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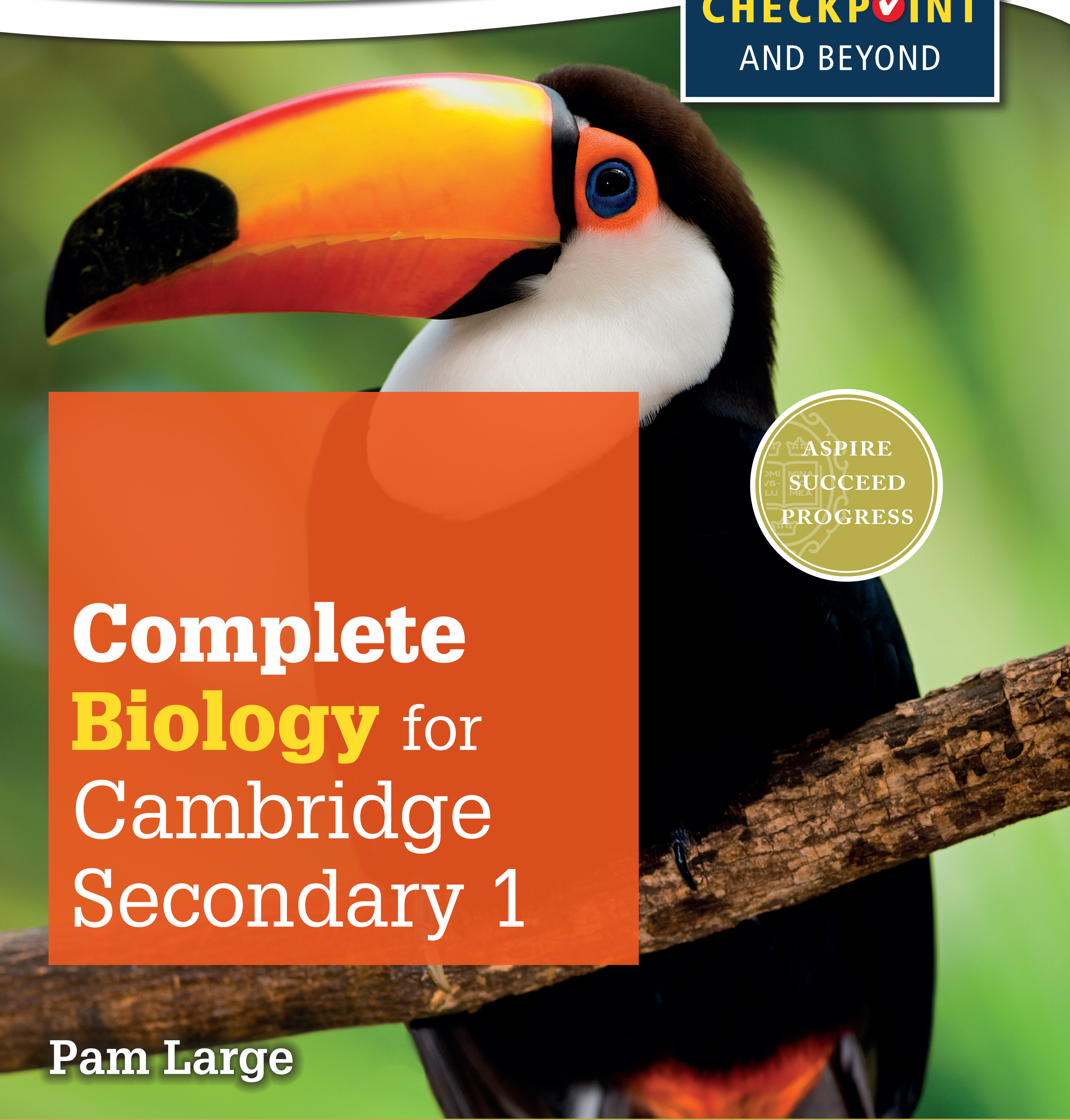

ASPIRE
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Complete **Biology** for Cambridge Secondary 1

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Contents

Key: Enquiry / Extension / Review
BOLD PAGE NO. = in this booklet

A dashed line to the left of the text indicates extension material.

1.1 Leaves, stems and roots

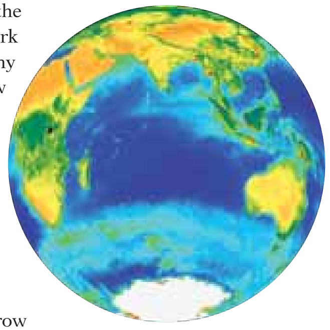
Objectives

- Recognise leaves, stems and roots and know their functions

Flowering plants

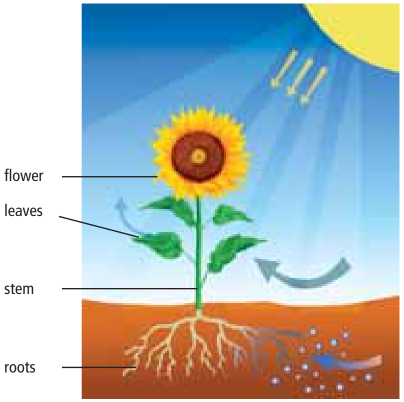
Flowering plants come in all shapes and sizes. It is plants like these that help to give our planet its colour.

From space you can see where most of the plants on Earth grow. The patches of dark green are rainforests. They are hot, sunny and wet – perfect for trees. Grasses grow best in the yellow areas, which are drier. The orange areas get much less rain – only desert plants, like cacti, can grow there.



Plant organs

Most plants have **leaves**, **stems** and **roots**. These **organs** work together to keep the plant alive. Flowering plants grow extra organs – **flowers** – when they are ready to reproduce.



Each organ in a plant has a different function.

- Leaves absorb energy from sunlight and make the plant's food.
- The stem transports water and food. It also supports the leaves and flowers.
- Roots hold the plant in place and absorb water and minerals.
- Flowers produces seeds so that new plants can grow.

Extra functions

In some plants these organs take on extra jobs. A cactus doesn't have leaves like most plants, instead it has spines to protect it. This means that its stem takes over the job of making food. The swollen, green stem also stores water to keep the plant alive.

A cactus makes its food inside its stem.

Some mangrove roots point upwards instead of down. These specialised roots collect air so mangroves can grow in muddy water.

These mangrove roots grow upwards to take in air.

Lost organs

Plants that are parasites are missing some organs. Some don't need leaves or stems as their roots steal food and water from other plants. They just send up a flower when they need to reproduce.

Parasitic plants, like *Hydnora Africana* and *Cuscuta europea*, don't need leaves as they take food from other plants.

Greater dodder (*Cuscuta europea*) survives with only a stem. It sends suckers into other plants to steal food and water. It can make flowers, but can also reproduce without them. When a bit of stem breaks off, it grows into a whole new plant.

Q

1. Roots spread out underground like the branches of a tree. Suggest why.
2. Most leaves are wide and thin. Suggest why this is helpful.
3. Stems have tubes running through them. Suggest why.
4. Desert plants often have swollen stems. Explain how these help them to survive.

!

- Flowers produce seeds.
- Leaves absorb sunlight and make food.
- Roots hold plants in place and absorb water and minerals.
- Stems transport water and food and support the leaves and flowers.

Enquiry 1.2

Questions, evidence, and explanations

Objectives

- Be able to talk about the importance of questions, evidence and explanations

What does a tree use to build its trunk and leaves?

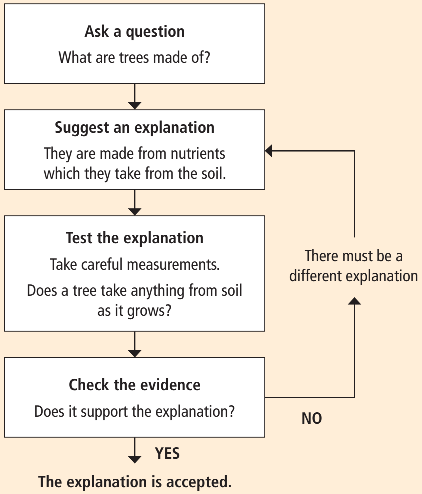
Questions

Have you ever wondered how trees grow so big? What are they made of and how do they get their nutrients? Investigations often start with **questions** like this.

One possible **explanation** is that trees take their nutrients from soil. Jan Baptista van Helmont tested this idea over 400 years ago.

Evidence

Van Helmont weighed a pot of dry soil and a tree seedling. Then he planted the seedling and watered it for 5 years. The willow gained 73 kg and the soil only lost a few grams.



Van Helmont asked a question and tested a possible explanation.

A new explanation

Van Helmont thought about his **evidence**. If the tree took all its nutrients from soil, the soil should lose as many kilograms as the tree gains.

There must be a different explanation. Plants cannot grow without water, so Van Helmont's new explanation was:

Plants are made from water.

New ideas and more evidence

An idea supported by evidence is usually accepted by other scientists; but it may not be a complete explanation.

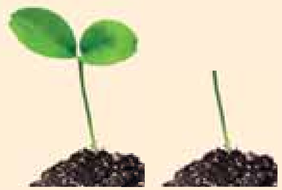
Malpighi's evidence

In the 1670's Marcello Malpighi looked at leaves through a microscope. He saw tubes running through them and asked new questions.

Do leaves make the nutrients plants use for growth?

Do they send these nutrients down to their roots?

To test his idea, Malpighi cut the leaves off a seedling. The seedling still had plenty of water, but it did not grow. He realised that a seedling needs its leaves to grow.



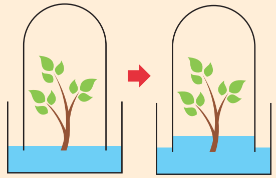
If its leaves are removed, a seedling stops growing.

Hale's evidence

In 1727, Stephen Hales grew a plant above water, inside a jar. The water level rose. Some of the air had gone.

Hales explanation was:

Plants take something out of the air.



When Hales grew a plant over water, the water level rose.

Changing explanations

Scientists use their ideas and evidence, to develop scientific explanations.

Van Helmont's idea was not completely correct. Evidence from other scientists supports a different explanation:

Leaves use a gas from the air, as well as water, to make nutrients.

Scientists build on each others' work. Over time, other scientists have shown that leaves can only make nutrients if they have light. Plants also need small amounts of minerals, which they absorb from soil through their roots.

More questions

Scientists still ask questions about how plants make nutrients. These questions are important. We use plants everyday: we eat them, feed them to farm animals, burn them as fuel, and turn them into paper, homes and furniture. As we learn more about plants we can grow more of the ones we need.

Q

1 Van Helmont rejected the idea that plants take nutrients from soil. Explain why.
2 What new explanation did Van Helmont suggest.
3 In 1699 John Woodwood grew plants in pure water and water with soil in it. The table shows some of his results.

Water	Growth (%)
Pure water	36
Water with soil in it	265

Do these results support Van Helmont's explanation?
4 Suggest an explanation for Woodwood's evidence.
5 How did Malpighi think plants got nutrients?
6 Did Malpighi have strong evidence for his ideas?
7 Explain what trees are made of using the evidence Van Helmont, Woodward, Malpighi and Hales collected.

!

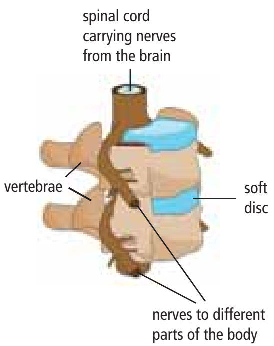
To develop explanations, scientists

- ask questions
- suggest explanations
- carry out tests
- collect and consider evidence.

2.1 The human skeleton

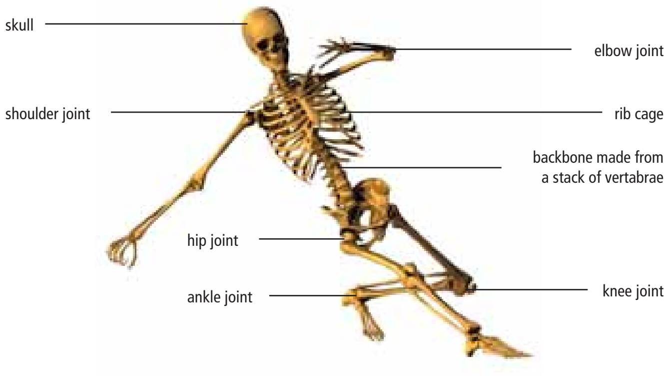
Objectives

- Describe the role of the skeleton
- Understand why joints are essential



The column of vertebrae in your backbone form a bony cage around your spinal cord.

Support and protection



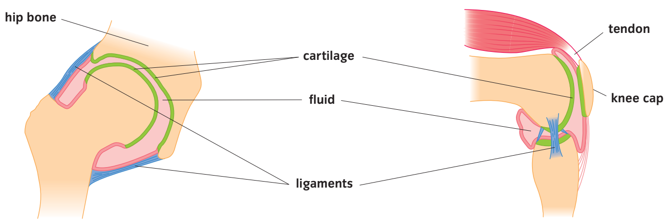
Your **skeleton** supports your body and helps you to move. It also protects delicate **organs** like your brain, heart and lungs.

- Your **skull** surrounds your brain and a strong vertical column called your **backbone** holds it up. This 'backbone' is actually a stack of smaller bones called **vertebrae**.
- A thick bundle of nerves, called your **spinal cord**, runs down your back. It connects your brain to the rest of your body. The vertebrae form a strong cage around it. A bigger cage, made of rib bones, protects your heart and lungs.

Movement

Wherever two bones meet there is a **joint**. These make your skeleton flexible, so you can move.

The **ball-and-socket** joints in your hips let your legs swing in every direction. You can also bend your legs using the hinge joint in each knee. Your arms use similar joints to swing around or bend.



Ball-and-socket joint

Hinge joint

Joints

Joints let bones swing smoothly because they are slippery inside. Two things make them like this. There is a smooth cushion of **cartilage** over the end of each bone and each joint is full of slippery **synovial fluid**. Strong **ligaments** hold bones together but stretch enough to let them swing freely.

Injury

Footballers often injure their joints. As the ball shoots around the pitch they need to keep changing direction. Their sudden stops and starts can damage ligaments and produce a painful **sprain**. If players collide, one may twist an arm bone out of its socket and **dislocate** their shoulder. Even minor injuries increase the risk of developing **arthritis**. Arthritis can make synovial fluid disappear, cartilage wear away and bones scrape together. Then any movement becomes very painful indeed.

Q

1. List three reasons why you need a skeleton.
2. Explain how bones protect your brain, heart and lungs.
3. Which of the labelled joints on the skeleton are hinge joints?
4. Which of the joints on the skeleton are ball-and-socket joints?
5. Dancers create their steps using their knee and hip joints. What is different about the way these joints work?
6. Draw a ball-and-socket joint and label two things that help bones swing smoothly.
7. Choose the right words to describe cartilage, bone, and a ligament. Is each of these hard, flexible, smooth, strong when squashed or strong when pulled?
8. Explain why ligaments, cartilage and bone need different properties.

!

- A skeleton provides support and protection.
- The joints between bones let you move.

2.2 Muscles and movement

Objectives

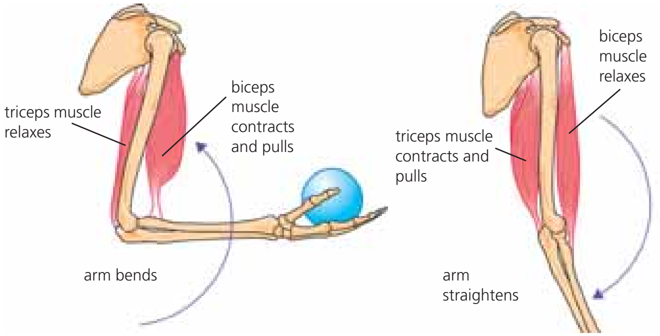
- Understand why muscles are arranged in pairs
- Predict what will happen when a given muscle contracts

Muscles

Puppets move when strings pull on their arms and legs. Muscles work like the strings of a puppet to move our arms and legs by pulling on bones.

Muscles can pull bones because they get shorter when they **contract**. Muscles are only able to moves bones in one direction – they cannot push. They work in pairs because each muscle can only contract and pull; it cannot push.

Muscles work like a puppet's strings to pull our arms and legs around.

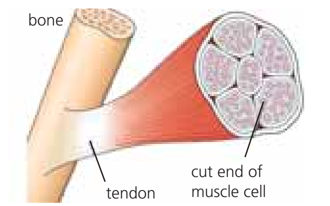


Your biceps and triceps are antagonistic muscles.

The biceps and triceps muscles in your arm work as a pair. When your biceps muscle contracts, your arm bends. At the same time, your triceps muscle relaxes and stretches. To straighten your arm, your triceps muscle contracts while the biceps relaxes and stretches.

The biceps and triceps are **antagonistic** muscles because they pull in opposite directions. Most movements are produced by antagonistic muscles.

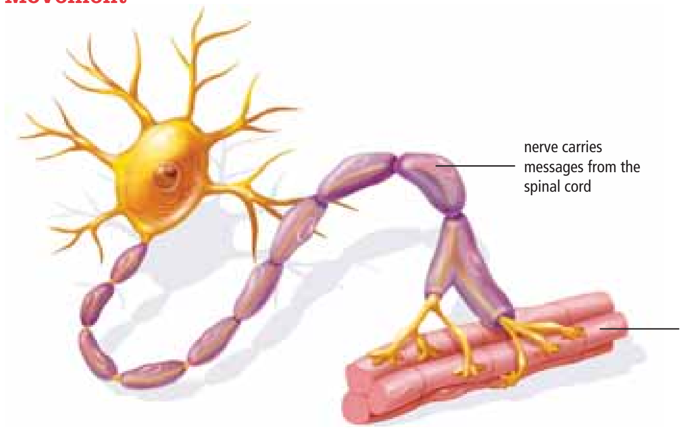
Muscles are attached to bones by strong cords called **tendons**. Tendons have to be very strong because muscles can exert enormous forces. Your Achilles tendons are the largest tendons in your body. They connect your calf muscles to your heel bone.



Tendons connect muscles to bones.

Trainers are designed to fit around the Achilles tendon.

Movement



Muscles are controlled by nerve messengers.

Muscle contraction is controlled by messages from your brain. They travel down through your spinal cord and along smaller nerves to every muscle fibre. If the spine is damaged it can stop messages reaching muscles and cause paralysis.

Normally muscles take turns to contract, but an electric shock can make every muscle pull at once – suddenly and violently. This can jerk your bones and throw you across a room.

Strength

Muscles can only lift heavy loads for a short time. Then they need to rest and repair themselves. A robotic exoskeleton could give you extra strength. The messages your brain sends to muscles control the exoskeleton's motors as well. So it copies every move you make, but with twenty times the strength.

Exoskeletons can even help people with damaged spinal cords walk again.

A robotic exoskeleton could make you stronger.

Q

1. How do muscles cause movement?
2. Why the muscles are in your upper arm called antagonistic muscles?
3. Balance a book on the palm of your hand and hold it in front of you.Which muscle feels firmer, the one at the front of your upper arm or the one at the back? Explain why.

4. Antagonistic muscles also make your legs bend and straighten. Which muscle bends your leg – the one at the front, or the one at the back?
5. Feel inside your elbow as you lift a book. You should feel a strong cord. Explain what this is and what it does.
6. What tells a muscle when to contract?

!

- Muscles pull on bones to make you move.
- Antagonistic muscles pull bones in opposite directions.

Extension 2.6

Extending lives

Objectives

- Recognise that lives can be extended by replacing faulty organs

A new heart

The surgeons are operating on a tiny baby boy. The heart he was born with didn't work, so his family feared he would die.

Now tubes carry his blood through a heart–lung machine while surgeons stitch a crash victim's heart into his chest. He is having a heart **transplant**. More than 80% of transplant patients survive, but they need to take special drugs for the rest of their lives. Otherwise their bodies will not accept their new organs. The organs will be **rejected**.

Very few patients get a transplant in time to save their lives.

The kidneys and bladder – the kidneys clean blood and produce urine, which is then stored in the bladder.

A kidney transplant

Hidden behind your other organs are two bean-shaped **kidneys**. These make **urine** by taking waste products out of your blood. The urine runs down through tubes to your bladder.

Fong's kidneys don't work. She has to be connected to this machine 3 times a week. It keeps her alive by clearing waste from her blood, but it isn't as good as a real kidney. She has to stick to a special diet and will die early if she doesn't get a transplant.

Her new kidney would need to be tissue matched – which means very like her own. Many patients' relatives give them a kidney. They know they can live a normal life with just one, and it's quite a safe operation.

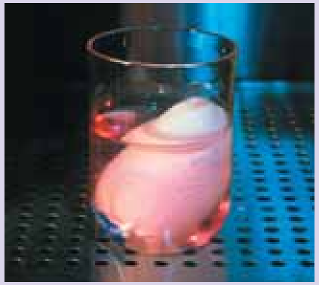
Other organ donations are more dangerous. You can give away enough liver or lung to keep someone else alive, but there's a high risk you'll suffer serious complications. So doctors may advise you not to do it.

Growing new organs

Sacha's body was badly burned in a fire. Scientists took undamaged skin from her legs and used it to grow sheets of new skin to cover the burns.

Growing a 3D organ like a heart will be much more difficult. It contains muscles and ligaments and has its own blood vessels and nerves. But organs grown from your own tissues are better than transplants. They are never rejected.

Using scaffolds

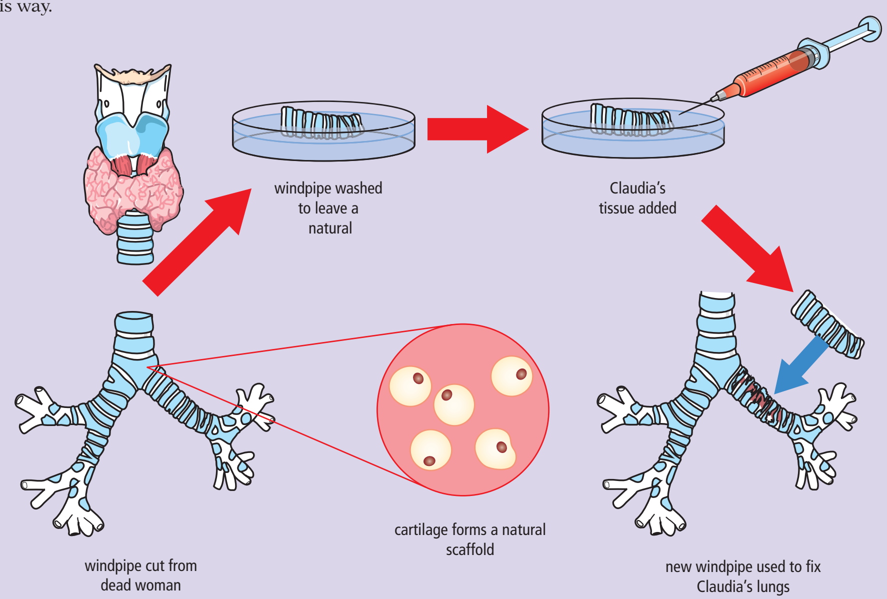


The pink thing in the beaker is an artificial bladder. Scientists grew it over a plastic shape called a **scaffold** – then took the scaffold away.

Many parts of your body, like your nose, earlobes and windpipe, use natural scaffolds made of cartilage to keep their shape.

When Claudia needed a new windpipe, her doctors took one from a dead woman.

They washed all the dead woman's tissues away to leave a natural scaffold. Then they let tissue from Claudia's body grow over it to make a new windpipe that her body would not reject. Now the race is on to make more complicated organs this way.



Q

1. Many people on the transplant waiting list die each year? Suggest why.
2. Why do patients who get transplants always need to take special drugs?
3. Give one reason why kidneys are transplanted more often than hearts.
4. Why might doctors advise against transplanting organs from living donors?
5. Why would it be useful to build new organs from a person's own tissues?

!

- Faulty organs can be replaced by transplants.
- Special drugs need to be taken to prevent the rejection of a transplant.
- Organs grown from your own tissues are never rejected.

Review 2.7

1 Five patients have just arrived at the hospital.

Karis: very pale, hardly breathing

Amarjit: pale, no pulse

Nadeen: back pain, can't move

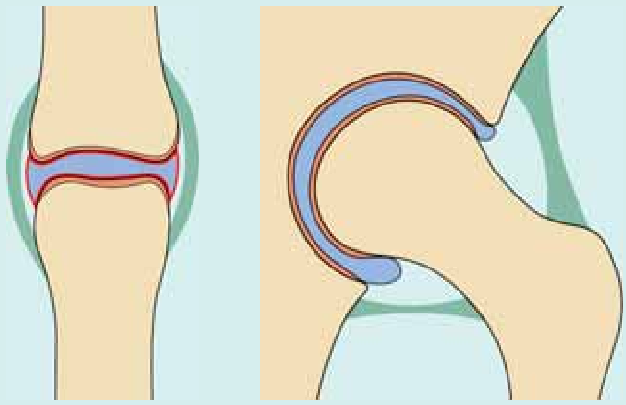
Ali: very weak, keeps being sick

Simon: leg bone sticking out

a Decide which organ system isn't working properly in each patient. [1]

b Decide which two patients should be treated first and explain why. [2]

2



a How do these two joints differ? [1]

b List 2 things that are the same about the structure of these two joints. [2]

3 Bones are moved by muscles that are attached to them.

a How does a muscle move a bone? [1]

b Muscles are normally found in pairs on either side of a bone. Explain why. [2]

c Your muscles are not directly attached to your bones. What connects muscle to bone? [1]

4 A hematologist compared the oxygen and carbon dioxide in blood entering and leaving a patient's lungs. The results are shown in the table.

Blood	Oxygen (mm Hg)	Carbon dioxide (mm Hg)
Entering lungs	60	50
Leaving lungs	100	40

a What changes take place as blood flows through the lungs? [2]

b Breathed in air is 21% oxygen and 0.04% carbon dioxide. Suggest what is different about breathed out air. [2]

c Where does blood go after it leaves the lungs? [2]

d A patient with lung disease may have much less oxygen in the blood leaving their lungs. Explain why that could make them feel very tired. [2]

5 Four students were asked about respiration.

a Study their replies and decide which student's answer is wrong. [1]

Kevin: Respiration is what your lungs do.

Sabrina: Respiration gives you energy.

Tom: Respiration is a chemical reaction.

Emmanuel: You need glucose and oxygen for respiration.

b Explain the difference between respiration and gas exchange. [2]

6 When Ben climbed a mountain his hand got so cold that blood stopped circulating through his fingers.

Suggest why that made the ends of his fingers turn black and die. [2]