●●●○○ **Level 3 · Science S3.1**

Cells

All living things are made of tiny cells, and each part of a cell has a job.

Learn the signs of life, look at cells through a drop of water and a microscope, and draw plant and animal cells. See how special cells suit their jobs, how cells join into organs, how things spread by diffusion, and how one cell can be a whole living thing.

YOU ARE READY FOR THIS BOOK IF

You can sort ten things into living, once living and never living.

One step up	S4.1 Cells, photosynthesis and respiration
This book	**S3.1 Cells**
One step down	S2.2 Food chains and habitats

Contents

S3.1.1 Signs of life

S3.1.2 Seeing small things

S3.1.3 Animal and plant cells

S3.1.4 What each part does

S3.1.5 Cells with special jobs

S3.1.6 Cells, tissues and organs

S3.1.7 Diffusion

S3.1.8 Living things with one cell

Key words, A to Z

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S3.1.1 CHAPTER 1

Signs of life

How can I tell whether something is alive?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Anything that moves is alive.
- ☐ **B** A plant is not alive, because it does not move about.
- ☐ **C** A living thing does several jobs, such as grow, feed and make young.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.1. It sorts things into living, once living and never living.
- Level 2, How plants grow, S2.1.2. It shows a seed starting to grow.

BY THE END YOU CAN

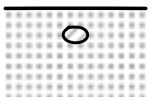
- List the life processes shared by all living things
- Use the life processes to decide if a seed or fire is alive

Think of a dog, a tree and a stone. The dog and the tree are alive. The stone is not. How do you know?

Scientists look for seven signs. Each one is a job that a living thing does. We call each job a **life process**. A living thing shows all seven during its life.

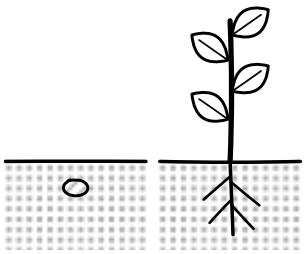
DRAW IT FIRST

Draw a plant growing



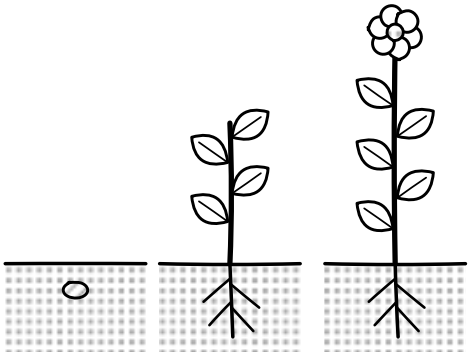
seed

1 Draw a seed lying in the soil.



seed young plant

2 Draw the same plant later. It is a young plant now, and taller.



seed young plant grown plant

3 Draw it later still. It has grown a lot. Growing is the first sign of life.

The seven signs are in the table. You can remember them with the first letters: M R S G R E N.

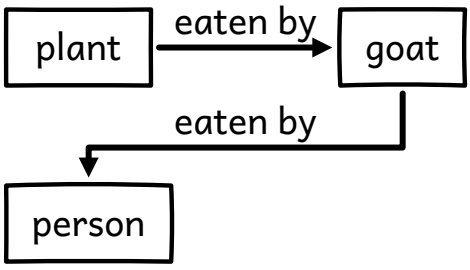
process	what it does
movement	moves
respiration	gets energy
sensitivity	notices things
growth	gets bigger
reproduction	makes young
excretion	removes waste
nutrition	takes in food

The seven life processes.

Animals move their whole body. Plants move too, but slowly. A plant turns its leaves to the light, and its roots grow down. Moving is only one sign. Wind moves a leaf, and that leaf is not alive because of it.

Sensitivity means noticing a change and reacting to it. You pull your hand back from a hot pan. A plant grows toward light.

Nutrition means taking in food. Animals eat. Plants make their own food from light, air and water.



Nutrition: a plant makes food. A goat and a person eat.

Respiration is not the same as breathing. Breathing brings air into your body. Respiration happens in every cell. It releases energy from food, using oxygen. Carbon dioxide and water are made too.

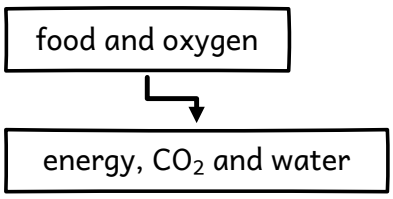
Excretion means getting rid of waste that the body makes. You breathe out carbon dioxide and you pass water and other waste. **Reproduction** means making young of the same kind.

SEE IT THREE WAYS

With things

Run on the spot for a minute. You feel warm and you breathe faster. Your cells are releasing more energy from food.

As a picture

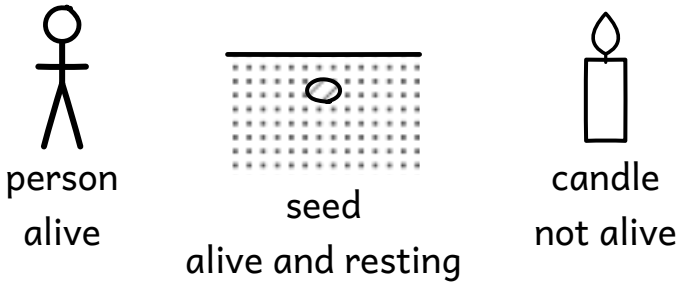


In words

Respiration uses food and oxygen. It releases energy. It makes carbon dioxide and water. It happens in every living cell, all day.

Now test two puzzling things. A candle flame moves, grows, and uses up air and wax. But it makes no young of its own. It cannot notice or react as a living thing does. Most of all, a fire is not made of cells. Every living thing is. So it is not alive.

A dry seed does not seem to move, grow or feed. But it is alive. It is resting. It respires very slowly. Give it water and warmth and it grows.



person
alive

seed
alive and resting

candle
not alive

Some things need a careful look.

TRY IT

Wake a resting seed

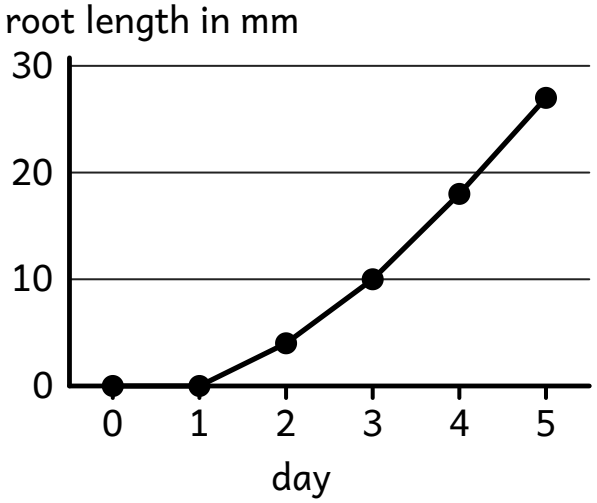
You need: 3 dry bean seeds, or peas or maize, a cloth or paper, a clean jar, water, a ruler.

Be safe: Do not eat the seeds. Raw beans can make you ill. Wash your hands when you finish. If mould grows, do not open the jar near your face or sniff it. Throw it away and wash your hands.

1. Wet the cloth. Squeeze it so it is damp, not dripping. Put it in the jar.
2. Put the seeds between the cloth and the glass, where you can see them. Keep the jar somewhere warm.
3. Look every day for five days. Keep the cloth damp. Measure the root with the ruler and write it down.

What you will see: The seeds lay still for a day or two. Then a root came out and grew longer each day. The dry seed was alive and resting all the time.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~Anything that moves is alive.~~

Why it feels right: Animals move all the time, so moving seems to mean life.

The test that breaks it: A river flows, a cloud drifts and a car rolls. None of them is alive. A tree does not walk anywhere, and it is alive.

What is true: Moving is one of seven signs. A living thing shows all seven during its life.

KEY WORDS

life process
a job that every living thing does, such as growing.

respiration
releasing energy from food inside cells. It is not the same as breathing.

sensitivity
noticing a change and reacting to it.

excretion
getting rid of waste that the body makes.

nutrition
taking in food, or making it, as plants do.

reproduction
making young of the same kind.

BACK TO YOUR GUESS

The answer is C: A living thing does several jobs, such as grow, feed and make young.

Moving is only one sign. A living thing shows seven signs in all. A plant shows every one of them, though often more slowly than an animal.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which of these is not one of the seven life processes?

   A Growth

   B Excretion

   C Making a noise

   D Reproduction

   Answer at the back of the book.

2. What is respiration?

   A Breathing air in and out.

   B Releasing energy from food inside cells.

   C Getting rid of waste.

   Answer at the back of the book.

3. A dry seed lay in a jar for a year. Then it grew when it was wet. What was it during the year?

   A Not alive. It came alive again.

   B Alive, but resting.

   C Not alive, because it did not move.

   Answer at the back of the book.

4. A fire moves, grows and uses up air. Why is it not alive?

   A It does not show all seven signs, and it is not made of cells.

   B Because it is hot.

   C It is alive, because it moves and grows.

   Answer at the back of the book.

5. A tree does not walk about. Why do we say it is alive?

   A Because it is green.

   B Because it grows in soil.

   C It shows all seven life processes, but slowly.

   Answer at the back of the book.

6. The root of a seed measures 4 mm on day 2 and 27 mm on day 5. How many millimetres did it grow?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Every living thing shows seven signs: movement, respiration, sensitivity, growth, reproduction, excretion and nutrition. A fire shows some, but it is not made of cells, so it is not alive. A dry seed is alive and resting.

Draw: Draw a seed, a young plant and a grown plant in a row, and write growth under them.

S3.1.2 CHAPTER 2

Seeing small things

How can we see things that are too small for our eyes?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** We cannot. Tiny things are too small to be seen at all.
- ☐ **B** A curved piece of clear material, such as a drop of water, can make small things look bigger.
- ☐ **C** We only need to hold the tiny thing closer to our eyes.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Light and shadows, S2.6.3. Light goes into the eye so that we see.

BY THE END YOU CAN

- Make a magnifier from a drop of water on clear plastic
- Explain how a microscope lets us see cells

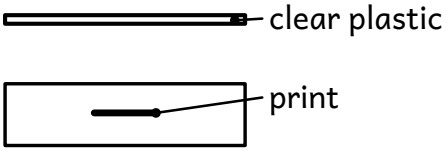
Every living thing is made of tiny parts called **cells**. A cell is the smallest part of a living thing that can do the jobs of life.

Most cells are far too small to see with your eyes alone. You need something to make them look bigger. A **lens** can do that.

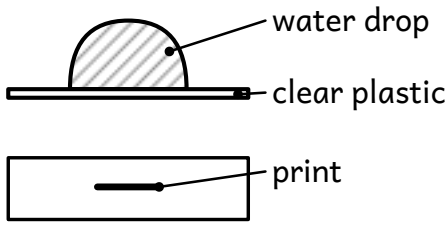
A lens is a piece of clear material with a curved surface. It bends the light that goes through it. A lens that is thicker in the middle makes things look bigger.

DRAW IT FIRST

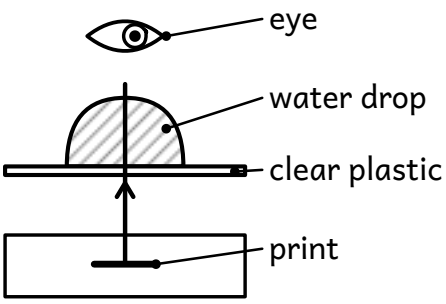
Draw a drop of water that makes things bigger



1 Draw a flat sheet of clear plastic over a line of print.



2 Draw a drop of water on the sheet. It is curved on top and flat underneath.



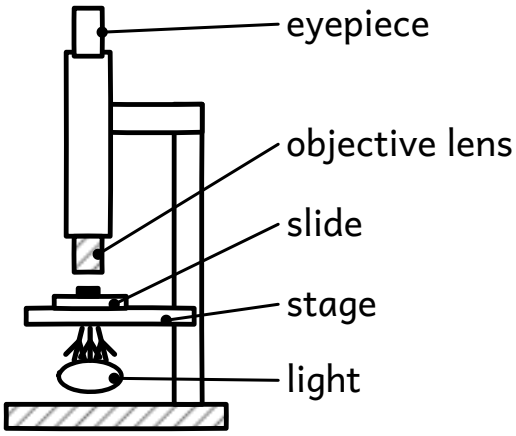
3 Draw an eye above the drop. Draw the line of light from the print, through the drop, to the eye.

A drop of water is thicker in the middle than at its edge. So it works as a small lens. Look at print through the drop and it looks bigger.

Be safe. Never look at the Sun through a lens or a drop of water. Never point one at the Sun. It can harm your eyes and set things alight. Keep your drop away from sunlight. Never turn a microscope mirror to catch the Sun.

A drop makes things look about two or three times bigger. To see a cell you need much more. For that we use a **microscope**.

A microscope has two lenses. The lens near your eye is the eyepiece. The lens near the thing you look at is the objective lens. Each one makes the thing look bigger.



A microscope. Light goes up through the slide and into the lenses.

You put the thing you want to see on a **slide**. A slide is a thin piece of glass or plastic. The light shines up through it. Only a very thin slice lets the light through.

The lenses multiply. Say the eyepiece makes things look 10 times bigger, and the objective lens 40 times bigger. Together they give 10 × 40 = 400 times. This is the **magnification**.

SEE IT THREE WAYS

With things

Ana has a microscope. The eyepiece is marked 10× and the objective lens is marked 40×.

As a picture

lens	magnifies
eyepiece	10 times
objective lens	40 times
together	400 times

In words

Each lens makes the thing look bigger. The two numbers are multiplied to give the total magnification.

In symbols

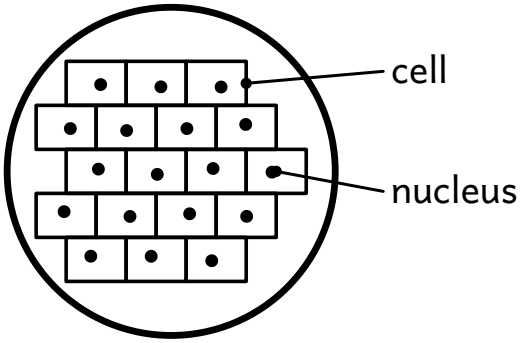
10 × 40 = 400

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thing	width
pinhead	1 mm
plant cell	0.05 mm
red blood cell	0.008 mm
bacterium	0.002 mm

About how wide some small things are. Cells differ, so these are rough sizes.

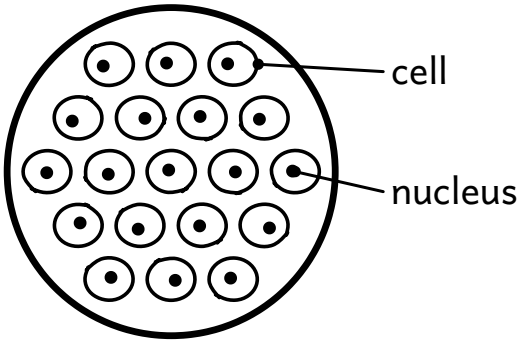
Look through a microscope at a thin skin from an onion, and you see rows of cells. Each one has a straight edge and a dark spot inside. The spot is the nucleus.



drawn, not to scale

Plant cells, as a microscope shows them. The picture is not to scale.

A thin scrape from the inside of a cheek shows animal cells. They have no hard straight edge. They are soft and rounded, and each has a nucleus.



drawn, not to scale

Animal cells, as a microscope shows them. The picture is not to scale.

TRY IT

Make a water drop magnifier

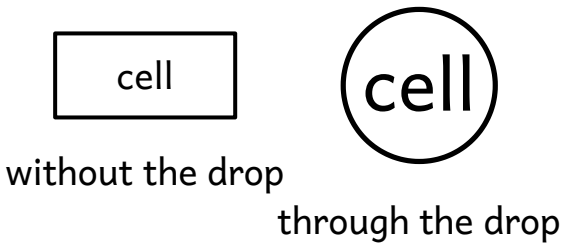
You need: a piece of clear plastic, such as from a clean bag or bottle, water, a stick or a straw, a page with small print, a leaf or a feather.

Be safe: Never look at the Sun through the drop. Work indoors or in the shade. Ask a grown up to cut the plastic with scissors.

1. Lay the clear plastic flat on top of a line of small print.
2. Dip the stick in water. Let one drop fall on the plastic over the print.
3. Look straight down at the drop. Then move your head a little nearer and a little farther. Find where the print looks clearest.
4. Try a leaf, or a feather, under the plastic in the same way.

What you will see: Through the drop, the print looks bigger. The drop works best when it is small and round. A flat puddle does not magnify.

If you cannot try it, this is what happens.



without the drop

through the drop

A WRONG IDEA MANY PEOPLE HAVE

~~**To see a tiny thing better, hold it closer to your eye.**~~

Why it feels right: A near thing looks bigger, so closer seems better.

The test that breaks it: Hold this page right up to your nose. The words are blurred. Your eye cannot focus on a thing that is too close. Hold a drop lens between, and the words are clear and bigger.

What is true: Your eye cannot focus on a very near thing. A lens makes a small thing look bigger and keeps it clear.

KEY WORDS

cell
a tiny part that living things are made of.

lens
a curved piece of clear material that bends light.

microscope
a tool with two lenses that shows very small things.

slide
a thin piece of glass or plastic that holds the thing you look at.

magnification
how many times bigger a thing looks.

BACK TO YOUR GUESS

The answer is B: A curved piece of clear material, such as a drop of water, can make small things look bigger.

A curved lens bends light and makes things look bigger. Holding a thing too close to your eye only makes it blurred.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Why does a drop of water on clear plastic make print look bigger?

   A The drop is curved and bends the light, so it works as a lens.

   B The water makes the letters swell.

   C The drop is closer to your eye, so everything looks bigger.

Answer at the back of the book.

2. A microscope has an eyepiece of 10 times and an objective lens of 40 times. How many times does it magnify in all?

   A 50 times

   B 400 times

   C 4 times

   Answer at the back of the book.

3. Where does the light in a microscope come from?

   A From the eyepiece, down onto the slide.

   B The objective lens makes its own light.

   C From below the stage. It shines up through the slide.

   Answer at the back of the book.

4. Why must a slide hold only a very thin slice?

   A Light has to pass through it to reach the lens.

   B A thick piece would not fit on the stage.

   C A thin slice makes the cells smaller.

   Answer at the back of the book.

5. A friend says, "A quick look at the Sun through a drop lens is safe." What is true?

   A It is safe if the drop is small.

   B It is safe if the sky is a little cloudy.

   C It is never safe. A lens can harm your eyes, even in a moment.

   Answer at the back of the book.

6. **From an earlier chapter**

   A bean seed lies dry and still in a jar. Is it alive?

   A No, because it does not grow.

   B Yes. It is alive and resting.

   C No. It only becomes alive when it is planted.

   Answer at the back of the book.

7. A plant cell is 0.05 mm wide. A microscope magnifies 400 times. How wide does the cell look, in millimetres?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A drop of water on clear plastic is a lens. It makes print look bigger. A microscope has two lenses, and their magnifications multiply. Never look at the Sun through a lens.

Draw: Draw a drop of water on plastic over print. Add an eye above and a line of light to it.

S3.1.3 CHAPTER 3

Animal and plant cells

What is inside a cell, and is a plant cell the same as an animal cell?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** A cell has parts inside, and a plant cell has some parts that an animal cell does not.
- ☐ **B** A cell is a flat bag with nothing inside it.
- ☐ **C** Plant cells and animal cells are exactly the same.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, How plants grow, S2.1.1. It shows the leaf and the root, where plant cells differ.

BY THE END YOU CAN

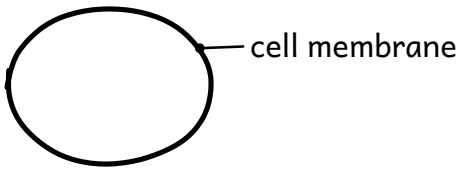
- Draw and label the nucleus, cytoplasm, membrane, cell wall and chloroplast
- Compare plant and animal cells in a table

In the last chapter you saw cells as boxes and ovals, each with a dark spot. Now look inside one. A cell has parts, like a house has rooms.

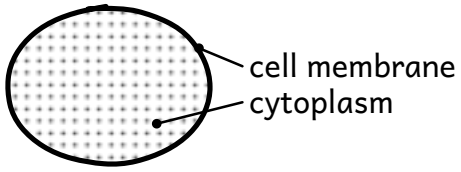
We start with an animal cell. People, dogs and birds are made of animal cells. We draw one in three steps.

DRAW IT FIRST

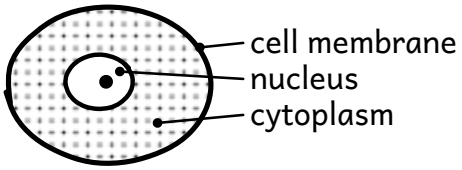
Draw an animal cell



1 Draw a soft oval. This outline is the **cell membrane**. It is a thin skin around the cell.



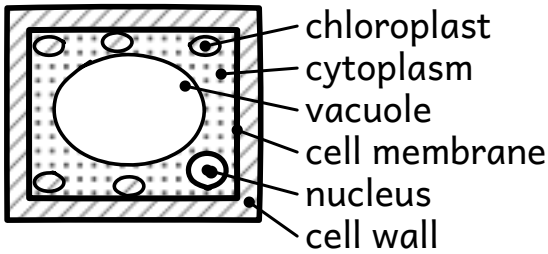
2 Fill the inside with dots. The dots are the **cytoplasm**. It is a watery jelly where the cell does its work.



3 Draw a round **nucleus** inside, with a dark spot. The nucleus is the part that controls the cell.

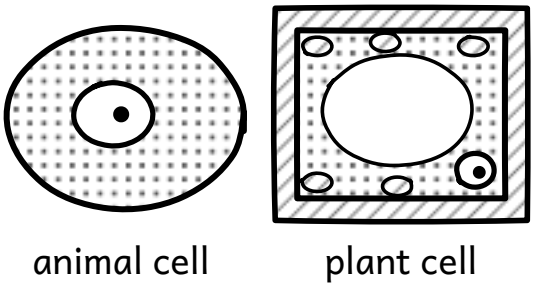
Almost every plant and animal cell has a membrane, cytoplasm and a nucleus. A plant cell has more.

A plant cell has a stiff **cell wall** outside the membrane. It has small green parts inside, and each one is a **chloroplast**. It has a large **vacuole**, which is a bag of watery liquid.



A plant cell. The wall is the hatched band, drawn outside the membrane.

Look at the order from the outside. First comes the cell wall. Next comes the membrane. Then the cytoplasm fills the inside, with the vacuole, the nucleus and the chloroplasts in it.



The two kinds of cell, side by side.

SEE IT THREE WAYS

With things

Imagine an animal cell. Now add a stiff box round it, add a large bag of water, and add little green parts. You have a plant cell.

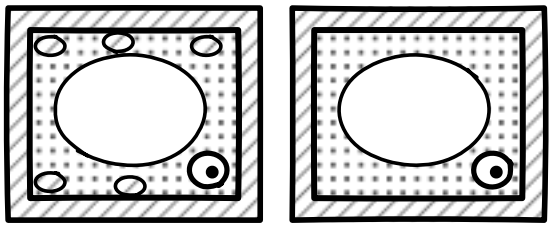
As a picture

part	animal	plant
nucleus	yes	yes
cytoplasm	yes	yes
membrane	yes	yes
cell wall	no	yes
chloroplast	no	some
vacuole	small	large

In words

Both kinds of cell have a nucleus, cytoplasm and a membrane. Of these two kinds, only the plant cell has a cell wall and chloroplasts. An animal cell never has them. A plant cell has a much larger vacuole.

The table says "some" for chloroplasts. Not every plant cell has them. Look at a leaf cell and a root cell.



leaf cell root cell

A leaf cell has chloroplasts. A root cell does not.

TRY IT

Build a model cell

You need: a small cardboard box, a clear plastic bag, water, a dry bean or a pebble.

Be safe: Plastic bags can stop a small child from breathing. Keep them away from young children and from your face. Do not eat the bean.

1. Put the bean in the plastic bag. Add a little water, enough to cover it. Tie the bag shut.
2. Hold the bag in your hands. It is floppy, like an animal cell.
3. Now put the bag in the box and shut the lid. The bag keeps its shape, like a plant cell.
4. Match each part of the model with a part of a cell.

What you will see: The bag alone is floppy. The bag in the box keeps its shape. The stiff box does the job of a cell wall.

If you cannot try it, this is what happens.

model	cell part
box	cell wall
bag	cell membrane
water	cytoplasm
bean	nucleus

A WRONG IDEA MANY PEOPLE HAVE

~~Every plant cell has chloroplasts.~~

Why it feels right: Plants are green, so it seems that all their cells are green.

The test that breaks it: Look at a root pulled from the soil. It is pale, not green. Root cells have no chloroplasts, and the root is still part of a plant.

What is true: Only cells in green parts of a plant, such as leaves, have chloroplasts.

KEY WORDS

cell membrane
the thin skin around a cell.

cytoplasm
the watery jelly inside a cell, where it does its work.

nucleus
the round part that controls the cell.

cell wall
a stiff layer outside the membrane of a plant cell.

chloroplast
a small part in green plant cells.

vacuole
a bag of watery liquid in a cell.

BACK TO YOUR GUESS

The answer is A: A cell has parts inside, and a plant cell has some parts that an animal cell does not.

A cell has parts, each with a job. A plant cell has three extra things: a cell wall, a large vacuole and, in green parts, chloroplasts.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which part is in a plant cell but not in an animal cell?

   A The cell wall

   B The nucleus

   C The cytoplasm

   Answer at the back of the book.

2. What is the thin skin round every cell called?

   A The cell wall

   B The cell membrane

   C The nucleus

   Answer at the back of the book.

3. Which list goes from the outside of a plant cell inward?

   A Cell wall, cell membrane, cytoplasm

   B Cell membrane, cell wall, cytoplasm

   C Cytoplasm, cell membrane, cell wall

   Answer at the back of the book.

4. Which plant cell has no chloroplasts?

   A A cell from a root

   B A cell from a leaf

   C No plant cell. Every plant cell has chloroplasts.

   Answer at the back of the book.

5. In the model cell, the bean stands for which part?

   A The cytoplasm

   B The cell wall

   C The nucleus

   Answer at the back of the book.

6. **From an earlier chapter**

Which part of a microscope do you look through?

A The objective lens

B The eyepiece

C The stage

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Plant and animal cells have a membrane, cytoplasm and, nearly always, a nucleus. A plant cell also has a cell wall, a large vacuole and, in green parts, chloroplasts.

Draw: Draw an animal cell and a plant cell next to each other. Label every part.

S3.1.4 CHAPTER 4

What each part does

What job does each part of a cell do?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The cell wall decides what goes in and out of the cell.
- ☐ **B** The nucleus controls the cell, and the membrane decides what goes in and out.
- ☐ **C** The cytoplasm is just empty space.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, How plants grow, S2.1.5. It shows that green leaves use light to make food.

BY THE END YOU CAN

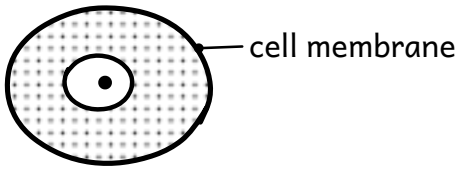
- Explain the job of the nucleus, membrane and cell wall
- Explain why only green plant cells have chloroplasts

A cell is like a tiny workshop. Each part has a job. When every part does its job, the cell stays alive.

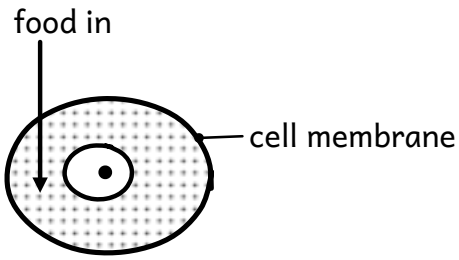
Start at the edge. The **cell membrane** is a thin skin. It is like a door with a guard. It lets in food and water and lets out waste. It keeps out things the cell does not need.

DRAW IT FIRST

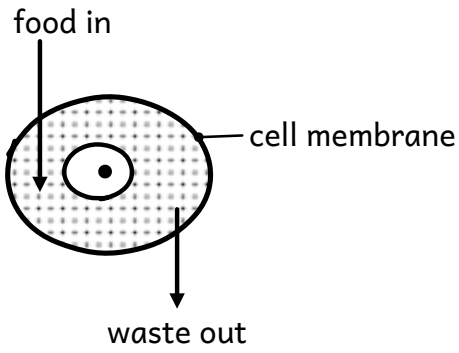
Draw what the cell membrane does



1 Draw a cell and point to its membrane. It is the skin round the cell.

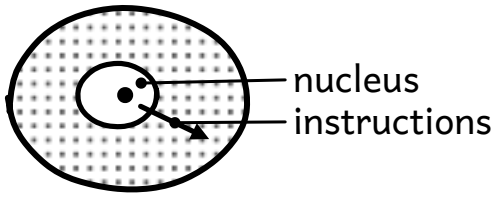


2 Draw an arrow going in through the membrane. Write food in.



3 Draw an arrow going out through the membrane. Write waste out.

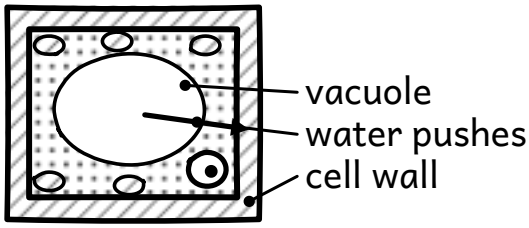
Next, the **nucleus**. It holds the cell's instructions. These tell the cell how to grow and what to make. The nucleus is the control centre.



The nucleus sends instructions to the rest of the cell.

The cytoplasm is the jelly that fills the cell. Most of the cell's work happens in it.

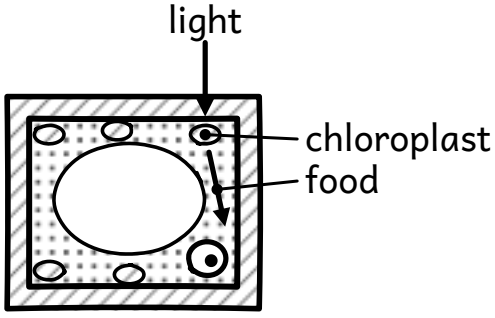
Now the plant cell. Its **cell wall** is stiff. It gives the cell a firm shape. Water and food pass through the wall easily. The thin membrane inside it decides what enters the cell.



Water in the vacuole pushes on the wall. The wall holds firm.

A plant cell full of water pushes hard against its wall, like a ball full of air. The wall holds firm and so the plant stands up. A plant with too little water goes limp.

Last, the **chloroplast**. It catches light. It uses the light, with water and carbon dioxide gas, to make food for the plant. This is called **photosynthesis**.



A chloroplast uses light to make food.

A chloroplast can only work in the light. A leaf is in the light, so its cells have many. A root is under the soil, in the dark, so its cells have none.

SEE IT THREE WAYS

With things

Look at a whole plant. The leaves are green and they are in the light. The roots are pale and they are in the dark.

As a picture

part	chloroplast	light
leaf	yes	yes
root	no	no

In words

Chloroplasts need light to make food. So only cells in the light, in the green parts of a plant, have them.

TRY IT

Wake a limp stalk

You need: 2 limp stalks or leaves of a green vegetable, a cup, water, a clock.

Be safe: Wash your hands when you finish. Do not eat the stalks.

1. Choose two stalks that are limp. Bend one gently and feel how floppy it is.
2. Stand one stalk in a cup of water. Leave the other in the open air, in the same room.
3. After two hours, bend each one gently. Which feels firmer?

What you will see: The stalk that stood in water is firmer. Its cells filled with water again and pushed on their walls.

If you cannot try it, this is what happens.

stalk	feels
in dry air	limp
in water	firm

A WRONG IDEA MANY PEOPLE HAVE

~~The cell wall decides what goes in and out of a plant cell.~~

Why it feels right: A wall sounds like a gate, and it is at the edge of the cell.

The test that breaks it: Water flows through the cell wall easily. The wall is made of fibres with small gaps in them. It is the thin membrane just inside that decides what enters.

What is true: The membrane decides what goes in and out. The cell wall holds the shape and lets water through.

KEY WORDS

nucleus
the part that controls the cell and holds its instructions.

cell membrane
the thin skin that decides what goes in and out of a cell.

cell wall
the stiff layer that gives a plant cell its shape.

chloroplast
the part that uses light to make food. It is found in the green parts of plants.

photosynthesis
making food from light, water and carbon dioxide.

BACK TO YOUR GUESS

The answer is B: The nucleus controls the cell, and the membrane decides what goes in and out.

The nucleus is the control centre. The thin membrane lets in what the cell needs and keeps out what it does not. The cytoplasm is full of jelly where the work is done.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What does the nucleus do?

   A It controls the cell and holds its instructions.

   B It makes food from light.

   C It gives the cell its shape.

   Answer at the back of the book.

2. Which part decides what goes in and out of a cell?

   A The cell wall

   B The cytoplasm

   C The cell membrane

   Answer at the back of the book.

3. What is the main job of the cell wall?

   A To control the cell.

   B To make food from light.

   C To give a plant cell a firm shape.

   Answer at the back of the book.

4. Why do root cells have no chloroplasts?

   A Roots are in the dark soil, and chloroplasts need light.

   B Roots do not need food.

   C Root cells are too small to hold chloroplasts.

   Answer at the back of the book.

5. A limp plant stands up again after watering. What helps it stand?

   A The nucleus grows bigger.

   B The chloroplasts fill with water.

   C The cells fill with water and push on their walls.

   Answer at the back of the book.

6. **From an earlier chapter**

A microscope has an eyepiece of 10 times and an objective lens of 20 times. How many times does it magnify?

A 30 times

B 200 times

C 2 times

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

The nucleus controls the cell. The membrane decides what goes in and out. The cell wall gives a plant cell its shape. Chloroplasts use light to make food, so only green parts have them.

Draw: Draw a plant cell. Label the nucleus, membrane, wall and chloroplast, and write each part's job.

S3.1.5 CHAPTER 5

Cells with special jobs

Why are some cells long and thin, and others round and flat?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Each kind of cell has a shape that helps it do its job.
- ☐ **B** All the cells in a body look the same.
- ☐ **C** The shape of a cell is just chance. It has nothing to do with its job.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, How plants grow, S2.1.1. It shows that roots take in water from the soil.

BY THE END YOU CAN

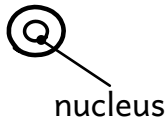
- Explain how nerve, red blood and root hair cells suit their jobs
- Match a special cell to the job it does

Your body has many kinds of cell. A **specialised cell** has a shape that suits one job. Look at three of them.

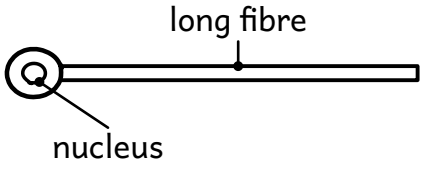
First, a **nerve cell**. Its job is to carry messages from one part of the body to another. A nerve cell draws in three steps.

DRAW IT FIRST

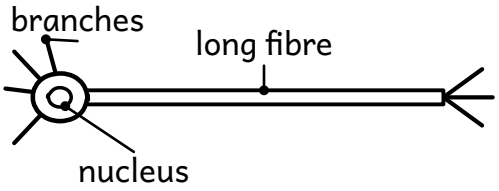
Draw a nerve cell



1 Draw a small round cell body with a nucleus inside it.



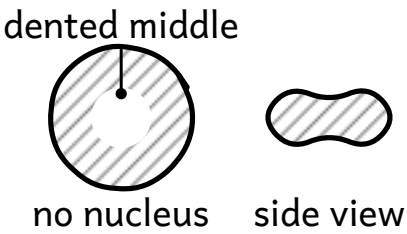
2 Draw a very long, thin fibre going out from it. This is the part that carries the message.



3 Draw short branches at both ends. They pass the message to the next cell.

A nerve cell can be about a metre long. Some run from your foot up to your back. Its long fibre carries a message a long way. The fastest messages travel about 100 metres every second.

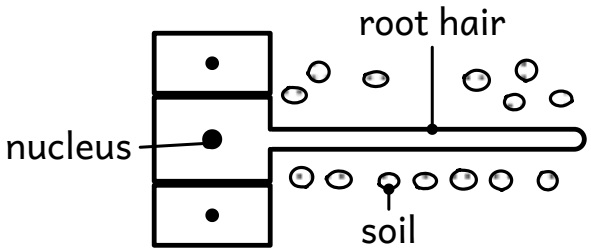
Next, the **red blood cell**. It carries oxygen round the body in your blood. Its shape is a flat disc with a dent on each side.



A red blood cell. It has a dented middle and no nucleus.

The flat, dented shape gives a large surface, so oxygen can get in and out quickly. The cell is also small and bendy, so it can squeeze through the thinnest blood tubes. In people and other mammals, a red blood cell has no nucleus. That leaves more room to carry oxygen.

Last, the **root hair cell**. It grows in the skin of a root, and it takes in water from the soil. It has a long thin hair that reaches between the grains of soil.



A root hair cell. The hair is many times longer than the cell is wide.

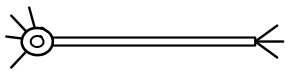
The hair gives the cell a much larger **surface area**. Surface area means how much outside a thing has. More surface means more water can pass in, so the plant gets water faster. A root cell is in the dark soil, so it has no chloroplasts.

SEE IT THREE WAYS

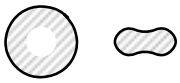
With things

Think of a telephone wire. It is long and thin so that it can carry a message far. A nerve cell is made for the same reason.

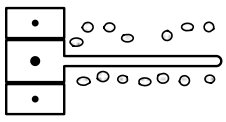
As a picture



nerve cell



red blood cell



root hair cell

In words

The shape of each cell suits its job. A long thin cell carries messages. A dented disc carries oxygen. A cell with a long hair takes in water. The three are not drawn to scale. A nerve cell can be far longer than the others.

---

cell	job
nerve	carries messages
red blood	carries oxygen
root hair	takes in water

Each cell has one job.

TRY IT

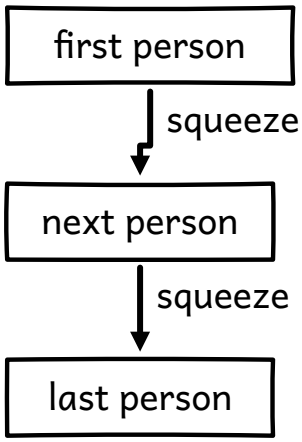
Pass a message down a line

You need: 4 or more people, a clock or a way to count seconds.

1. Stand in a line and hold hands. Everyone but the first person closes their eyes.
2. The first person squeezes the hand of the next. Each person passes the squeeze on as soon as they feel it.
3. The last person says "yes" aloud. Count how many seconds it takes.
4. Try again with a longer line. Does it take longer?

What you will see: The squeeze runs down the line, one person after another. A message runs along nerve cells in a similar way, but much faster.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~Every cell has a nucleus.~~

Why it feels right: Pictures of cells almost always show a nucleus.

The test that breaks it: Look at the red blood cell in the picture. It has a dented middle and no nucleus. Red blood cells in people lose their nucleus as they grow.

What is true: Most cells have a nucleus, but a red blood cell in a mammal has none.

KEY WORDS

specialised cell
a cell with a shape that suits one job.

nerve cell
a long thin cell that carries messages.

red blood cell
a dented disc that carries oxygen round the body.

root hair cell
a root cell with a long hair that takes in water.

surface area
how much outside a thing has.

BACK TO YOUR GUESS

The answer is A: Each kind of cell has a shape that helps it do its job.

Many cells are built for one job. A long thin cell carries messages. A flat dented disc carries oxygen. A cell with a hair takes in water.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Why is a nerve cell long and thin, with branches?

    A It stores food for the body.

    B It carries messages a long way and passes them on.

    C It carries oxygen round the body.

    Answer at the back of the book.

2. Which feature helps a red blood cell carry oxygen?

    A Its long thin fibre.

    B Its flat, dented shape gives a large surface.

    C Its long hair.

    Answer at the back of the book.

3. What does the long hair of a root hair cell do?

    A It gives a large surface to take in water from the soil.

    B It carries messages to the leaves.

    C It makes food from light.

    Answer at the back of the book.

4. A cell carries oxygen round the body. Which cell is it?

    A A nerve cell

    B A root hair cell

    C A red blood cell

    Answer at the back of the book.

5. Which cell takes in water from the soil for a plant?

    A A root hair cell

    B A nerve cell

    C A red blood cell

    Answer at the back of the book.

6. **From an earlier chapter**

   Which cell part uses light to make food?

   A The nucleus

   B The vacuole

   C The chloroplast

   Answer at the back of the book.

7. A red blood cell is 0.008 mm wide. How many fit side by side along a line 1 mm long?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A nerve cell is long and branched, to carry messages. A red blood cell is a dented disc, to carry oxygen. A root hair cell has a long hair, to take in water.

Draw: Draw a nerve cell, a red blood cell and a root hair cell. Write each cell's job beside it.

S3.1.6 CHAPTER 6

Cells, tissues and organs

How do tiny cells make a whole body, or a whole tree?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Cells join in groups, and the groups join to make the parts of the body.
- ☐ **B** A big living thing is one very large cell.
- ☐ **C** The cells in a body all work alone and never work together.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Bones, muscles, teeth and food, S2.3.3. It shows muscles, which are made of cells.
- Level 2, How plants grow, S2.1.1. It names the leaf, stem and root.

BY THE END YOU CAN

- Put cell, tissue, organ, organ system and organism in order of size
- Give an example of each level in a plant and an animal

A dog is not one huge cell. It is made of an enormous number of tiny cells. They join together in steps, from small to large.

A **tissue** is a group of the same kind of cell, doing one job. Muscle cells together make muscle tissue.

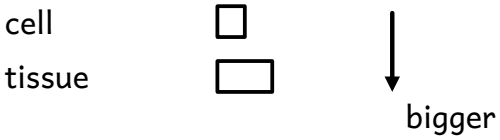
An **organ** is made of different tissues that work together. The heart is an organ. It has muscle tissue to squeeze, and other tissues too.

An **organ system** is a group of organs that do one big job together. The heart and the blood tubes form the blood system.

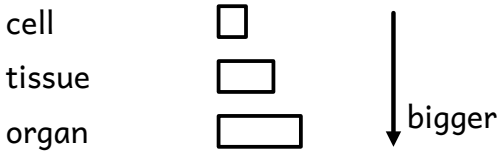
An **organism** is a whole living thing, such as a dog or a tree. Draw the steps from cell to organism.

DRAW IT FIRST

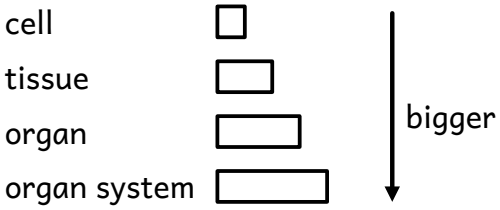
Draw the steps up from a cell



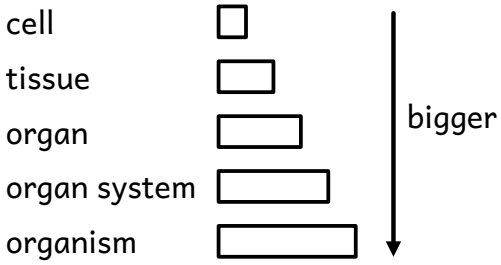
1 Write cell, then tissue. Draw a bar for each, with the tissue bar longer.



2 Add organ. Its bar is longer still.

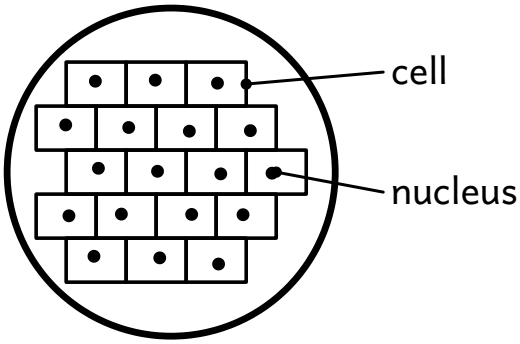


3 Add organ system, with a longer bar again.



4 Add organism, the longest bar. Draw an arrow marked bigger beside them.

Here is a tissue. Every cell is the same kind and they fit together. Together they do one job.



many cells make *a* tissue

A tissue is many cells of one kind.

Plants have the same levels. A leaf cell is *a* cell. The skin of *a* leaf is *a* tissue. The whole leaf is an organ. The stem and leaves together form the shoot system, which is an organ system. The roots form the root system. The whole tree is the organism.

level	**plant**
cell	leaf cell
tissue	leaf skin
organ	leaf
organ system	shoot system
organism	*a* tree

The five levels in *a* plant.

An animal has them too. A muscle cell is *a* cell. Heart muscle is *a* tissue. The heart is an organ. The heart and blood tubes are the blood system. The whole dog is the organism.

level	animal
cell	muscle cell
tissue	heart muscle
organ	heart
organ system	blood system
organism	a dog

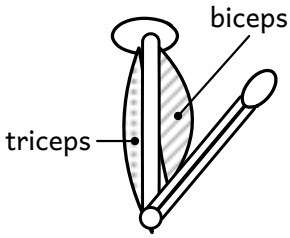
The five levels in an animal.

SEE IT THREE WAYS

With things

Tighten the muscle at the front of your upper arm and feel it go hard. That muscle is an organ.

As a picture



In words

A muscle is an organ. It is made of muscle tissue, which is made of muscle cells. It also has tissue that carries blood and tissue that carries messages.

Your skin is an organ too. It is the biggest organ you have. Here are some organs and what they do.

organ	job
heart	pumps blood
lungs	take in oxygen
stomach	digests food
brain	controls the body

Four organs and their jobs.

TRY IT

Find an organ on yourself

You need: your own body, a quiet place.

1. Sit still for a minute. Put two fingers on the inside of your other wrist, below the thumb. Feel your pulse. It comes from your heart.
2. Put a hand on your chest. Breathe in slowly. Feel your chest rise. Your lungs are filling with air.
3. Run a fingertip along your arm. Your skin is an organ too.

What you will see: Each thing you felt came from an organ. Each organ is made of tissues, and each tissue is made of cells.

If you cannot try it, this is what happens.

you feel	part	level
pulse	heart	organ
skin touch	skin	organ
chest rises	lungs	organs

A WRONG IDEA MANY PEOPLE HAVE

~~An organ is just a very big cell.~~

Why it feels right: An organ is a bigger thing than a cell, and the word sounds like one object.

The test that breaks it: Look at the heart in the table of levels. It is made of many tissues. Each tissue is made of millions of cells. One cell cannot be a heart.

What is true: An organ is made of tissues, and tissues are made of cells.

KEY WORDS

tissue

a group of the same kind of cell, doing one job.

organ
different tissues that work together, such as the heart.

organ system
a group of organs that do one big job together.

organism
a whole living thing.

BACK TO YOUR GUESS

The answer is A: Cells join in groups, and the groups join to make the parts of the body.

Cells join into tissues. Tissues join into organs. Organs work together in systems. Together the systems make the whole living thing.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which list goes from the smallest to the largest?

   A Cell, organ, tissue, organ system, organism

   B Organism, organ system, organ, tissue, cell

   C Cell, tissue, organ, organ system, organism

   Answer at the back of the book.

2. What is a tissue?

   A One very large cell.

   B A group of different organs.

   C A group of the same kind of cell, doing one job.

   Answer at the back of the book.

3. Which is an example of an organ system in an animal?

   A The heart on its own

   B The heart and blood tubes together

   C A muscle cell

   Answer at the back of the book.

4. Which is an example of a tissue in an animal?

   A The heart

   B A dog

   C Heart muscle

   Answer at the back of the book.

5. In a tree, which is an organ?

   A A leaf

   B The skin of a leaf

   C The whole tree

   Answer at the back of the book.

6. **From an earlier chapter**

   Which special cell carries messages?

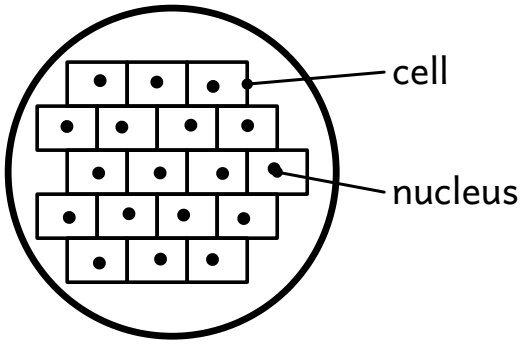
   A A red blood cell

   B A nerve cell

   C A root hair cell

   Answer at the back of the book.

7. How many cells are drawn in the picture of the tissue?



Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Cells make tissues. Tissues make organs. Organs form organ systems. Systems together make an organism. The order is cell, tissue, organ, organ system, organism.

Draw: Draw five bars, each longer than the last. Write the five levels beside them, smallest first.

S3.1.7 CHAPTER 7

Diffusion

Why can you smell cooking from across a room?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The smell can only travel if a wind blows it.
- ☐ **B** Smell particles spread out by themselves, from where they are crowded.
- ☐ **C** Your nose pulls the smell towards it.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Particles, S3.5.2. It shows that everything is made of moving particles.
- Level 3, Particles, S3.5.1. It pictures particles in a solid, a liquid and a gas.

BY THE END YOU CAN

- Explain diffusion as spreading from a crowded place to a less crowded one
- Show diffusion with a drop of ink or tea in still water

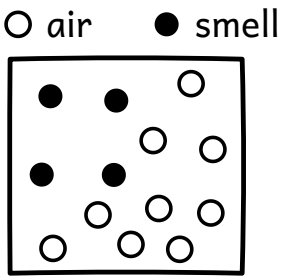
Someone cooks in one corner of a room. After a little while, you can smell the food at the other side. Nobody carried the smell across. How did it get there?

Everything is made of tiny **particles**. In a gas the particles are far apart, and they are always moving. A smell is made of particles too.

Moving air carries a smell much of the way. But even in still air, the smell particles spread on their own. That spreading is what this chapter is about.

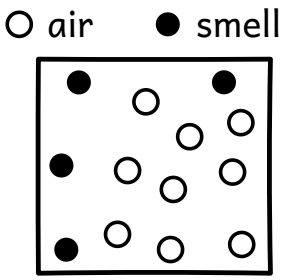
DRAW IT FIRST

Draw a smell spreading



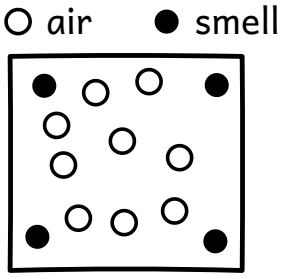
start

1 Draw a box of air. Put the smell, dark dots, close together in one corner.



a little later

2 Draw the same box a little later. The dark dots have moved out into the empty places.



much later

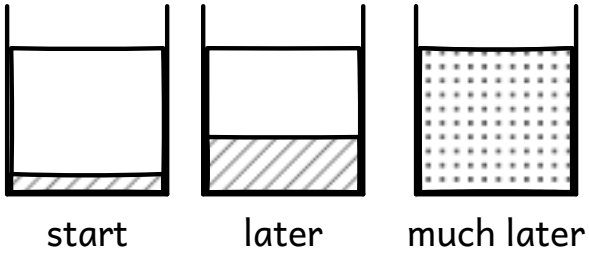
3 Draw it much later. The dark dots are spread through the whole box.

The smell particles bump about, and they move in every direction. Near the pot there are many of them, so many bump into their neighbours and move away. Few come back. So the smell spreads out into the less crowded air.

This spreading is called **diffusion**. Particles spread from a place where they are crowded to a place where they are less crowded. They do it by their own movement, with no stirring.

In the end the particles are spread evenly. They do not stop moving. Just as many go one way as the other, so you see no more change.

Diffusion happens in liquids too, but it is much slower. Do not drop colour in from the top. Colour is heavier than water, so it sinks in streaks. That is not diffusion. Lay a little colour at the bottom of still water instead, and watch it.



Colour spreads up through still water, from where it is crowded.

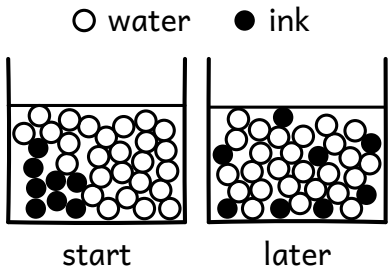
In still water, diffusion is slow. The edge of the colour may creep up only a centimetre or two in a day. A small shake or a warm spot makes currents that mix it faster. So keep the cup still to see diffusion alone.

SEE IT THREE WAYS

With things

Lay a little colour at the bottom of a jar of still water. Look after an hour and after a day. The colour has spread a little further up each time.

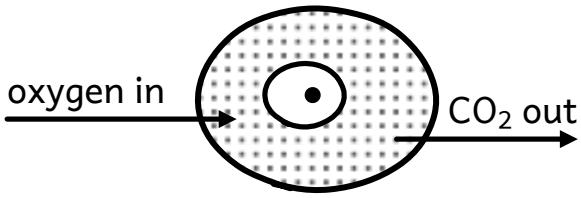
As a picture



In words

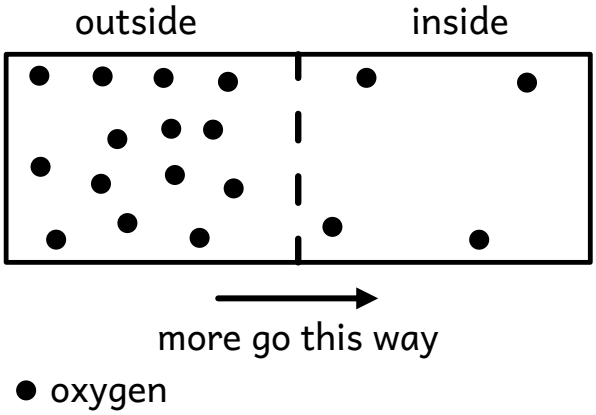
Ink particles move among the water particles. They spread from where there are many ink particles to where there are few. This goes on until they are mixed evenly.

Your cells use diffusion. A cell uses up oxygen, so there is less oxygen inside than outside. Oxygen spreads in through the membrane. The cell makes carbon dioxide, so there is more inside than outside. It spreads out.



A cell takes in oxygen and lets out carbon dioxide by diffusion.

Here is the membrane, with oxygen on both sides. The arrow shows the way that more of the oxygen goes.



More oxygen is outside the cell, so more goes in than comes out.

TRY IT

Colour at the bottom of still water

You need: a clear glass or jar, water, ink or food colour, a thin straw or a hollow grass stem, a ruler, a place where the glass will not be knocked.

Be safe: Ink and food colour stain. Cover the table. Keep them away from your eyes and mouth. Do not drink the water. Wash your hands after.

1. Fill the glass with water. Leave it for ten minutes on a table, so the water is still.
2. Dip the straw a little way into the colour. Put a finger over the top end of the straw, to trap the colour inside.
3. Lower the straw slowly to the bottom of the glass. Lift your finger so the colour runs out. Lift the straw out gently. Do not stir.
4. Look at once. Measure with the ruler how high the colour reaches, in centimetres. Look again after an hour, and the next day.

What you will see: The colour stays low, because it is heavier than water. Its top edge slowly turns blurred and creeps upward. This is diffusion, and it is slow. It takes a day to move a centimetre or two.

If you cannot try it, this is what happens.

when	you see
at once	dark at bottom
1 hour	edge blurred
next day	creeps higher

A WRONG IDEA MANY PEOPLE HAVE

~~When the ink is spread evenly, the particles have stopped moving.~~

Why it feels right: Nothing seems to change any more, so it seems that nothing moves.

The test that breaks it: Particles never stop moving. In an even mixture, just as many ink particles move one way as the other. Lay a little more colour at the bottom and you see it spread again.

What is true: The particles keep moving. The mixture only looks still because there is no more net change.

KEY WORDS

particle
one of the tiny pieces that everything is made of.

diffusion
the spreading of particles from where they are crowded to where they are less crowded.

BACK TO YOUR GUESS

The answer is B: Smell particles spread out by themselves, from where they are crowded.

Smell particles move all the time. They spread from the crowded place near the pot into the emptier air, until they reach you. This spreading is called diffusion.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. In diffusion, which way do particles spread?

    A From a less crowded place to a crowded place.

    B Only downwards, because they are heavy.

    C From a crowded place to a less crowded place.

    Answer at the back of the book.

2. Why can you smell cooking from across a room?

    A The smell particles spread out by diffusion.

    B Your nose pulls the smell towards it.

    C The smell cannot travel unless a wind blows it.

    Answer at the back of the book.

3. A little colour is laid at the bottom of still water. You leave it for a day. What happens?

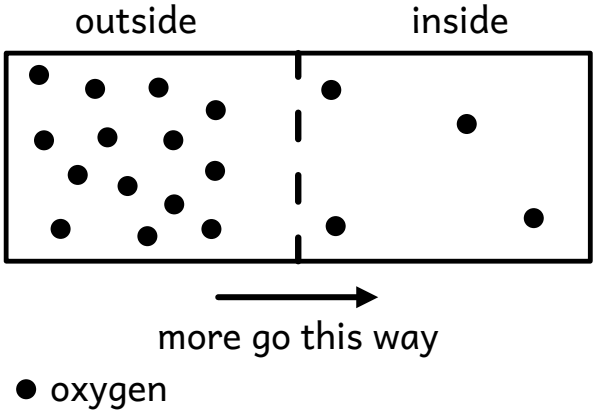
    A The colour slowly spreads up through the water on its own.

    B The colour stays in one patch for ever.

    C The colour spreads through all the water within a few seconds.

    Answer at the back of the book.

4. Look at the picture of the membrane. Which way do most of the oxygen particles move?



A Out of the cell.

B Into the cell.

C They do not move.

Answer at the back of the book.

5. The colour has spread evenly through the water. What are the colour particles doing?

A They have stopped moving.

B They are all moving the same way.

C They are still moving about in every direction.

Answer at the back of the book.

6. **From an earlier chapter**

Which part of a cell decides what goes in and out?

A The cell wall

B The nucleus

C The cell membrane

Answer at the back of the book.

7. In the picture, 14 oxygen dots are outside the cell and 4 are inside. How many more are outside than inside?

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Diffusion is the spreading of particles from where they are crowded to where they are less crowded. It needs no stirring. In still water it is slow. Cells take in oxygen by diffusion.

Draw: Draw a box with dark dots crowded in one corner. Draw it again later with the dots spread out.

S3.1.8 CHAPTER 8

Living things with one cell

Can a whole living thing be just one cell?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Yes. Yeast and bacteria are living things made of a single cell.
- ☐ **B** No. Every living thing is made of many cells.
- ☐ **C** A single cell cannot be alive. It is only a part of something.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Bones, muscles, teeth and food, S2.3.8. It shows how germs get into food and how to stop them.

BY THE END YOU CAN

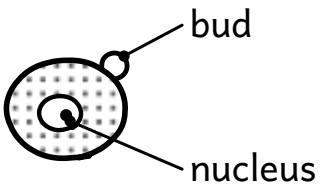
- Name living things made of one cell, such as yeast and bacteria
- Explain how some microbes cause disease and others are useful
- Make bread dough rise with yeast and explain why it rises

A person is made of many cells, and so is a tree. But some living things are just one cell. That one cell does the jobs of life by itself.

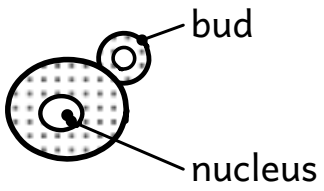
A **microbe** is a living thing too small to see without a microscope. Many microbes are made of one cell. **Yeast** is one of them. It is a fungus, like a mushroom, but it is only one cell. It has a nucleus, and it feeds on sugar.

DRAW IT FIRST

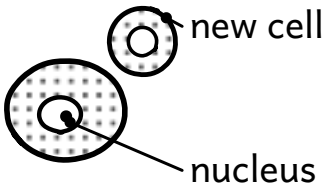
Draw a yeast cell making a new cell



1 Draw a yeast cell with a nucleus. Draw a small bud growing on its side.



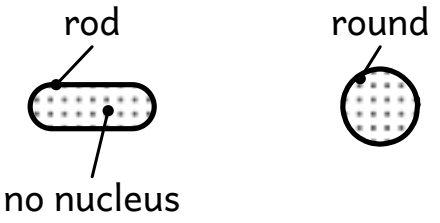
2 Draw the same cell later. The bud has grown bigger, and a copy of the nucleus is inside it.



3 Draw it later still. The bud has broken away. It is a new yeast cell, with its own nucleus.

This is how yeast reproduces. One cell becomes two. Each of them can grow a bud. So the number grows fast when yeast has sugar and warmth.

Bacteria are the other well known one cell microbes. One of them is a bacterium. A bacterium has no nucleus. Bacteria come in shapes such as rods and balls.



Bacteria. Each is one cell, with no nucleus.

Bacteria live almost everywhere: in soil, in water, in the air, on your skin and inside you. They are even smaller than yeast cells.

thing	width
pinhead	1 mm
yeast cell	0.005 mm
bacterium	0.002 mm

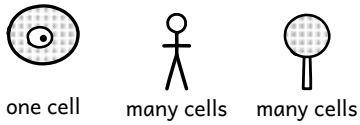
About how wide they are. Yeast and bacteria are far too small to see.

SEE IT THREE WAYS

With things

You are made of many cells, and so is a tree. A yeast cell is a whole living thing on its own.

As a picture



In words

A one cell living thing does every job in its single cell. A person has many cells that share the jobs, and some of the cells are special.

Microbes affect us in two ways. Some are useful. Yeast makes bread rise. Some bacteria turn milk into yoghurt. Bacteria and other microbes in a compost heap rot dead leaves so that they feed the soil.

A few microbes cause **disease**. Bacteria in dirty water cause cholera. Bacteria on teeth, with sugar, cause tooth decay. Bacteria in badly kept food cause food poisoning.

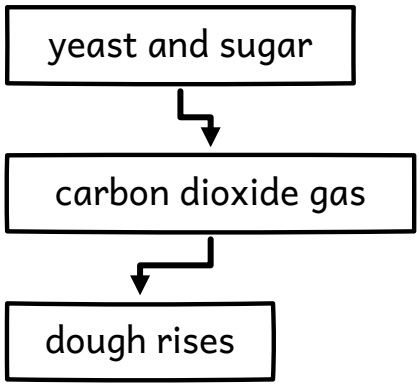
helps us	can harm us
bread rises	tooth decay
yoghurt	food poisoning
compost	cholera

Some microbes help us. A few can harm us.

You can keep disease microbes away. Wash your hands with soap and clean water before you eat and after the toilet. Drink clean water. Keep food covered and cooked well.

A **virus** is not a cell. It is far smaller than a bacterium. Colds and flu are caused by viruses. Do not mix up a virus with a bacterium.

Now see yeast at work. Yeast feeds on sugar. It releases energy from the sugar and makes carbon dioxide gas. In dough, the gas makes bubbles. The bubbles push the dough up.



Why dough rises.

TRY IT

Make dough rise

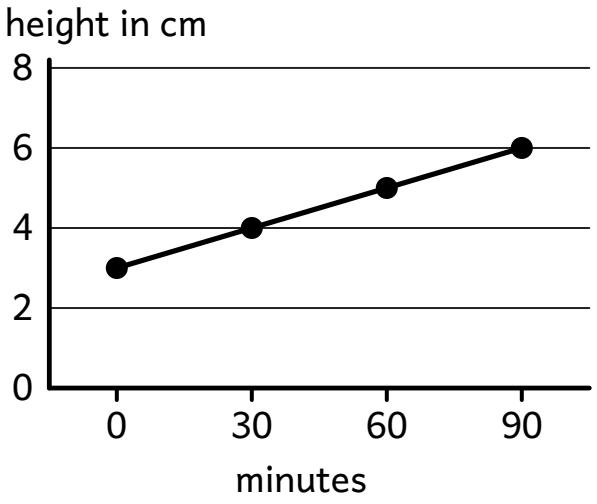
You need: 2 big spoons of flour, 1 small spoon of sugar, 1 small spoon of dried yeast, a little warm water, a narrow clear glass or jar, a rubber band, a ruler.

Be safe: Use water that is warm to the hand, never hot. Hot water can burn you and it kills yeast. Do not eat the raw dough. Wash your hands. If you bake, a grown up must use the oven. Yeast is safe to use. Never try to grow other microbes at home, such as from soil, food or a swab.

1. Mix the flour, the sugar and the yeast in a cup. Add warm water a little at a time, until you have a thick, sticky dough.
2. Put the dough in the clear glass. Press it flat. Slide the rubber band onto the glass at the top of the dough. Measure the height of the dough in centimetres.
3. Keep the glass in a warm place. Measure the height every half hour for an hour and a half.

What you will see: The dough grows taller, and you can see small bubbles of gas in it. The yeast made carbon dioxide, and it pushed the dough up. Your heights will differ from the graph, which shows example readings.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~All microbes are germs that make us ill.~~

Why it feels right: We hear about microbes mostly when we are sick.

The test that breaks it: Yeast makes bread rise and harms nobody. Bacteria turn milk into yoghurt. Both are microbes. Most microbes are harmless or helpful.

What is true: Most microbes do no harm, many are useful, and only a few cause disease.

KEY WORDS

microbe
a living thing too small to see without a microscope.

yeast
a one cell living thing that feeds on sugar and makes carbon dioxide gas.

bacteria
tiny one cell living things with no nucleus.

disease
an illness, often caused by a microbe.

virus
a tiny thing that causes illness. It is not a cell.

BACK TO YOUR GUESS

The answer is A: Yes. Yeast and bacteria are living things made of a single cell.

Some living things are one cell. That one cell does every job of life: it feeds, respires, grows and makes young.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which of these is a living thing made of one cell?

    A A mushroom

    B Yeast

    C A virus

    Answer at the back of the book.

2. What is different about a bacterium, compared with a yeast cell?

    A It has a nucleus like yeast.

    B It is much bigger than a yeast cell.

    C It has no nucleus.

    Answer at the back of the book.

3. Why does bread dough rise when it has yeast in it?

    A The yeast makes carbon dioxide gas, and the bubbles push the dough up.

    B The flour swells by itself when it is warm.

    C The yeast grows into one big lump.

    Answer at the back of the book.

4. Which sentence about microbes is true?

    A All microbes make us ill.

    B Some microbes cause disease and others are useful.

    C No microbe ever harms anyone. Only dirt does.

    Answer at the back of the book.

5. Which is a good way to keep disease microbes away?

    A Wash your hands with soap and clean water before you eat.

    B Drink water from any stream, if it looks clear.

    C Leave food uncovered in the warm sun to make it safe.

    Answer at the back of the book.

6. **From an earlier chapter**

   Which cell in your body has no nucleus?

   A A nerve cell

   B A cheek cell

   C A red blood cell

   Answer at the back of the book.

7. Dough in a glass was 3 cm high at the start and 6 cm high after 90 minutes. How many centimetres did it rise?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Yeast and bacteria are living things made of one cell. Yeast has a nucleus and bacteria have none. Some microbes help us and a few cause disease. A virus is not a cell. Yeast makes gas that makes dough rise.

Draw: Draw a yeast cell with a bud growing on it. Label the nucleus and the bud.

Key words, A to Z

Every key word in this book, what it means, and the chapter that teaches it.

bacteria
tiny one cell living things with no nucleus. S3.1.8

cell
a tiny part that living things are made of. S3.1.2

cell membrane
the thin skin around a cell. S3.1.3, S3.1.4

cell wall
a stiff layer outside the membrane of a plant cell. S3.1.3, S3.1.4

chloroplast
a small part in green plant cells. S3.1.3, S3.1.4

cytoplasm
the watery jelly inside a cell, where it does its work. S3.1.3

diffusion
the spreading of particles from where they are crowded to where they are less crowded. S3.1.7

disease
an illness, often caused by a microbe. S3.1.8

excretion
getting rid of waste that the body makes. S3.1.1

lens
a curved piece of clear material that bends light. S3.1.2

life process
a job that every living thing does, such as growing. S3.1.1

magnification
how many times bigger a thing looks. S3.1.2

microbe
a living thing too small to see without a microscope. S3.1.8

microscope
a tool with two lenses that shows very small things. S3.1.2

nerve cell

a long thin cell that carries messages. S3.1.5

nucleus
the round part that controls the cell. S3.1.3, S3.1.4

nutrition
taking in food, or making it, as plants do. S3.1.1

organ
different tissues that work together, such as the heart. S3.1.6

organ system
a group of organs that do one big job together. S3.1.6

organism
a whole living thing. S3.1.6

particle
one of the tiny pieces that everything is made of. S3.1.7

photosynthesis
making food from light, water and carbon dioxide. S3.1.4

red blood cell
a dented disc that carries oxygen round the body. S3.1.5

reproduction
making young of the same kind. S3.1.1

respiration
releasing energy from food inside cells. It is not the same as breathing. S3.1.1

root hair cell
a root cell with a long hair that takes in water. S3.1.5

sensitivity
noticing a change and reacting to it. S3.1.1

slide
a thin piece of glass or plastic that holds the thing you look at. S3.1.2

specialised cell
a cell with a shape that suits one job. S3.1.5

surface area
how much outside a thing has. S3.1.5

tissue
a group of the same kind of cell, doing one job. S3.1.6

vacuole

a bag of watery liquid in a cell. S3.1.3

virus

a tiny thing that causes illness. It is not a cell. S3.1.8

yeast

a one cell living thing that feeds on sugar and makes carbon dioxide gas. S3.1.8

Answers

S3.1.1. Signs of life

1. **Making a noise**

   Many living things, such as plants, make no sound at all. The seven are movement, respiration, sensitivity, growth, reproduction, excretion and nutrition.

   - **If you chose A:** Growth is a life process. Even a tree grows, though slowly. You may think only animals grow. Go to S3.1.1.
   - **If you chose B:** Excretion, getting rid of waste, is a life process. You may be thinking of it as something only animals do. Go to S3.1.1.
   - **If you chose D:** Reproduction, making young, is a life process. You may think it only means having babies, but plants do it too. Go to S3.1.1.

2. **Releasing energy from food inside cells.**

   Cells use oxygen to release energy from food. Breathing only brings the air in.

   - **If you chose A:** Breathing is not respiration. Breathing brings air to your body. Respiration happens inside cells. Go to S3.1.1.
   - **If you chose C:** That is excretion. Respiration is the release of energy from food. Go to S3.1.1.

3. **Alive, but resting.**

   The seed respired very slowly all year. With water and warmth it started to grow.

   - **If you chose A:** A thing that is not alive cannot become alive. The seed was alive all the time, only resting. Go to S3.1.1.
   - **If you chose C:** Moving is only one sign of life. A plant seed does not move, and it is alive. Go to S3.1.1.

4. **It does not show all seven signs, and it is not made of cells.**

   A fire makes no young of its own. It does not notice and react as a living thing does. Most of all, it is not made of cells, and every living thing is.

   - **If you chose B:** Heat is not the test. Some living things are warm and some are cold. Look at the seven signs. Go to S3.1.1.
   - **If you chose C:** Moving and growing are only two signs. A living thing shows all seven. Go to S3.1.1.

5. **It shows all seven life processes, but slowly.**

   A tree grows, makes food, notices light, makes seeds, and moves its leaves and roots slowly.

   - **If you chose A:** Colour does not make a thing alive. Many living things are not green. Go to S3.1.1.
   - **If you chose B:** A stone can lie in soil too. We look at what the thing does, not where it is. Go to S3.1.1.

6. **23 mm**

   Take the first length from the second length. 27 − 4 = 23.

S3.1.2. Seeing small things

1. **The drop is curved and bends the light, so it works as a lens.**

   A drop is thicker in the middle than at its edge. It bends light and makes the print look bigger.

   - **If you chose B:** The letters do not change. The drop bends the light on its way to your eye, so they look bigger. Go to S3.1.2.
   - **If you chose C:** A flat sheet of plastic is just as close, and it does not magnify. The curve of the drop is what matters. Go to S3.1.2.

2. **400 times**

   Multiply the two magnifications. 10 × 40 = 400.

   - **If you chose A:** You added the two numbers. The lenses work one after the other, so the numbers are multiplied. Go to S3.1.2.
   - **If you chose C:** You divided. Each lens makes the thing bigger again, so you multiply. Go to S3.1.2.

3. **From below the stage. It shines up through the slide.**

   Light shines up through a thin slide and into the objective lens. It goes up the tube to the eyepiece and your eye.

   - **If you chose A:** The eyepiece is where your eye looks. It gives out no light. The light goes into it. Go to S3.1.2.
   - **If you chose B:** A lens only bends light. It makes none. The light starts below the stage. Go to S3.1.2.

4. **Light has to pass through it to reach the lens.**

   The light shines up through the slide. A thick piece blocks it, and then you see only a dark patch.

   - **If you chose B:** The stage can hold something quite thick. The problem is light, not room. Go to S3.1.2.
   - **If you chose C:** Slicing does not change the cells. It lets light through so that you can see them. Go to S3.1.2.

5. **It is never safe. A lens can harm your eyes, even in a moment.**

   A lens gathers light. Sunlight is strong enough to harm your eyes. Never look at the Sun through a lens or a drop.

   - **If you chose A:** Size does not make it safe. Any lens can gather sunlight into your eye. Go to S3.1.2.
   - **If you chose B:** Cloud thins the light but does not make it safe. Never look at the Sun through any lens. Go to S3.1.2.

6. **Yes. It is alive and resting.**

   A dry seed respires very slowly. It is alive, and it wakes up when it has water and warmth.

   - **If you chose A:** A resting seed is not growing now, but it is alive. It grows again with water and warmth. Go to S3.1.1.
   - **If you chose C:** A thing that is not alive cannot become alive. The seed was alive all the time. Go to S3.1.1.

7. **20 mm**

   Multiply the width by the magnification. 0.05 × 400 = 20.

S3.1.3. Animal and plant cells

1. **The cell wall**

   An animal cell has only a thin membrane round it. A plant cell has a stiff cell wall outside its membrane.

   - **If you chose B:** Plant cells and animal cells both have a nucleus. So it is not the part that only plants have. Go to S3.1.3.
   - **If you chose C:** Both kinds of cell are filled with cytoplasm. Look for the part that is only in plants. Go to S3.1.3.

2. **The cell membrane**

   Every cell, plant or animal, has a cell membrane round it.

   - **If you chose A:** An animal cell has no wall. Every cell has a membrane, and it is the thin skin round the cell. Go to S3.1.3.
   - **If you chose C:** The nucleus is the round part inside the cell, not the skin around it. Go to S3.1.3.

3. **Cell wall, cell membrane, cytoplasm**

   The stiff wall is outermost. The thin membrane is just inside it, and the cytoplasm fills the inside.

   - **If you chose B:** You have the wall and membrane the wrong way round. The wall is the outer layer. Go to S3.1.3.
   - **If you chose C:** That list goes from the inside to the outside. Start at the edge of the cell. Go to S3.1.3.

4. **A cell from a root**

   A root grows in the dark soil. Its cells have no chloroplasts.

   - **If you chose B:** Leaf cells have many chloroplasts. They are in the green part of the plant. Go to S3.1.3.
   - **If you chose C:** That is a common mistake. Plants are green, so it feels right, but roots are not green and have none. Go to S3.1.3.

5. **The nucleus**

   The bean is a round thing inside the water, like the nucleus inside the cytoplasm.

   - **If you chose A:** The water, not the bean, is the cytoplasm. The bean is the round part inside it. Go to S3.1.3.
   - **If you chose B:** The stiff box is the wall. The bean sits deep inside. Go to S3.1.3.

6. **The eyepiece**

   You put your eye to the eyepiece. The objective lens is near the slide.

   - **If you chose A:** The objective lens is near the slide. Your eye is at the other end of the tube. Go to S3.1.2.
   - **If you chose C:** The stage is the flat shelf that holds the slide. It is not a lens. Go to S3.1.2.

S3.1.4. What each part does

1. **It controls the cell and holds its instructions.**

   The nucleus tells the cell how to grow and what to make. It is the control centre.

   - **If you chose B:** That is the job of the chloroplast. The nucleus is the control centre. Go to S3.1.4.
   - **If you chose C:** Shape is the job of the cell wall in a plant cell. The nucleus holds the instructions. Go to S3.1.4.

2. **The cell membrane**

   The thin membrane lets in what the cell needs, such as food and water, and lets out waste.

   - **If you chose A:** The wall lets water through easily, and animal cells have none. The membrane is the part that decides. Go to S3.1.4.
   - **If you chose B:** The cytoplasm is the jelly inside the cell. It does not guard the edge. Go to S3.1.4.

3. **To give a plant cell a firm shape.**

   A stiff wall, with water pushing on it from inside, helps a plant stand up.

   - **If you chose A:** The nucleus controls the cell. The wall is a stiff layer round it. Go to S3.1.4.
   - **If you chose B:** That is the chloroplast. The wall only holds the shape. Go to S3.1.4.

4. **Roots are in the dark soil, and chloroplasts need light.**

   A chloroplast uses light to make food. Underground there is no light, so root cells have none.

   - **If you chose B:** Roots need food, like every living part. They get it from the leaves. Go to S3.1.4.
   - **If you chose C:** Size is not the reason. Root cells are about as big as leaf cells. A chloroplast needs light, and a root has none. Go to S3.1.4.

5. **The cells fill with water and push on their walls.**

   The water in the vacuole pushes on the stiff wall. A cell full of water is firm, and so is the plant.

   - **If you chose A:** The nucleus does not change with water. The water fills the vacuole and pushes on the wall. Go to S3.1.4.
   - **If you chose B:** Chloroplasts make food. It is the vacuole that fills with water. Go to S3.1.4.

6. **200 times**

   Multiply the two magnifications. 10 × 20 = 200.

   - **If you chose A:** You added. The lenses work one after the other, so you multiply. Go to S3.1.2.
   - **If you chose C:** You divided. Multiply the two numbers. Go to S3.1.2.

S3.1.5. Cells with special jobs

1. **It carries messages a long way and passes them on.**

   The long fibre reaches far, and the branches hand the message to the next cell.

   - **If you chose A:** Nerve cells carry messages. They do not store food. You may be thinking of a different kind of cell. Go to S3.1.5.
   - **If you chose C:** That is the job of the red blood cell, which is a small dented disc. Go to S3.1.5.

2. **Its flat, dented shape gives a large surface.**

   The large surface lets oxygen get in and out quickly. The small bendy shape squeezes through thin blood tubes.

   - **If you chose A:** A long fibre belongs to a nerve cell. A red blood cell is a small disc. Go to S3.1.5.
   - **If you chose C:** A long hair belongs to a root hair cell. A red blood cell has none. Go to S3.1.5.

3. **It gives a large surface to take in water from the soil.**

   More surface means more water can pass in. The hair reaches between grains of soil.

   - **If you chose B:** Carrying messages is the job of nerve cells. A root hair takes in water. Go to S3.1.5.
   - **If you chose C:** Making food is the job of the chloroplast. A root has none, because it is in the dark. Go to S3.1.4.

4. **A red blood cell**

   Red blood cells are carried in the blood, and they carry oxygen.

   - **If you chose A:** A nerve cell carries messages, not oxygen. Go to S3.1.5.
   - **If you chose B:** A root hair cell belongs to a plant and takes in water. It is not in blood. Go to S3.1.5.

5. **A root hair cell**

   Its long hair gives a large surface, and it grows in the soil where the water is.

   - **If you chose B:** A nerve cell is in an animal and carries messages. A plant has no nerve cells. Go to S3.1.5.
   - **If you chose C:** A red blood cell is in blood and carries oxygen. A plant has none. Go to S3.1.5.

6. **The chloroplast**

   A chloroplast catches light and uses it, with water and carbon dioxide, to make food.

   - **If you chose A:** The nucleus controls the cell. It does not use light. Go to S3.1.4.
   - **If you chose B:** The vacuole holds watery liquid. It makes no food. Go to S3.1.3.

7. **125 cells**

   Divide the length of the line by the width of one cell. 1 ÷ 0.008 = 125.

S3.1.6. Cells, tissues and organs

1. **Cell, tissue, organ, organ system, organism**

   Cells make tissues, tissues make organs, organs make organ systems, and the systems make an organism.

   - **If you chose A:** You have swapped tissue and organ. Tissues join to make an organ, so the tissue is smaller. Go to S3.1.6.
   - **If you chose B:** That list goes from the largest to the smallest. The question asks for smallest first. Go to S3.1.6.

2. **A group of the same kind of cell, doing one job.**

   Muscle cells together make muscle tissue, for example.

   - **If you chose A:** A tissue is made of many cells, not one. A cell is smaller than a tissue. Go to S3.1.6.
   - **If you chose B:** That sounds like an organ system. A tissue is made of cells, and it is smaller than an organ. Go to S3.1.6.

3. **The heart and blood tubes together**

   Organs that work together on one big job form an organ system. The heart and blood tubes move blood round the body.

   - **If you chose A:** The heart alone is one organ. A system is a group of organs. Go to S3.1.6.
   - **If you chose C:** A muscle cell is the smallest level, a cell. A system is much bigger. Go to S3.1.6.

4. **Heart muscle**

   Heart muscle is a group of the same kind of cell doing one job. That is a tissue.

   - **If you chose A:** The heart is an organ. It is made of several tissues, and heart muscle is one of them. Go to S3.1.6.
   - **If you chose B:** A whole dog is an organism, the largest level. Go to S3.1.6.

5. **A leaf**

   A leaf is made of several tissues working together, so it is an organ.

   - **If you chose B:** The skin of a leaf is a tissue, a group of the same cells. The leaf has other tissues too. Go to S3.1.6.
   - **If you chose C:** The whole tree is the organism, the largest level. Go to S3.1.6.

6. **A nerve cell**

   A nerve cell is long and thin. It carries messages from one part of the body to another.

   - **If you chose A:** A red blood cell carries oxygen. A nerve cell carries messages. Go to S3.1.5.
   - **If you chose C:** A root hair cell takes in water for a plant. Go to S3.1.5.

7. **18 cells**

   Count every box in the picture, row by row. There are 18.

S3.1.7. Diffusion

1. **From a crowded place to a less crowded place.**

   More particles move out of the crowded place than into it. So they spread out until they are even.

   - **If you chose A:** That is the wrong way round. More particles leave the crowded place, so the spreading goes away from it. Go to S3.1.7.
   - **If you chose B:** Particles move in every direction. Diffusion goes from crowded to less crowded, up or down. Go to S3.1.7.

2. **The smell particles spread out by diffusion.**

   Smell particles move in all directions. They spread from the crowded place near the pot into the rest of the room.

   - **If you chose B:** Your nose does not pull. The smell particles move out from the pot on their own. Go to S3.1.7.
   - **If you chose C:** Moving air helps a lot, but even in still air the particles spread by themselves, only more slowly. Go to S3.1.7.

3. **The colour slowly spreads up through the water on its own.**

   The colour particles move among the water particles and spread out. In still water this takes a long time.

   - **If you chose B:** The colour particles keep moving, so they spread. It is slow, but it does happen. Go to S3.1.7.
   - **If you chose C:** Stirring spreads it in seconds. In still water, diffusion is slow. It takes days. Go to S3.1.7.

4. **Into the cell.**

   There are more oxygen particles outside, so more of them move in than out.

   - **If you chose A:** Out is from the less crowded side. Diffusion goes from the crowded side, which is outside. Go to S3.1.7.
   - **If you chose C:** Particles are always moving. Here more move in than out. Go to S3.1.7.

5. **They are still moving about in every direction.**

   Particles keep moving. Evenly spread means that just as many go each way, so you see no more change.

   - **If you chose A:** Particles never stop. The mixture only looks still because just as many go one way as the other. Go to S3.1.7.
   - **If you chose B:** Particles move in every direction. If they all went one way, the colour would not stay spread out. Go to S3.1.7.

6. **The cell membrane**

   The thin membrane lets in what the cell needs and lets out waste.

   - **If you chose A:** The wall only holds the shape. Water goes through it easily. The membrane decides. Go to S3.1.4.
   - **If you chose B:** The nucleus controls the cell from the inside. It is not at the edge. Go to S3.1.4.

7. **10 more**

   Take the smaller count from the larger count. 14 − 4 = 10.

S3.1.8. Living things with one cell

1. **Yeast**

   A yeast cell is a whole living thing. It feeds, respires and makes new cells by budding.

   - **If you chose A:** A mushroom is made of many cells. Yeast is also a fungus, but it is only one cell. Go to S3.1.8.
   - **If you chose C:** A virus is not a cell at all. It is much smaller than a bacterium. Go to S3.1.8.

2. **It has no nucleus.**

   A bacterium is a single cell with no nucleus. It is also smaller than a yeast cell.

   - **If you chose A:** Yeast has a nucleus. A bacterium does not, and that is one big difference. Go to S3.1.8.
   - **If you chose B:** Bacteria are smaller than yeast cells. The table of widths shows this. Go to S3.1.8.

3. **The yeast makes carbon dioxide gas, and the bubbles push the dough up.**

   Yeast feeds on sugar and makes carbon dioxide. The gas forms bubbles that stretch the dough.

   - **If you chose B:** Dough without yeast hardly rises. The gas that the yeast makes does the work. Go to S3.1.8.
   - **If you chose C:** The yeast cells are far too small to fill the dough. It is the gas bubbles that make it rise. Go to S3.1.8.

4. **Some microbes cause disease and others are useful.**

   Yeast, yoghurt bacteria and compost microbes help us. A few microbes cause diseases such as cholera.

   - **If you chose A:** Yeast and the bacteria in yoghurt are microbes, and they do not make us ill. Go to S3.1.8.
   - **If you chose C:** Some microbes do cause disease, such as cholera. Washing and clean water keep them away. Go to S3.1.8.

5. **Wash your hands with soap and clean water before you eat.**

   Clean hands, clean water and covered food keep disease microbes away.

   - **If you chose B:** Clear water can still hold microbes, such as the ones that cause cholera. Drink clean water, or boil it first. Go to S3.1.8.
   - **If you chose C:** Warmth helps microbes grow. Keep food covered and cooked well. Go to S3.1.8.

6. **A red blood cell**

   A red blood cell in a mammal has no nucleus. That leaves more room to carry oxygen.

   - **If you chose A:** A nerve cell has a nucleus in its round body. Look at the picture of the nerve cell. Go to S3.1.5.
   - **If you chose B:** A cheek cell has a nucleus, as you saw down the microscope. Look at the picture of the animal cells. Go to S3.1.2.

7. **3 cm**

   Take the first height from the last height. 6 − 3 = 3.

About this book

For learners who can read a page alone and use the four operations. In many schools this fits children of about 11 to 13, and older learners can use it too. Activities use water, jars, beans, cloth and dough. Nothing is tasted. Anyone who looks through a lens or a drop of water must never point it at the Sun. A learner can work alone: every exercise has its answer and the reason for it.

Written and drawn by attnom. Edition 1.0, 2026-11-12.

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