figure 1.4 Structure of a yeast cell

KEY POINT

The singular of hyphae is hypha.

▲ Figure 1.5 Toadstools growing on a rotting tree trunk



▲ Figure 1.6 The 'pin mould' *Mucor* growing on a piece of bread. The dark spots are structures that produce spores for reproduction.

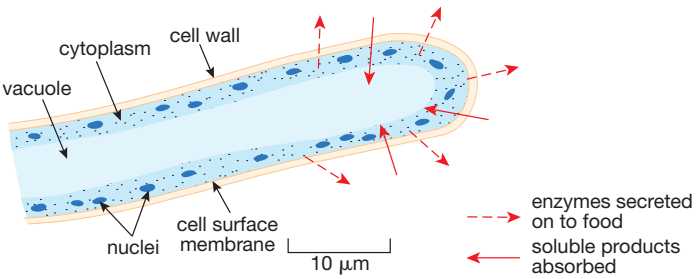
KEY POINT

Digestive enzymes are chemicals that break down food. They are studied in **Chapter 5**.

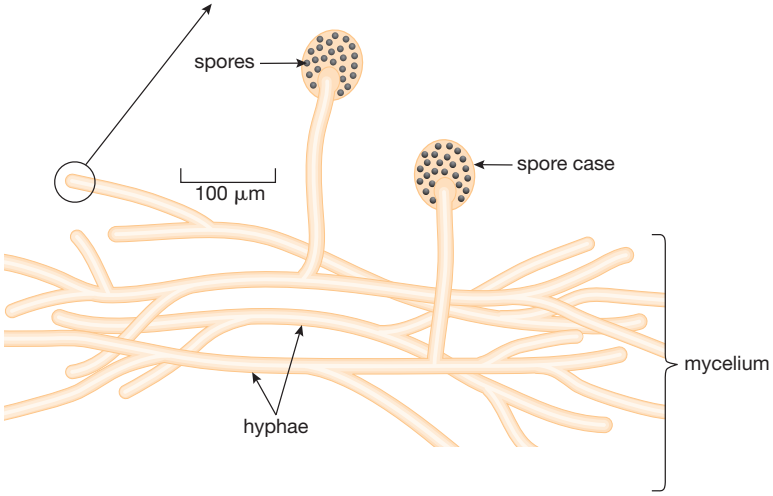
The thing we know as a mushroom or toadstool is the reproductive structure of the organism, and this is technically known as a fruiting body (**Figure 1.5**). Under the soil, the mushroom has many fine thread-like filaments called **hyphae** (pronounced high-fee). A mould consists only of the network of hyphae (**Figure 1.6**) and has no fruiting body. The whole network is called a **mycelium** (pronounced my-sea-lee-um). Most fungi feed by absorbing nutrients from dead animal or plant material, so they are found wherever this is present, for example in soil, rotting leaves or decaying fruit. Some species of fungi feed on living tissues and cause diseases in other organisms.

If you leave a piece of bread or fruit exposed to the air for a few days, it will soon become mouldy. Mould spores carried in the air have landed on the food and grown into a mycelium of hyphae (**Figure 1.7**).

(a) Highly magnified tip of a feeding hypha



(b) Mycelium of *Mucor*



▲ Figure 1.7 The structure of a typical mould fungus, the 'pin mould' *Mucor*

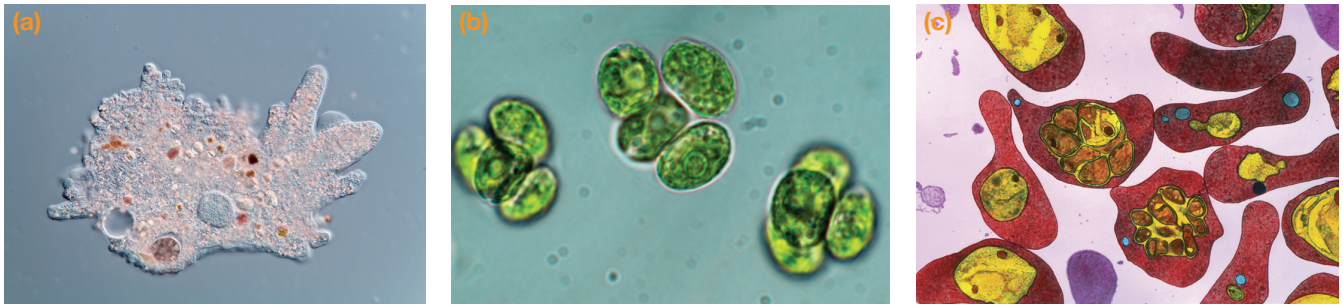
The thread-like hyphae of *Mucor* have cell walls surrounding their **cytoplasm**. The cytoplasm contains many nuclei. In other words the hyphae are not divided up into separate cells.

When a spore from *Mucor* lands on some food, a hypha grows out from it. The hypha grows and branches again and again, until the mycelium covers the surface of the food. The hyphae secrete digestive enzymes on to the food, breaking it down into soluble substances such as sugars, which are then absorbed by the mould. Eventually, the food is used up and the mould must infect another source of food by producing more spores.

When an organism feeds on dead organic material in this way, and digestion takes place outside of the organism, this is called **saprotrophic** nutrition. Enzymes that are secreted out of cells for this purpose are called *extracellular* enzymes (see **Chapter 5**).

PROTOCTISTS

Protoctists are sometimes called the 'dustbin group', because they are a mixed group of organisms – they are neither plants, animals nor fungi groups. Most protoctists are microscopic single-celled organisms (**Figure 1.8**). Some look like animal cells, such as *Amoeba*, which lives in pond water. These are known as **protozoa**. Other protoctists, called **algae**, have chloroplasts and carry out photosynthesis, so they are more like plants. Most algae are unicellular, but some species such as seaweeds are multicellular and can grow to a great size. Some protoctists cause disease, such as *Plasmodium*, the organism that causes malaria.



▲ Figure 1.8 (a) *Amoeba*, a protozoan that lives in ponds. (b) *Chlorella*, a unicellular freshwater alga. (c) Blood cells containing the protoctist parasite *Plasmodium*, the organism responsible for causing malaria.

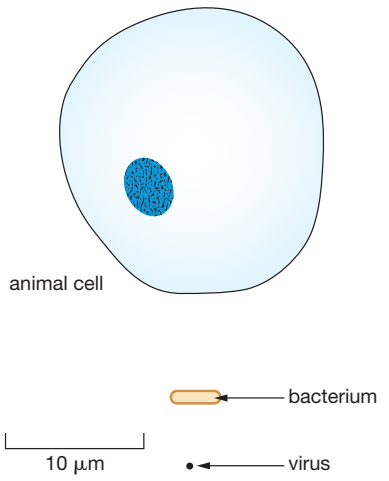
EUKARYOTIC AND PROKARYOTIC ORGANISMS

All the organisms described so far are composed of **eukaryotic** cells and are known as eukaryotic organisms. 'Eukaryotic' means 'having a **nucleus**' – their cells contain a nucleus surrounded by a membrane, along with other membrane-bound **organelles**, such as mitochondria and chloroplasts. The structure of eukaryotic cells is described in **Chapter 2**.

There are also organisms made of simpler cells, which have no nucleus, mitochondria or chloroplasts. These are called **prokaryotic** cells. 'Prokaryotic' means 'before nucleus'. The main forms of prokaryotic organisms are the bacteria.

BACTERIA

Bacteria are small single-celled organisms. Their cells are much smaller than those of eukaryotic organisms and have a much simpler structure. To give you some idea of their size, a typical animal cell might be 10 to 50 µm in diameter (1 µm, or one micrometre, is a millionth of a metre). Compared with this, a typical bacterium is only 1 to 5 µm in length (**Figure 1.9**) and its volume is thousands of times smaller than that of an animal cell.



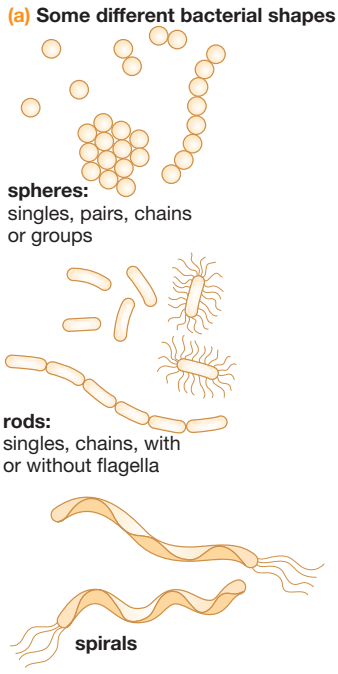
▲ Figure 1.9 A bacterium is much smaller than an animal cell. The relative size of a virus is also shown.

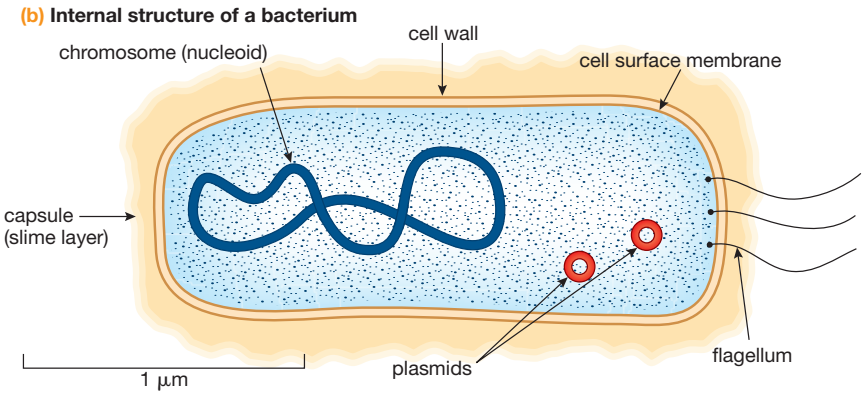
There are three basic shapes of bacteria – spheres, rods and spirals – but they all have a similar internal structure (**Figure 1.10**).

All bacteria are surrounded by a cell wall, which protects the bacterium and keeps the shape of the cell. Underneath the cell wall is the **cell membrane**, as in other cells. The middle of the cell is made of cytoplasm. Because it is a prokaryotic cell, the bacterium has no nucleus. Instead, its genetic material (DNA) is in a single **chromosome**, loose in the cytoplasm, forming a circular loop.

KEY POINT

Bacterial cell walls are not made of cellulose but a complex compound of sugars and proteins called peptidoglycan. Some species have another layer outside this wall, called a capsule or slime layer. Both give the bacterium extra protection.





◀▲ Figure 1.10 Structure of bacteria

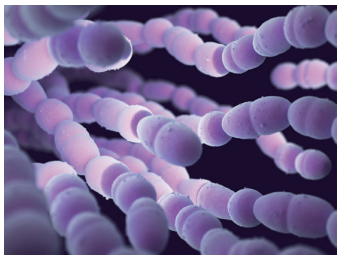
Some bacteria can swim, propelled through water by corkscrew-like movements of structures called flagella (a single one of these is called a **flagellum**). However, most bacteria do not have flagella and cannot move by themselves. Other structures present in the cytoplasm include the **plasmids**. These are small circular rings of **DNA**, carrying some of the bacterium's genes. Not all bacteria contain plasmids, although about three-quarters of all known species do. Plasmids have very important uses in **genetic engineering** (see **Chapter 14**).

Some bacteria contain a form of **chlorophyll** in their cytoplasm, and can carry out photosynthesis. However, most bacteria feed off other living or dead organisms. Along with the fungi, many bacteria are important **decomposers** (see **Chapter 12**), recycling dead organisms and waste products in the soil and elsewhere. Some bacteria are used by humans to make food, such as *Lactobacillus bulgaricus*, a rod-shaped species used in the production of yoghurt from milk (**Figure 1.11**). Other species are **pathogens**, which means that they cause disease (**Figure 1.12**).

▲ Figure 1.11 The bacterium *Lactobacillus bulgaricus*, used in the production of yoghurt

KEY POINT

Pathogens are organisms that cause disease. Many common animal and plant diseases are caused by bacteria or viruses. Most protoctists are free-living, but a few species are pathogens, such as *Plasmodium* (**Figure 1.8c**). Even some species of fungi can cause disease, for example the skin infection called 'athlete's foot' is caused by a mould.

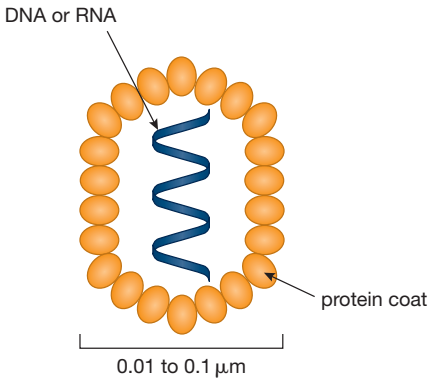


▲ Figure 1.12 Rounded cells of the bacterium *Pneumococcus*, one cause of pneumonia

Despite the relatively simple structure of the bacterial cell, it is a living cell that carries out the normal processes of life, such as respiration, feeding, excretion, growth and reproduction. Some bacteria can move, and they can also respond to a range of stimuli. For example, they may move towards a source of food, or away from a poisonous chemical. You should think about these features when you compare bacteria with the next group, the much simpler viruses.

VIRUSES

All **viruses** are **parasites** and can only reproduce inside living cells. The cell in which the virus lives is called the host. There are many different types of viruses. Some live in the cells of animals or plants, and there are even viruses



▲ Figure 1.13 The structure of a typical virus, such as the type causing influenza (flu)

EXTENSION

AIDS is not actually a disease but a 'syndrome'. A syndrome is a set of symptoms caused by a medical condition. In the case of HIV, the virus severely damages the person's immune system, so they are more likely to get other diseases, such as tuberculosis. They may also develop some unusual types of cancer. It is this collection of different symptoms that is referred to as AIDS.

that infect bacteria. Viruses are much smaller than bacterial cells: most are between 0.01 and 0.1 μm in diameter (see **Figure 1.9**).

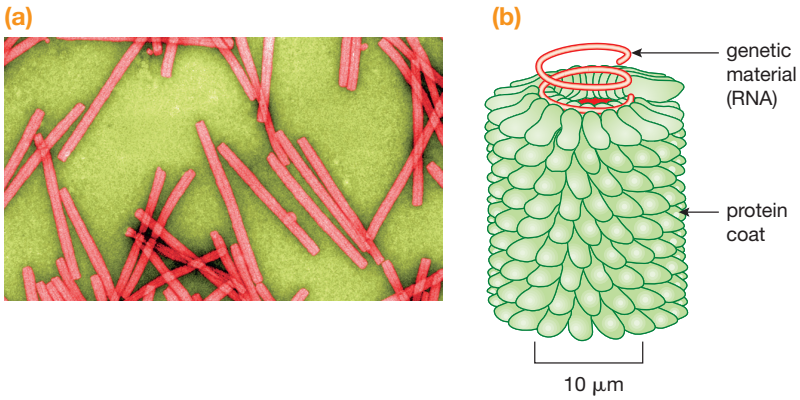
Viruses are not made of cells. A virus particle is very simple. It has no nucleus or cytoplasm, and is composed of a core of genetic material surrounded by a protein coat (**Figure 1.13**). The genetic material can be either **DNA**, or a similar chemical called **ribonucleic acid (RNA)**. In either case, the genetic material makes up just a few genes – all that is needed for the virus to reproduce inside its host cell.

Viruses do not feed, respire, excrete, move, grow or respond to their surroundings. They do not carry out any of the normal characteristics of living things except reproduction, and they can only do this parasitically. This is why biologists do not consider viruses to be living organisms. You can think of viruses as being on the border between an organism and a non-living chemical.

A virus reproduces by entering the host cell and taking over the host's genetic machinery to make more virus particles. After many virus particles have been made, the host cell dies and the particles are released to infect more cells. Many human diseases are caused in this way, such as influenza. Other examples include colds, measles, mumps, polio and rubella. Of course, the reproduction process does not continue forever. Usually, the body's immune system destroys the virus and the person recovers. Sometimes, however, a virus cannot be destroyed by the immune system quickly enough, and it may cause permanent damage or death. With other infections, the virus may attack cells of the immune system itself. This is what happens with HIV (the human immunodeficiency virus), which causes the condition called AIDS (acquired immune deficiency syndrome).

Some viruses, such as the tobacco mosaic virus (**Figure 1.14**), infect plant cells. It interferes with the tobacco plant's ability to make chloroplasts. This causes mottled patches to develop on the leaves (**Figure 1.15**).

▲ Figure 1.15 Discolouration of the leaves of a tobacco plant, caused by infection with tobacco mosaic virus



▲ Figure 1.14 (a) Tobacco mosaic virus (TMV), seen through an electron microscope. (b) Structure of part of a TMV particle, magnified 1.25 million times.

CHAPTER QUESTIONS

Exam-style questions on the characteristics of living organisms and their variety can be found at the end of Unit 1 on page 12.

SKILLS CRITICAL THINKING

1 Which of the following is *not* a characteristic of plants?

A cells contain chloroplasts

B cell wall made of cellulose

C they are multicellular

D they store carbohydrate as glycogen

SKILLS CRITICAL THINKING

2 Fungi carry out *saprotrophic nutrition*. What is the meaning of this term?

A extracellular digestion of dead organic matter

B feeding on other living organisms

C making organic molecules by photosynthesis

D secreting digestive enzymes

SKILLS CRITICAL THINKING

3 Below are three groups of organisms.

1. viruses
2. bacteria
3. yeasts

Which of these organisms are prokaryotic?

A 1 only

B 2 only

C 1 and 2

D 1, 2 and 3

SKILLS CRITICAL THINKING

4 Which of the following is *not* caused by a virus?

A influenza

B measles

C malaria

D AIDS

5 a The six main groups of living organisms are plants, animals, fungi, protoctists, bacteria and viruses. Name the group to which each of the following organisms belongs.

i mushroom

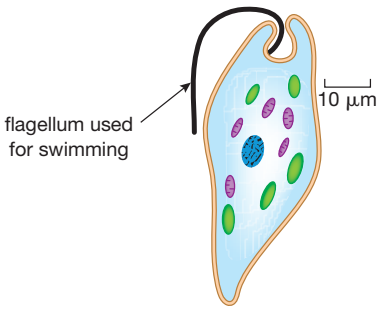
ii *Chlorella*

iii moss

iv *Lactobacillus*

SKILLS ANALYSIS, REASONING

b The diagram shows a species of protoctist called *Euglena*. Use the diagram to explain why *Euglena* is classified as a protoctist and not as an animal or plant.



SKILLS INTERPRETATION, CRITICAL THINKING

6 a Draw a diagram to show the structure of a typical virus particle.

b Is a virus a living organism? Explain your answer.

c Explain the statement 'viruses are all parasites'.

7 Explain the meanings of the following terms:

a prokaryotic

b hyphae

c saprotrophic

EXAM PRACTICE

SKILLS CRITICAL THINKING

1 Which of the following is a characteristic of *both* bacteria and viruses?

A nutrition

B respiration

C movement

D reproduction

(Total 1 mark)

SKILLS INTERPRETATION

2 The table below shows some features of different groups of organisms. Copy and complete the table, putting a tick in the box if the organism has that feature or a cross if it lacks the feature.

Feature	Type of organism		
	Plant	Fungus	Virus
they are all parasites			
they are made up of a mycelium of hyphae			
they can only reproduce inside living cells			
they feed using extracellular digestion by enzymes			
they store carbohydrate as starch			

(Total 5 marks)

SKILLS CRITICAL THINKING

3 Copy and complete the following account.

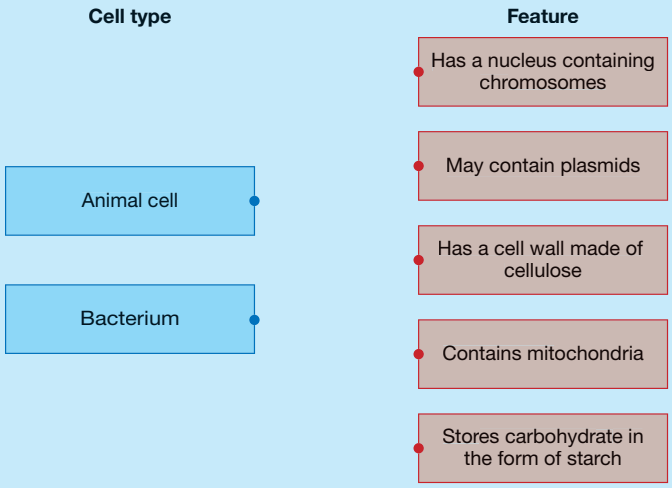
Plants have cell walls made of _____ . They store carbohydrate as the insoluble compound called _____ or sometimes as the sugar _____ . Plants make these substances as a result of the process called _____ . Animals, on the other hand, store carbohydrate as the compound _____ . Both animal cells and plant cells have nuclei, but the cells of bacteria lack a true nucleus, having their DNA in a circular chromosome. Bacteria sometimes also contain small rings of DNA called _____ , which are used in genetic engineering. Bacteria and fungi break down organic matter in the soil. They are known as _____ . Some bacteria are pathogens, which means that they _____ .

(Total 8 marks)

SKILLS INTERPRETATION

4 The diagram shows two types of cell and some features that may or may not be shown by these cells.

Copy the boxes and draw a straight line from each type of cell to any feature that is shown by that cell.



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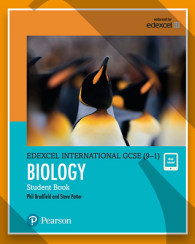

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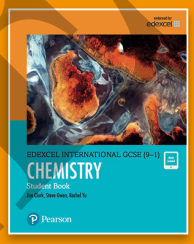

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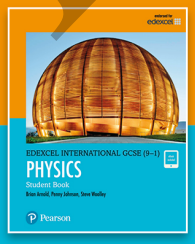

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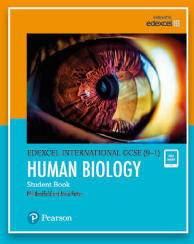

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