



# 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?



## Life processes

There is actually no simple definition of life. But scientists think there is a set of jobs that all living things, or **organisms**, carry out. They are called **life processes**. Their names are easy to remember – they spell MRS GREN.

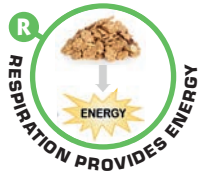
**FOCUS ON**  
what processes all living organisms carry out.

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 has 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. Sensing what is going on around you, then taking action, is called sensitivity.



### 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. Many 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.



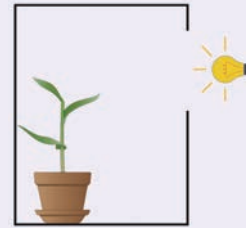
**Question**

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?

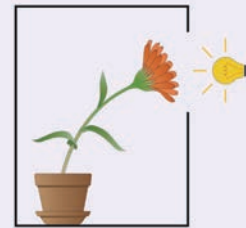
**Answer**

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

There was evidence for four life processes.



▲ At start



▲ One month later

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 and answer 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?



This is what you looked like when your life began. You started out as a tiny structure called a cell.

How did that cell become you?

**TERMS**  
 Microscope  
 Cell theory  
 Single-celled  
 Multicellular

0.7 mm

**FOCUS ON**  
 what each scientist did and what they found out.

What does a microscope do?



## Cells make organisms

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

<p><b>1655, ENGLAND: ROBERT HOOKE DISCOVERS THE CELL</b></p> <p>I've got my hands on a wonderful new invention. The light microscope magnifies everything.</p> <p>Let's see what dead tree bark looks like.</p>	<p>These tiny blocks remind me of prison cells. I will name them cells!</p>
<p><b>1674, NETHERLANDS: ANTONIE VAN LEEUWENHOEK SEES TINY LIFE</b></p> <p>My microscope is more powerful than Hooke's.</p> <p>I'm going to use it to look at the gunk on my teeth.</p>	<p>Wow! There are tiny animals moving around on my teeth.</p>
<p><b>1830s, GERMANY: MATTHIAS SCHLEIDEN STUDIES PLANTS</b></p> <p>I can see more than ever with this powerful new microscope.</p>	<p>Every plant I observe contains cells. I think plants are just lots of cells joined together.</p>
<p><b>1830s, GERMANY: THEODOR SCHWANN STUDIES HUMANS</b></p> <p>Brain</p> <p>Muscle</p> <p>Cheek</p> <p>I study parts of the human body under the microscope.</p>	<p>They all contain cells of different shapes and sizes.</p>



**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?

**WRONG!**  
Bones don't contain cells.

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

### 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 cells are called **cell theory**.

### Single-celled vs multicellular

Think of cells as building blocks, like LEGO® bricks. Bricks are small, but they can make a large structure if you connect lots of them together. Similarly, 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 were microscopes 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 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 from 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. Can you figure out where the problem is?

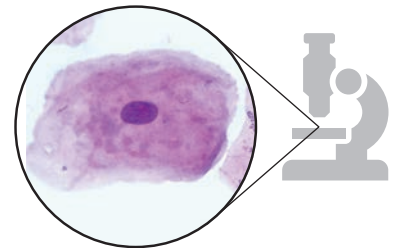
- TERMS**
- Cell membrane
  - Cytoplasm
  - Nucleus
  - Ribosome
  - Mitochondrion/ mitochondria



## Cell parts in animals

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

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.



▲ Microscope image of an animal cell

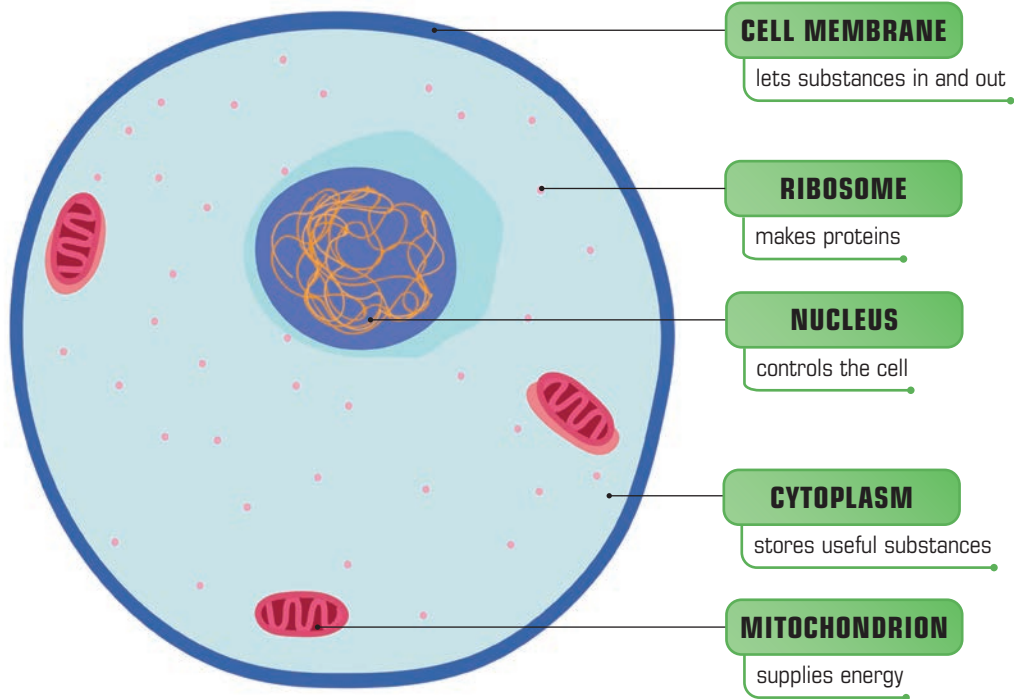
Why do animal cells have parts like these? The different parts of the cell are needed to keep the cell alive. They carry out life processes, like removing waste, helping the cell grow, and supplying energy.

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 five main parts of an animal cell?

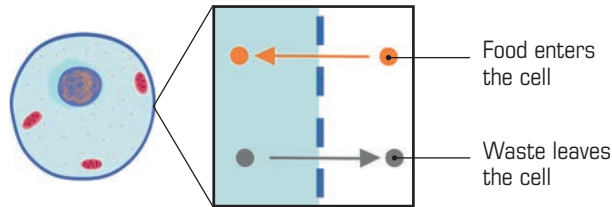


▲ Animal cell



### Cell membrane

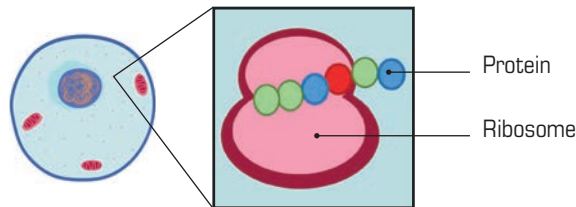
This is the cell's protective cover. It stops harmful substances getting in and stops the contents of the cell spilling out. But the cell membrane isn't a complete barrier. It's full of tiny holes that let in food and allow the waste out.



*Why does the cell membrane need holes?*

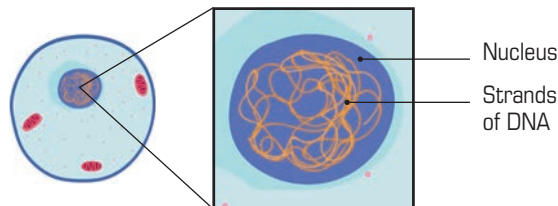
### Ribosome

The job of a ribosome is to churn out new materials, called proteins, which the cell needs to grow and repair itself. There are many ribosomes in a cell, scattered throughout the cytoplasm.



### Nucleus

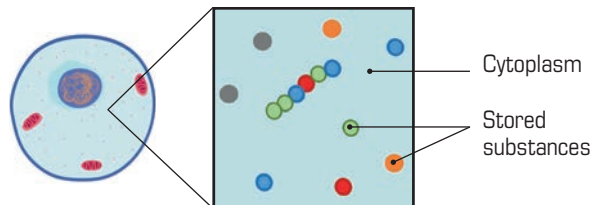
This is the control centre of the cell. It instructs the ribosomes how to make proteins. The instructions are written in a chemical code on long strands of a substance called DNA.



*What does the nucleus contain?*

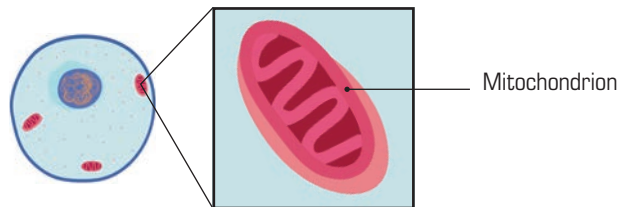
### Cytoplasm

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.

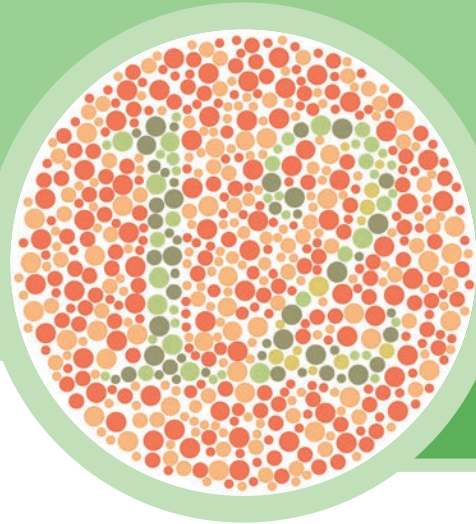


## REVIEW

- 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 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?



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

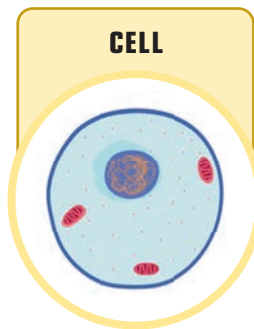
How does a small change in DNA lead to colour-blindness?



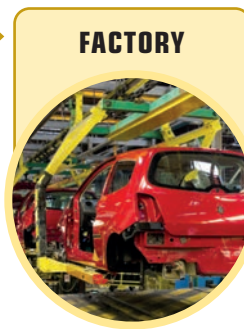
**FOCUS ON**  
 imagining what's going on inside a cell, like playing a movie in your mind.



## A Cell is like a factory



is like

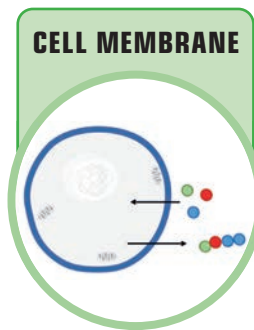


A drawing like this gives the idea there's not much happening in a cell. But it's quite the opposite. The parts of a cell are always busy making new proteins.

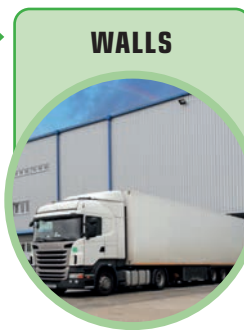
Instead, imagine the cell as a car factory. Inside, hundreds of robots are joining together the bits of a car.

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 helps you to understand the parts of a cell.

Imagine things entering and leaving all over the cell membrane.

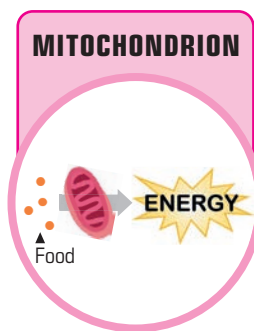


is like

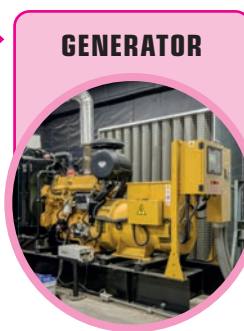


The cell membrane is full of tiny holes to let food enter...  
 ...and finished proteins leave.

The factory walls are full of gates that let raw materials enter...  
 ...and finished cars leave.

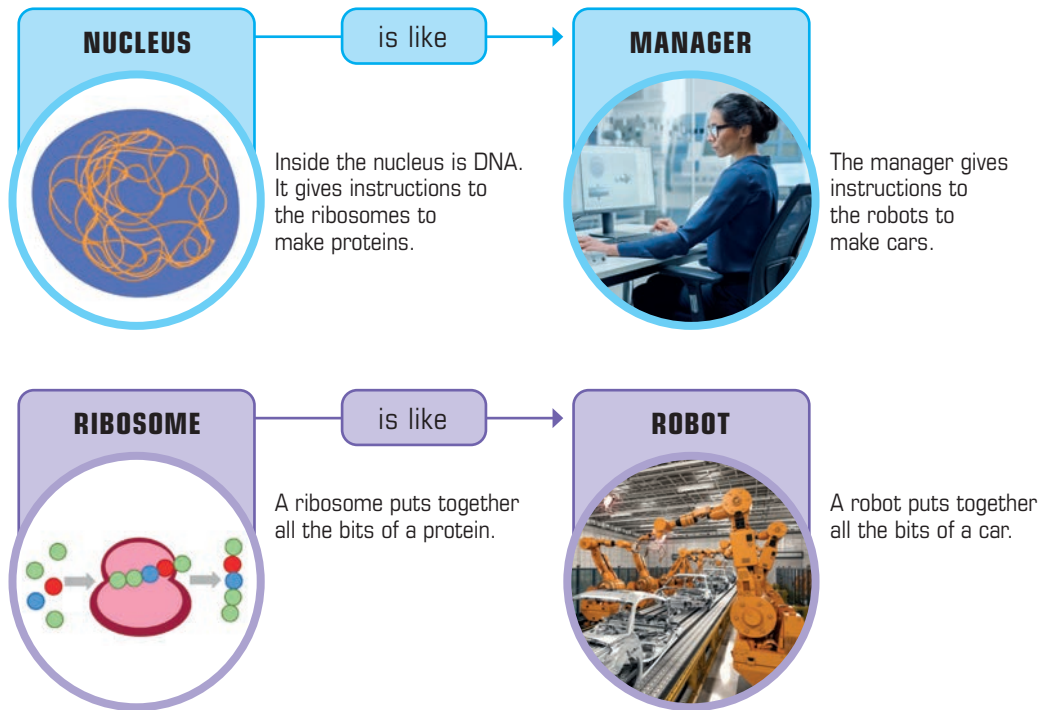


is like



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

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



**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?

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

<p>If the generator stops working</p> <p>↓</p> <p><b>Then</b> no more energy is released</p> <p>↓</p> <p><b>Therefore</b> the robots stop working</p> <p>↓</p> <p><b>So</b> no more cars can be made</p>	<p>➔</p>	<p>If the mitochondria stop working</p> <p>↓</p> <p><b>Then</b> no more energy is released</p> <p>↓</p> <p><b>Therefore</b> the ribosomes stop working</p> <p>↓</p> <p><b>So</b> no more proteins can be made</p>
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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 has been done for you.
  - A mitochondrion is like the generator in a factory because it releases energy.
  - The cell membrane is like the \_\_\_\_\_ of 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 an impressive feat. It doesn't have a skeleton like we do, only a thin stem. How does the thin stem support the heavy flower?

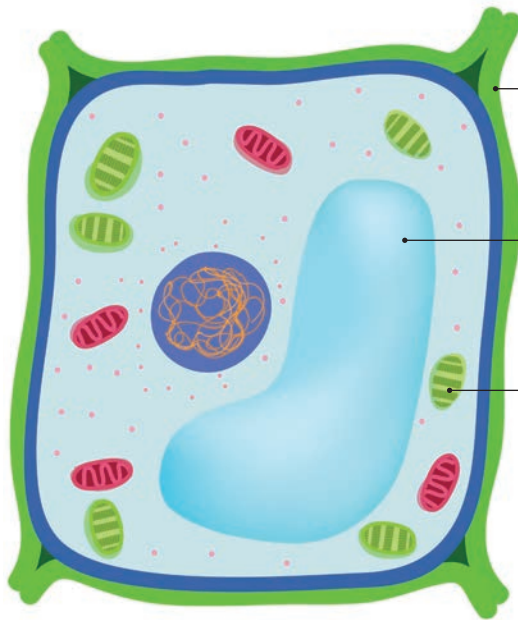
**TERMS**  
 Cell wall  
 Vacuole  
 Chloroplast  
 Photosynthesis

**FOCUS ON**  
 the position,  
 job and  
 special features  
 of each part.



## Cell parts in plants

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



**CELL WALL**  
 strengthens the cell

**VACUOLE**  
 keeps the cell rigid (hard)

**CHLOROPLAST**  
 makes food

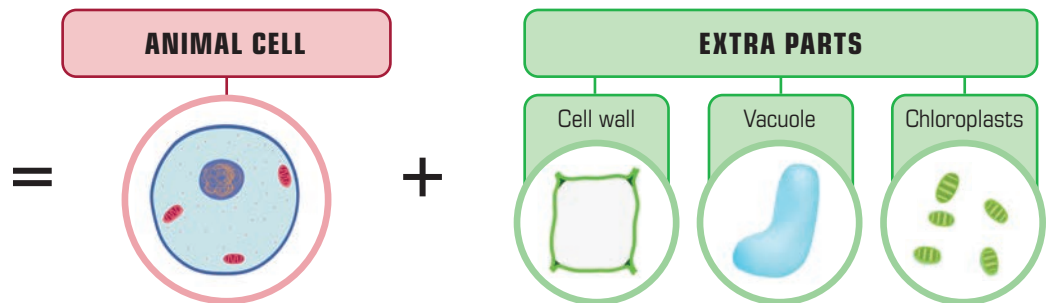
Name each part of the plant cell.

▲ Plant cell

**WRONG!**  
 Plant cells don't have a cell membrane.

**RIGHT!**  
 Plant cells have both a cell membrane and a cell wall.

A plant cell is similar to an animal cell, but with extra parts.



The extra parts make a plant cell bigger than an animal cell.

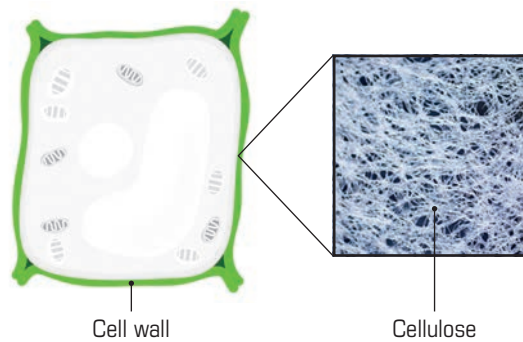


Here is what the extra parts of a plant cell do:

### 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 the cell wall as a box around the cell. It gives the plant cell a cube-like shape.

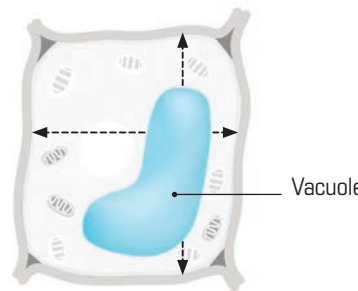


Why are plant cells stronger than animal cells?

### Vacuole

The vacuole is a container full of watery liquid. Its job is to keep the cell rigid. The liquid inside pushes outwards on the cytoplasm and cell wall.

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

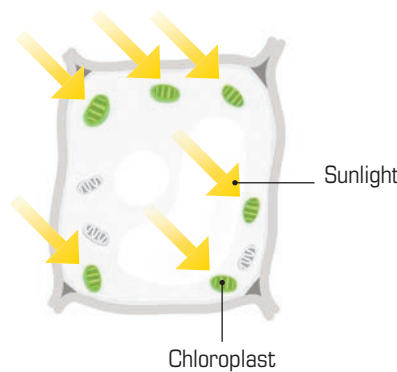


Imagine a cell going floppy when the vacuole loses water.

### Chloroplasts

Plants don't eat food like animals do. They make their own. Inside plant cells are parts called chloroplasts, which contain the green substance chlorophyll. This is 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 - 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

- Name three parts of a plant cell that animal cells don't have.
- Copy and complete this table.

Plant cell part	Property	Function
	Strong	
	Pushes outward	
	Absorbs light	

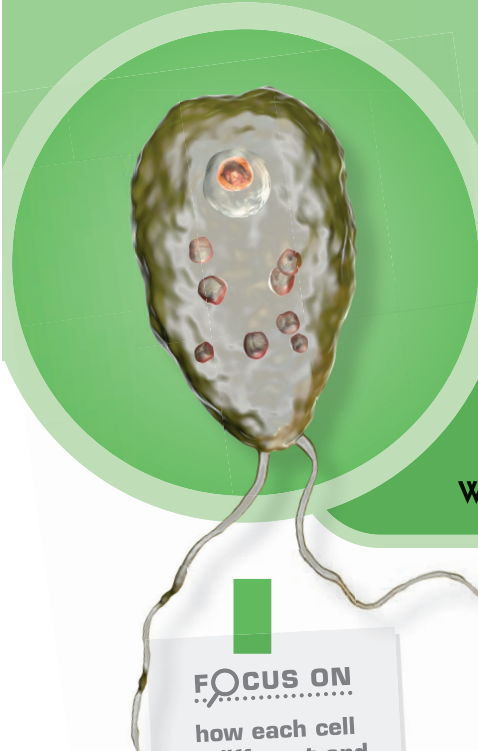
- Draw a plant cell and label all its parts.

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

- 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.

What type of organism is a brain-eater?

- TERMS**
- Bacteria
  - Flagellum
  - Yeast
  - Protist
  - Virus

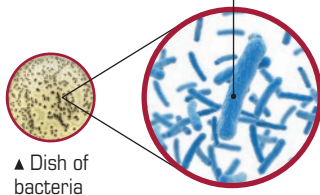
**FOCUS ON**  
how each cell is different and similar to plant and animal cells.



## 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 ANIMAL OR PLANT CELLS**

- Cell wall
- Cell membrane
- Cytoplasm
- Ribosomes

**MISSING PARTS**

- Nucleus
- Mitochondria
- Chloroplasts

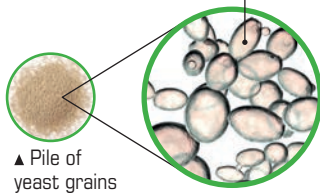
**PARTS THAT ARE DIFFERENT**

- 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. The picture shows that a bacteria cell does contain DNA, but it's floating around in the cell. Bacteria also have an extra part called a **flagellum**.

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

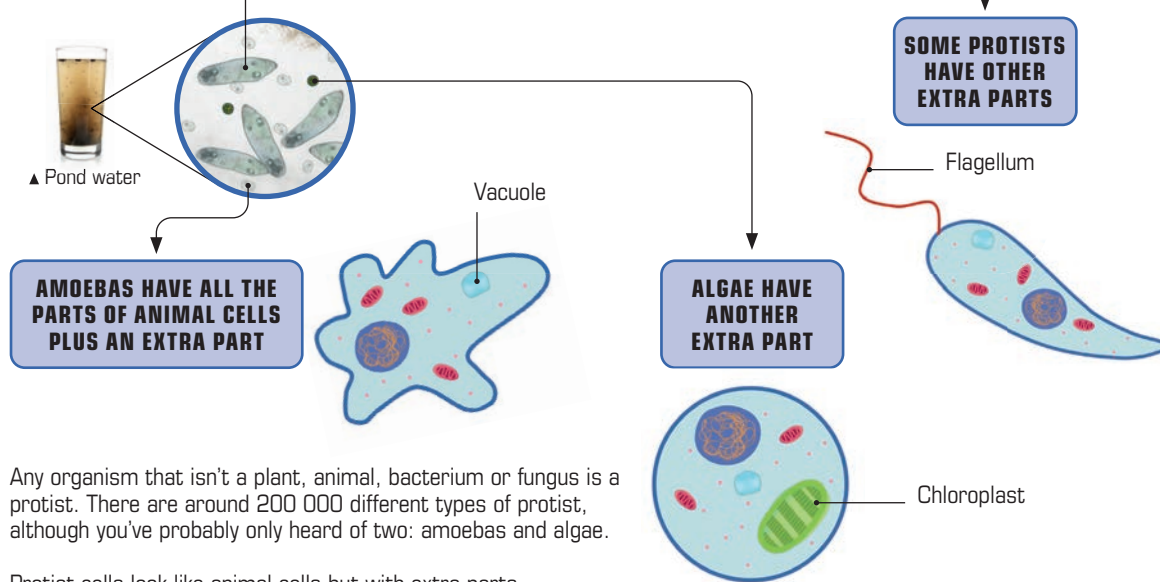
Yeasts are fungi. They are the only kind that are single-celled. When yeasts respire, they produce bubbles of carbon dioxide. We use this superpower to make bread.

Yeast cells do have a nucleus and the picture shows they are similar to plant cells. However, yeast cells lack chloroplasts.

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



## Protists

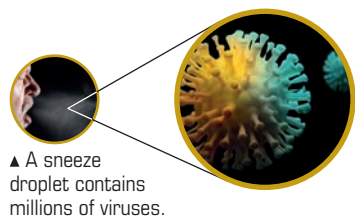


Any organism that isn't a plant, animal, bacterium or fungus is a protist. There are around 200 000 different types of protist, although you've probably only heard of two: amoebas and algae.

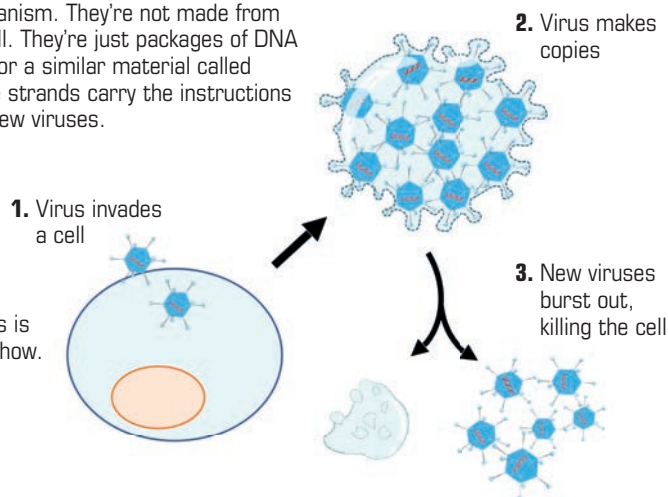
Protist cells look like animal cells but with extra parts.

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 of DNA strands, or a similar material called RNA. The strands carry the instructions to build new viruses.



You might be wondering how a virus can reproduce without cell parts. What it does is take over other cells. The diagram shows how.

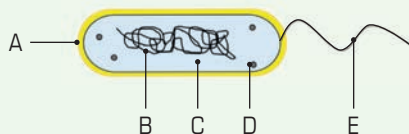
What one thing do viruses have in common with cells?

## REVIEW

1. Copy and complete: Bacteria, \_\_\_\_\_ and most protists are \_\_\_\_\_-celled organisms. They are only made up of \_\_\_\_\_ cell.
2. 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, vacuole.

Part	Bacteria	Yeast	Protist
Cell wall	✓	✓	✗

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



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

