

UNDERSTANDING SCIENCE

Master the Key Concepts



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What is alive?

"I'm Sophia. Some humans say that I'm not alive. But I can recognise people, have a conversation, and even draw you."

Can a robot like Sophia be alive? You might have a better answer once you've read this.



Life Processes

There is actually no simple definition of life. But scientists think what living things, or organisms, have in common is a set of jobs they do. They are called life processes. You can easily remember their names - they spell MRS GREN.

FOCUS ON

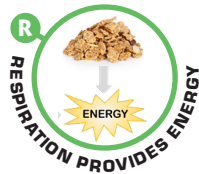
what processes all living organisms carry out.

What's another example of sensitivity?



Movement

Moving isn't just for animals. Plants do it too. This lily opens its petals in the daytime and closes them again at night.



Respiration

Everything you do requires energy. Your energy comes from food but your body needs to break down the food to release energy. This is called respiration.



Sensitivity

A deer runs when it hears a loud noise. Organisms are always on the look out for threats, food or mates. Sensitivity means sensing what is going on around you, then taking action.



Growth

Animals start their lives small and then grow until they're adults. Plants can keep growing all their lives.



Reproduction

Humans usually have just one baby at a time, while insects can lay thousands of eggs in one go. All organisms need to replace themselves, or reproduce, otherwise there would soon be none left.



Excretion

Excreting means getting rid of waste. Organisms produce unwanted products when they break down food. Animals excrete carbon dioxide in their breath and other waste in urine.



Nutrition

Nutrition means taking in food and using it for other life processes. Carbohydrate, fat and protein are nutrients for humans. Plants can make their own nutrients.



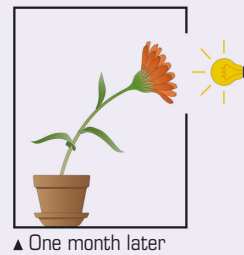
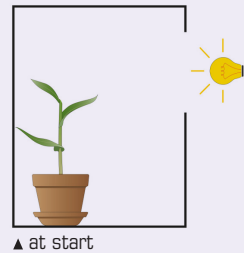
Question

A scientist put a young plant in a box with a light shining into it and left it for one month to see what would happen. What life processes did she find evidence for when she returned?

Answer

Movement	✓	It bent towards the light
Respiration	?	–
Sensitivity	✓	It sensed light and grows towards it
Growth	✓	It grew in size
Reproduction	✓	The flower contained seeds
Excretion	?	–
Nutrition	?	–

There was evidence for 4 life processes.



Why are seeds evidence for reproduction?



WRONG!

Seeds are not alive.



RIGHT!

Seeds are alive. They may not be doing much now but give them water and warmth and they will grow.

Grouping Organisms

Organisms perform all the life processes – but they do them in different ways. Animals eat food, plants make their own and fungi break down other organisms for their nutrition. Scientists arrange organisms into groups based on how they carry out life processes.

ANIMALS



Eat food

PLANTS



Make food

FUNGI



Break down dead organisms to get food

BACTERIA



Absorb food

What group do mushrooms belong to?

REVIEW

- Copy and complete: All living organisms carry out seven life processes. These are M ____, R ____, S ____, G ____, R ____, E ____, and N ____
- Write a sentence to describe what each life process means.
- Copy this diagram of a bacteria. Add two arrows to show the direction of the food and waste.



- If an organism stops carrying out respiration, it dies. Explain why.
- In the question in the purple box, the scientist saw only four life processes. Does that mean the plant is not alive? Give a reason.



6. Can a robot like Sophia be alive? Give reasons for your opinion.

What are you made of?



Do you know what you looked like when your life began? You started life as a tiny structure like this – a single cell.

Can you explain how that cell became you?

TERMS

microscope
cell theory
single-celled
multicellular



Cells Make Organisms

You may have seen cells under a microscope. But working out how cells relate to life was a hard puzzle. It took scientists 200 years. Let's find out how they did it.

0.7 mm

FOCUS ON

what each scientist did and what they found out.

What does a microscope do?

1655, ENGLAND: ROBERT HOOKE DISCOVERS THE CELL

I've got my hands on a wonderful new invention. The light microscope magnifies everything.

Let's see what dead tree bark looks like.

cells

These tiny blocks remind me of prison cells. I will name them cells!

1674, NETHERLANDS: ANTONIE VAN LEEUWENHOEK SEES TINY LIFE

My microscope is more powerful than Hooke's.

I'm going to use it to look at the gunk on my teeth.

Wow! There are tiny animals moving around on my teeth.

1830s, GERMANY: MATTHIAS SCHLEIDEN STUDIES PLANTS

I can see more than ever with this powerful new microscope.

Every plant I observe contains cells. I think plants are just lots of cells joined together.

1830s, GERMANY: THEODOR SCHWANN STUDIES HUMANS

brain

muscle

cheek

I study parts of the human body under the microscope.

They all contain cells of different shapes and sizes.



1839, GERMANY: SCHLEIDEN AND SCHWANN SHARE THEIR IDEAS OVER DINNER

If all plants are collections of cells...

...and all animals are too...

...then every living organism must be made of cells!

LATE 1800S, EUROPE: THREE SCIENTISTS WORKING SEPARATELY MAKE THE SAME DISCOVERY

I have seen cells splitting in half to make new cells!
This must be how organisms grow.

Ramak, Poland Raspali, France Vichow, Germany

SCIENTISTS HAD WORKED OUT THAT WE GROW FROM ONE CELL

one cell → trillions of cells

Why is it important scientists talk to each other?

The Theory Of Cells

Here's what the scientists worked out:

1. All living things contain cells.
2. Cells split in half to make new cells.



These ideas about what cells are like are called **cell theory**.

WRONG!
Bones don't contain cells

RIGHT!
All parts of your body are made up of cells – even bones.

Single-Celled Vs Multicellular



Think of cells as building blocks, like LEGO® bricks. Bricks are small, but if you connect lots of them together they can make a large structure. Connecting trillions of cells together makes a large organism.

Some organisms are just one cell:

SINGLE-CELLED ORGANISMS

Yeast (type of fungi)

Bacteria

One cell

Others are made of many cells:

MULTICELLULAR ORGANISMS

Animals

Plants

Mushrooms

Many cells

What type of organism are humans?

REVIEW

1. Describe what a cell is.
2. Why was the microscope important for discovering cells?
3. Copy and complete the table. Add a row for each scientist in the story. The first one has been done.

Scientist	What they did	What they discovered
Robert Hooke	Used a microscope to look at tree bark	Tree bark is made up of tiny compartments. Hooke called them cells.

4. A scientist uses a microscope to look at bacteria. Which diagram, X or Y, shows what they might see? Give a reason for your choice.



5. The text says that cells are like LEGO® bricks. List some ways cells are different to LEGO®.



6. You started off life as a single cell. You are now made of trillions of cells joined together. Explain what happened for you to go from one cell to many.

What's inside your cells?



Jo used to be a fast runner. But now, she finds it an effort just to walk. Jo's doctor thinks her muscle cells are not working correctly.

Read about cell parts and see if you can figure out where the problem is.

TERMS

cell membrane
cytoplasm
nucleus
ribosome
mitochondrion/
mitochondria

FOCUS ON

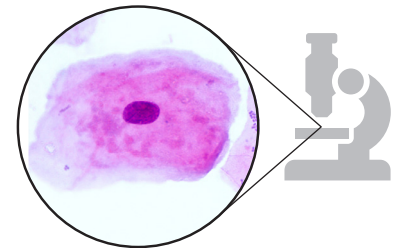
how each part of the cell helps it to carry out life processes.



Cell Parts In Animals

You may have seen a microscope image like this of a cell from your body. If you look closely, you might see that there are different parts visible inside it. The drawing below shows the parts more clearly.

Why do animal cells have parts like these? The different parts of the cell are needed to keep the cell alive. They carry out life processes, like removing waste, helping the cell grow, and supplying energy.



▲ Microscope image of an animal cell

Look at the opposite page for a description of each part.

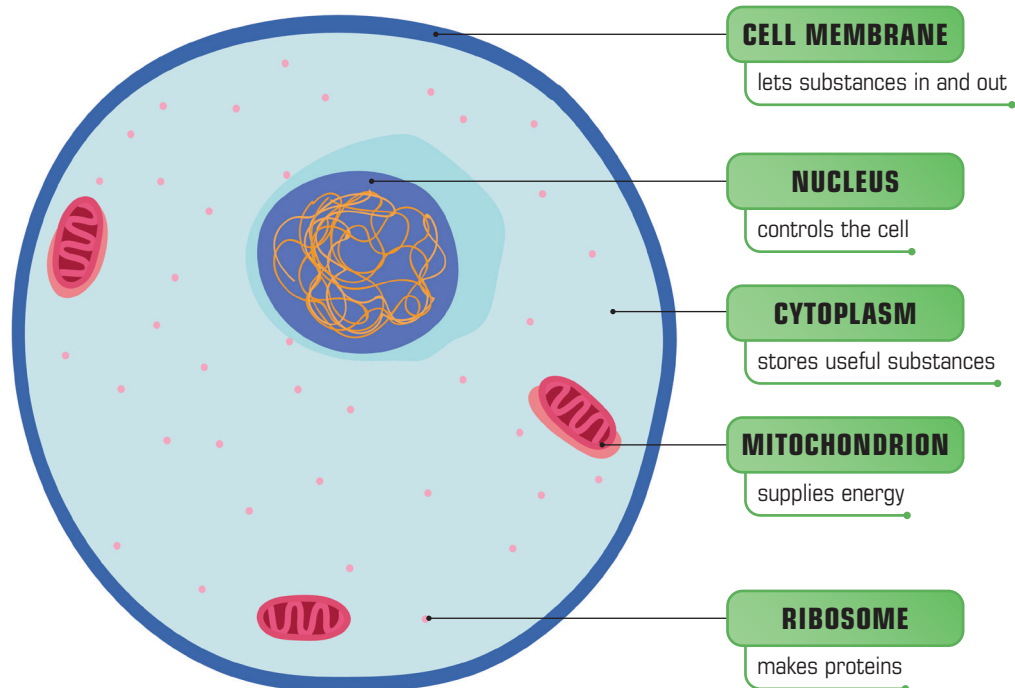
WRONG!

Cells are flat like the simplified picture

RIGHT!

Real cells are 3D, like balloons, not pancakes.

What are the 5 main parts of an animal cell?

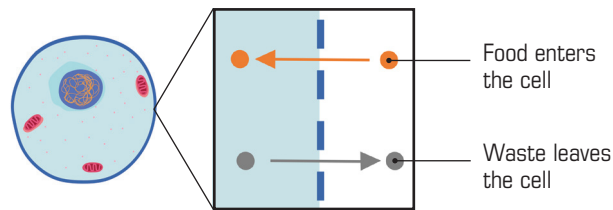


▲ Animal cell



Cell Membrane

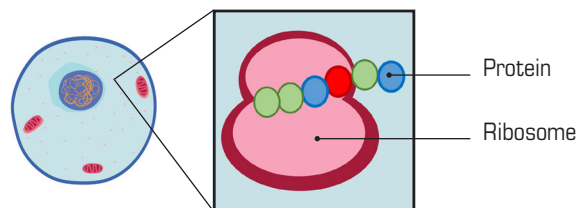
This is the cell's protective cover. It stops harmful substances getting in and it stops the contents of the cell from spilling out. But the cell membrane isn't a complete barrier. It is full of tiny holes to let in food and allow the waste out.



Why does the cell membrane need holes?

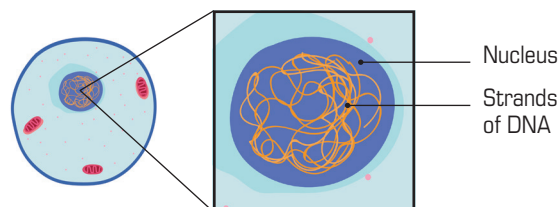
Ribosome

The job of a ribosome is to churn out new materials that the cell needs for growth and repair. These are called proteins. A cell has lots of ribosomes, scattered throughout the cytoplasm.



Nucleus

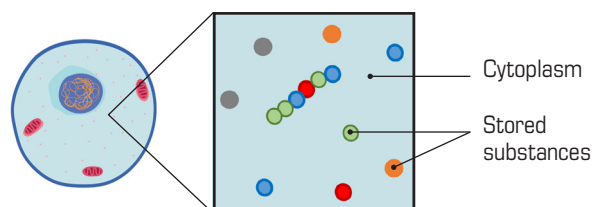
This is the control centre of the cell. It instructs the ribosomes how to make proteins. The instructions are written as a chemical code on the long strands of a substance called DNA.



What does the nucleus contain?

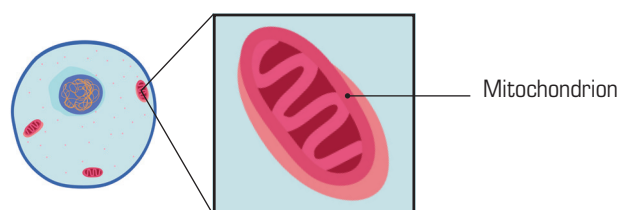
Cytoplasm

The cell is not empty. It's full of a watery liquid called cytoplasm. The cytoplasm stores substances that the cell needs and gives the cell its shape.



Mitochondrion

This part is in charge of respiration. A mitochondrion releases energy from food to keep the cell working. There are lots of mitochondria (the plural) scattered throughout the cytoplasm.

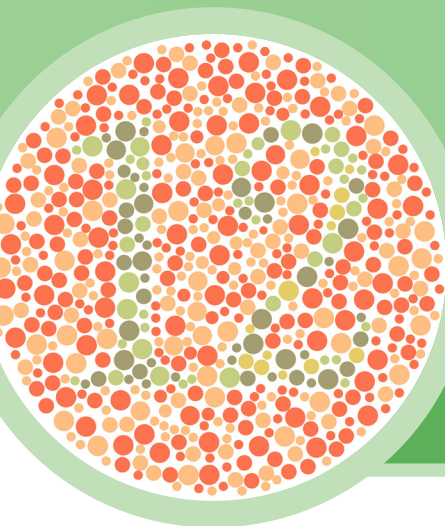


REVIEW

- True or false?
 - Humans are made up of animal cells.
 - Mitochondria make proteins.
 - Your skin is made of cells.
 - Cells are flat.
- Give the function of each part of an animal cell.
- Some substances can't enter a cell because they are too large to pass through the cell membrane. Draw a diagram to show this.
- Which life process does each statement describe?
 - Mitochondria release energy from food.
 - Food enters the cell through the cell membrane.
 - Waste leaves the cell through the cell membrane.
 - Ribosomes make new cell parts.
 - The nucleus makes the cell divide into two.
- Explain why cells are made up of several parts.
- What cell part might not be working correctly in Jo's cells? Give a reason for your answer.



How do your cells work?



Can you see the number in this image? Some people can't. This colour-blindness is the result of a small mistake in their DNA.

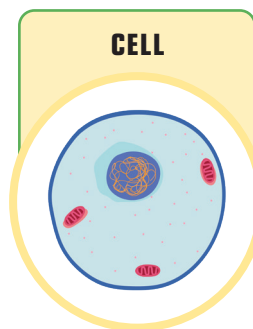
But how does a small change in DNA lead to colour-blindness? Let's find out how cell parts make the substances your body needs.



A Cell Is Like A Factory

FOCUS ON

imaging what's going on inside a cell, like playing a movie in your mind.



CELL

is like

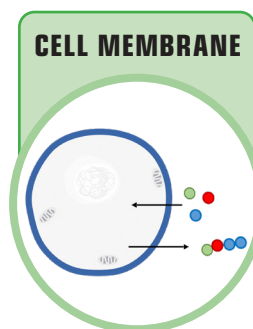


FACTORY

A drawing of a cell can give you the idea there's not much happening, but it's quite the opposite. The parts of a cell are always busy making new proteins.

Instead, imagine the cell as a car factory. Inside hundreds of robots are joining together the bits of a car.

When you imagine something as being like another thing, it's called an **analogy**. Scientists use analogies to make difficult ideas easier to grasp. Let's see how the factory analogy can help you understand the parts of a cell.



CELL MEMBRANE

is like



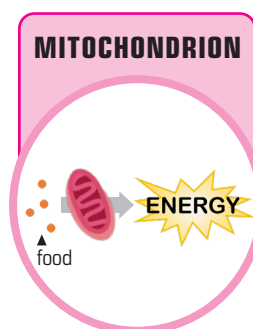
WALLS

Is full of tiny holes to let food enter the cell...

...and finished proteins leave.

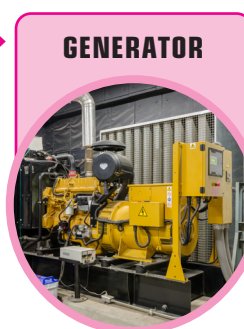
The factory walls are full of gates that let raw materials enter...

...and finished cars leave.



MITOCHONDRION

is like

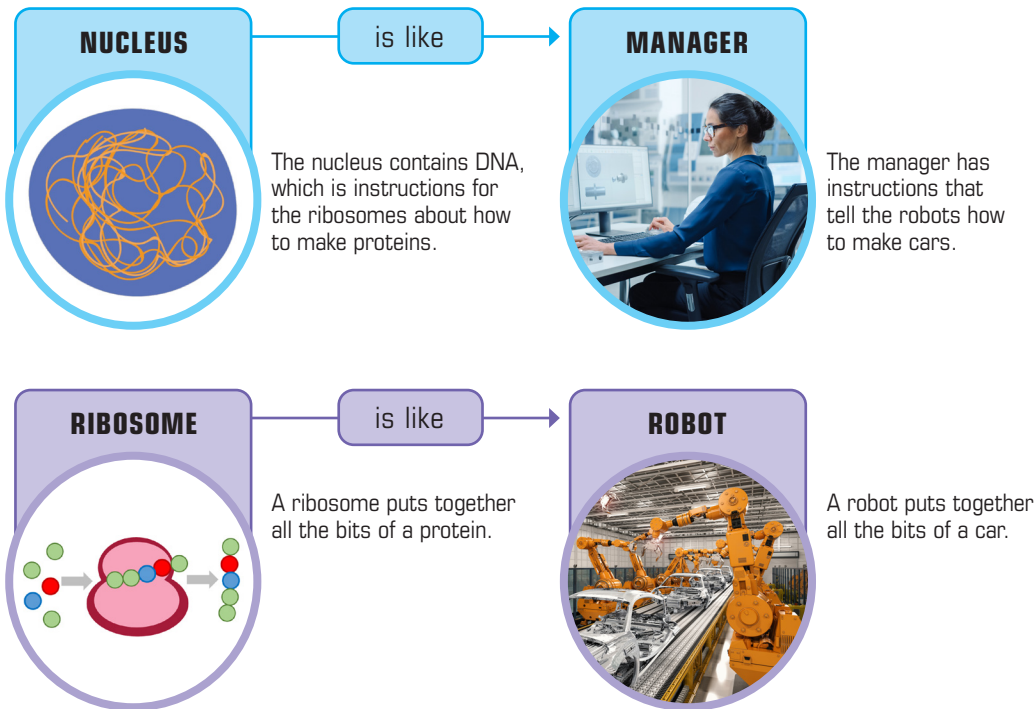


GENERATOR

A mitochondrion releases energy from food for other cell parts to use.

A generator releases energy from fuel for other factory parts to use.

Imagine things entering and leaving all over the cell membrane.



WRONG!
The cell is just like a factory.

RIGHT!
A cell is not exactly the same as a factory. In an analogy, some things are the same, others are different.

Question

What would happen to a cell if its mitochondria stopped working?

Answer

First, think about the factory.
A mitochondrion is like a generator.
What would happen if that stopped working?

If the generator stops working



Then no more energy is released



Therefore the robots stop working



So no more cars can be made



Then think about the cell.
Work through the same steps with a mitochondrion.

If the mitochondria stop working



Then no more energy is released



Therefore the ribosomes stop working



So no more proteins can be made

A cell would be unable to make new proteins if its mitochondria stopped working.

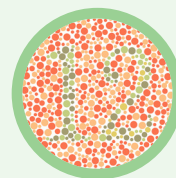
Why can't a cell make proteins without mitochondria?

REVIEW

- What is an analogy?
- Copy and complete these sentences. The first one is done for you.
 - Mitochondria are like the generator in a factory because they release energy.
 - The cell membrane is like the _____ in a factory because...
 - The nucleus is like the _____ in a factory because...
 - The ribosomes are like the _____ in a factory because...
- Imagine you were shrunk so small that you could move inside a cell. Describe what you might see.

- Write down or discuss with a partner how the factory analogy makes cells easier to understand.
- Describe two ways that a cell is not like a tiny factory.

- How does a mistake in DNA lead to colour-blindness?
Hint: People are colour-blind when they cannot make a certain protein.



How are plants different?



In this field, one sunflower has grown a bigger flower than all the rest. How did it manage that?

Keeping that huge flower up is another impressive feat – especially since it doesn't have a skeleton like we do, only a thin stem. How does the thin stem support the heavy flower?

TERMS
cell wall
vacuole
chloroplast



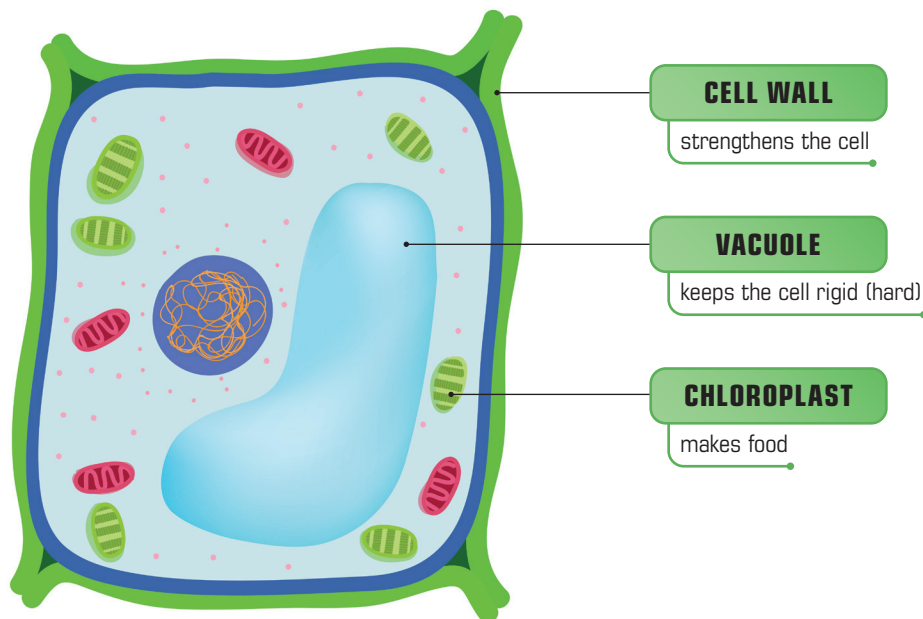
Cell Parts In Plants

Here's what a plant cell looks like inside. Can you see how it's different to an animal cell?

FOCUS ON

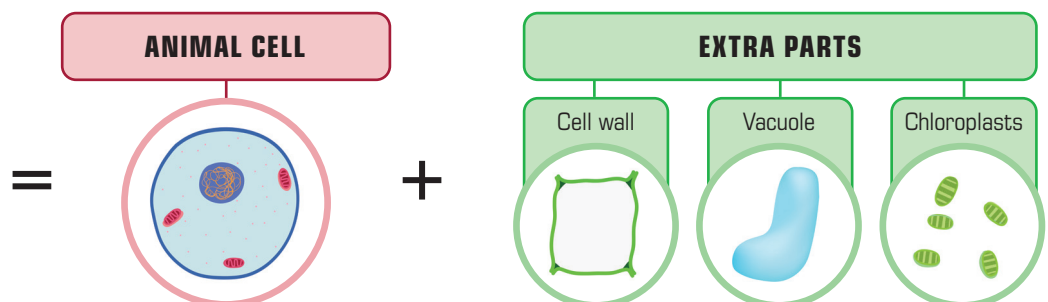
the position,
job and
special features
of each part.

Name each
part of the
plant cell.



▲ Plant cell

A plant cell looks like an animal cell but with extra parts.



The extra parts make a plant cell bigger than an animal cell.
Look at the opposite page for a description of each part.

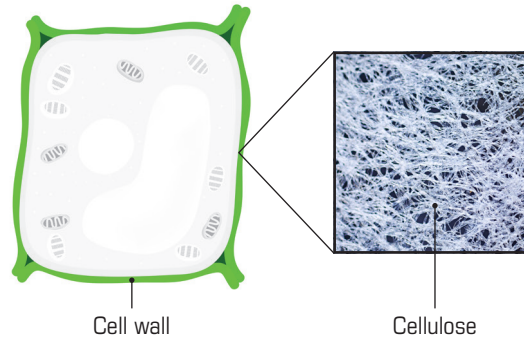


Cell Wall

Plant cells have an extra layer around the cell membrane called the cell wall.

It's made from a tough material called cellulose, which strengthens the cell.

You can imagine it as a box around the cell. The cell wall gives the plant cell a cube-like shape.



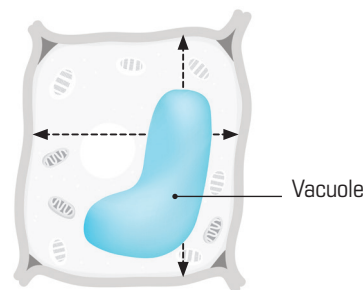
Why are plant cells stronger than animal cells?

Vacuole

The vacuole is a container full of watery liquid.

Its job is keep the cell rigid. The liquid inside pushes outwards on the cytoplasm and cell wall.

If a plant gets too dry the vacuoles in its cells empty. This makes the cells go floppy, and the plant starts to wilt.

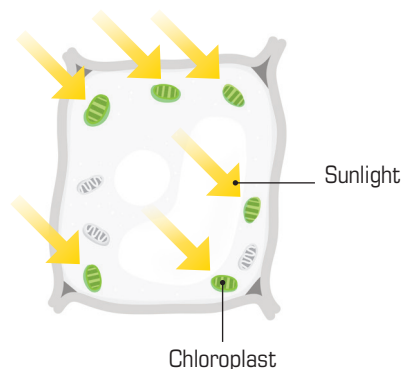


Imagine a cell going floppy when the vacuole loses water.

Chloroplasts

Plants don't eat food like animals, they make their own. Inside plant cells are parts called chloroplasts that contain a green substance called chlorophyll. That's what makes plants green.

Chlorophyll has a superpower - it captures the energy in sunlight. The chloroplasts use this energy to combine water with carbon dioxide and make sugar, which is food for the plant. This way of making food is called photosynthesis.



WRONG!
All plant cells have chloroplasts.

RIGHT!
Root cells don't have chloroplasts, because they don't receive light.

REVIEW

1. Name 3 parts that plant cells have but animal cells don't.
2. Copy and complete this table.

Plant cell part	Property	Function
	Strong	
	Pushes outward	
	Absorbs light	

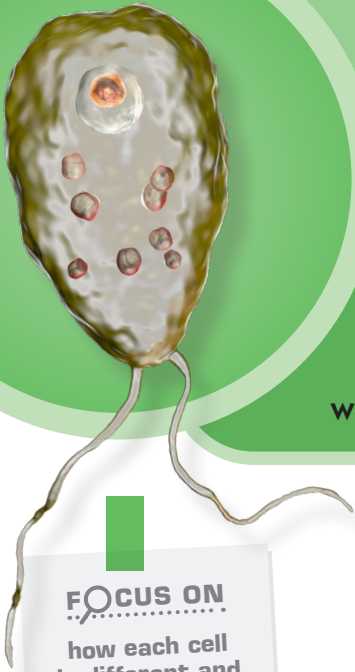
3. Draw a plant cell and label all its parts.

4. Complete the sentences:
 - a) Plants don't eat food because...
 - b) Plants don't need a skeleton for support because...
5. Explain why a plant dies if its chloroplasts stop working.

6. Explain how one sunflower has grown a bigger flower than all the rest.
Hint: the taller the plant, the more light it gets.



How are other organisms different?



This is a brain-eater. If you get infected water up your nose, these creatures can devour your brain cells.

To defeat invaders like these, scientists need to identify what kind of organism they are. See if you can work out what a brain-eater is.

TERMS

bacteria
flagellum
yeast
protist
virus

FOCUS ON

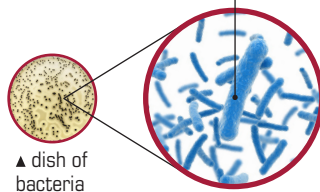
how each cell is different and similar to plant and animal cells.



Single-Celled Organisms

Most organisms on Earth are not animals or plants. They're tiny microorganisms made of only one cell. Let's look at the different kinds of **single-celled** organisms.

Bacteria



▲ dish of bacteria

SAME PARTS AS ANIMALS OR PLANT CELLS

Cell wall
Cell membrane
Cytoplasm
Ribosomes

MISSING PARTS

Nucleus
Mitochondria
Chloroplasts

PARTS THAT ARE DIFFERENT

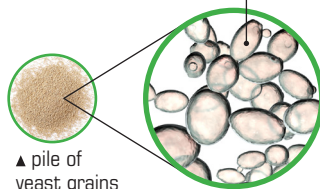
DNA not in a nucleus
Flagellum (for movement)

Bacteria are everywhere. Your gut has lots of good ones, but bad ones can make you sick. Bacteria are single-celled organisms that lack a nucleus. You can see from the picture that a bacteria cell does contain DNA, but it's floating around in the cell.

What other differences from animal and plant cells can you see?

Why do bacteria need a flagellum?

Yeast



▲ pile of yeast grains

PARTS LIKE PLANT CELLS

Cell wall
Nucleus
Mitochondrion
Vacuole
Ribosomes
Cytoplasm
Cell membrane

MISSING PARTS

Chloroplasts

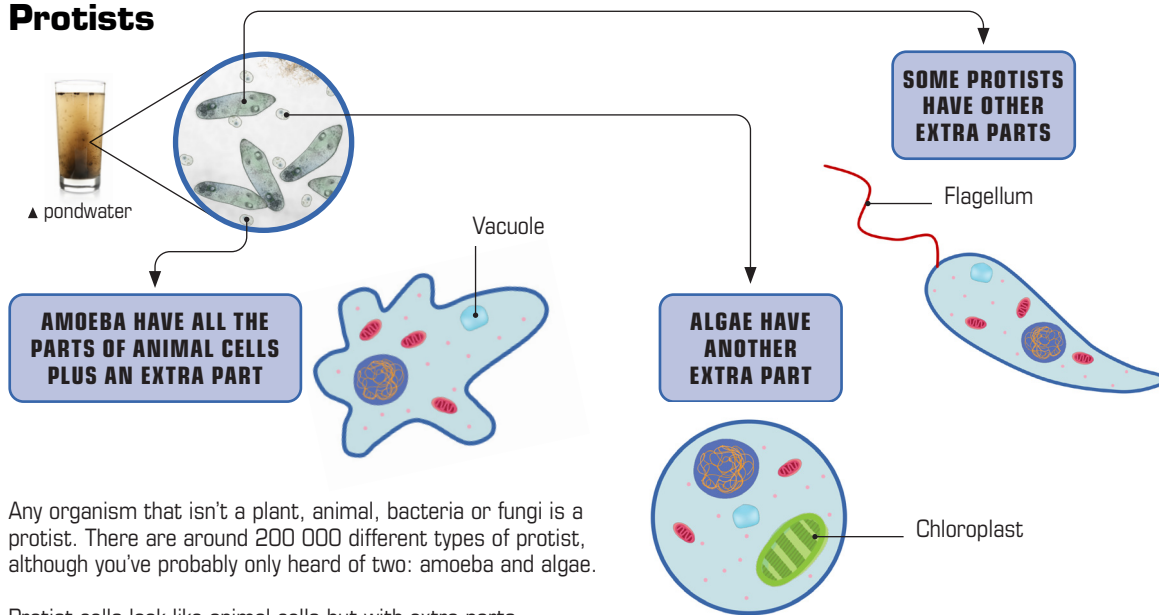
Yeast are fungi. It's the only kind of fungi that is single-celled. When yeast respire, it produces bubbles of carbon dioxide. We use this superpower to make bread.

Yeast cells do have a nucleus. You can see from the picture that their parts are similar to plant cells. However, yeast cells lack any chloroplasts.

What process can plant cells perform, that yeast cells can't?



Protists

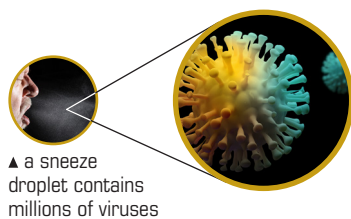


Any organism that isn't a plant, animal, bacteria or fungi is a protist. There are around 200 000 different types of protist, although you've probably only heard of two: amoeba and algae.

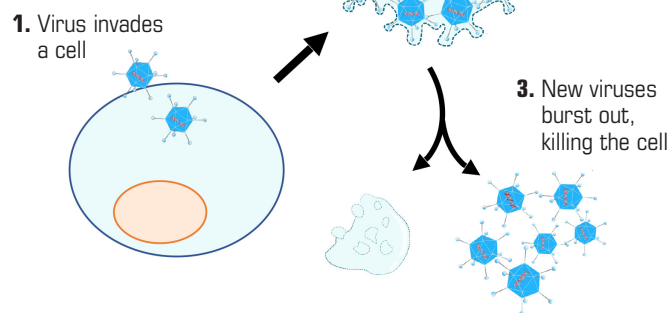
Protist cells look like animal cells but with extra parts.

What do algae use chloroplasts for?

Viruses



Viruses are a special group of microorganism. They're not made from cells at all. They're just packages containing DNA strands, or a similar substance called RNA. Both carry the instructions to build new viruses.



You might be wondering how a virus can reproduce if it doesn't have cell parts?

What it does is take over other cells. The diagram shows how.

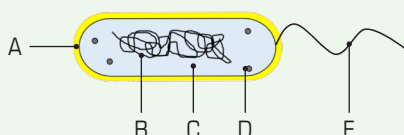
What one thing do viruses have in common with cells?

REVIEW

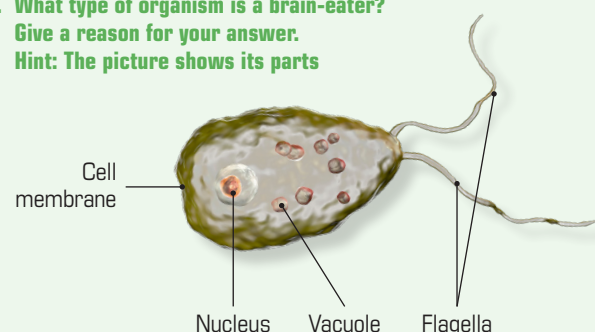
- Copy and complete: Bacteria, _____ and most protists are _____-celled organisms. They are only made up of _____ cell.
- Make a table to compare the cell parts in different single-celled organisms. The first row has been done for you. Add one row for each cell part: cell membrane, nucleus, cytoplasm, mitochondria, chloroplasts, ribosomes.

Part	Bacteria	Yeast	Protist
cell wall	✓	✓	✗

- The diagram shows a bacteria cell. Name each part A-E.



- Give the name of a single-celled organism that makes its own food. Explain how it does this.
- Imagine you see a single-celled organism under a powerful microscope. Explain how you could work out what type of organism it was.
- What type of organism is a brain-eater? Give a reason for your answer. Hint: The picture shows its parts



Mixed-up Questions

Recall

1 mark for each question part

1. Copy and complete the statements.

- We know cells exist because you can see them with a...
- Waste leaves a cell through the...
- Animals and plants are made up of many cells – they are...
- Both bacteria and plant cells have a...
- For movement, sperm cells have a...

2. For each organism, say whether it is single-celled (S) or multicellular (M):

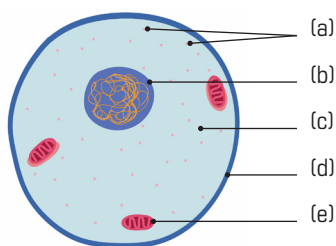
- | | |
|-------------|-------------|
| a) amoeba | e) bacteria |
| b) flea | f) moss |
| c) worm | g) yeast |
| d) mushroom | h) daffodil |

3. Name three parts that a plant cell has, but an animal cell doesn't.

4. Name the plant or animal cell part that:

- makes proteins.
- carries out photosynthesis.
- contains instructions to make proteins.
- releases energy from food.
- is full of liquid to keep a plant rigid.
- controls what enters and leaves the cell.
- gives the cell strength and a regular shape.

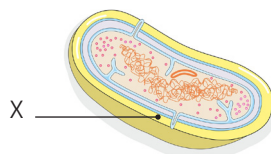
5. Name these parts of an animal cell.



6. This is a cell from your intestines. Describe the special feature it has.



7. Name the part of the bacteria cell labelled X.



8. Copy the words below. Draw lines to match each cell to its function and special feature.

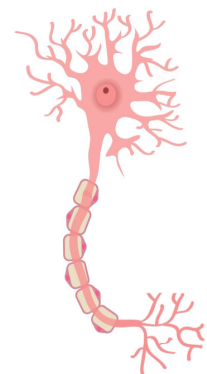
CELL	FUNCTION	SPECIAL FEATURE
a) red blood	photosynthesis	no nucleus
b) palisade	movement	an extension
c) root hair	carry oxygen	contracts
d) muscle	absorb water	many chloroplasts

9. Copy and complete the table. Put a tick or a cross in each box.

Cell part	Present in plant cell?	Present in bacteria cell?
a) Cell wall		
b) Cell membrane		
c) Nucleus		
d) Mitochondria		
e) Chloroplasts		
f) Cytoplasm		
g) Ribosomes		

10. This is a drawing of an animal cell.

- Name the cell.
- Say where it is found.
- Describe one special feature it has, and its function.



Hints

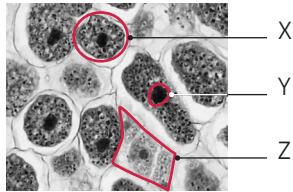
- 1a) → p3, b) → p5, c) → p4, d) → p11, e) → p15
 2. → p4 3. → p9 4. → p5/9 5. → p5 6. → p15
 7. → p11 8. → p15-18 9. → p11 10. → p15.

Describe & Explain

2 marks for each question

1. This microscope image shows part of an organism.

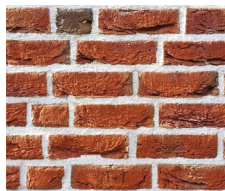
- Is it a multicellular or single-celled organism? Give a reason for your choice.
- Which outline (X, Y or Z) shows one cell?



2. Describe two ways that bacteria cells are different to plant cells.

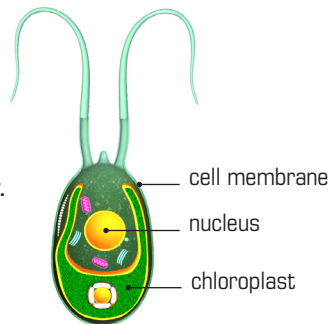
3. A website explains cells using the analogy that they are like bricks in a house.

- What does the house represent in this analogy?
- Describe one way that a cell is not like a brick.



4. Here is a single-celled organism called *Chlamydomonas*.

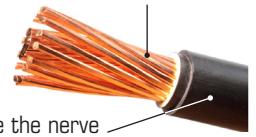
Some of its parts have been labelled. What type of organism is it? Give a reason for your answer.



5. This cable is a bunch of wires. A nerve is a bunch of nerve cells. Give two ways that nerve cells are like wires.

wires – like the nerve cells

cable – like the nerve



6.



▲ *Vibrio cholerae* is a bacteria cell.

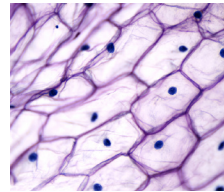
(images are not to scale)



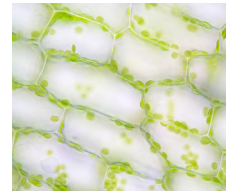
▲ Sperm is an animal cell.

- Which part does only the bacteria cell have?
- Which parts do only the sperm cell have?

7. Here are two different types of plant cell.



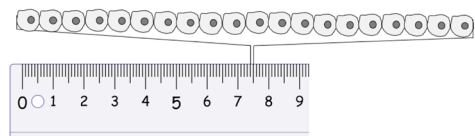
▲ root cells



▲ leaf cells

- Describe how the cells are similar.
- Describe how the cells are different.

8. A human cell is so small that 20 fit next to each other in 1 mm.



Calculate the width of a single human cell.

Hints

1. → p4 2. → p11 3. → p7-8 4. → p12
5. → p15 6. → p11/15 7. → p9

Apply

3 marks for each question

1. Explain why a cell dies if its ribosomes stop working.

2. This is a muscle cell from the stomach wall. It is relaxed.



- Sketch the cell when it is contracted.
- Food is squeezed when it moves through the stomach. Explain how the muscle cells changing shape help the stomach squeeze the food.

3. Martha has not watered her pot plant for a while. Its stems have gone all floppy. Explain what has happened using ideas about cells.

4. If an animal cell takes in too much water, it bursts. Explain why a plant cell does not burst if this happens.

Hints

1. → p7-8 2. → p16 3. → p10 4. → p10

SCORE YOURSELF:

Recall /42

Describe & Explain /16

Apply /12



UNDERSTANDING SCIENCE

Understanding Science is more than a textbook. It's a step-by-step guide to mastering the difficult concepts in science. Based firmly on research, Understanding Science will give students deep knowledge that they can apply to get high grades.

- ✓ Starts by going previously taught concepts
- ✓ Gives crystal-clear explanations and visuals
- ✓ Works through examples on how to use the concepts
- ✓ Shows how to avoid misconceptions
- ✓ Helps students fully process the ideas using questions
- ✓ Provides strategies for learning by reading

Understanding Science covers all the key concept in year 7.



GENES

Sexual & Asexual
Menstrual Cycle
Embryo Development



ENERGY

Energy Transfer
Wasted Energy
Heat & Temperature
Electric Current
Resistance



MATTER

Particle Model
Mixtures
Solutions
Chemical & Physical
pH Scale
Neutralisation



ORGANISMS

Cell Structure
Specialised Cells
Feeding Relationships
Competition
Abiotic & Biotic



FORCES

Balanced &
Unbalanced
Friction
Density

