YEAR 8

Science

STUDENT COMPANION

Pearson | Secondary Teaching Hub

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Pearson Secondary Teaching Hub Science 8

Student Companion

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We pay our respects to Elders, past and present.

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Contents

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Contents

How to use this Student Companion

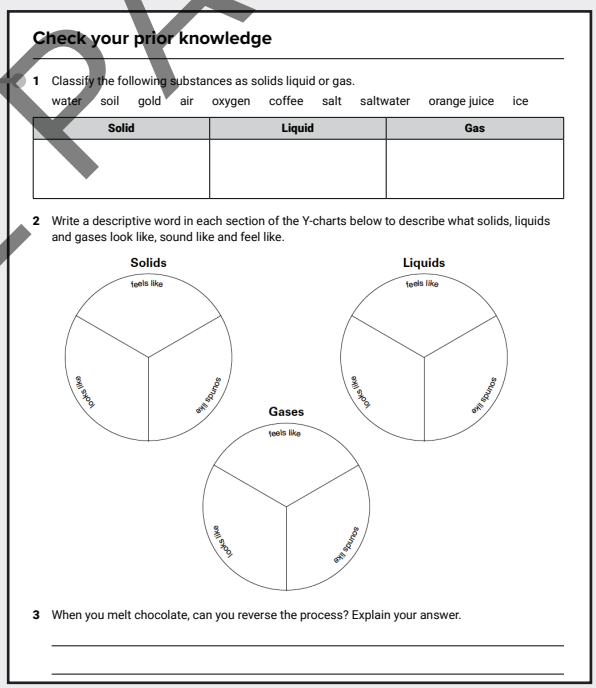
The Student Companion serves as a supplementary resource that complements the lessons offered within Pearson Secondary Teaching Hub. Its primary purpose is to enhance the teaching and learning process by providing students with a platform to curate a personalised portfolio of their educational journey. Whether you are:

- supporting a blended classroom approach that draws on the strengths of print and digital resources
- preparing for examinations by creating a hardcopy compilation of notes for revision or reference
- requiring a tool that supports differentiated learning experiences
- seeking meaningful homework assignments.

Learners can develop their learning portfolio as part of in-class instruction or independently at home, offering an additional avenue to interact with and reinforce the knowledge and skills acquired during the lessons. This can be accomplished through prior preparation in a flipped classroom setting or as supplementary revision or homework assignments.

Check your prior knowledge

Each topic begins with 3–5 questions that test learners' knowledge from previous years or topics in the Australian Curriculum. These questions provide insight into learners' prior knowledge before beginning a topic, allowing teachers to adapt their teaching and support as needed.



Check your prior knowledge

1 Classify the following substances as solids liquid or gas.

water soil gold air oxygen coffee salt saltwater orange juice ice

Solid	Liquid	Gas

2 Write a descriptive word in each section of the Y-charts below to describe what solids, liquids and gases look like, sound like and feel like.

Solids: feels like, sounds like, looks like

Liquids: feels like, sounds like, looks like

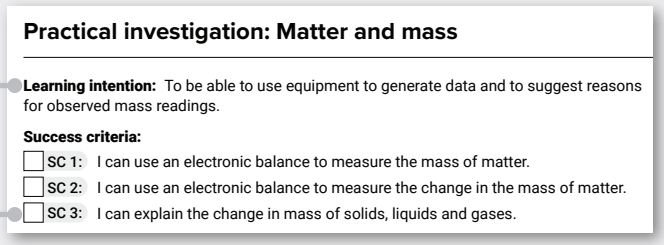
Gases: feels like, sounds like, looks like

3 When you melt chocolate, can you reverse the process? Explain your answer.

Learning intentions and success criteria

Learning intentions are provided for every lesson. The learning intentions are goals or objectives that align to the corresponding digital lesson. They describe what learners should know, understand or be able to do by the end of the lesson.

Success criteria clarify expectations and describe what success looks like. The success criteria are specific, concrete and measurable so learners can actively engage with and reflect on their evidence of learning within each lesson.



Practical investigation: Matter and mass

Learning intention: To be able to use equipment to generate data and to suggest reasons for observed mass readings.

Success criteria:

- ☐ SC 1: I can use an electronic balance to measure the mass of matter.
- ☐ SC 2: I can use an electronic balance to measure the change in the mass of matter.
- ☐ SC 3: I can explain the change in mass of solids, liquids and gases.

Icons and features

The **Teaching Hub icon** prompts learners to engage with supporting digital resources to enhance their learning.

SPARKlab icons direct learners to alternative, online practical investigations.

Materials boxes list all the materials needed to complete a practical investigation.

MATERIALS
- 2 eggs
- 500 mL white vinegar
- 1 tablespoon salt
- 500 mL distilled water
- electronic balance
- 200 mL measuring cylinder
- container large enough to hold two eggs immersed in vinegar
- 2 × 500 mL beakers
- plastic wrap

Hint boxes provide hints and tips where relevant in practical investigations and inquiry activities.

HINT
Try to inflate the balloons to the same size at the start.

The **safety icon** highlights substances or equipment that may cause harm. Be sure to prepare a risk assessment for these activities and take care when preparing or using these substances and equipment.

KEY TERMS
volume the amount of space that a substance or object occupies
mass the amount of matter in a substance

Key term boxes provide learners with definitions for the bolded key terms found throughout the text, supporting the development of their scientific vocabulary and literacy.

Check-in boxes prompt learners to check their risk assessment, method or plan with a teacher before proceeding with the practical investigation or inquiry activity.

☐ Check in with your teacher to discuss your method and risk assessment.

Rate my learning tool

Rate my learning tool Each lesson in the Student Companion contains a space for students to reflect on their understanding. The simple and intuitive design of the Rate my learning tool allows students to scale their confidence, reflect on their learning and identify areas in which they need support.

RATE MY LEARNING ○ I need some help ○ I am getting there ○ I get it ○ I am confident

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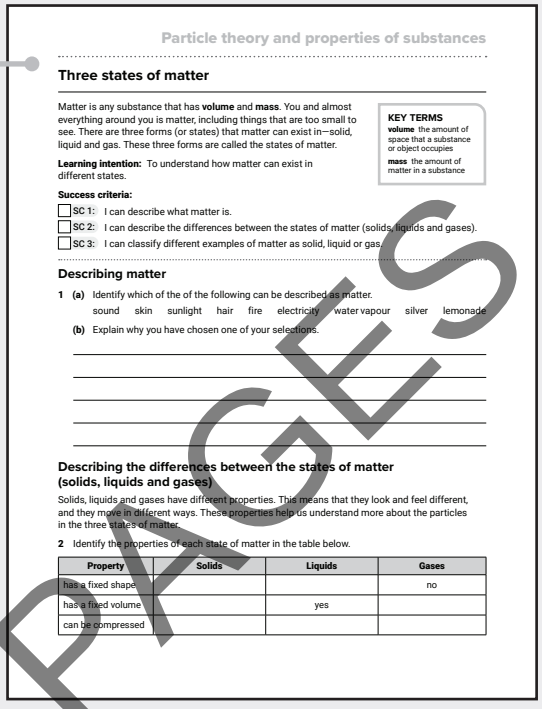
Theory lessons

Theory lessons support the development of science knowledge and understanding by providing content in short, accessible chunks. Questions to check learners' understanding are provided at regular intervals throughout the lesson. Each theory lesson ends with a lesson review that includes 3–6 questions.



Particle theory and properties of substances

Three states of matter

Matter is any substance that has **volume** and **mass**. You and almost everything around you is matter, including things that are too small to see. There are three forms (or states) that matter can exist in—solid, liquid and gas. These three forms are called the states of matter.

KEY TERMS
volume the amount of space that a substance or object occupies
mass the amount of matter in a substance

Learning intention: To understand how matter can exist in different states.

Success criteria:
- ☐ SC 1: I can describe what matter is.
- ☐ SC 2: I can describe the differences between the states of matter (solids, liquids and gases).
- ☐ SC 3: I can classify different examples of matter as solid, liquid or gas.

Describing matter

1 (a) Identify which of the of the following can be described as matter.

sound skin sunlight hair fire electricity water vapour silver lemonade

(b) Explain why you have chosen one of your selections.

Describing the differences between the states of matter (solids, liquids and gases)

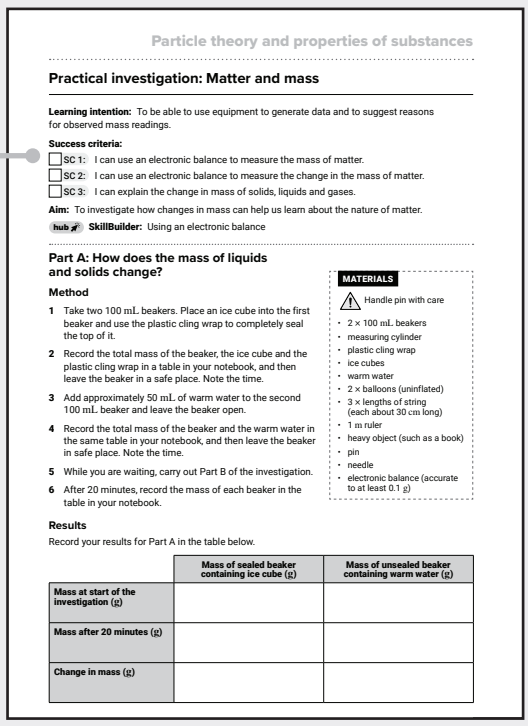
Solids, liquids and gases have different properties. This means that they look and feel different, and they move in different ways. These properties help us understand more about the particles in the three states of matter.

2 Identify the properties of each state of matter in the table below.

Property	Solids	Liquids	Gases
has a fixed shape			no
has a fixed volume		yes	
can be compressed			

Practical investigations

Practical investigations offer learners the chance to complete practical work related to the topics in their Student Companion. They will have the chance to design and conduct experiments, record results, analyse data, and prepare evidence-based conclusions. Risk assessments will need to be completed for all practical investigations, to ensure learners understand how to conduct investigations safely. SPARKlab icons indicate where an alternative, online practical investigation is available.



Particle theory and properties of substances

Practical investigation: Matter and mass

Learning intention: To be able to use equipment to generate data and to suggest reasons for observed mass readings.

Success criteria:
- ☐ SC 1: I can use an electronic balance to measure the mass of matter.
- ☐ SC 2: I can use an electronic balance to measure the change in the mass of matter.
- ☐ SC 3: I can explain the change in mass of solids, liquids and gases.

Aim: To investigate how changes in mass can help us learn about the nature of matter.

hub **SkillBuilder:** Using an electronic balance

Part A: How does the mass of liquids and solids change?

MATERIALS
- ⚠ Handle pin with care
- 2 × 100 mL beakers
- measuring cylinder
- plastic cling wrap
- ice cubes
- warm water
- 2 × balloons (uninflated)
- 3 × lengths of string (each about 30 cm long)
- 1 m ruler
- heavy object (such as a book)
- pin
- needle
- electronic balance (accurate to at least 0.1 g)

Method

1. Take two 100 mL beakers. Place an ice cube into the first beaker and use the plastic cling wrap to completely seal the top of it.
2. Record the total mass of the beaker, the ice cube and the plastic cling wrap in a table in your notebook, and then leave the beaker in a safe place. Note the time.
3. Add approximately 50 mL of warm water to the second 100 mL beaker and leave the beaker open.
4. Record the total mass of the beaker and the warm water in the same table in your notebook, and then leave the beaker in safe place. Note the time.
5. While you are waiting, carry out Part B of the investigation.
6. After 20 minutes, record the mass of each beaker in the table in your notebook.

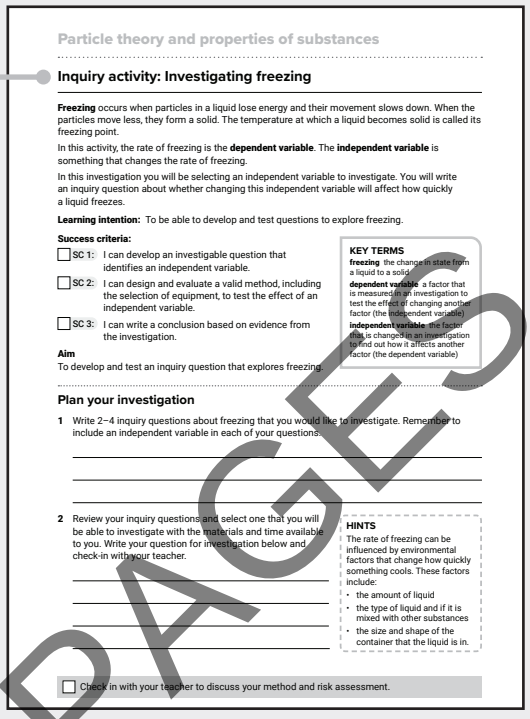
Results

Record your results for Part A in the table below.

	Mass of sealed beaker containing ice cube (g)	Mass of unsealed beaker containing warm water (g)
Mass at start of the investigation (g)		
Mass after 20 minutes (g)		
Change in mass (g)		

Inquiry activities

Inquiry activities are open-ended investigations that encourage learners to plan and design solutions to problems. Learners are encouraged to improve and evaluate their ideas, designs or investigations. Inquiry activities require learners to use their understanding of scientific concepts and the science inquiry skills that they have developed throughout each topic in the Student Companion.



Particle theory and properties of substances

Inquiry activity: Investigating freezing

Freezing occurs when particles in a liquid lose energy and their movement slows down. When the particles move less, they form a solid. The temperature at which a liquid becomes solid is called its freezing point.

In this activity, the rate of freezing is the **dependent variable**. The **independent variable** is something that changes the rate of freezing.

In this investigation you will be selecting an independent variable to investigate. You will write an inquiry question about whether changing this independent variable will affect how quickly a liquid freezes.

Learning intention: To be able to develop and test questions to explore freezing.

Success criteria:

- ☐ SC 1: I can develop an investigable question that identifies an independent variable.
- ☐ SC 2: I can design and evaluate a valid method, including the selection of equipment, to test the effect of an independent variable.
- ☐ SC 3: I can write a conclusion based on evidence from the investigation.

KEY TERMS

freezing the change in state from a liquid to a solid

dependent variable a factor that is measured in an investigation to test the effect of changing another factor (the independent variable)

independent variable the factor that is changed in an investigation to find out how it affects another factor (the dependent variable)

Aim

To develop and test an inquiry question that explores freezing.

Plan your investigation

1 Write 2–4 inquiry questions about freezing that you would like to investigate. Remember to include an independent variable in each of your questions.

2 Review your inquiry questions and select one that you will be able to investigate with the materials and time available to you. Write your question for investigation below and check-in with your teacher.

HINTS

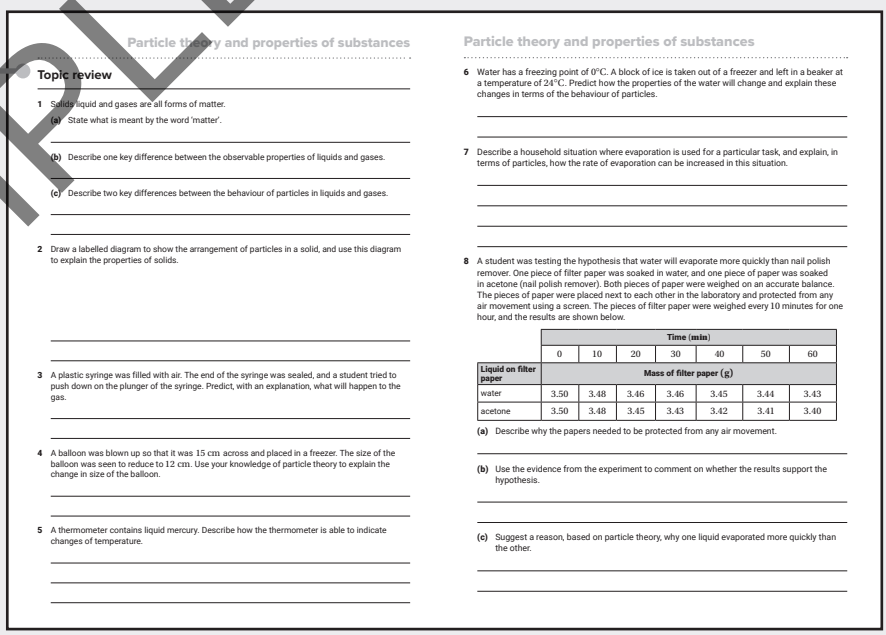
The rate of freezing can be influenced by environmental factors that change how quickly something cools. These factors include:

- the amount of liquid
- the type of liquid and if it is mixed with other substances
- the size and shape of the container that the liquid is in.

☐ Check in with your teacher to discuss your method and risk assessment.

Topic review

Each topic finishes with a **topic review** that includes 8–15 questions that address every learning intention in the topic. These questions give learners the opportunity to apply the knowledge and skills they have developed throughout the topic.



Particle theory and properties of substances

Topic review

1 Solids, liquid and gases are all forms of matter.

(a) State what is meant by the word 'matter'.

(b) Describe one key difference between the observable properties of liquids and gases.

(c) Describe two key differences between the behaviour of particles in liquids and gases.

2 Draw a labelled diagram to show the arrangement of particles in a solid, and use this diagram to explain the properties of solids.

3 A plastic syringe was filled with air. The end of the syringe was sealed, and a student tried to push down on the plunger of the syringe. Predict, with an explanation, what will happen to the gas.

4 A balloon was blown up so that it was 15 cm across and placed in a freezer. The size of the balloon was seen to reduce to 12 cm. Use your knowledge of particle theory to explain the change in size of the balloon.

5 A thermometer contains liquid mercury. Describe how the thermometer is able to indicate changes of temperature.

Particle theory and properties of substances

6 Water has a freezing point of 0°C. A block of ice is taken out of a freezer and left in a beaker at a temperature of 24°C. Predict how the properties of the water will change and explain these changes in terms of the behaviour of particles.

7 Describe a household situation where evaporation is used for a particular task, and explain, in terms of particles, how the rate of evaporation can be increased in this situation.

8 A student was testing the hypothesis that water will evaporate more quickly than nail polish remover. One piece of filter paper was soaked in water, and one piece of paper was soaked in acetone (nail polish remover). Both pieces of paper were weighed on an accurate balance. The pieces of paper were placed next to each other in the laboratory and protected from any air movement using a screen. The pieces of filter paper were weighed every 10 minutes for one hour, and the results are shown below.

	Time (min)						
	0	10	20	30	40	50	60
Liquid on filter paper	Mass of filter paper (g)						
water	3.50	3.48	3.46	3.46	3.45	3.44	3.43
acetone	3.50	3.48	3.45	3.43	3.42	3.41	3.40

(a) Describe why the papers needed to be protected from any air movement.

(b) Use the evidence from the experiment to comment on whether the results support the hypothesis.

(c) Suggest a reason, based on particle theory, why one liquid evaporated more quickly than the other.

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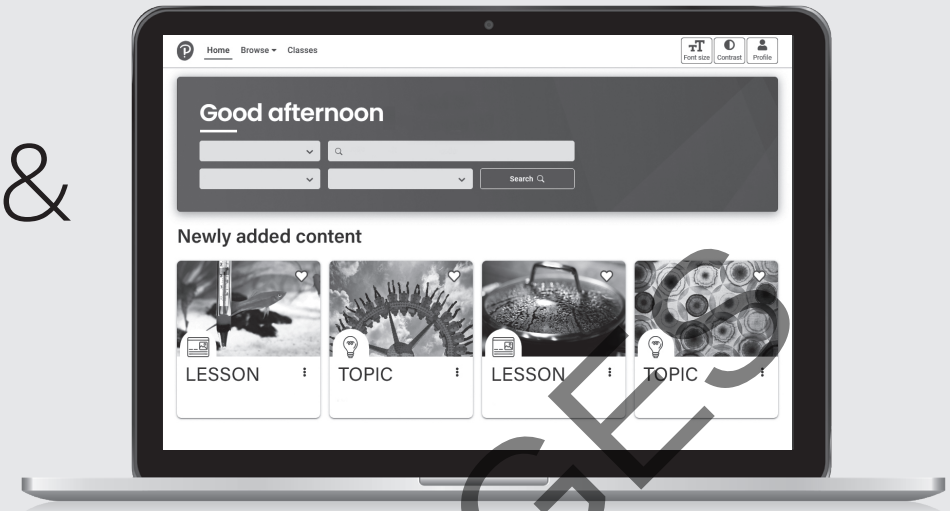

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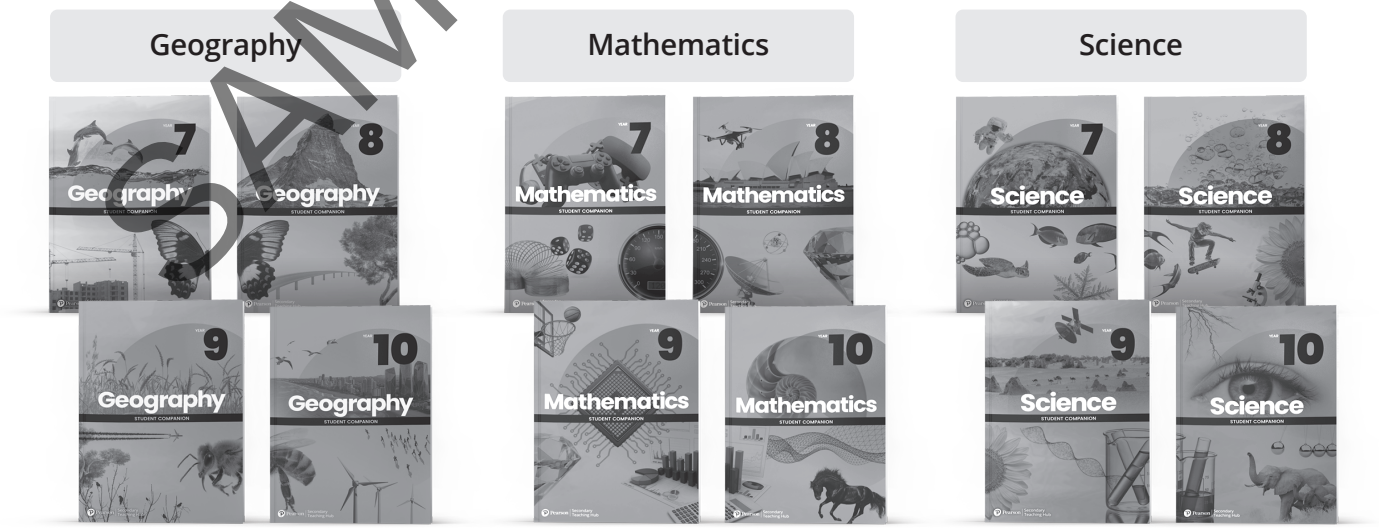

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Cells in plants and animals

For thousands of years, humans have studied the structure and behaviour of living things. It is only since the development of the microscope, less than 500 years ago, that scientists discovered that all living things were made up of tiny structures called cells. Some living things are made up of just one cell. Other living things are made up of trillions of cells. The features and functions of these cells support the growth and survival of all living things.

In this topic, you will learn about cells as the building blocks of life and their features and functions in plants and animals.

Check your prior knowledge

1 (a) Classify the following as living or non-living.

ant rock tree fire bacteria crystal worm computer car mushroom

Living	Non-living

(b) List four features that all living things have in common.

1 _____

2 _____

3 _____

4 _____

2 (a) Underline the features that belong to living things.

skin pencil cell lung bolt phone ear string
toe paper heart clamp tail wool feather

(b) Some of the features in the list are too small to be seen without a microscope. Put a star next to the microscopic features in the list in part **(a)**.

3 Despite being too small to see, certain features of living things are essential for their survival. Propose the roles that these microscopic features play in the lives of living organisms.

_____

_____

_____

_____

RATE MY LEARNING ○ I need some help ○ I am getting there ○ I get it ○ I am confident

1.1 Cells as the building blocks of living things

Learning intention: To understand that cells are the basic unit of living things

Success criteria:

- ☐ SC 1: I can explain that cells are the fundamental building blocks of all living organisms.
- ☐ SC 2: I can explain the difference between unicellular and multicellular organisms.

Biological cells are the units that you and every other living thing are made from.

In this lesson, you will learn about how cells are the building blocks of life, and the role they play in all living systems.

Cells as microscopic units of living things

All living things are made of **cells**, which are the smallest living unit and can be thought of as tiny factories that perform essential functions for an **organism's** survival. These functions include obtaining energy from food, eliminating waste, and replicating to support growth.

Cell theory states that:

- all living things are composed of one or more cells
- cells are the fundamental units of life
- new cells originate from existing cells.

KEY TERMS

cell building block of all living things

organism a living thing

cell theory the idea that all living things are made up of one or more cells that come from existing cells

multicellular made of many cells

organ system two or more different organs that work together

organ a structure that contains at least two different types of tissues that work together to complete a task

tissue a group of cells of the same type that carry out the same job in the body

organelle a part of the internal structure of a cell located in the cytoplasm

Cells in body systems

Cells are the fundamental units of life, with some organisms consisting of a single cell, such as bacteria. Most organisms, including humans, are **multicellular**, organised into intricate **organ systems** such as the circulatory system. **Organs**, made up of various **tissues** and cells, work together within these systems.

Inside cells

Organelles are specialised parts within cells that perform special functions.

1 Three of the statements about cell theory are incorrect. Identify these, and rewrite them to be correct.

(a) Some cells can survive without other cells.

(b) The human heart is a body system.

(c) Human cells have different functions to cells in other animals.

(d) All organisms are made up of a large number of cells.

(e) Cell theory will change as more scientific evidence is discovered.

Differences between unicellular and multicellular organisms

Some living things, such as bacteria, are composed of just one cell. These living things are called **unicellular** organisms. When a living thing is composed of two or more cells, it is called **multicellular**. Examples of multicellular organisms include plants, animals and fungi.

KEY TERMS
unicellular made of only one cell
multicellular made of many cells

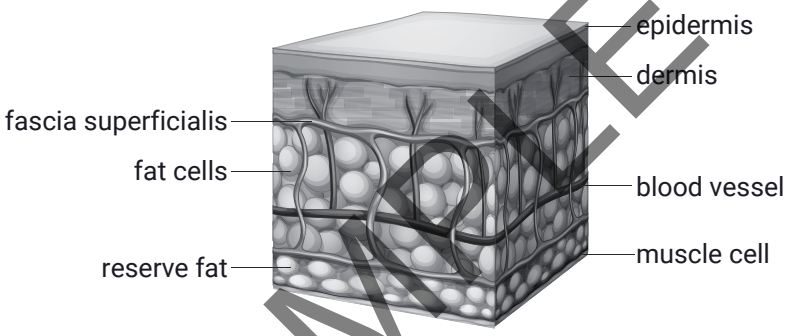
Multicellular organisms

In multicellular organisms, various tasks are performed by different types of cells, or groups of cells collaborating within different systems.

Examples of different cell types and functions in humans

Cell type	Function
red blood cells	carry oxygen around the body
muscle cells	provide support and allow movement
egg cells	involved in reproduction
nerve cells (neurons)	carry messages around the body
fat cells	store fat that can be used as energy when the body needs it
stem cells	have the ability to develop into many different cell types

Skin, a type of tissue, comprises some of these cell types, as shown below.



Types of cells in human skin

Unicellular organisms

Unicellular organisms, such as bacteria, manage all life functions within a single cell. These life functions include obtaining nutrients, eliminating waste, and reproducing. Some bacteria, such as *Staphylococcus,* can cause diseases. Other bacteria, such as *Lactobacillus,* can benefit human health. Unicellular organisms reproduce through **cell division,** creating **clones** with identical **genetic information** to the parent organism.

KEY TERMS
cell division process that results in two new cells each having the same genetic information as the parent cell; also called mitosis
clone an organism with exactly the same genetic information as its parent
genetic information information that is passed from parents to offspring through DNA

2 Connect each term to its description by joining them with a line.

a type of unicellular organism •	• neuron
the way that unicellular organisms reproduce •	• mammals
a cell responsible for the transfer of messages •	• division
a classification of multicellular organisms •	• bacteria
an organism that is made from just one cell •	• unicellular

Lesson review

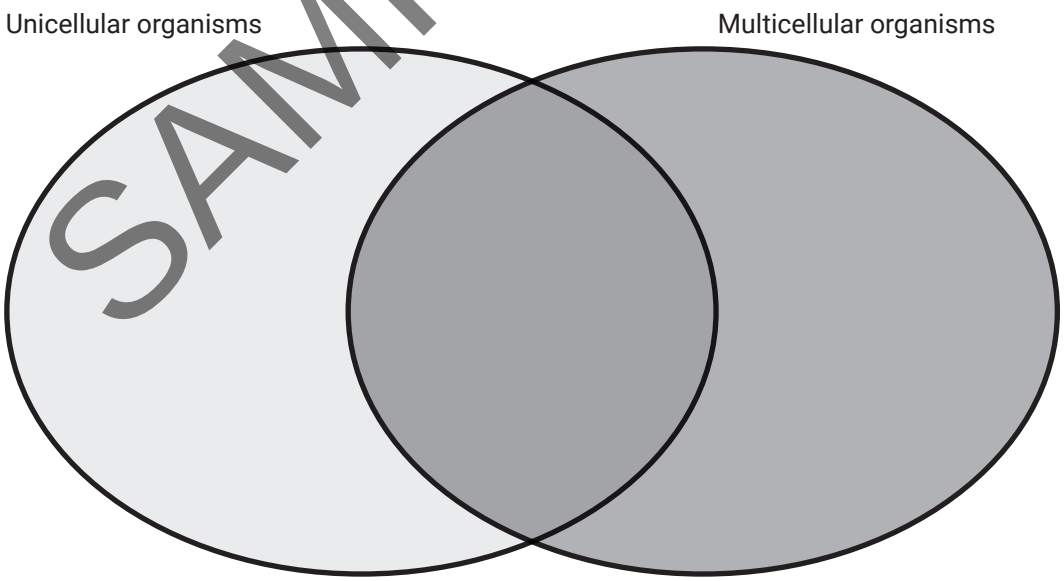
1 Indicate whether the following statements are true or false.

Statement	True or false?
fungi are not made up of cells	
animals are unicellular organisms	
the human body is made up of just one type of cell	
bacteria are classified as plants	

Statement	True or false?
most cells contain organs	
cells are the building blocks of living things	
organ systems are made up of connected organs	
multicellular organisms can grow when cells divide to make copies of themselves	

2 Add the following information to the correct place in the Venn diagram to compare and contrast unicellular and multicellular organisms.

cells contain genetic information	organisms reproduce by splitting	new cells produce new organisms
new cells produce growth	cells can survive on their own	cells reproduce by splitting
contain different types of cells	cells are the basic unit of life	cells are part of tissue



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1.2 Cells in humans

Learning intention: To understand the features and function of some cells found in the human body

Success criteria:

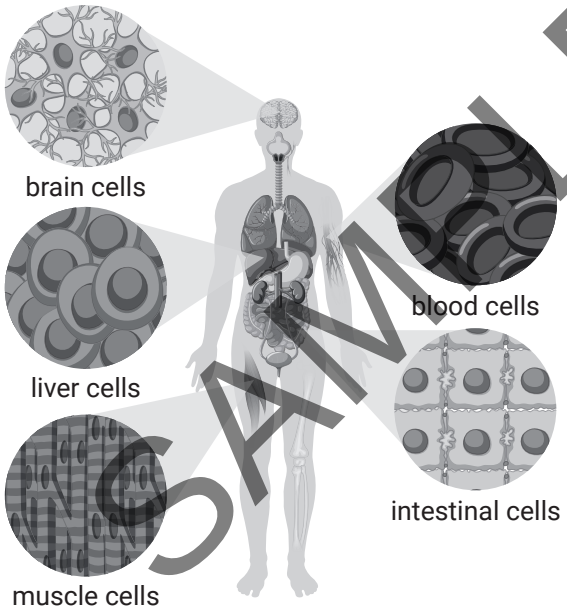
- ☐ SC 1: I can state the function of different types of cells in humans.
- ☐ SC 2: I can compare the scale of different types of cells in humans.
- ☐ SC 3: I can describe some features that are common to most types of cells.

A fertilised cell holds the genetic information necessary for forming more than 30 trillion cells in an average human body. These cells come from cell division, called mitosis. The cells in the human body perform various roles. For example, some specialise in transporting oxygen, while others are responsible for digesting food.

In this lesson, you will learn about the various cell types in your body, their sizes, and common characteristics they share.

Function of different types of cells in humans

Cells work together to allow the whole organism to function. In multicellular organisms, there are many different types of cells with specific roles, such as transporting oxygen and sending signals throughout the body. Even though cells have many different structures and functions, all cells contain genetic information in the form of DNA.



A human has many different types of cells that have different features and functions

Some cell functions and the cells responsible for carrying out these tasks

Cell function	Cells responsible
transporting gases around the body	red blood cells
protection from infection	white blood cells
barrier against microorganisms and environmental factors	skin cells
receiving information from our environment and sending commands	nerve cells

When cells cannot do their job

Unhealthy cells can result from factors such as genetic mutations, infections, toxins, and lack of nutrients. These factors can disrupt the cell's normal function and cause health issues. Diseases often stem from compromised cells that cannot function properly.

The table below highlights medical conditions related to weakened cell health, some of which can be serious.

Some common cell health issues and diseases

Cell health issue	Disease	Effects
lack of healthy red blood cells	anaemia	fatigue, pale skin, shortness of breath
body's defence system cannot distinguish between its own cells and foreign ones	autoimmune diseases	a range of diseases including arthritis and type 1 diabetes
cells reproduce uncontrollably	cancer	range of cancers depending on part of body and cells affected
low white blood cell count	leukopenia	a range of infections, including tuberculosis and HIV

1 **(a)** Explain why red blood cells need to travel to carry out their role in the body.

(b) Explain why nerve cells have long extensions to carry out their role in the body.

Scale of different types of cells in humans

The size of cells in our bodies

The human eye can only see macroscopic objects without magnification. Those visible without **microscopes** are **macroscopic**, while those requiring microscopes are **microscopic**. Cells are measured in micrometres (μm), one-thousandth of a millimetre, as shown in the table below.

KEY TERMS

microscope an instrument used to make very small things look bigger

macroscopic able to be seen without the help of a microscope

microscopic can be seen only using a microscope

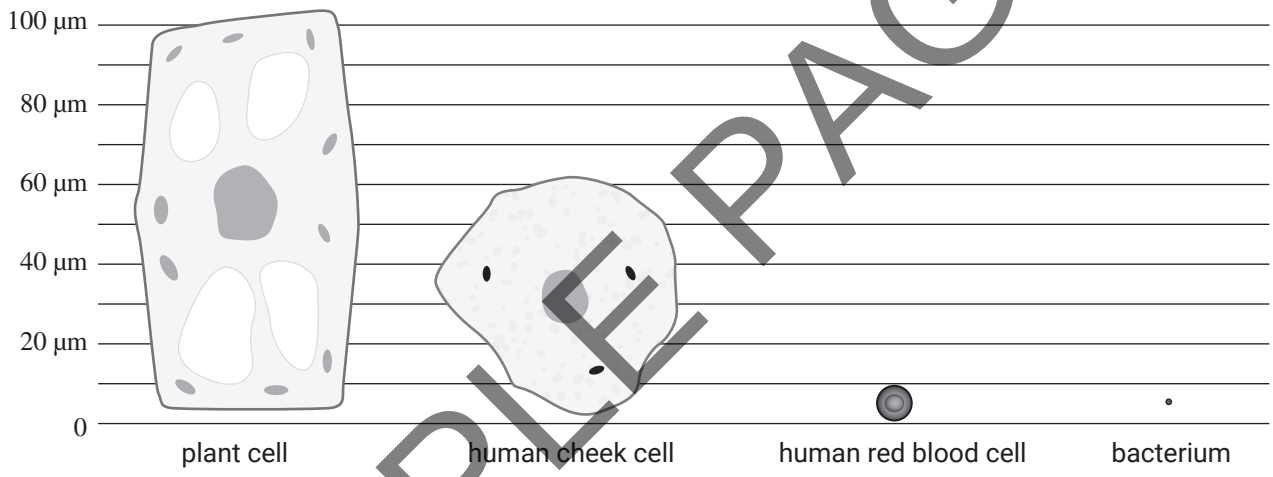
Micrometres compared to larger units

Unit	Number of micrometres (μm)
1 metre (m)	1 000 000
1 centimetre (cm)	10 000
1 millimetre (mm)	1000

Most human cells are between 8 and $60\ \mu m$. Bacteria are between 0.1 and $1.5\ \mu m$. The table below shows some sizes of human cells, followed by a diagram for comparison.

Approximate sizes of cells in the human body

Type of cell	Approximate size of cells (μm)
sperm	length 4.5, width 2.8
red blood cells	5-8
white blood cells	6-14
egg	100
cheek cells	50-100
cardiac muscle cells (in the heart)	length 100, width 20
skeletal muscle cells (connected to bones)	length up to $50\,000$, width 100
nerve cells	length 100 up to $1\,000\,000$



The relative sizes of cells

hub **SkillBuilder:** Converting between micrometres, millimetres and centimetres

2 Answer the following questions about cheek cells.

(a) Estimate how much bigger a cheek cell is compared to a red blood cell.

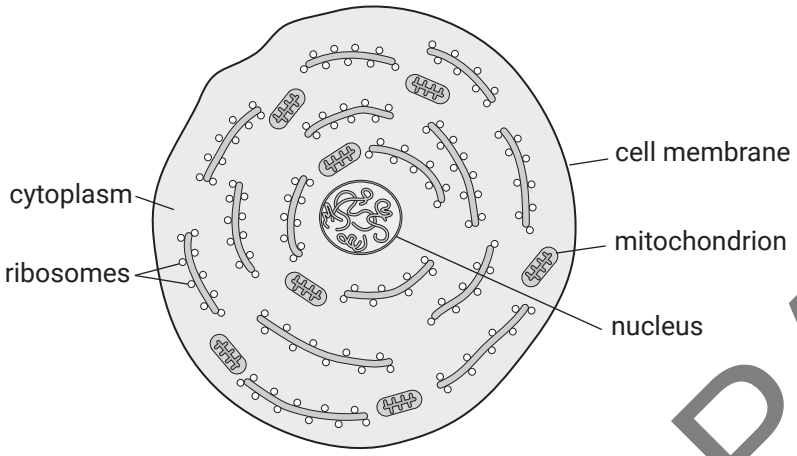
(b) The cheek cell has a diameter of approximately $50\ (\mu m)$. How many cheek cells would fit on a line $1\ cm$ long?

(c) Explain why you would need a microscope to observe a cheek cell.

Features that are common to most types of cells

Although our bodies consist of various cell types, most human cells share common features and organelles (specialised structures), as shown in the diagram.

- **Cell membrane:** Surrounds the cell, controls what enters and exits.
- **Ribosomes:** Produce proteins for cell growth and repair.
- **Nucleus:** Contains DNA with genetic instructions.
- **Mitochondria:** Generates energy via cellular respiration.
- **Cytoplasm:** Jelly-like fluid containing cell components.



3 **(a)** Describe the role of the cell membrane.

(b) Predict what might happen if the cell membrane is not able to function correctly.

Lesson review

1 **(a)** List four functions of different types of cells in humans.

(b) Describe how water can play a part in one of these functions.

2 **(a)** Cells are measured in micrometres (μm). How many micrometres make up a millimetre?

(b) If the size of a white blood cell is $10\ (\mu m)$, what would this be in millimetres (mm)?

3 **(a)** Name the structure inside a cell that produces proteins.

(b) Explain why this organelle is present in most human cells.

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1.3 Practical investigation: Using a microscope

Learning intention: To be able to use a microscope to generate data and information

Success criteria:

- ☐ SC 1: I can identify key parts of a light microscope and describe their function.
- ☐ SC 2: I can calculate the total magnification of a light microscope.
- ☐ SC 3: I can safely use a microscope to observe and record observations of specimens at a range of magnifications.

Microscopes are essential for exploring cells and advancing cell theory. They extend our vision beyond the naked eye's limits. School laboratory microscopes provide vital evidence, revealing unseen cell structures.

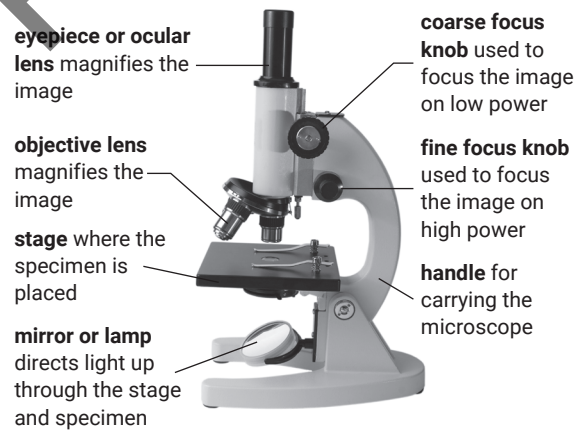
In this practical investigation, you will learn how to use a light microscope and calculate the magnification of a microscope when viewing specimens.

Key parts of a light microscope and their functions

Light microscopes are commonly used in schools and laboratories. They come in two variations: monocular (with one eyepiece) and binocular (with two eyepieces). The photograph below shows the main components of a light microscope.

How microscopes magnify images

Light microscopes magnify images using lenses and light. The eyepiece (**ocular lens**) is near your eye. The **objective lens** is closer to the specimen. Microscopes with two lenses, like the one in the diagram, are called compound microscopes.



Magnification indicates how much bigger the image is than the real object. A magnification of $10\times$ means the image is ten times larger. The **field of view** determines what you see; higher magnification narrows it. Light compound microscopes magnify up to around 1000 times, revealing large bacteria. Stereo microscopes can magnify up to around 40 times.

1 Match the parts of a microscope to the correct description by joining them with a line.

eyepiece •	• part of the microscope on which the specimen is placed
coarse focus knob •	• sharpens the focus on high power
stage •	• used to light the specimen
objective lens •	• sharpens the focus on low power
specimen •	• the object being studied using the microscope
light source •	• the lens of the microscope closest to the specimen
fine focus knob •	• the part of the microscope you look through

KEY TERMS

light microscope a microscope that uses light to view specimens

ocular lens the lens of the microscope closest to your eye, also known as the eyepiece

objective lens the lens in a microscope or telescope that is nearest to the object being viewed

magnification the amount by which the image is magnified (made bigger) compared to the real object (specimen)

field of view maximum area visible when looking through a microscope

Calculate the total magnification of a light microscope

Most microscopes can be set to magnify at a range of powers of magnification. This is because they contain an eyepiece and a second objective lens. Different combinations of lenses will produce a different overall magnification.

Refer to the SkillBuilder to learn how to calculate the magnification of a light microscope.

hub **SkillBuilder:** Calculating the magnification of a microscope

2 A microscope has an eyepiece labelled $10\times$ and an objective lens labelled $40\times$. Calculate the magnification of this microscope.

Using a microscope to observe specimens

Background

There are different types of light microscopes, but most that you will use in a school laboratory will have the parts you have already learnt about. If the microscope does not have its own light source, light is directed onto the specimen using a mirror that reflects from a microscope lamp or other suitable light source. Some microscopes have only one focus knob.

Aim

To become familiar with the workings of a microscope by observing common objects at various magnifications.

Safety notes

Ensure that you follow the correct way to focus the microscope so that you do not damage the specimen or the objective lens.

MATERIALS

- various small samples for microscope observation; for example, sugar crystals (plain and caster), salt, copper sulfate crystal, hair strand, clothing fibres, leaf section, writing sample, newsprint
- light microscope
- microscope lamp (if not built-in)
- glass microscope slides
- tweezers

Method

1 Place the sample carefully on a microscope slide. Secure it with clips on the stage.

2 Adjust the mirror or light source for optimal light passing through the slide.

3 Choose the lowest magnification objective lens.

4 Adjust the coarse focus knob to bring the stage and lens closer without touching.

5 Look through the eyepiece and turn the coarse focus knob to move the lens and stage apart.

6 Repeat step 5 until the specimen comes into focus.

7 If focus is lost, return to step 4 and begin again.

8 Use this method to observe each specimen under the microscope.

Results

In the table:

- note the specimen and the magnification used for the clearest image
- describe any observations made using the microscope
- sketch diagrams of your observations for each specimen.

Specimen		**Sketch**
Magnification		
Microscopic observations		
Specimen		**Sketch**
Magnification		
Microscopic observations		
Specimen		**Sketch**
Magnification		
Microscopic observations		
Specimen		**Sketch**
Magnification		
Microscopic observations		
Specimen		**Sketch**
Magnification		
Microscopic observations		

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1.4 The function of the nucleus in cells

Learning intention: To understand the key role of the nucleus in the function of cells

Success criteria:

- ☐ SC 1: I can identify the nucleus from a visual representation of a cell.
- ☐ SC 2: I can explain the function of the nucleus of a cell.

The nucleus serves as the cell's information hub, containing essential genetic instructions. Every cell in an organism carries this genetic information crucial for both cell and organism survival.

In this lesson, you will learn about the nucleus and its fundamental role in the cell.

Identifying the nucleus from a visual representation of a cell

Cells that contain a **nucleus** are called **eukaryotic cells**, while cells that don't have a nucleus are called **prokaryotic cells**. Plants and animals are called eukaryotes because their cells contain nuclei. Unicellular organisms, such as bacteria, are called prokaryotes because their cells do not contain nuclei.

The nucleus was the first organelle identified within a cell. It is often depicted as a circular or oval shape at the cell's centre, with a smaller structure called the **nucleolus** within it. The nucleolus produces ribosomes, which aid in protein production.

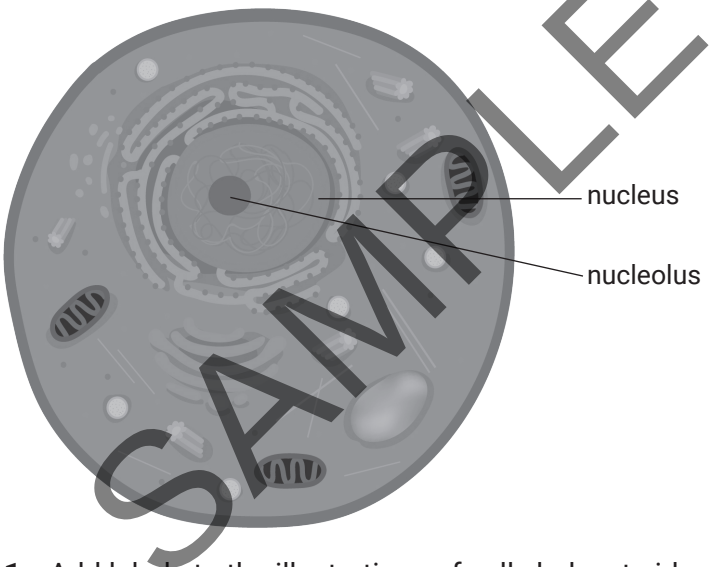
KEY TERMS

nucleus organelle that contains the genetic information for the cell (plural nuclei)

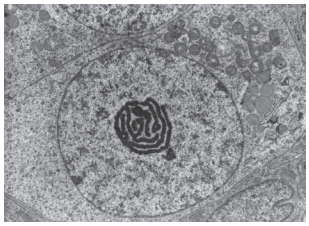
eukaryotic cell cell that contains a nucleus

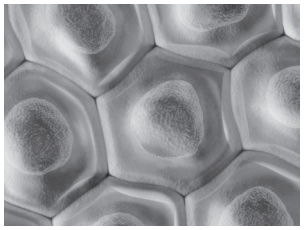
prokaryotic cells a cell that does not have a nucleus

nucleolus organelle within a cell nucleus that produces ribosomes



1 Add labels to the illustrations of cells below to identify the nucleus in each cell.





Function of the nucleus of a cell

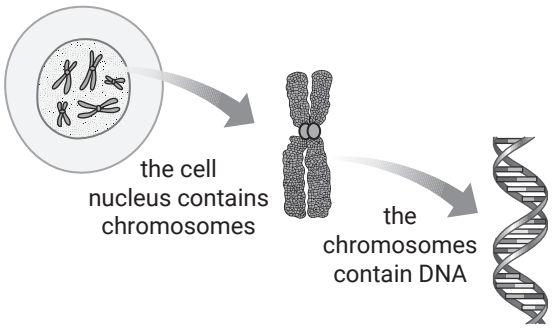
The nucleus is like a control centre for the cell. It contains **DNA**, which is packaged into **chromosomes**. DNA holds instructions for the cell's functions, such as growth, making more cells and guiding protein production. Most protein-making happens outside the nucleus, in the cytoplasm. All cells have the same DNA in their nucleus, which is protected by a membrane. DNA consists of **genes**, small segments responsible for encoding information.

KEY TERMS

DNA deoxyribonucleic acid, the molecule that contains genetic information for an organism

chromosomes thread-like structures in the nucleus; composed of DNA and proteins; contain the genetic information in the form of genes

gene a section of DNA that carries the genetic code for a particular characteristic



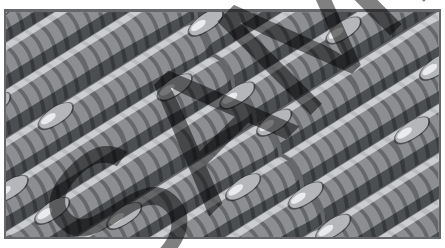
The nucleus of the cell contains chromosomes, which contain tightly packed DNA

Not all cells have a nucleus. For instance, bacteria do not have a nucleus, so the DNA floats freely. Similarly, mature red blood cells lose their nucleus to carry more oxygen, which means the cells have a short lifespan of just a few days.

2 Predict what would happen if the nucleus was removed from an animal or plant cell.

Lesson review

1 Label two nuclei in this microscope image of muscle cells.



2 Describe the function of the nucleus of a cell.

3 Describe one way that the nucleus controls the functions of the cell.

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1.5 Practical investigation: Observing cells

Learning intention: To be able to use a microscope to observe and record images of plant cells

Success criteria:

- ☐ SC 1: I can use a microscope at a range of magnifications to observe and record features of plant cells.
- ☐ SC 2: I can use microscopic observations to describe and compare plant cells.

Background

Light microscopes are valuable tools to help scientists explore cells and their structures. Light microscopes can magnify specimens up to $400\times$ to reveal cell shapes and internal features.

Previously, you learnt how to operate a light microscope. In this practical investigation, you will use a light microscope to examine plant cells from onions and rhubarb. With careful observation, you will sketch the fundamental cell components.

Aim

To test your microscopy skills and observe and compare plant cells

MATERIALS

- slices of onion and rhubarb leaf stalk
- a few drops of iodine
- a few drops of water
- microscope and lamp
- filter paper
- 2 microscope slides and cover slips
- eye-dropper and tweezers
- safety glasses

Safety notes

- Iodine is harmful and can stain skin and clothing. Wear safety glasses and avoid contact with skin and clothes
- Complete a risk assessment that outlines the risks and precautions you need to take to minimise them.

Method

1. Gently remove a thin layer of onion skin, ensuring it is one cell thick.
2. Use tweezers to place the onion skin on a glass microscope slide. Make sure it lies flat.
3. Add a drop of water and a drop of iodine on the onion skin sample. Carefully place a cover slip over the sample on the microscope slide. Take care not to trap bubbles under the cover slip. Soak up any excess water or stain with a piece of filter paper or tissue.
4. Use the microscope to examine the cells under two different magnifications.
5. Carefully extract a thin layer of skin from the outer part of a rhubarb leaf stalk. Repeat the preparation steps used for the onion skin – but do not use iodine stain.

HINT

To avoid trapping bubbles under the cover slip, place one edge of the cover slip on the microscope slide and gently lower it onto your sample using a toothpick, tweezers or your finger.

hub **SkillBuilder:** Increasing magnification

hub **SkillBuilder:** Drawing from the microscope

Results

Draw a few cells at the higher magnification. On your diagram, record the type of cell you have drawn and the magnification used.

Conclusion

Write your conclusion to the experiment by answering the following questions.

HINT

To calculate total magnification, multiply the magnification of the eyepiece (ocular lens) by the magnification of the objective lens.

1 List the parts of the cell you were able to see clearly in the onion skin cell and in the rhubarb skin cell.

2 Explain why there may be parts of the cell that you were not able to observe.

3 Compare and contrast the onion cells and rhubarb cells.

4 Propose a reason why iodine was used to stain the onion cells but not the rhubarb cells.

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1.6 The roles of the cell wall and cell membrane

Learning intention: To understand the roles of the cell wall and cell membrane in the function of cells

Success criteria:

- ☐ SC 1: I can identify the cell membrane and cell wall of a cell from a photomicrograph, model or other visual representation.
- ☐ SC 2: I can describe the functions of cell membranes and cell walls.
- ☐ SC 3: I can compare the functions of the cell membrane and cell walls.

The cell membrane and cell wall play important roles in providing protection and structural support to the cell.

In this lesson, you will explore the roles of the cell membrane and cell wall. You will also understand why plant cells have cell walls while animal cells do not.

Identifying cell membranes and cell walls

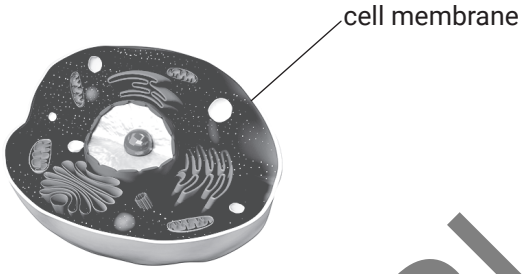
Both plant and animal cells have a **cell membrane**. The cell membrane is visible in diagrams and in **micrographs** as a thin outline around the cell.

KEY TERMS

cell membrane a thin layer that separates the cell from its surroundings

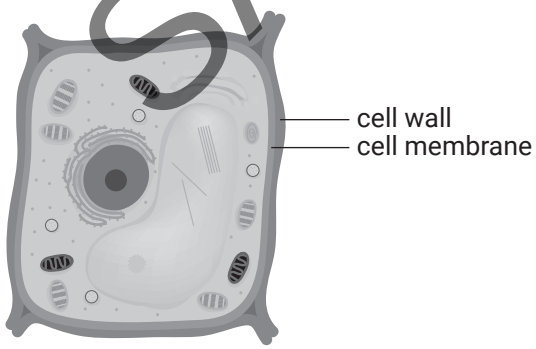
micrograph photograph of an image from a microscope

cell wall a rigid layer on the outside of plant cells that supports and protects the cell



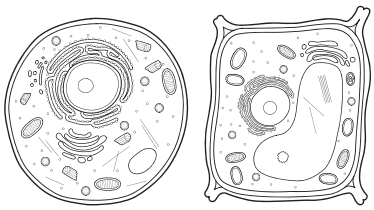
A representation of a typical animal cell

The **cell wall** is a rigid structure outside the cell membrane. Plant cells have cell walls but animal cells do not. When viewing plant cells it can be difficult to differentiate the cell wall from the cell membrane. The cell wall is thicker and more rigid than the cell membrane and it surrounds the plant cell.



A diagram showing the cell wall and cell membrane of a plant cell

1 Distinguish the animal cell from the plant cell in the diagrams below. Label the cell membrane and cell wall (if present).



Describing the functions of cell membranes and cell walls

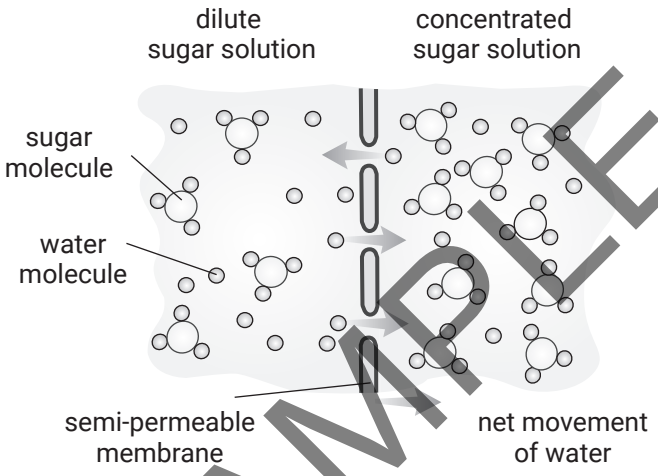
The cell membrane protects the cell and controls the movement of substances in and out of the cell. It is a **semi-permeable membrane**, allowing certain substances to pass through while restricting others.

Movement in and out of a cell involves proteins helping with transport, or substances diffusing through small gaps in the membrane. Water particles can easily move through the cell membrane in a process called **osmosis**.

KEY TERMS

semi-permeable membrane a thin layer of material that only certain particles can pass through

osmosis process by which particles of water pass through a semi-permeable membrane from a less concentrated solution into a more concentrated one



Osmosis: Water molecules permeate the cell membrane, while larger sugar molecules are restricted

The cell wall provides structural support to the plant cell and, like the cell membrane, the cell wall controls what goes in and out of the cell.

2 Outline the function of the following cell parts.

(a) cell wall

(b) cell membrane

Comparing the functions of cell membranes and cell walls

Cell membranes are thin and often invisible without staining when observed through a microscope. They are semi-permeable, allowing specific particles to pass through like filters. Additionally, they feature gatekeeper pathways that control the movement of substances into and out of the cell.

Cell walls in plants consist mostly of cellulose, a sturdy material similar to cardboard. This composition provides strength and shape to plant cells, contributing to their overall support and protection.

3 Create a table outlining the key differences between cell membranes and cell walls.

Lesson review

1 **(a)** Identify and label a cell wall in the light micrograph of algae cells, right.

(b) State where you would expect to find the cell membrane of an algae cell.

2 Identify the advantages and disadvantages associated with cells having a cell wall.

3 Describe the main difference between the function of a cell wall and the function of a cell membrane.

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1.7 Practical investigation: Investigating the action of a cell membrane

Learning intention: To be able to investigate the action of a cell membrane

Success criteria:

- ☐ SC 1: I can develop a prediction around the movement of water through a membrane.
- ☐ SC 2: I can measure and record masses and volumes with a high level of precision.
- ☐ SC 3: I can use knowledge of cell membranes to explain experimental results.

Background

Hens' eggs can be used to model some of the functions of cell membranes. The structure and function of the thin membrane inside the egg's shell is similar to that of the cell membrane.

In this practical investigation, you will use eggs to investigate the movement of water through the cell membrane.

MATERIALS

- 2 eggs
- 500mL white vinegar
- 1 tablespoon salt
- 500mL distilled water
- electronic balance
- 200mL measuring cylinder
- container large enough to hold two eggs immersed in vinegar
- 2×500mL beakers
- plastic wrap

Aim

To investigate the movement of water through a cell membrane

Prediction

Read the method, then predict the changes in egg mass and water volumes in the salt water and distilled water.

Safety notes

⚠ Wear eye protection when using the vinegar during the experiment.

Method

Part A

1. Review the results tables to understand what you need to record.
2. Immerse both eggs in a vinegar-filled container. Make sure they are completely covered.
3. Allow the eggs to sit undisturbed for two days. During this period, the vinegar will dissolve the eggshell, leaving the inner membrane as the outer layer.

Part B

4. Create a concentrated salt solution by adding a tablespoon (15 mL) of salt to 250mL of distilled water.
5. Label two glass beakers as 'salt water' and 'distilled water'.

6 Pour $200\,\text{mL}$ of distilled water into the 'distilled water' beaker, using purified, chemical-free distilled water.

7 Pour $200\,\text{mL}$ of the prepared salt water into the 'salt water' beaker.

8 Record the initial water volume in both beakers as Day 0 in Table 2.

9 Gently rinse and pat dry the eggs after removing them from the vinegar.

10 Use a balance to determine and document the mass of each egg on Day 0 in Table 1.

11 Place one egg in each water beaker, covering them with plastic wrap.

12 Over the next three days, measure and document the egg masses daily.

13 On Day 3, measure and record the remaining water volume in each beaker.

HINT

When measuring the egg mass, take one egg at a time from the solutions to ensure they are returned to the correct solution.

Results

Record your results in the tables.

Table 1 Changes in the mass of eggs in salt water and distilled water

Treatment	Mass of egg (g)				Total change in mass (g)
	Day 0	Day 1	Day 2	Day 3	
distilled water					
salt water					

Table 2 Changes in the volume of salt water and distilled water

Treatment	Volume of water (mL)		Total change in volume mL
	Day 0	Day 3	
distilled water			
salt water			

Conclusion

Answer the following questions to construct a conclusion to the experiment.

1 Describe any changes that took place in the two eggs.

2 Describe any change in the volume of the water in the two beakers.

3 Compare the actual results with your prediction.

4 Consider the process of osmosis, and explain what you think was happening to the eggs and the role the membrane played.

Evaluation

Evaluate your investigation and the quality of the data with reference to reliability, validity and accuracy.

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1.8 The functions of mitochondria and chloroplasts in cells

Learning intention: To understand the roles of mitochondria and chloroplasts in cellular function

Success criteria:

- ☐ SC 1: I can identify the mitochondria and chloroplasts of a cell from a photomicrograph, model or other visual representation.
- ☐ SC 2: I can describe the functions of the mitochondria and chloroplasts of a cell.
- ☐ SC 3: I can compare and contrast the presence and functions of the mitochondria and chloroplasts in cells.

All cells need energy to function. Chloroplasts and mitochondria convert organic compounds, such as glucose, into energy that can be used by the cell.

In this lesson, you will learn about the essential roles these organelles play in plants and animals.

Identifying mitochondria and chloroplasts

Mitochondria are small organelles that measure 0.5 to $3\ \mu m$ long. They are not visible through a light microscope and require an electron microscope for detailed examination. Certain energy-intensive cells have more than 1000 mitochondria.

Mitochondria have two membranes — an inner membrane and an outer membrane. These membranes usually appear as ovals with internal folds in diagrams.

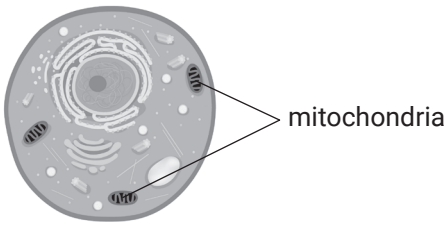
Chloroplasts are slightly larger than mitochondria. They are about 5 to 7 µm in length, and are visible under a light microscope. They have stacked compartments, often depicted as green ovals with internal lines in diagrams. Chloroplasts are green because they contain a pigment called **chlorophyll**. The green pigment in chloroplasts means that they don't need to be stained to be visible under a light microscope. These organelles are enclosed by an outer membrane and contain folded membrane compartments, visible in cross-section images.

KEY TERMS

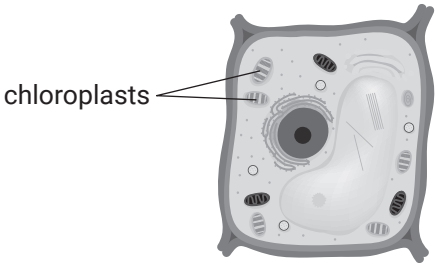
mitochondria organelles in plant and animal cells where cellular respiration takes place (singular mitochondrion)

chloroplast organelle in plant cells where photosynthesis takes place

chlorophyll green pigment in plant cells that absorbs sunlight for photosynthesis

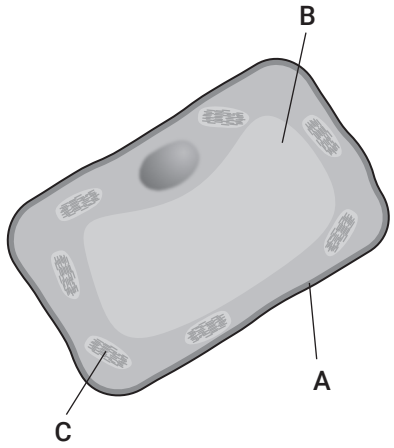


An animal cell showing the mitochondria



A plant cell showing the chloroplasts scattered throughout the cytoplasm

1 Which of the labels (A, B or C) is pointing to a chloroplast in the image below?



Functions of mitochondria and chloroplasts

Mitochondria

Mitochondria are cell powerhouses. They convert food into energy via **cellular respiration**. This process relies on oxygen. Cellular respiration occurs in both plant and animal cells. Highly active cells contain more mitochondria than cells that are less active.

KEY TERM

cellular respiration a set of processes in the cells that convert chemical energy from nutrients into energy used by cells

photosynthesis the chemical reaction in plants that converts carbon dioxide and water into oxygen and glucose using energy from the Sun

protist a single-celled organism with a distinct nucleus

Chloroplasts

Chloroplasts are specialised organelles that carry out **photosynthesis**. Photosynthesis is a series of chemical reactions that convert sunlight into chemical energy that can be used by the plant's cells. Chloroplasts are found in plants and in some protists, but not in animals or fungi.

2 **(a)** Describe the function of chloroplasts using correct scientific language.

(b) Describe the function of mitochondria using correct scientific language.

Comparing and contrasting mitochondria and chloroplasts

Similarities

Both mitochondria and chloroplasts have inner and outer membranes, where chemical processes occur. Functioning like mini factories, both organelles involve input (energy or substances entering) and output (energy or substances exiting).

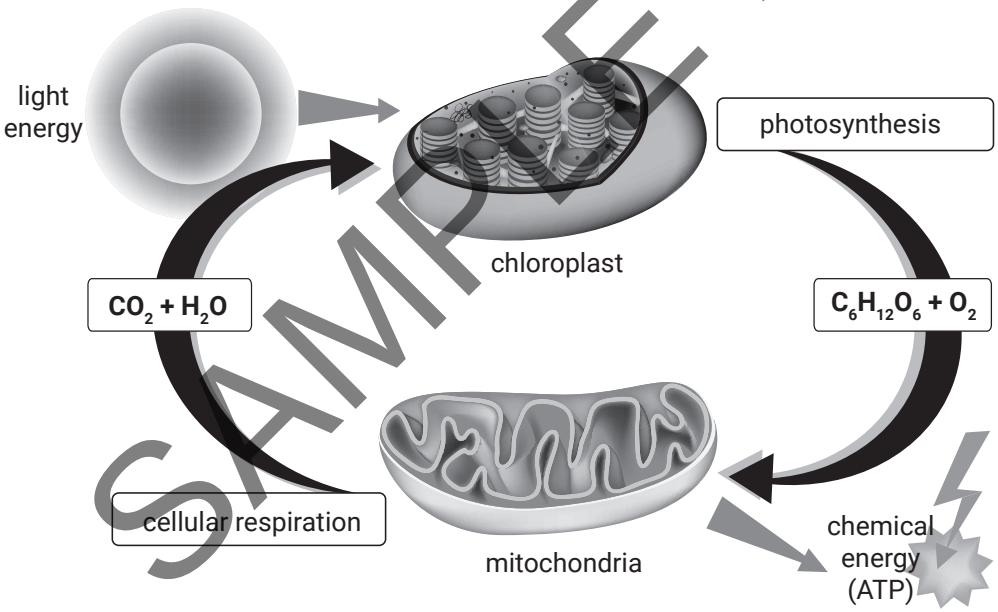
(a) **(b)**

Cross-section illustration of (a) a mitochondrion and (b) a chloroplast

Differences

Photosynthesis takes place in chloroplasts. Light energy is used to convert carbon dioxide (CO_2) and water (H_2O) into glucose and water oxygen (O_2).

In contrast, cellular respiration takes place in mitochondria. Glucose and O_2 is converted into CO_2 and H_2O, releasing energy (ATP).

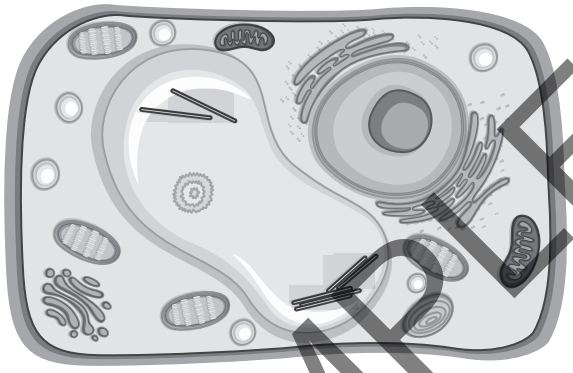


The relationship between the chemical processes occurring in mitochondria and chloroplasts

3 Design and complete a graphic organiser that compares and contrasts mitochondria and chloroplasts.

Lesson review

1 How many mitochondria are shown in this representation of a cell?



2 Describe why athletes try to maximise the number of mitochondria in their muscle cells.

3 Discuss whether you agree or disagree with the statement:
'Without chloroplasts, there would be no mitochondria. Without plants, there would be no animals.'

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1.9 Comparing plant and animal cells

Learning intention: To understand the similarities and differences between animal and plant cells

Success criteria:

- ☐ SC 1: I can distinguish animal and plant cells in a photomicrograph, model or other visual representation based on their appearance and organelles present.
- ☐ SC 2: I can compare and contrast animal and plant cells based on the functions of their organelles.

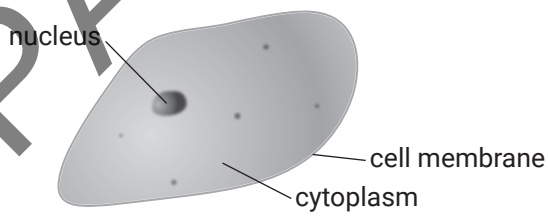
Cells in plants and animals have different structures and functions. These differences have evolved because plants and animals have different needs for survival and reproduction.

In this lesson, you will bring together what you know about cells and their organelles to compare and contrast the structure and function of plant and animal cells. You will practice organising and explaining these differences using scientific terms and diagrams.

Distinguishing animal and plant cells

Viewing animal cells

Organelles such as the nucleus are visible using a light microscope. Other, smaller organelles such as mitochondria require an electron microscope with higher magnification. The diagram illustrates an animal cell's key organelles seen with a light microscope.



A diagram of an animal cell

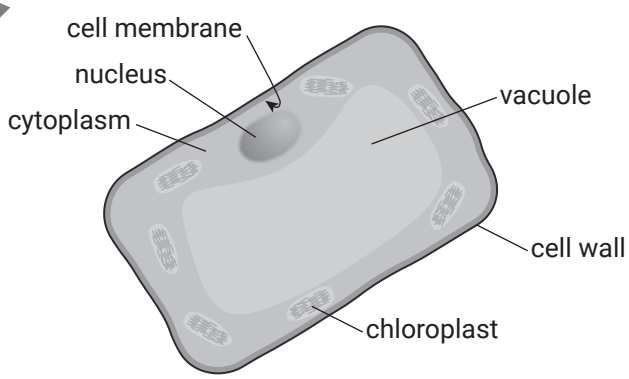
Viewing plant cells

Plant cells look like animal cells, but they have distinct structures due to their unique functions – including cell walls, chloroplasts, and a large **vacuole**.

Plant cells are generally larger than animal cells. Notably, plant cells were among the first to be discovered. The diagram illustrates a typical plant cell's key organelles seen with a light microscope.

KEY TERMS

vacuole organelle that stores water, food or waste materials

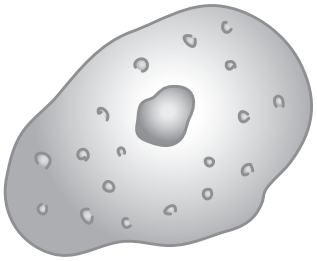
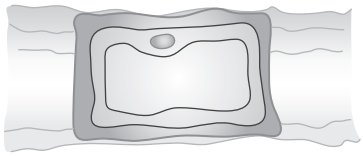


A diagram of a plant cell

1 A scientist examined two distinct specimens under a microscope. They drew diagrams and noted magnification levels.

Determine whether each specimen is an animal or plant cell.

Provide a reason for your classification.

Specimen	Animal or plant cell	Reason
		
		

Comparing and contrasting animal and plant cells

Organelles have distinct functions. Organelles that are in both plant and animal cells include the cell membrane, cytoplasm, nucleus and mitochondria.

Animal cell organelles

Unique to animal cells are:

- **lysosomes**, responsible for disposing of cellular waste
- **centrioles** which aid in cell division.

KEY TERMS

lysosome organelle that breaks down waste material in a cell

centriole barrel-shaped structure made from microtubes that is part of the cytoskeleton in animal cells

Plant cell organelles

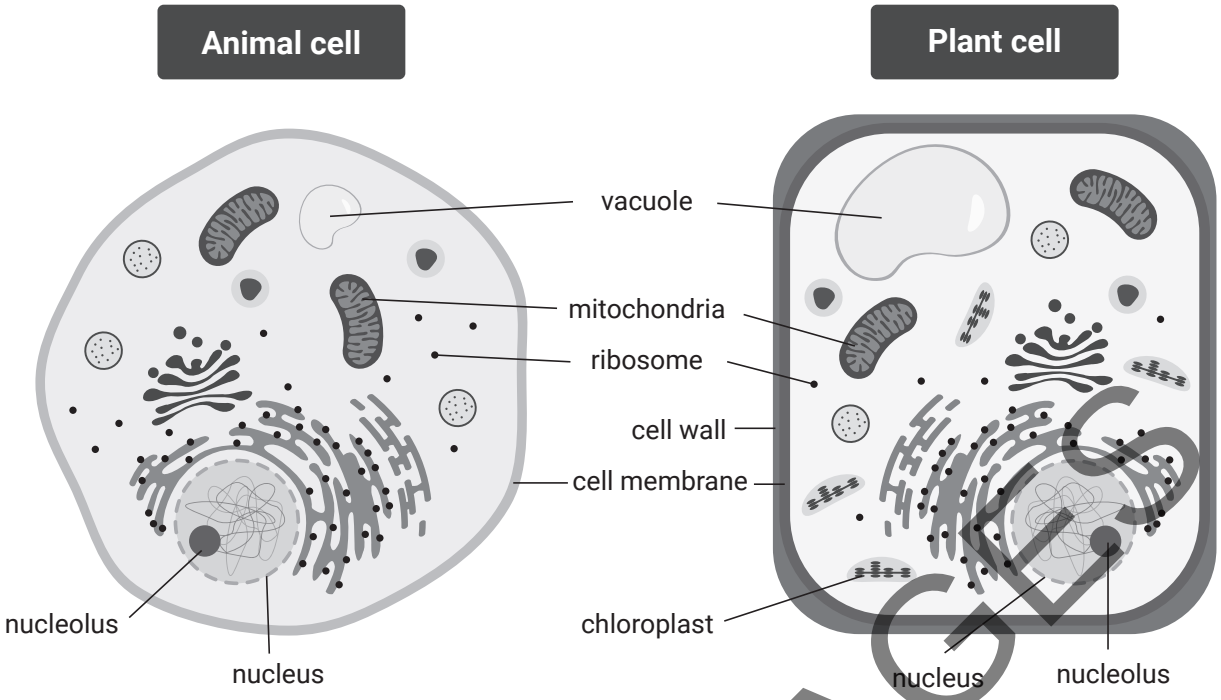
Unique to plant cells are:

- the cell wall, which provides structural support
- large vacuoles, in comparison to those in animal cells
- chloroplasts, essential for photosynthesis to occur in leaf cells.

Comparing plant and animal cells

The table and diagram below give an overview of the similarities and differences between organelles in plant cells and animal cells.

Function	Organelle	Present in animal cells	Present in plant cells
making and processing proteins	nucleus	✓	✓
	ribosomes	✓	✓
energy and food production	mitochondria	✓	✓
	chloroplasts	✗	✓
storage and structure	vacuole	✓ small	✓ large
	cell wall	✗	✓
	cell membrane	✓	✓



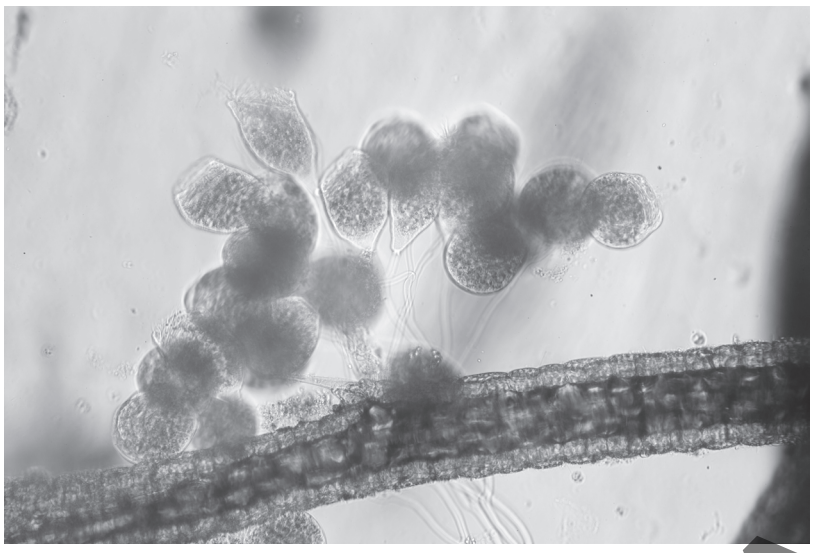
A diagram of an animal cell and a plant cell, showing their organelles

2 Complete the table.

Organelle	Animal cell function	Plant cell function
cell membrane		
cytoplasm		
nucleus		
mitochondria		
cell wall		
vacuoles		
chloroplasts		

Lesson review

1 Examine the microscope image below. Identify which is the animal cell and which is the plant cell in the image. Explain how you have classified these cells.



2 Explain why animal and plant cells are similar in some ways but different in other ways.

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1.10 Practical investigation: Organisms under the microscope

Learning intention: To be able to use microscopes to observe, record and compare unicellular and multicellular organisms

Success criteria:

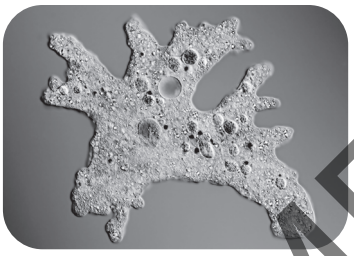
- ☐ SC 1: I can use a microscope, with the appropriate magnification, to observe a variety of unicellular and multicellular organisms.
- ☐ SC 2: I can record observations, including the magnification used, of unicellular and multicellular organisms using a microscope.
- ☐ SC 3: I can evaluate the experimental method used to observe cells and organisms at the microscopic scale.

Background

Microscopes reveal hidden structures in pond water, such as organelles within cells and unicellular organisms. The species *Euglena, Paramecium, Amoeba*, and *Spirogyra* found in pond water are intriguing for microscopic observation due to their distinct structures. *Euglena, Paramecium*, and *Amoeba* are freshwater protists, while *Spirogyra* is a green algae. In this practical investigation, you will use a light microscope to observe pond life, mastering wet mounts, varied magnifications, and scientific drawings.

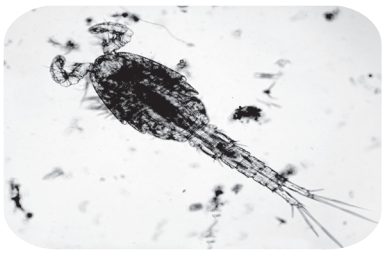
Field guide

Use the provided diagram to help identify organisms observed using a microscope.



Amoeba

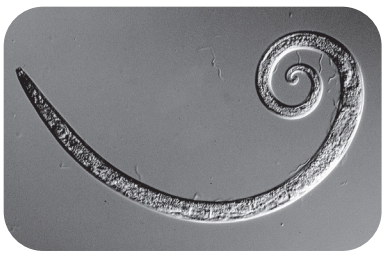
diatom



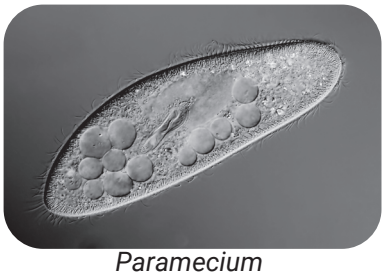
Cyclops

Euglena

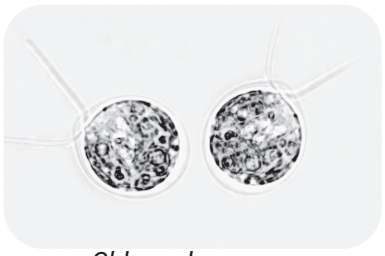
Spirogyra



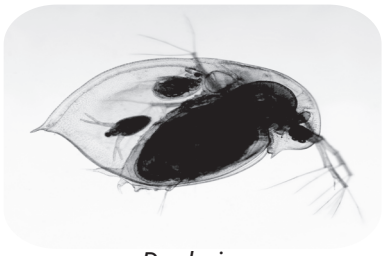
nematode



Paramecium



Chlamydomonas



Daphnia

Aim

To view unicellular and multicellular organisms under a light microscope and identify cell structures and organelles

hub **SkillBuilder:** Preparing a wet mount

Safety notes

- Handle glass slides and cover slips with care. If they break, inform your teacher and they will direct you on the correct method of disposal.
- Do not taste the pond water.

MATERIALS

- sample of pond water, or separate samples of microorganisms such as *Euglena, Paramecium* and *Spirogyra*
- glass microscope slides
- glass cover slips
- plastic Pasteur pipettes
- forceps
- toothpicks
- cotton wool
- light microscope

Method

1. Position the sample at the centre of the slide. Use a plastic Pasteur pipette to place a sample drop for pond water, *Euglena* and *Paramecium*. Use forceps for *Spirogyra* by adding a leaf segment.
2. For specimens in water, add a few cotton wool fibres to slow organism movement for easier observation.
3. Carefully place a cover slip over the sample on the microscope slide. Take care not to trap bubbles under the cover slip. Soak up any excess water or stain with a piece of filter paper or tissue.
4. Place the slide on the microscope stage and turn on the microscope light.
5. Use the $4\times$ objective lens and adjust coarse and fine focus for clear viewing.
6. Switch to the $10\times$ objective lens, adjusting focus.
7. Move to the $40\times$ objective lens, focusing as needed. Make observations.

HINT

To avoid trapping bubbles under the cover slip, place one edge of the cover slip on the microscope slide and gently lower it onto your sample using a toothpick, tweezers or your finger.

Results

Record your observations in the table on the next page. In 'observations', include a sketch and information about the structure and movement of the organism, and any cell structures or organelles that you observed.

HINT

To calculate total magnification, multiply the magnification of the eyepiece (ocular lens) by the magnification of the objective lens.

Organism name		**Observations**
Unicellular or multicellular?		
Magnification		
Organism name		**Observations**
Unicellular or multicellular?		
Magnification		
Organism name		**Observations**
Unicellular or multicellular?		
Magnification		
Organism name		**Observations**
Unicellular or multicellular?		
Magnification		

Conclusion

Write your conclusion to the experiment by answering the following questions.

1 Explain why some organisms, such as *Euglena* and *Spirogyra*, are green.

2 Compare the movement of unicellular organisms in your samples.

3 Have you noticed the spaces called vacuoles within cells in your specimens? Describe the role of vacuoles.

Evaluation.

Evaluate your practical investigation by considering the following.

1 Describe any difficulties you had observing the organisms.

2 How did you overcome these difficulties?

3 Suggest other improvements that could be made to the experiment.

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Topic review

1 Briefly describe how unicellular organisms reproduce.

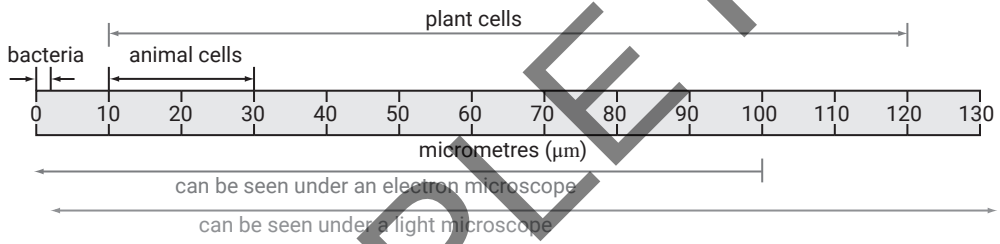
2 Describe the function of red and white blood cells in the human body.

3 A human egg cell has a diameter of approximately $100\ \mu m$ (micrometres).

(a) What would be the diameter of the egg cell measured in millimetres (mm)?

(b) The length of nerve cells can range from $100\ \mu m$ up to 1 m. Explain why nerve cells can be so long.

4 Refer to the diagram below to answer the following questions.



(a) Compare the size of plant cells and animal cells.

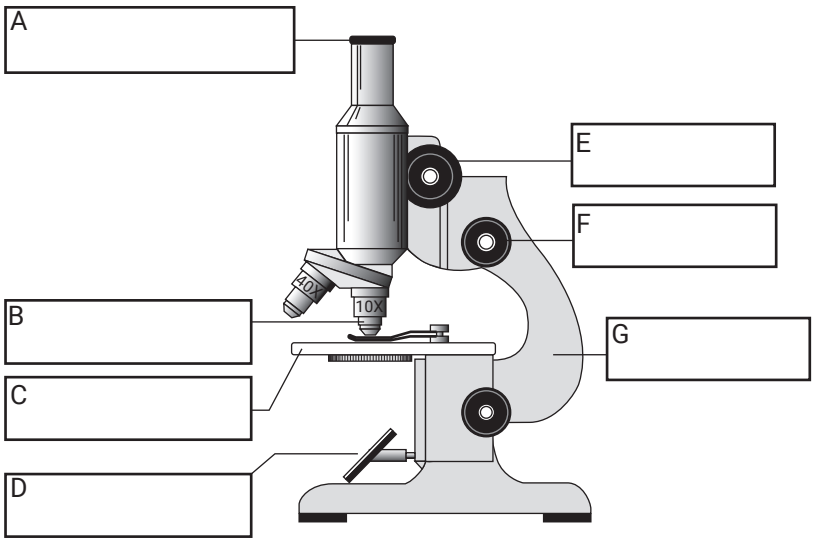
(b) Bacteria do not form true multicellular organisms. Suggest how this may have contributed to bacteria not being discovered until long after animal and plant cells were discovered.

5 (a) Calculate the magnification of a light microscope with an eyepiece of $10\times$ and an objective lens of $25\times$.

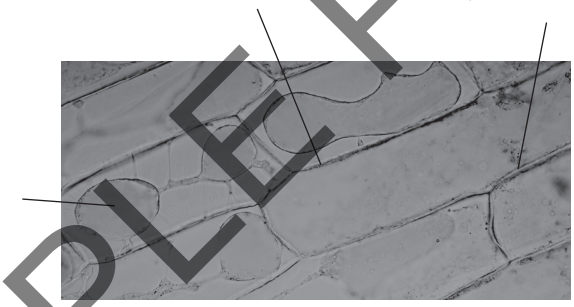
(b) Explain why it is important to record the magnification used when drawing cells seen using a microscope.

6 Use the following terms to name the parts of a microscope, labelled A to G on the diagram below.

coarse focus knob	eyepiece	fine focus knob	handle	light source	objective lens	stage



7 Consider the image of the plant cells below. Add labels to the image that identify the main cell features that can be observed.



8 Describe, using a diagram, how a cell membrane allows only certain materials to pass into and out of a cell.

9 Identify which organelles or structures would be present in large numbers in the following cells. Give reasons for your answers.

(a) cells that require a lot of energy

(b) cells that manufacture proteins

(c) cells that carry out photosynthesis

10 Explain why some plant cells are green.

11 Explain why the following structures are found in plant cells but not in animal cells.

(a) cell wall

(b) chloroplasts

(c) large vacuole

12 The invention of the light microscope led to the discovery of unicellular organisms. The combination of improvements in light microscopes and the invention of electron microscopes has greatly improved our understanding of these microorganisms.

(a) Describe how developments in light microscopes led to the discovery of microorganisms.

(b) Explain how the invention of electron microscopes allowed for a greater understanding of the functions of organelles.

13 A student described the nucleus as the 'brain of a cell'. Discuss whether you think this is an accurate description of a cell nucleus.

14 Describe three ways that you could improve the clarity of the observations when observing microscopic organisms using a light microscope.

15 When creating a three-dimensional model of a cell, the choice of materials is important so that they represent the characteristics of the structures and organelles of the cell as accurately as possible.

Suggest a material that could be used to represent the following components. For each one, explain your reasons for your suggestion.

(a) cell wall

(b) cytoplasm

(c) the boundary of a vacuole

(d) ribosomes

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