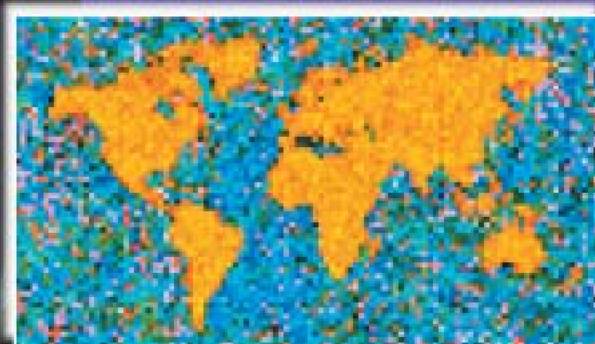
CHAPTER 7

Cells

When you play a computer game, you move a hero about, drive a car, fly a plane, or even speed through space. If you are good at the game, your hero survives, beats the clock or wins the race. The images you see on the screen are made up of tiny boxes, or pixels, of colour on the screen. These boxes have different colours. Groups of boxes of the same colour work together to make one object — like a rock. Or the tiny boxes of colour may just form part of an object — like a cloud.



Your body is made up of very tiny 'boxes'. These are called cells. You have about 10 trillion of them! To carry out the various tasks your body needs, you have more than 200 different types of cell, including muscle cells, nerve cells, liver cells and skin cells. Similar types of cell are grouped together in your body. They form the tissues and organs that carry out everyday tasks like breathing, walking, digesting food and even sleeping.

1 How is your body like the image on a computer screen?
2 What do the cells in your body really look like?
3 Why do different types of cell have different shapes?
4 What happens inside your cells to keep you alive?

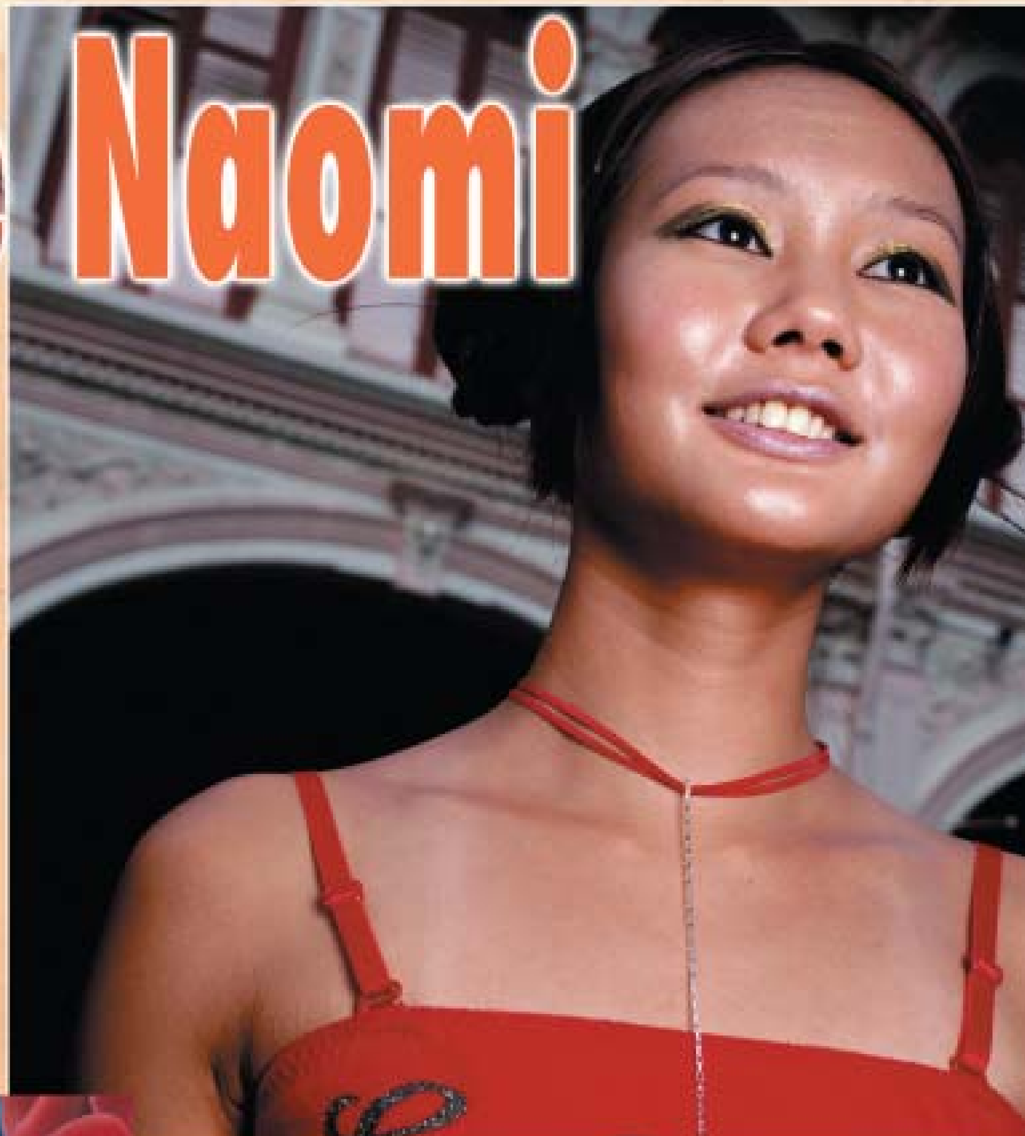
You will discover

What a cell is
Ways to see cells
How cells keep you alive
Why cells are so small
How and why plant and animal cells are different

Health & Beauty Weekly

28 NOVEMBER 2008 WEATHER: FINE, 22 °C

Inside Naomi



by Mike Roscopic

Supermodel and fashion designer Naomi Daniel's latest exhibition called *The Beauty Inside* promises to be a huge success. I headed off to the gala opening last week to find the answer to the question that everybody is asking, 'Is beauty just skin deep?'

Naomi's manager Art Buckle explained as he met me at the entrance. 'Naomi is just like every other human being . . . on the inside. We are all made up of tiny **cells**. Each of us has trillions of these cells in our body. And each human cell is a beautiful packet of life', he said.

The exhibition is packed with photographs that show what Naomi looks like inside. There are poster-size images of blood cells, skin cells, muscle cells, brain cells, lung cells and stomach cells. Art explains, 'Most people don't know what they look like on the inside. Each one of these cells helps keep Naomi alive'.

According to Art, the inside of Naomi's body, just like all other humans, is at least as beautiful as the outside. As we admired the huge **photomicrograph** of human blood (shown at left), he pointed out the white blood cells, red blood cells and platelets. He explained, 'The red blood cells deliver **oxygen** to every cell in your body, the white blood cells fight disease and the smaller platelets clump together to plug up any holes that are made in your blood vessels'.

He added, 'Each cell in your body is constantly taking in food and oxygen, and removing wastes'.

Go to worksheet 31

Living takes teamwork

As we moved onto a photograph of a soccer team I asked Art what this has to do with cells inside Naomi's body. His answer made sense. 'Your cells work together as a team to keep you alive', he said. He told me that cells in a body are a bit like that soccer team. 'There are lots of different kinds of cells in your team. Some are your running cells — your muscles. Others are your thinking cells — your brain cells. They all work together as a team, each playing their role in helping you move, eat, drink, sleep, play soccer, sing or play the guitar.'

It turns out that if you are looking at the inside of a human body, you just can't tell who's who. Art stood in front of two photographs of skin cells under a microscope. He asked, 'Which one is Naomi's?'. They both looked the same to me so I couldn't answer. Just as well — the skin cells belonged to a newborn baby! I didn't feel so silly when Art said, 'The amazing truth is that, on the inside, we all look just the same'. He added, 'The muscle cells of a newborn baby are about the same size as your muscle cells, and the same as those of supermodel Naomi. You and Naomi just have many more muscle cells than a baby'.

Is your skin dull and dry?

Overexposure to the Sun or air-conditioning can dry out your skin cells.

New, improved **CELL GELL** replaces water in your skin cells with its deep, penetrating 'hydrospheres'.

If you order this month, you'll receive a free packet of CELL SCRUB, our special soap that helps remove dead skin cells to expose fresh, new skin cells.

Big ones, small ones

The exhibition shows some of the largest and smallest cells that exist. Art says you can often work out what job a cell does by looking at its shape and size. In front of us was a display of a real egg from an ostrich. The label on the ostrich egg said:

> *Most cells can be seen only with a microscope. But in this egg is the world's largest single cell. The egg weighs 1.8 kg. The cell inside is more than 10 cm across.*

Art asked, 'Why do you think this one cell is so large?'. I just took a guess and crossed my fingers. I said, 'An egg cell has to store lots of food'. Luckily I was right. Art explained in more technical terms: 'You're right. A bird's egg cell has lots of **cytoplasm** which contains the stored food'. He went on to ask, 'Did you know that an ostrich egg is 1500 times bigger than a human egg?'. This makes sense too. A bird lays eggs. Their eggs need to have many days worth of food inside them to help the chick grow and hatch out of the egg. Women don't lay eggs because the growing baby stays inside the body. Human egg cells don't have to store as much food as bird eggs because the growing human baby gets its food directly from its mother and not from inside an egg.

Naomi's exhibition is well worth a visit. I had a great time at the museum and learnt heaps! I came away feeling confident that I knew the answer to that big question. *Beauty is certainly NOT just skin deep!*

Activities

REMEMBER

1. What is Naomi and every other human (and every animal and plant) made up of?
2. Which cells are your thinking cells?
3. Which animal has the largest cell in the world?
4. Why does the egg cell of a bird need to be large?
5. Why is a human egg cell smaller than an ostrich egg cell?

THINK

6. How are your cells like a soccer team?
7. Why can't you tell the difference between Naomi's, a newborn baby's and your own skin cells?
8. If a newborn baby's cells are the same size as Naomi's cells, why is the baby smaller?

INVESTIGATE

9. Use the 'Summary of key terms' on page 168 to find out what a photomicrograph and cytoplasm are.
10. Find out what a human sperm cell looks like and suggest a reason for its shape.

CREATE

11. Form a small group and create your own exhibition that shows that there is beauty below the skin.

✓ checklist

I can:

- ☐ explain that humans are made up of many tiny cells
- ☐ recognise that different types of cell in the human body work together as a team.

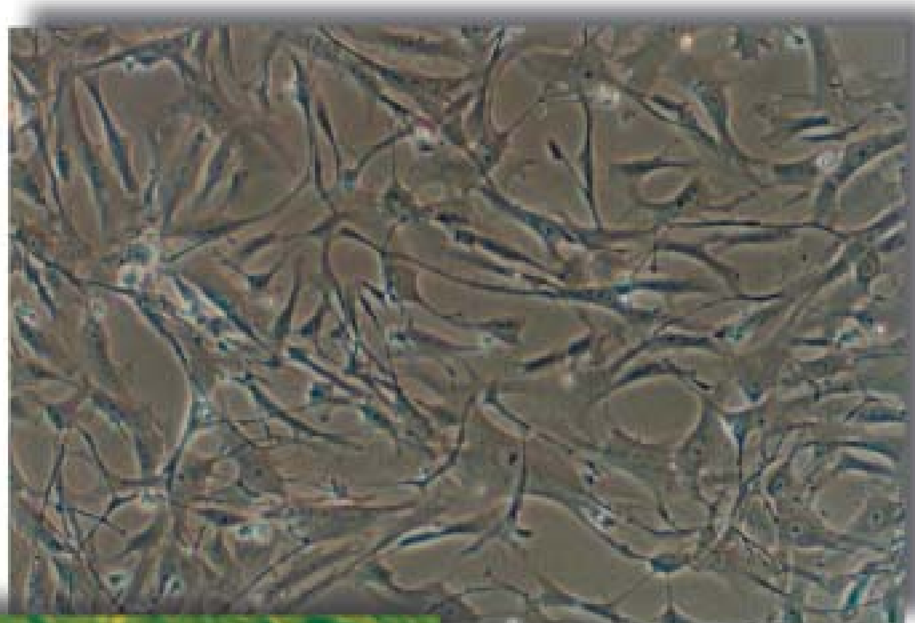
Living building blocks

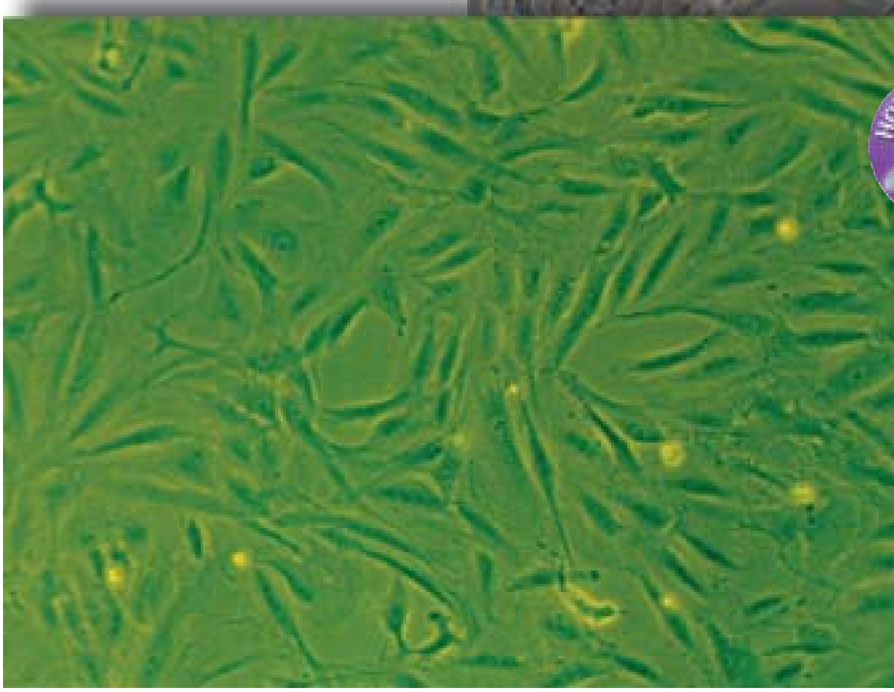
You, and every animal and every plant, are made of **cells**. Cells are the building blocks of life — the smallest units of living things. The cells of an ant, mouse and elephant are all quite similar to your cells. In fact, the cells of an elephant are about the same size as your cells, and those of a mouse or an ant. The elephant is bigger than you simply because it has many more cells, and a great many more than an ant.

The cells in all animals and plants work together to perform the many jobs needed to keep them alive.

There are many different types of cell in your body. Their size and shape depends on which job they do. All cells are very, very small. The cells in your blood would need to be magnified ten times before you could ever see that they were there.

Human muscle cells look very similar to the muscle cells in an elephant, a dog or a rat. That's because they do a similar job. These cells come from the muscles in an artery — human on the top, rat on the bottom.

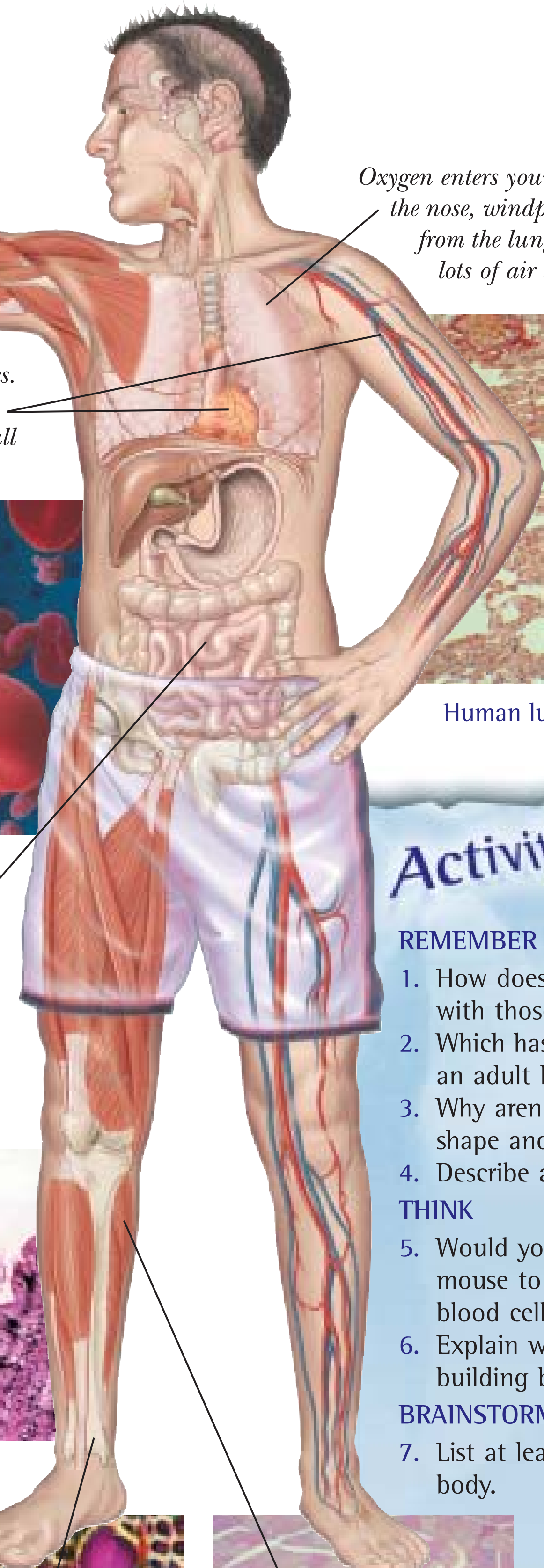




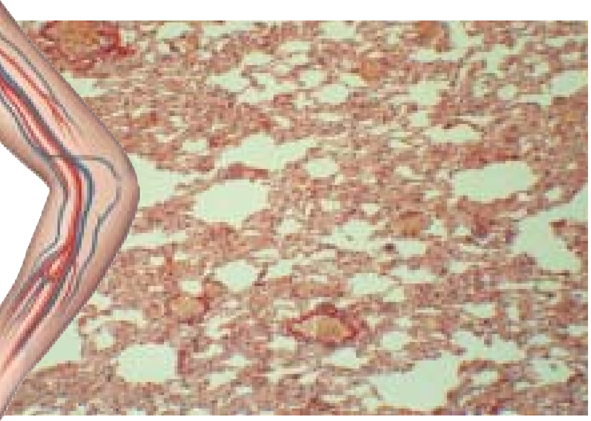
HOW ABOUT THAT!

Cell count

An adult human body is made up of more than one million million cells. That's amazing when you consider that a human life begins in the mother's **womb** with only two cells. New cells are being produced all the time, even when you've stopped growing. That's just as well, because while you are alive, about 50 million of your cells die every second and need to be replaced.



Oxygen enters your body through your respiratory system: the nose, windpipe and lungs. Your blood collects oxygen from the lungs before taking it to other cells. There are lots of air spaces between the groups of cells.



Human lung cells

The circulatory ***system*** *moves blood around your body. It includes your heart, veins and arteries. Most of the cells in your blood are red blood cells. These cells carry* ***oxygen*** *to all of the other cells in your body.*

Human red blood cells

The digestive system involves the mouth, liver, stomach, small intestine, large intestine, rectum and anus. In your small intestine, cells are lined up along the edges of finger-like structures. Digested food passes through these cells into your blood.

Human small intestine cells

Bones and muscles help support and move the body. The bone cells work together to provide strength. The muscle cells work together to stretch or relax.

Human bone cells

Human muscle cells

Activities

REMEMBER

1. How does the size of your cells compare with those of an elephant?
2. Which has more cells — an adult elephant or an adult human?
3. Why aren't all cells in your body the same shape and size?
4. Describe a human red blood cell.

THINK

5. Would you expect the red blood cells in a mouse to be the same shape as human red blood cells? Give a reason for your answer.
6. Explain why cells are sometimes called the building blocks of life.

BRAINSTORM

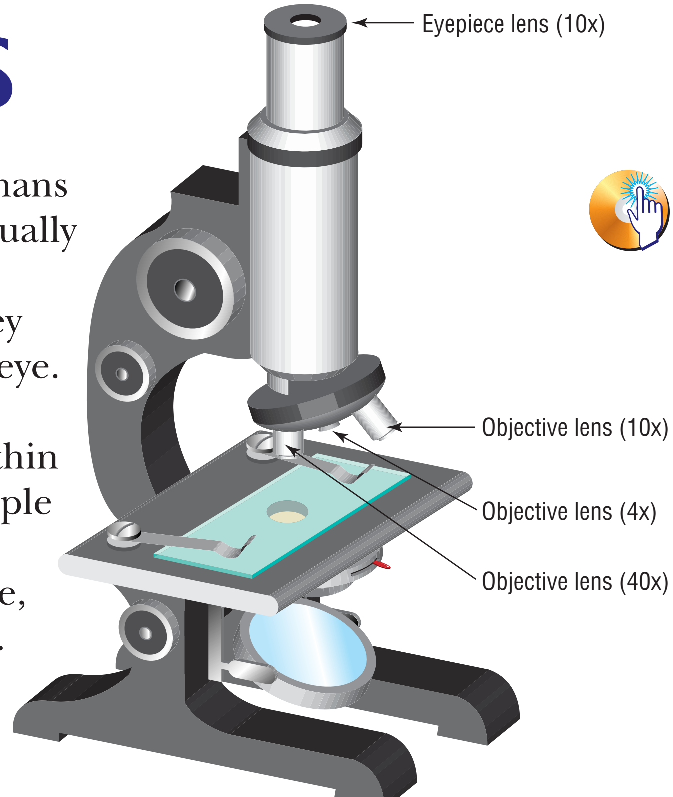
7. List at least 10 types of cell found in your body.

✓ checklist

I can:
- ☐ explain that cells are the smallest living units of plants and animals
- ☐ recognise that the shape and size of cells depends on the job they do.

Seeing cells

Cells existed long before the first humans walked the Earth . . . but no-one actually saw a cell until the seventeenth century. This is because cells are so small that they cannot be seen with the unaided human eye. In 1665, Robert Hooke became the first person to see cells when he looked at a thin slice of cork through one of the first simple **light microscopes**. Seeing the cork cells magnified to about 30 times their real size, he described them as ‘many little boxes’. The microscopes used in schools today can magnify things to about 400–500 times their real size.

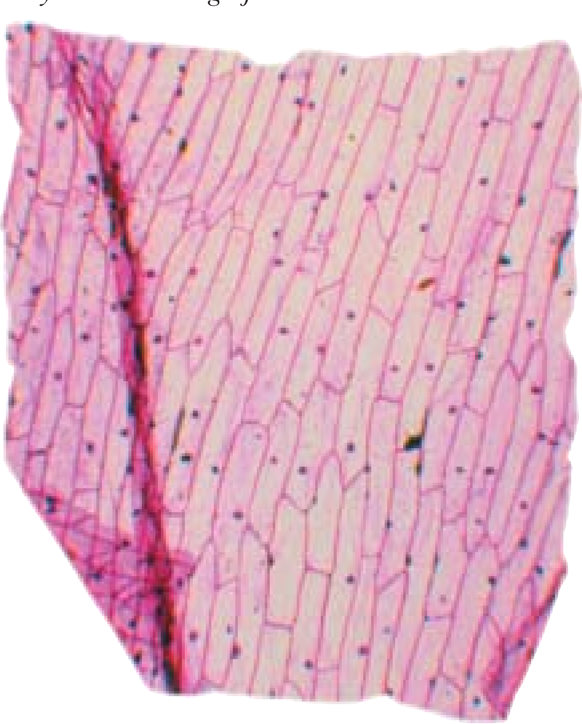


A school microscope.
Not all school microscopes look exactly like this. Your school’s microscopes might not have all of the features of this one. They might even have additional features.

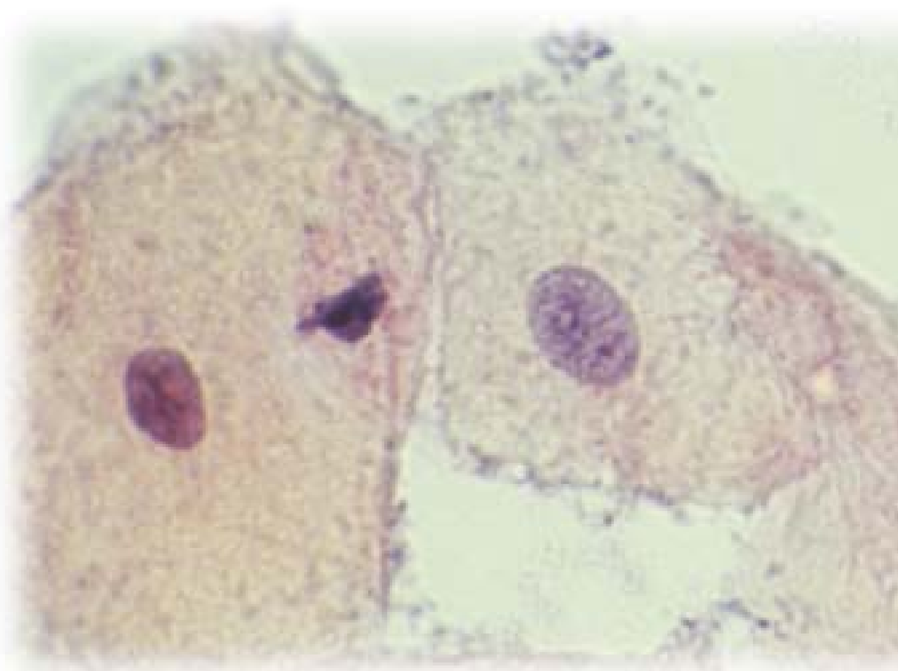
The microscopic world of cells

To calculate the total magnification of a microscope, multiply the magnification written on the eyepiece by the magnification written on the objective lens. For example, a 10× eyepiece and a 40× objective lens would provide 10 multiplied by 40 = 400× magnification. This combination magnifies things to 400 times their actual size. You can use different combinations of microscope eyepieces and objective lenses to get different magnifications.

These onion cells form the skin of the onion. They have been magnified to nine times their real size.



Human cheek cells are about 0.05 mm wide. The smallest object visible to the unaided eye is one-tenth of a millimetre or 0.1 mm across. Because cells are smaller than 0.1 mm across, we need a microscope to see them. This photograph (below) shows the cheek cells magnified to 1000 times their real size.

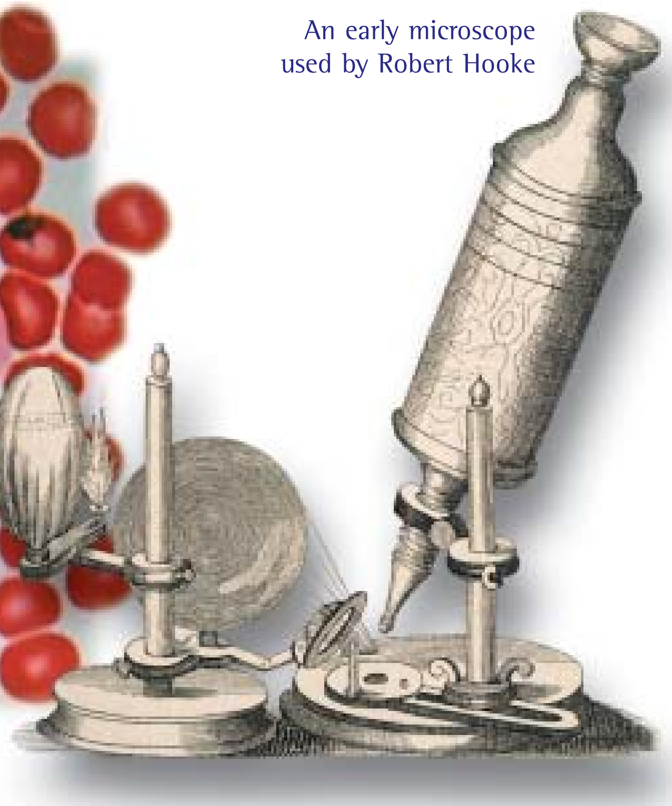


Go to worksheet 32

The first light microscope magnified about 30 times. Today's light microscopes magnify up to 1500 times. **Electron microscopes** are even more powerful and magnify up to 1 million times.

Human blood cells as seen through a light microscope

An early microscope used by Robert Hooke



An electron microscope

Human red blood cells as seen through an electron microscope

Making a wet mount: Onion cells

Read all the instructions before you begin. You can read more about using a microscope in the Laboratory Toolbox (pages 247–8).

You will need:

microscope	dropping bottle of water	toothpick
clean microscope slide	forceps (tweezers)	small section of a peeled onion
coverslip	scalpel	blotting paper.

- Use the dropper to place a drop of water on a microscope slide.

- Use forceps to peel a small piece of the very thin, almost transparent onion skin from the inside surface of the onion.

- Put the piece of the onion skin into the drop of water on the microscope slide.

1. Set the microscope to low magnification (see page 247). What is the total magnification?
2. Draw and label a group of cells. Is your drawing large enough to see clearly?
3. Set the microscope to a higher magnification. What is the total magnification?
4. Find the same group of cells that you were looking at on low magnification. Draw them again at this higher magnification. Add any extra detail that you can now see.

- Place a coverslip over the top of the water containing the onion skin. Use a toothpick to lower the coverslip gently to avoid air bubbles. Use blotting paper to soak up any excess water outside the coverslip.

Drawing cells — size matters!

A key skill in using microscopes is accurately drawing what you see.

- Your drawings of cells should be large enough to show detail.
- Look down the microscope with one eye but keep both eyes open. Don't squint! Squinting is hard work for your eye muscles.
- Choose two or three typical cells to draw.
- Use a sharp HB pencil.
- Give your drawing a title and include the date (e.g. Onion cells, 2 May 03).
- Include the magnification (e.g. 400×).

Staining onion cells

Read all the instructions before you begin. You can read more about using a microscope in the Laboratory Toolbox (pages 247–8).

!CAUTION: Take care when using stains. Stains can stain your clothing and books. Always keep stains where they won't be knocked over. Replace droppers on bottles promptly after use. Use newspaper or other covering to protect tables.

You will need:

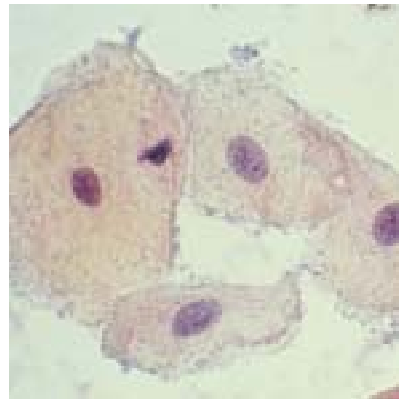
microscope	microscope slide
dropping bottle of methylene blue or other similar stain (check with your teacher)	
coverslip	forceps
small section of a peeled onion	
dropping bottle of water	toothpick.

- Use the dropper to place a drop of methylene blue (or other stain) in the centre of a microscope slide.
- Use forceps to place the section of onion in the drop of stain. Allow the stain to soak in for about three minutes. Then use blotting paper to soak up any excess stain.
- Place one drop of water on the section of onion.
- Use a toothpick to lower the coverslip gently onto the slide.
- View the sample with the microscope on low power, then on high power.

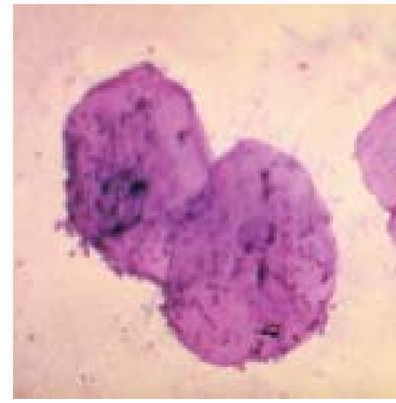
1. Make a drawing of a group of four or five cells. Include as much detail in your drawing as possible.
2. Give your drawing a title and date. Don't forget to include the magnification.
3. What difference does the stain make to your observation of onion cells?

Adding colour cells

It is much easier to see the details of cells if they are coloured with stains. Unstained cells are harder to see because cells do not normally have much colour in them.



Unstained human cheek cells



Stained human cheek cells

Activities

REMEMBER

1. What is the smallest size we can see with the unaided eye?
2. In which century was the light microscope invented?
3. Which type of microscope can magnify objects up to:
   (a) 1 million times?
   (b) 1500 times?
4. Why are stains used to make microscope slides?

THINK

5. What total magnification do a 10× eyepiece and a 100× objective provide?

INVESTIGATE

6. Find out how a light microscope works.
7. Find out how an electron microscope works.
8. Make a table to compare the light and electron microscope using these headings: 'Magnification', 'Advantages of use', 'Disadvantages of use'.
9. Observe the following under the light microscope: cat hair, dog hair and human hair. Suggest why hair can be used to identify some animals.

checklist

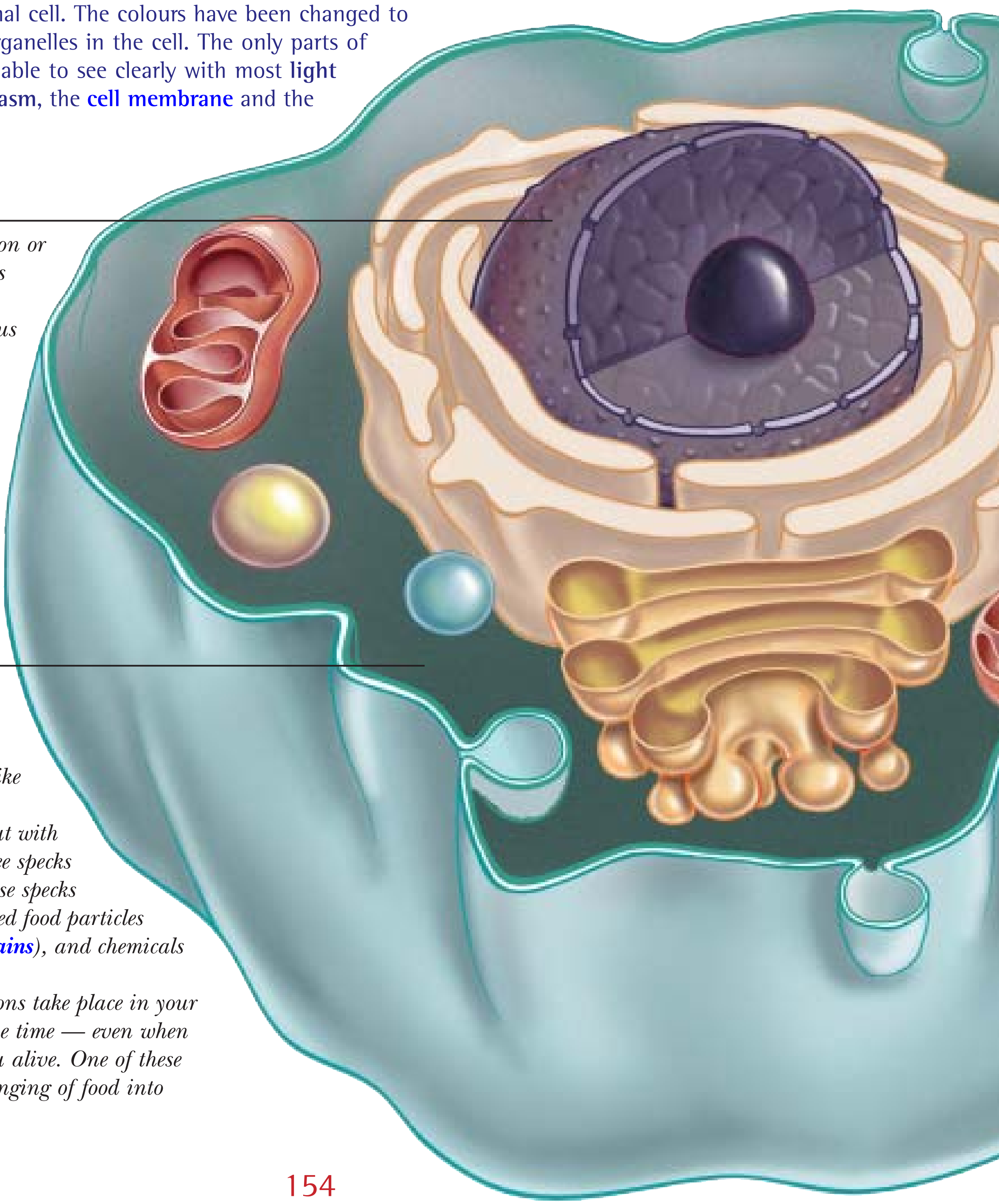
I can:

- ☐ explain why microscopes are used to look at cells
- ☐ use a microscope to see cells
- ☐ make a wet mount
- ☐ stain cells
- ☐ make accurate drawings of cells.

Inside cells

Most of the **cells** in your body take in food and **oxygen**, remove wastes, and produce new living cells. Your cells control the amount of water they hold, produce important chemicals, react to changes in the environment and reproduce to give more cells. So can the cells of every animal and plant. Every cell contains 'little organs' called **organelles**. There are different types of organelle and each type plays a role in helping the cell survive.

A look inside a typical animal cell. The colours have been changed to make it easier to see the organelles in the cell. The only parts of the cell that you would be able to see clearly with most **light microscopes** are the **cytoplasm**, the **cell membrane** and the **nucleus.**



Nucleus

*The nucleus is the information or control centre of the cell. This roundish organelle controls what the cell does. The nucleus contains **chromosomes** that carry information that is passed on to newly created cells. The nucleus looks like a clear globule in a living cell. It appears much darker than the cytoplasm when the cell is stained.*

Cytoplasm

*The cytoplasm is the jelly-like material inside a cell. In a living cell, the cytoplasm is usually moving about. It is like mucus in texture — slimy! Cytoplasm is mostly water, but with a light microscope you can see specks and blobs floating in it. These specks and blobs are organelles, stored food particles (like fat globules or **starch grains**), and chemicals such as salts and proteins.*

Important chemical reactions take place in your cytoplasm. These occur all the time — even when you are asleep. They keep you alive. One of these chemical reactions is the changing of food into energy for your cells to use.

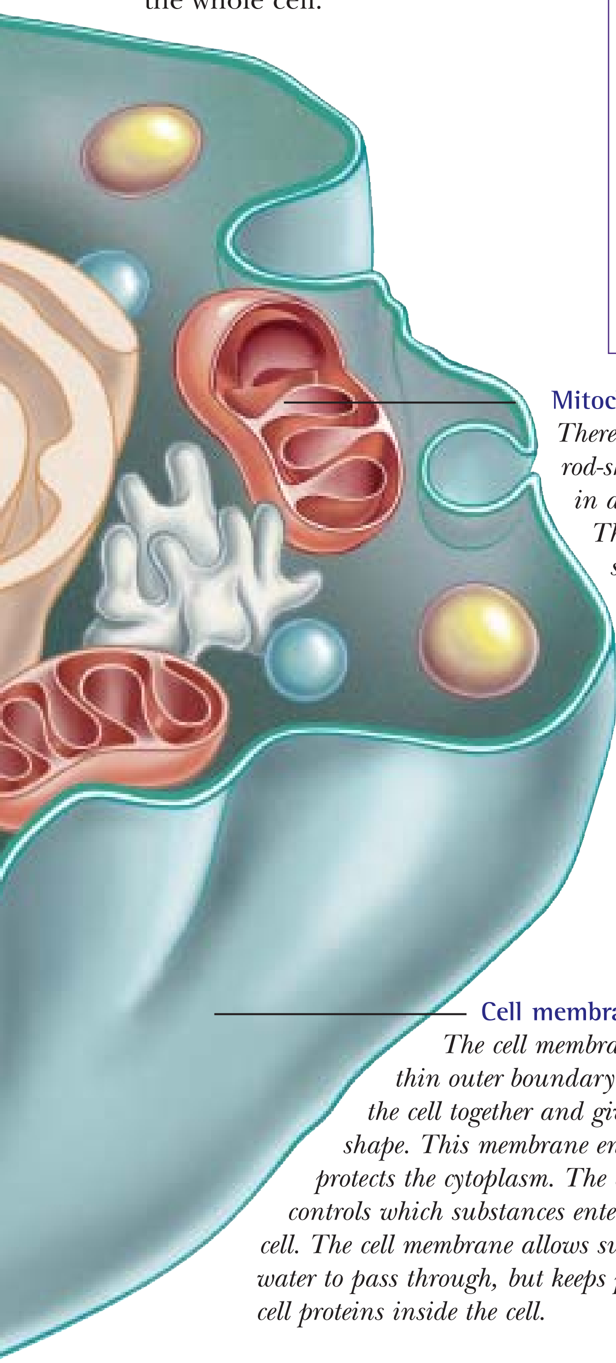
Go to worksheet 33

Why are cells so small?

Cells have to be very small because they must be able to take up the substances they need and remove wastes quickly. The bigger a cell is, the further the centre is from the edge and the longer it takes to move material in and out. If a cell was too big, it would not be able to take up or remove materials fast enough to support itself. In a cell that was too big, the nucleus would not be able to pass on information and control the whole cell.

When cells die

Most of the cells in your body don't live for as long as you do. Usually, when they die they are replaced. The cells that make up your skin live for only between 20 and 35 days. Skin cells are able to replace themselves before they die. Luckily they don't all die at the same time! The dead cells are rubbed off, or just fall from your body. They land on the floor, on furniture and in your bed. In fact, most of the 'dust' that you sweep up or vacuum is actually dead skin cells. Snakes, on the other hand, usually shed their dead skin cells all at once. Young snakes shed their skin every six to eight weeks. Adult snakes shed their skin only once every year or two.



Mitochondrion

There are many of these rod-shaped organelles in an animal cell. The ***mitochondria*** *supply energy wherever it is needed in the cell. They are too small to be seen clearly with a light microscope.*

Cell membrane

The cell membrane is the very thin outer boundary of a cell. It holds the cell together and gives the cell its shape. This membrane encloses and protects the cytoplasm. The cell membrane controls which substances enter and leave the cell. The cell membrane allows substances such as water to pass through, but keeps particles such as cell proteins inside the cell.

Activities

REMEMBER

1. What are organelles? List two examples of organelles.
2. What substance fills a cell?
3. Why is the nucleus important to a cell?
4. What is the role of the cell membrane?
5. Why do cells need to be so small?

THINK

6. Why do mitochondria move around in the cytoplasm?
7. If most of our cells don't live as long as we do, how do we stay alive?

SKILLBUILDER

8. Look through a microscope at prepared stained slides of animal cells under high power. Make accurate drawings of cells you can see. Label any features you can identify.

checklist

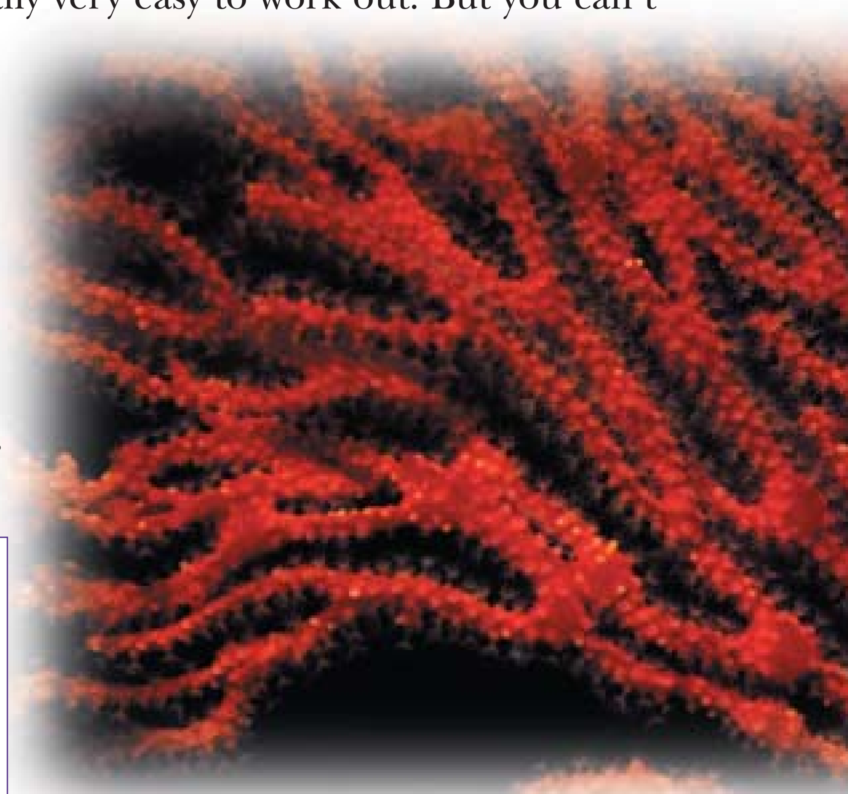
I can:
- ☐ name the main parts of cells
- ☐ state the role of each of the main parts of cells
- ☐ identify structures in cells
- ☐ make accurate drawings of cells.

Plant or animal?

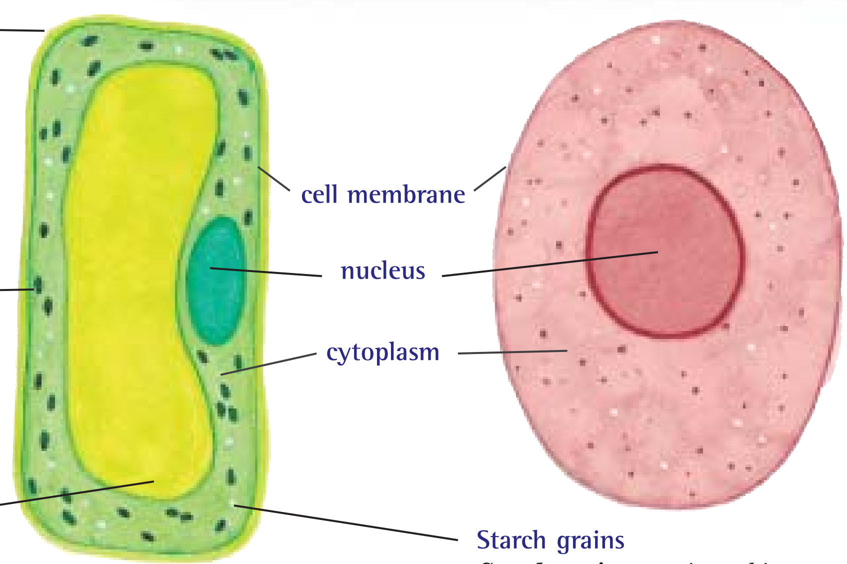
The organism in the photograph below is a coral on the Great Barrier Reef. Is it a plant or an animal? It's usually very easy to work out. But you can't always tell with a quick look. You can decide whether an organism is a plant or animal by looking at its basic building blocks — its **cells**.

All plant and animal cells have a **cell membrane**, **cytoplasm** and a **nucleus** at some stage in their life. That's because all plant and animal cells need food for energy, water and a 'control centre'. Plant cells also have **cell walls**, **chloroplasts** and **vacuoles**. Plants need those extra features in their cells to make and store food, and to keep their shape. Some animal cells have vacuoles, but they are very small.

The cellulose fibres in cell walls in trees are used to make paper. The cork used in wine bottles is also made of cell walls. The cork cells have died and only the wall is left.



Is this a plant or an animal?



Cell wall

The tough covering around plant cells is the cell wall. It gives plant cells strength and holds them in shape. Cell walls are made of a substance called ***cellulose****. Water and dissolved substances can pass through the cell wall. Animal cells do not have a cell wall.*

Chloroplasts

Chloroplasts are the oval-shaped ***organelles*** *found only in plant cells. Chloroplasts contain a green substance called* ***chlorophyll****. Chloroplasts use energy from the Sun to make food. Not all plant cells contain chloroplasts. They are found only in leaf and stem cells.*

Vacuole

The vacuole is an organelle used to store water and dissolved substances. Vacuoles also store food and waste material. Vacuoles can look empty, like an air bubble. Plant cells usually have one large vacuole. The mixture inside a plant's vacuoles is called ***cell sap****. The red, blue and violet colours that you often see in plant leaves and flowers are due to the substances stored in vacuoles. Most animal cells don't have vacuoles.*

Starch grains

Starch grains *are tiny white granules in the cytoplasm. These granules are not organelles. They are a form of food. The food made by the plants is stored as starch for later use.*

Comparing some features of plant and animal cells

Feature	Plant cells	Animal cells
Cell membrane	Yes	Yes
Cytoplasm	Yes	Yes
Nucleus	Yes	Yes
Cell wall	Yes	No
Vacuoles	Yes, large	Sometimes, but are small
Chloroplasts	All plants have some cells with these.	No

The coral shown in the photograph on the left is actually a colony of tiny animals called **coral polyps**. Most coral polyps are only a couple of centimetres in diameter. Each cell of a coral polyp has a cell membrane, cytoplasm and a nucleus. None of the coral polyps have a cell wall or chloroplasts.

Comparing plant and animal cells

You will need:
microscope
prepared slide of leaf epidermal cells
prepared slide of skin cells.

- Look at a prepared slide of the cells on the surface of a leaf (epidermal cells).

1. What shape are the cells? Draw three or four cells clearly. What features can you see that tell you these are plant cells? Label the features of the cell.

- Look at a prepared slide of the skin cells.

2. What shape are the cells? Draw three or four cells clearly. What features can you see that tell you these are animal cells? Label the features of the cell.
3. Why do these plant and animal cells have a similar shape?

Activities

REMEMBER

1. List three features that are found in both plant and animal cells.
2. List two features of plant cells that are not found in animal cells.
3. How do plant cells obtain food?
4. What material are cell walls made of?
5. Where in a cell do you find cell sap?
6. What happens inside chloroplasts?

THINK

7. Why do animal cells need to be more flexible than plant cells?
8. Which cell structure could be described as a 'rigid jacket'? Would you find this in a plant or an animal cell?
9. How do we know that a coral polyp is an animal?

SKILLBUILDER

10. Look through a microscope at prepared stained slides of animal cells under high power. Make accurate drawings of cells you can see. Label any features you can identify.

INVESTIGATE

11. Research different products made from plant cell walls. In what ways do people use them?

CREATE

12. Make a model of a plant and animal cell using edible materials like jelly, lollies and sponge cake. Think carefully about what you should use for each part. Devise a suitable way of labelling all the parts of your model cells.

!CAUTION: Do not eat any of the parts if your model has been made in the science laboratory!

checklist

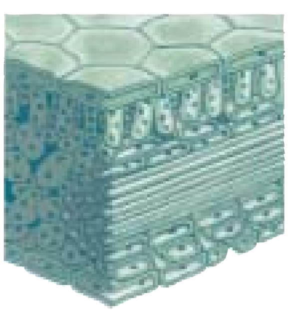
I can:
- ☐ describe the differences between plant and animal cells
- ☐ describe features that plant and animal cells have in common
- ☐ explain why there are differences between plant and animal cells.

Plants up close

The job of keeping a plant alive is shared between different **cells**. Some cells mainly make food while others move water and minerals around the plant. There are even special cells that shut the pores in a leaf to stop a plant drying up in hot weather. Because each of these types of cell does a different job, they look different. A cell's shape, size and features all depend on the job it has to do.

The outer lining

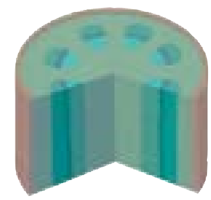
The upper and lower ***epidermal cells*** *protect the top and bottom surfaces of the leaf. These cells have a flattened shape so that they can easily cover the whole leaf. Leaf epidermal cells do not usually have* ***chloroplasts*** *because their role is to protect, not to make food. Stems and roots also have an outer lining of cells for protection.*



Plant highways

The stem contains long hollow tubes. These tubes run all the way from the end of each leaf, through the stem, down to the deepest root tips.

One set of tubes transports water and dissolved minerals up from the roots to the stem and leaves. This set of tubes is made up of long narrow cells called ***xylem cells****. Xylem cells have to die before they can link together end to end to form tubes. When each xylem cell dies, its top and bottom walls dissolve, forming a long tube made up of dead cells. Xylem cells have very thick walls with lots of* ***cellulose****. This makes them very strong. Tiny holes in their dead cell walls allow substances to move in and out of the tube. Xylem cells form the inner parts of stems, trunks and branches. Xylem cells form the bulk of the wood that makes up a tree trunk.*

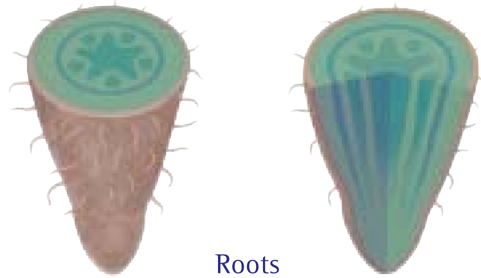


A different set of tubes, made up of ***phloem cells****, transports food made in the leaves to other parts of the plant. Like xylem cells, the phloem cells join end to end to form long hollow vessels.*

On guard

Among the lining cells are pairs of special cells called ***guard cells****. These control the movement of gases into and out of the leaf though pores called* ***stomata****. When water enters the guard cells, they expand and pull open the pore. One leaf pore is called a 'stoma'; the plural is 'stomata'. When these stomata are open, water vapour and gases (carbon dioxide and* ***oxygen****) can move into and out of the leaf. During hot, dry weather the guard cells close the pores so that the plant does not lose too much water.*

As well as the guard cells, most leaves also have a waxy coating that helps reduce the loss of water and gas.



Roots

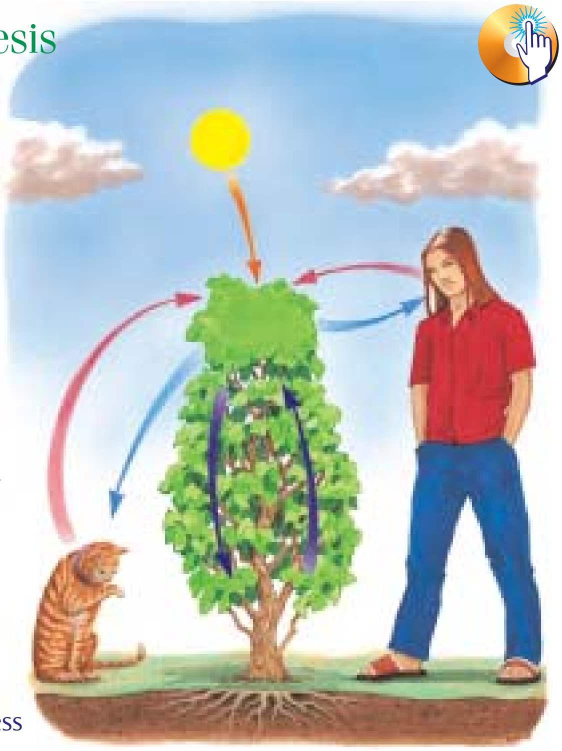
Go to worksheet 34

HOW IT WORKS

Photosynthesis

Plants make their own food using a process called **photosynthesis**. This happens because **chlorophyll** in the chloroplasts is able to absorb energy from the Sun.

Plants use the Sun's energy, carbon dioxide in the air (which animals breathe out) and water and minerals in the soil to create sugars (their food) and oxygen (which we breathe in).



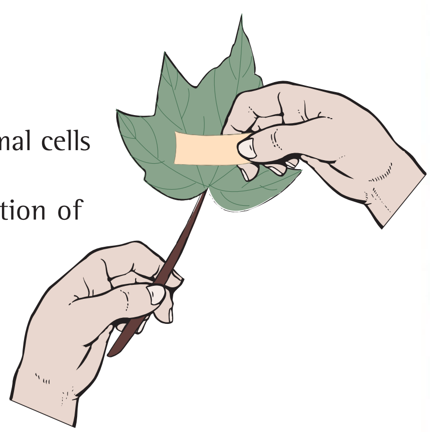
The photosynthesis process

HANDS ON SCIENCE

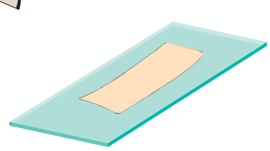
Observing leaf epidermal cells

You will need:
leaf
clear sticky tape
microscope slide
microscope.

You can make a 'slide' of leaf epidermal cells with sticky tape.



- Place some sticky tape over a section of the underside of a leaf.
- Press the sticky tape firmly onto the leaf.
- Tear the tape off. Some of the lining cells should come off with the sticky tape.
- Press the tape, sticky side down onto a microscope slide.
- View the sticky tape under the microscope.
- Try to find a pair of guard cells and one of the stomata.



1. Is the stoma (the opening) open or closed?
2. Make a drawing of a group of cells, including the guard cells. Include as much detail in your drawing as possible.
3. Label the guard cells and stomata.
4. Title and date your drawing. Write down the magnification used.

MI BODILY/KINAESTHETIC

Activities

REMEMBER

1. Why do the epidermal cells in leaves have a flattened shape?
2. How does the waxy coating found on most leaves protect them?
3. How do xylem cells change into long tubes?
4. Which cells make up the tubes that transport food in the leaves down through the stem?

THINK

5. How did guard cells get their name?
6. Guard cells and stomata mainly occur only on the lower part of the leaf, away from direct sunlight. Suggest why.
7. Would you expect to find chloroplasts in roots? Give a reason for your answer.
8. Why are all plant cells not the same?

CREATE

9. Draw a flow chart to show the processes that occur during photosynthesis.

INVESTIGATE

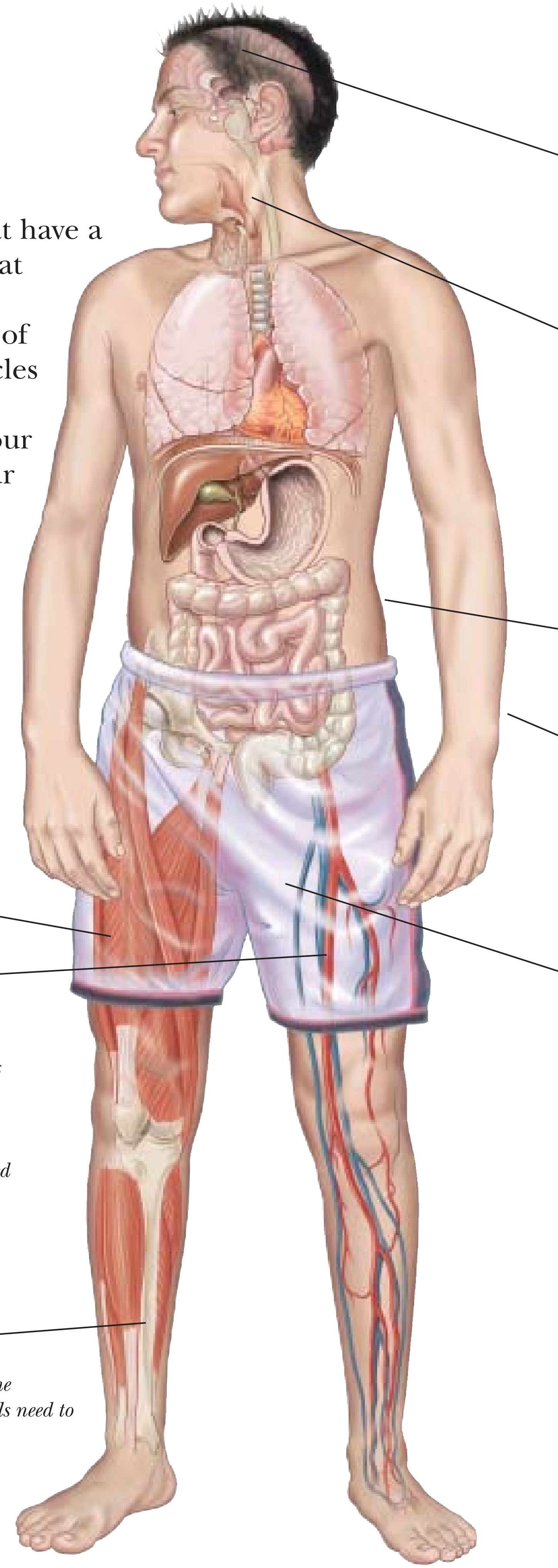
10. Look at prepared microscope slides of plant leaves, roots or stems. For each slide, accurately draw a group of cells and label the cell types.

✓ checklist

I can:
- ☐ describe the function (job) of different types of plant cell
- ☐ explain how the shape and features of plant cells help them do their job.

Animal cells

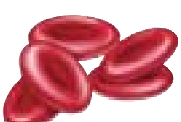
Like all other animals, humans have **cells** that have a **cell membrane**, **cytoplasm** and a **nucleus** at some stage in their life. You have about 200 different types of cell in your body. Each type of cell does a specific job. The cells in your muscles look a bit different from the cells in your skin because they do different tasks. The cells in your blood do not look the same as the cells in your bones. Every cell must be the right size and shape for its job!



Every cell has its purpose

Muscle cells

Muscle cells are long and elastic. Long thin cells can slide further over each other to allow you to move. There are even different types of muscle cell. The walls of your blood vessels and parts of your digestive ***system*** *have 'smooth muscle' cells. The muscles that are joined to your bones are called 'skeletal muscles'. Skeletal muscles work in pairs — one muscle contracts (shortens) and pulls the bone in one direction while the other muscle relaxes.*

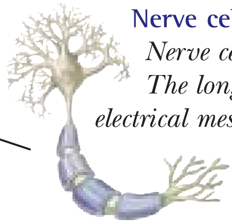


Red blood cells

Red blood cells carry ***oxygen*** *around the body. Their round shape helps them move easily through blood vessels. The nucleus in a red blood cell dies soon after the cell is made. Without a nucleus, red blood cells live for only a few weeks. The body keeps making new blood cells to replace those that have died. Red blood cells are made in* ***bone marrow*** *at the rate of 17 million cells per minute! This is why most people can donate some of their blood to the Red Cross without harm. White blood cells, which are larger than red blood cells, are also made in the bone marrow. Their job is to rid the body of disease-causing organisms and foreign material.*

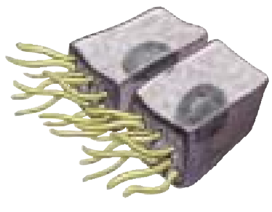
Bone cells

Minerals such as calcium surround your bone cells. The minerals help make bone cells hard and strong. Bone cells need to be hard so that they can keep you upright.



Nerve cells

Nerve cells are very long and have a star shape at one end. The long shape of nerve cells helps them detect and send electrical messages through the body at the speed of a Formula 1 racing car. There are nerve cells all over your body. They allow you to detect touch, smell, taste, sound, light and, unfortunately, pain.



Living filters

The cells that line your nose, throat and windpipe are a type of lining cell. They have hair-like tips called ***cilia****. These cells help protect you by stopping dust and fluid from getting down your windpipe. The cilia can also move these substances away from your lungs. You remove some of these unwanted substances whenever you sneeze, cough or blow your nose.*

Energy storage

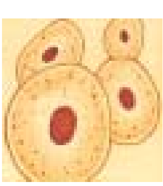
Some cells store fat. Fat stores a lot of energy for cells to use later. Round shapes are good for holding a lot of material in a small space. Fat cells are mostly found underneath your skin, especially in the chest, waist and buttocks.

Body liners

Special cells line the inside and outside surfaces of your body. These are the cells that form your skin and the lining of your mouth, nose, throat, stomach and intestine. These cells have a flattened shape so they can better cover and protect your body.

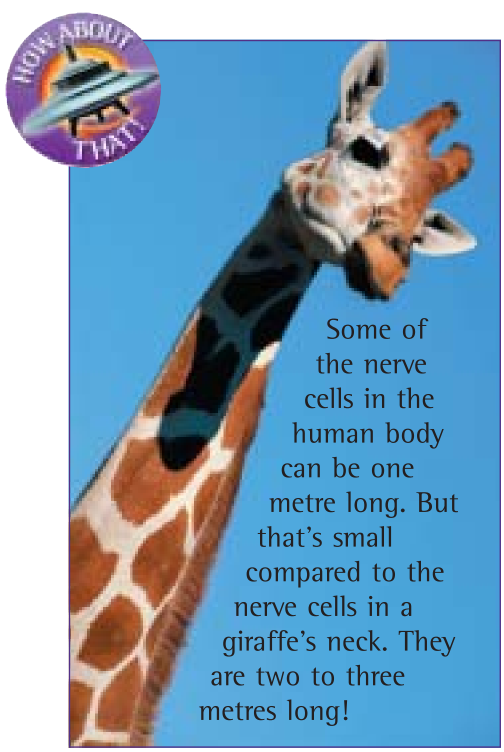
Made for swimming

Sperm cells have a long tail which helps them swim towards egg cells. Only males have sperm cells.



Egg cells

Egg cells are some of the largest cells in a human body. Their large round shape helps them store plenty of food. Only females have egg cells. When a sperm cell moves into an egg cell, the egg cell is ***fertilised****.*



Some of the nerve cells in the human body can be one metre long. But that's small compared to the nerve cells in a giraffe's neck. They are two to three metres long!

Activities

REMEMBER

1. What three features do all animal cells have at some stage in their life?
2. Which type of animal cell spends most of its life without a nucleus?
3. Which type of cell is found in the walls of blood vessels?
4. What special job is done by:
   (a) blood cells?
   (b) skin cells?
   (c) nerve cells?
5. How do the cilia in your nose, throat and windpipe protect your lungs?
6. Why are egg cells so large?

THINK

7. Redraw the table below with the correct shape next to each type of cell.

Cell	Shape
(a) Muscle cells	Disc shaped
(b) Egg cells	Star shaped
(c) Red blood cells	Flat
(d) Nerve cells	Long, thin
(e) Skin cells	Spherical

8. Explain how the shape of each of the cells in the table above helps the cell do its job.

SKILLBUILDER

9. Compare the cells from different animals. Use a microscope to look at prepared slides of blood cells from a human and a frog. Draw and describe the cells.

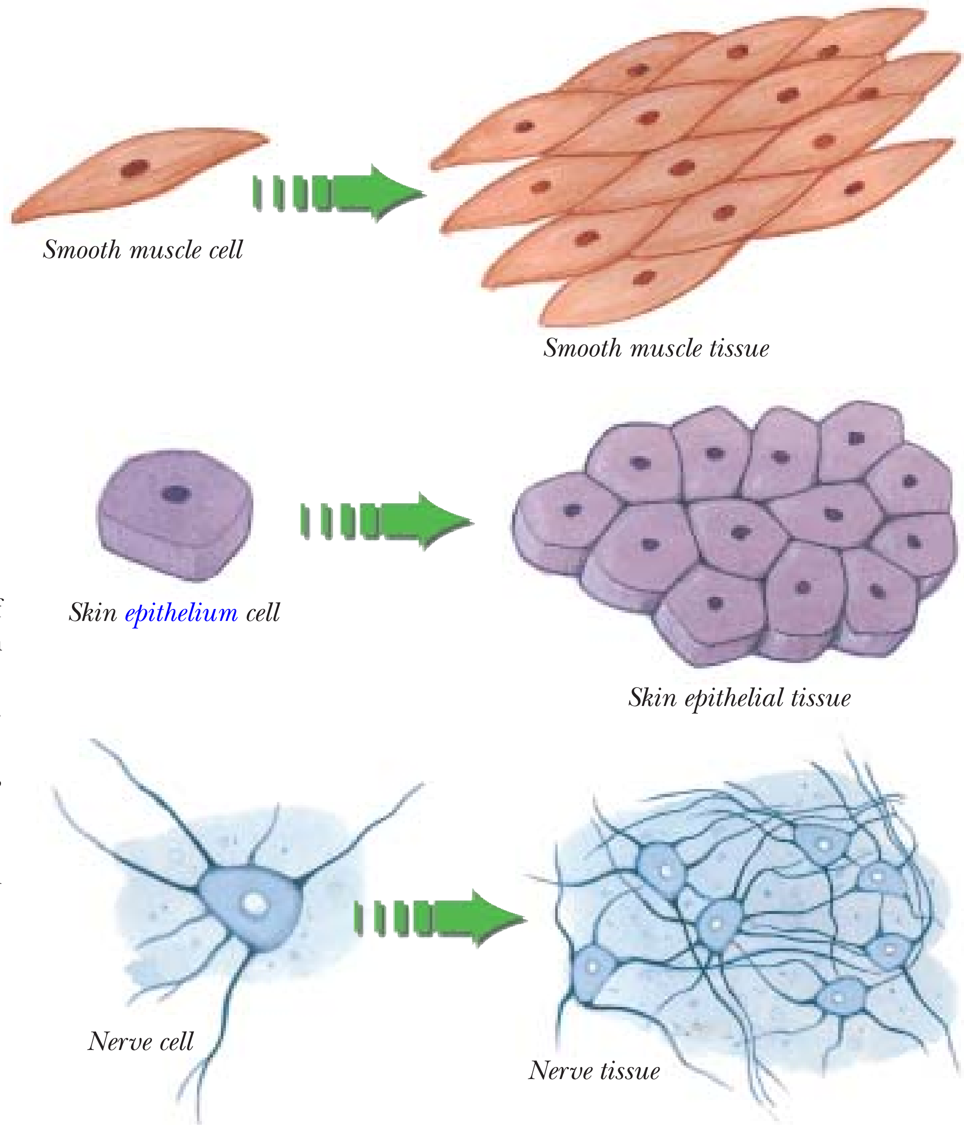
checklist

I can:

- ☐ describe features of animal cells
- ☐ describe the function (job) of different types of animal cell
- ☐ explain how the shape and features of animal cells help them do their job.

Tissues and organs

In animals and plants, **cells** work together in teams. Each team has a particular job to do. As long as all of the teams do their job properly, the animal or plant stays alive and healthy. If one or more of the teams doesn't do its job, the animal or plant becomes sick. It could even die.



Teams working together

Your **organs** are made of different types of tissue. Your brain, heart, liver and stomach are just some of the organs in your body. Each organ has a very important job to do. The tissues in the organ work together so that the job is done properly. For example, each of your lungs is an organ in which **oxygen** enters your blood and carbon dioxide is removed from your blood. Each lung is made of muscle tissue joined to lining tissue. Within this lining tissue are blood vessels which carry the connective tissue that we call blood. Nerve tissue in the lung lining sends and receives messages from your brain to help you breathe.

All animals and plants are **multicellular.** That means that they have many cells. Plants and animals can have billions of cells. Cells of the same type group together to form teams of cells called **tissue.** For example, your muscle cells form muscle tissue. Smooth muscle cells group together to form the smooth muscular tissue in your blood vessels and your digestive **system.** Other types of muscle cell group together to form the cardiac muscle that keeps your heart beating. Your skin cells form skin tissue and your nerve cells form nerve tissue.

The different types of cell in the human body are grouped into four main types of tissue:

Type of tissue	What it does	Example
Epithelial tissue (or lining tissue)	Forms a lining around other body parts to protect them	Skin surface (epidermis), stomach lining, lung lining
Muscle tissue	Tightens and loosens itself to move other body parts	Biceps in your arm, cardiac muscle (heart muscle)
Nerve tissue	Carries messages around your body	Optic nerve (from your eye), spinal cord
Connective tissue	Holds other tissues together	Bone, cartilage, blood

Skinny stuff

Your skin is an organ. It protects your body from germs and water, helps control your body temperature and releases some of your waste products. It senses warmth (or lack of it), pressure and pain. It even uses sunlight to make a vitamin. Your skin contains lining tissue, nerve tissue and connective tissue.

The skin of an adult human weighs about 5 kg. The thinnest part of your skin is on your eyelids (about 0.5 mm thick). The thickest part of your skin is on the soles of your feet (about 4 mm thick).

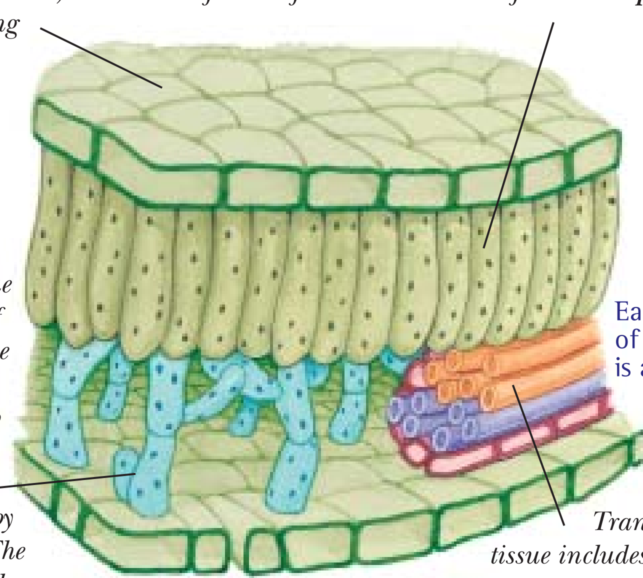
The elephant and rhinoceros are the most thick-skinned animals — the skin on their back can be 2.5 cm thick.

Plants have organs too!

It's not just animals that have organs. Each leaf, flower, stem and root is an organ. Each organ is made up of different types of tissue. Each type of tissue has its own job that helps the organ work properly.

Lining tissue (a layer of ***epidermal cells****) forms a lining around the leaf to protect it.*

Food-making tissue is usually found on the top side of the leaf. It contains most of the ***chloroplasts****.*



Support tissue gives the leaf its shape. The spongy cells that make up this support tissue are surrounded by air spaces. The air spaces allow gases like carbon dioxide and oxygen to flow in and out of these cells.

Each leaf of a plant is an organ.

Transport tissue includes the bundles of ***xylem*** *and* ***phloem cells*** *that carry water and minerals from the roots to the rest of the plant, and food from the leaves to the rest of the plant.*

Activities

REMEMBER

1. What is meant by the term multicellular?
2. Which types of cell work together to form muscle tissue?
3. Name four types of tissue that can be found in your lungs.
4. In animals, what is the main job of:
   (a) epithelial tissue?
   (b) muscle tissue?
   (c) nerve tissue?
   (d) connective tissue?
5. What important jobs are done by your skin?
6. List four organs that you could find in a plant.
7. What is the main job of transport tissue in plants?

THINK

8. How do you know that skin is an organ rather than a tissue?
9. Why is the food-making tissue in a leaf usually found on its top side?

IMAGINE

10. Imagine that you are a tree. You need to get as much water and as much sunlight as you can — but you can't move to another location. What features do your organs need to have?

INVESTIGATE

11. What jobs are done by the human brain, liver and stomach?

checklist

I can:

- ☐ explain the links between organs, tissues and cells
- ☐ describe the jobs done by different tissues in animals and plants.

Putting it all together

Some eucalypt trees grow over 100 m tall. The leaves at the top of the tree need to get water from the soil so they can make food. That's a long way to move water straight upwards! It requires teamwork — and some of the tree's **organs** work together to make it possible.

Reaching great heights

The leaves, stem and roots are some of the tree's organs. ***Cells*** *work together to form* ***tissue****. Tissues work together in organs. Organs work together as* ***systems****. The leaves work together as a system to make enough food to keep the tree alive. The roots work together as a system to collect water and minerals from the soil. The roots, stem and leaves work together as a transport system. This system moves water up from the ground and food all the way down to the root tips.*

Animal systems

The systems of animals are also made up of organs working together. For example, your own respiratory system includes your windpipe and lungs. The respiratory system takes **oxygen** from the air to your blood and gets carbon dioxide out of your blood back into the air. Another system, your circulatory system, moves food and gases, like oxygen and carbon dioxide, around your body. The respiratory system and circulatory system work together with other systems to keep you alive and healthy.

Some systems in the human body

System	Main organs	Job
Digestive system	Stomach, liver, intestines	To digest and move food into your circulatory system
Respiratory system	Trachea (windpipe), lungs	To take oxygen from the air and return carbon dioxide to the air
Circulatory system	Heart, blood vessels	To move food and gases around the body
Nervous system	Brain, spinal cord	To send messages around the body

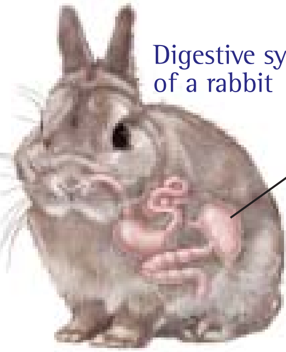
Variety is the spice of life

The digestive system in all animals does the same job. It digests and moves food into the blood so that it can be carried to every cell. But the organs that make up the system don't always look the same in different animals. The animals shown on the right each have:

- a mouth to take in food
- an oesophagus to move food away from the mouth
- intestines to absorb food and water
- an anus to remove waste material.

Apart from the earthworm, they all have a stomach where food is mixed with digestive juices to break it down. The rabbit uses its stomach to store food.

Digestive system of a human



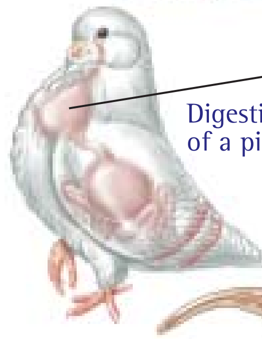
Digestive system of a rabbit

Go to worksheet 35

VISUAL/SPATIAL

Caecum

The caecum is an organ found in animals that eat plants. Rabbits eat leaves. The ***cellulose*** *in the cell walls is digested in the caecum. Humans also have a caecum but it doesn't play a big role in digestion.*



Digestive system of a pigeon

Crop

The crop is an organ found in birds, insects and worms. Food is stored in the crop before passing through to the gizzard.

Digestive system of an earthworm

Gizzard

The gizzard is a grinding organ found in birds, reptiles, insects and worms. In grain-eating birds like pigeons, the gizzard contains small stones that grind hard seeds. In earthworm gizzards, sand and dirt are used to grind food.

Activities

REMEMBER

1. Which organs make up the food-making system of a tree?
2. Which organs work together in a plant to move water up from the ground and food down to the roots?
3. What is the main job of your:
   (a) respiratory system?
   (b) circulatory system?
4. List two of the organs that make up your:
   (a) digestive system
   (b) nervous system.
5. What is the job of the digestive system in animals?
6. Complete the following sentences about animals and plants.
   (a) __________work together to form tissues.
   (b) Tissues work together to form __________.
   (c) __________ work together to form systems.
7. Which two organs can be found in birds and earthworms, but not humans?
8. Which organ in a rabbit is used to digest the cellulose in plant cell walls?

THINK

9. The sensory system in humans is the system that allows us to sense the world around us. List five organs that are part of the sensory system.
10. Why do all animals need a digestive system?
11. Why is a caecum less important to the digestive system of humans than it is to the digestive system of rabbits?
12. Name a well-known Australian native animal that is likely to have a caecum and explain your choice.

INVESTIGATE

13. Research and report on the digestive system of one of the animals listed below. Include a diagram of the digestive system in your report, along with a short description of what each organ does. Choose your animal from: frog, grasshopper, ant, shark, cow, horse, pelican, chicken, crocodile, lizard, whale, elephant, tiger.

checklist

I can:

- ☐ explain the links between systems, organs, tissues and cells
- ☐ describe the jobs done by different systems in animals and plants.

Check and challenge

CELLS

Check

Sizing up cells

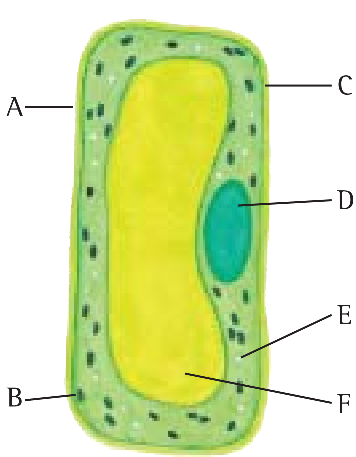
1. Cells are described as the building blocks of life. Why is this a good description?
2. Draw a labelled set of diagrams to show how to make a wet mount and how to stain cells.
3. What magnification does a 10× eyepiece used with a 10× objective lens in a microscope give?
4. Why is a microscope needed to see cells and the parts inside them?
5. Copy and complete: The lens of a microscope that is closest to the object that you are looking at is called the ____________ lens.

The structure of cells

6. Copy this table and complete the first column by referring to the diagram in question 7 and inserting the correct label (A, B, C, D, E or F) next to each feature in the table. Use the third column to briefly describe the main job done by each feature.

Correct label	Cell feature	Main job done by feature
	Cell wall	
	Cytoplasm	
	Vacuole	
	Chloroplast	
	Cell membrane	
	Nucleus	

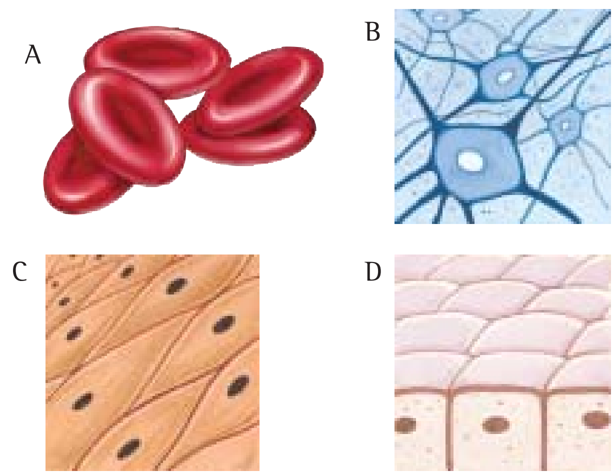
7. Is the cell shown at right a plant cell or an animal cell? State three reasons for your answer.



8. Draw an animal cell and a plant cell, showing and labelling the parts that can be seen with a normal school microscope.

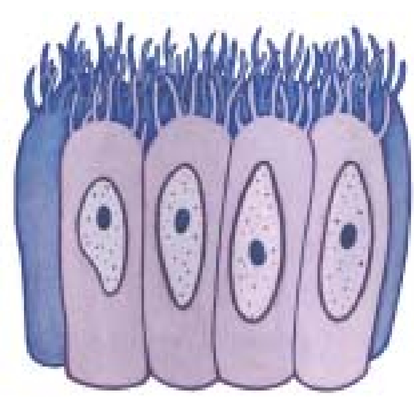
The function of cells

9. Copy and complete the table below. Identify each of the human cell types shown below. Describe the job done by each cell type and explain the reason for its shape.

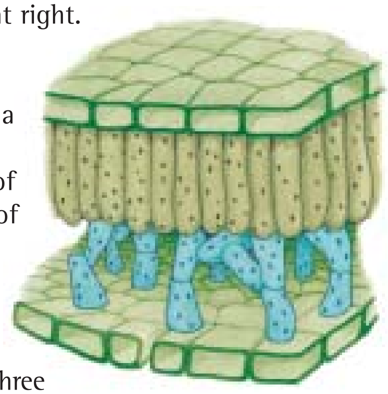


Cell type	Name of cell type	Job and reason for shape
Type A		
Type B		
Type C		
Type D		

10. Cells like the ones shown below can be found in your windpipe.
    (a) What are the hair-like structures on the cells and what do they do?
    (b) Name one other place in your body where you might find cells with these structures.



11. Copy the diagram at right.
    (a) Label a chloroplast, a guard cell and a stoma.
    (b) In which part of a plant are all of these features found?
    (c) State the major job of each of these three features.



Teamwork — cells, tissues and organs

12. Groups of similar cells that carry out the same job are called __________.
13. The main jobs in the table below have been placed incorrectly. Redraw the table so that the jobs correctly match the tissue.

Tissue	Main job
Lining tissue	To move
Bone tissue	To send messages
Muscle tissue	To support
Nerve tissue	To protect

14. True or false?
    (a) Tissues are made of different types of organ.
    (b) Lining tissue can be found in animal and plant cells.
    (c) A system is made of organs working together.
    (d) The skin is made up of one type of tissue.
    (e) Blood is an example of connective tissue.
15. Name four different organs that can be found in plants.
16. Copy and complete the table below. The table describes some of the systems in animals and plants.

System	Organs	Main job of system
Animal digestive system		
Animal circulatory system		
Root system		
Plant transport system		

17. Complete the flow chart below to show how systems, cells, organs and tissues are related to each other.

CELLS → (Work together to form) ☐ → (Work together to form) ☐ → (Work together to form) ☐

Animal and plant cells

1. Which organelles will definitely not be found in any of the cells shown in the figures on the top right of page 166?
2. How can the root cells of a plant survive without having chloroplasts?
3. Plant cells have a vacuole whereas most animal cells have no vacuoles.
    (a) Why do plant cells need to have a large vacuole?
    (b) Suggest why some animals might need to have vacuoles in their cells.

Stem cells in animals?

The stem cells that have been in the news in recent years have nothing to do with plants. Animals with bony skeletons have stem cells in their bone marrow. Stem cells are important because blood cells are produced from them. One type of blood cell — the white blood cell — helps fight diseases like cancer. Scientists are studying these stem cells to find ways to make them better at fighting diseases. The stem cells for this research come from people who donate their cells.

Another type of stem cell is the embryonic stem cell. These stem cells come from unborn babies. These special stem cells can be used to research white blood cells, but have another use too. The stem cells from unborn babies can be used to produce any type of body part. Embryonic stem cells could eventually be used to replace any damaged or injured body parts.

4. Where are stem cells found in animals?
5. Why would some people be unhappy about using embryonic stem cells to make human body parts?
6. Imagine a time when every part of the human body could be replaced by growing 'spare parts' from embryonic stem cells. Explain how it would change human life. Describe any problems that would be caused by using 'spare parts'.
7. Scientists are trying to grow body parts from adult animal stem cells. Their research is being done on small animals like mice. List some arguments for and against this type of research.

Summary of key terms

bone marrow: a substance inside bones in which blood cells are made

cell: the smallest unit of life. Cells are the building blocks of life.

cell membrane: the thin outer boundary of a cell. This membrane encloses and protects the cytoplasm.

cell sap: the mixture of water, dissolved substances, food and waste material that can be found in the vacuoles of plant cells.

cell wall: a wall around the cell membrane in plant cells, providing a tough extra covering which gives strength and support to the plant cell

cellulose: the cell walls of plants are made of this

chlorophyll: the green pigment that occurs in chloroplasts

chloroplast: oval-shaped organelles found only in plant cells. Chloroplasts contain the pigment chlorophyll. They are the 'factories' in which carbon dioxide and water are changed by sunlight and water into food through the process of photosynthesis.

chromosome: tiny thread-like structure inside the nucleus of a cell. Chromosomes contain genes which carry information that is passed on when an organism reproduces itself.

cilia: hair-like tips on cells. The cilia that line your windpipe and lungs help stop germs, dust and fluid getting to your lungs.

coral polyp: tiny animal that mostly lives in colonies and forms corals, some of which look like plants

cytoplasm: the jelly-like material inside a cell. It contains organelles such as the nucleus, vacuoles and many others.

electron microscope: tool for viewing very small objects. An electron microscope is much more powerful than a light microscope and can magnify things up to a million times.

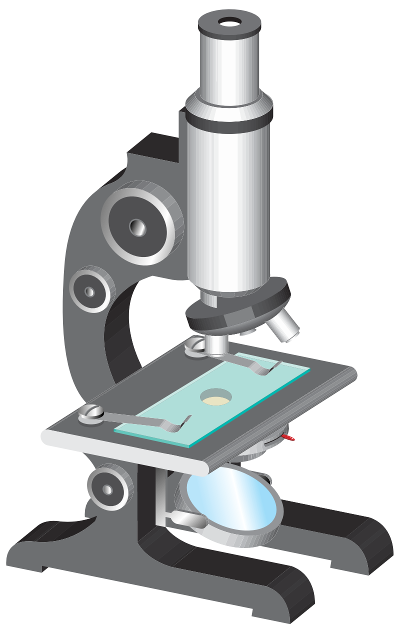
epidermal cell: flattened type of cell that protects the top and bottom surfaces of leaves. Stems and roots also have an outer ring of these cells for protection.

epithelial tissue: the lining cells that form the outside or inside surfaces of a plant or animal

fertilised: an egg cell is fertilised when a live sperm cell enters it. A fertilised egg eventually grows into a new organism.

guard cell: special cell that occurs among the lining cells in a leaf. They control the movement of gases into and out of the leaf through pores called stomata (singular = 'stoma'). When these pores are open, water vapour, carbon dioxide and oxygen gases can move into and out of the leaf. The guard cells close the pores during hot weather so that the plant does not wilt.

light microscope: tool for viewing very small objects. A light microscope can magnify things up to 1500 times.



mitochondria: small rod-shaped organelles that supply energy to other parts of the cell. Mitochondria are usually too small to be seen with light microscopes. Singular = mitochondrion.

multicellular: having many cells. All animals and plants are multicellular.

nucleus: the roundish structure inside cells which acts as the control centre for the cell

organ: group of tissues working together to carry out a particular job

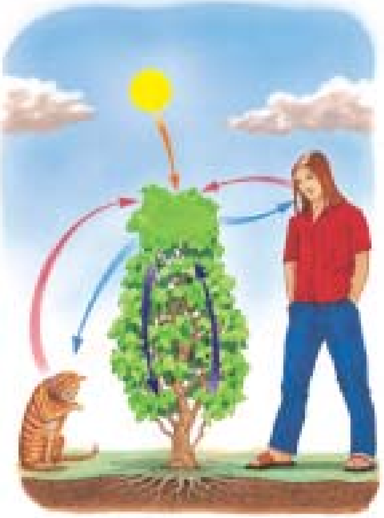
organelles: the 'little organs' found in the cytoplasm of a cell. Each organelle performs a particular job for the cell.

oxygen: a gas in the air (and water) that animals need to breathe in. Plants produce oxygen as part of photosynthesis.

phloem cells: long, narrow cells that are joined together to form long tubes in a plant. The tubes made from phloem cells move the food made in the leaves to other parts of the plant such as its roots and storage areas.

photomicrograph: photograph taken through a microscope

photosynthesis: the food-making process in plants that takes place in chloroplasts within cells. The process uses carbon dioxide, water and energy from the sun.



starch grains: tiny white granules in the cytoplasm. Starch is stored energy for plant cells.

stem cells: the cells in your bone marrow that make your blood cells

stomata: pores located on leaf surfaces. These pores are opened and closed by guard cells. Singular = stoma.

system: groups of organs work together in a system. Each system performs a particular job. Examples of systems include the circulatory system and the digestive system.

tissue: a group of similar cells that work together to do a job

vacuole: a sac within a cell used to store food and wastes. Plant cells usually have one large vacuole. Animal cells may have several small vacuoles or none at all.

womb: the organ in humans and most other mammals in which a fertilised egg cell develops into a baby

xylem cells: long narrow cells that are joined together to form long tubes in a plant. The tubes, made from xylem cells, move water and dissolved minerals up from the roots to the stem and leaves. The wood in a tree trunk consists mostly of dead xylem cells.