



ROBERT WINSTON

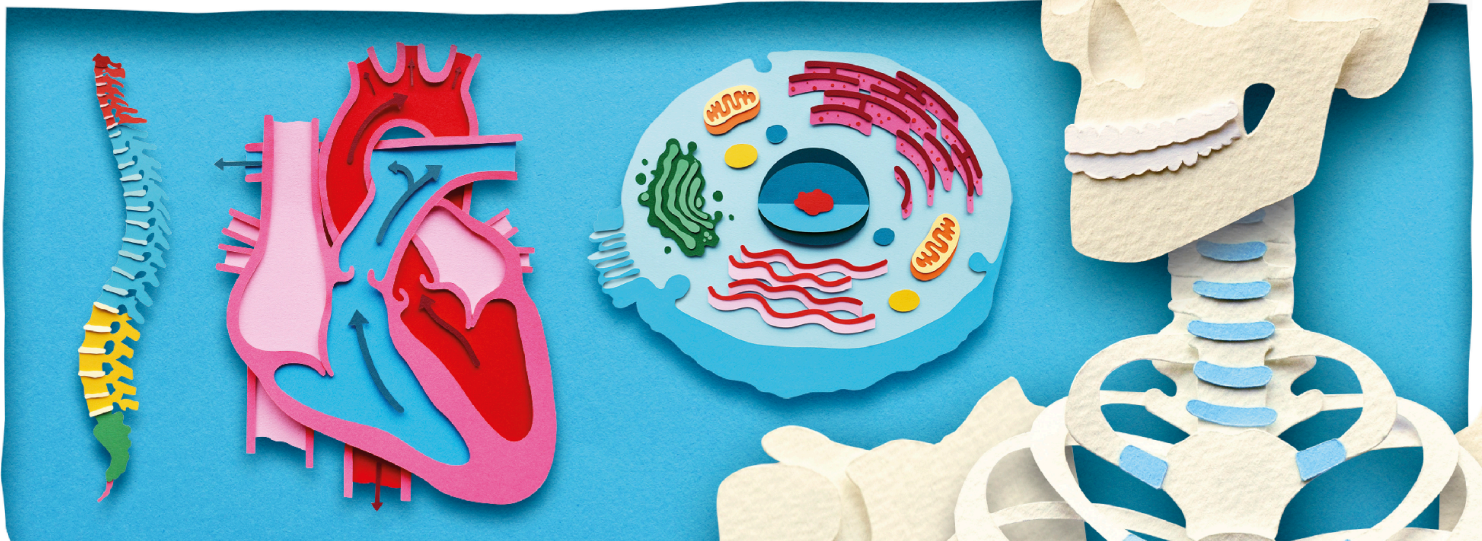


My Amazing

BODY

MACHINE

**A colourful visual guide
to how your body works**



Illustrated by *Owen Gildersleeve*





ROBERT WINSTON



My Amazing
BODY
MACHINE

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Penguin
Random
House



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**A WORLD OF IDEAS:
SEE ALL THERE IS TO KNOW**

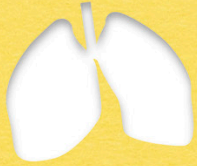
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Contents

- 7 Foreword
- 8 Building the Machine**
- 10 Code of life
- 12 One of a kind
- 14 Mini-machine
- 16 Getting organized
- 18 Body barrier
- 20 Marvellous machine
- 22 Super Structures**
- 24 Framework
- 26 Bone structure
- 28 Growing and mending
- 30 Skull and spine
- 32 Moving parts
- 34 Moving machine
- 36 Give it some muscle
- 38 Control Centre**
- 40 Nerve network
- 42 Wired up
- 44 Headquarters
- 46 Mind map





48 Sleep mode

50 Seeing

52 Hearing

54 Taste and smell

56 How you feel

58 Chemical messengers

60 Heart and Blood

62 Blood flow

64 In the blood

66 Heartbeat

68 Feel the beat

70 Lungs and Breathing

72 Air supply

74 Take a breath

76 Making noise

78 Out of control

80 Under Attack

82 Body defences

84 Germs and disease

86 Battle plan

88 Allergies

90 Fuelling the Machine

92 Filling up

94 Open wide

96 In the stomach

98 Tangled tubes

100 Cleaning station

102 The right fuel

104 Waterworks

106 Waste disposal

108 Full and empty

110 Water of life

112 Life Cycle

114 Starting out

116 Growing a human

118 Bigger and stronger

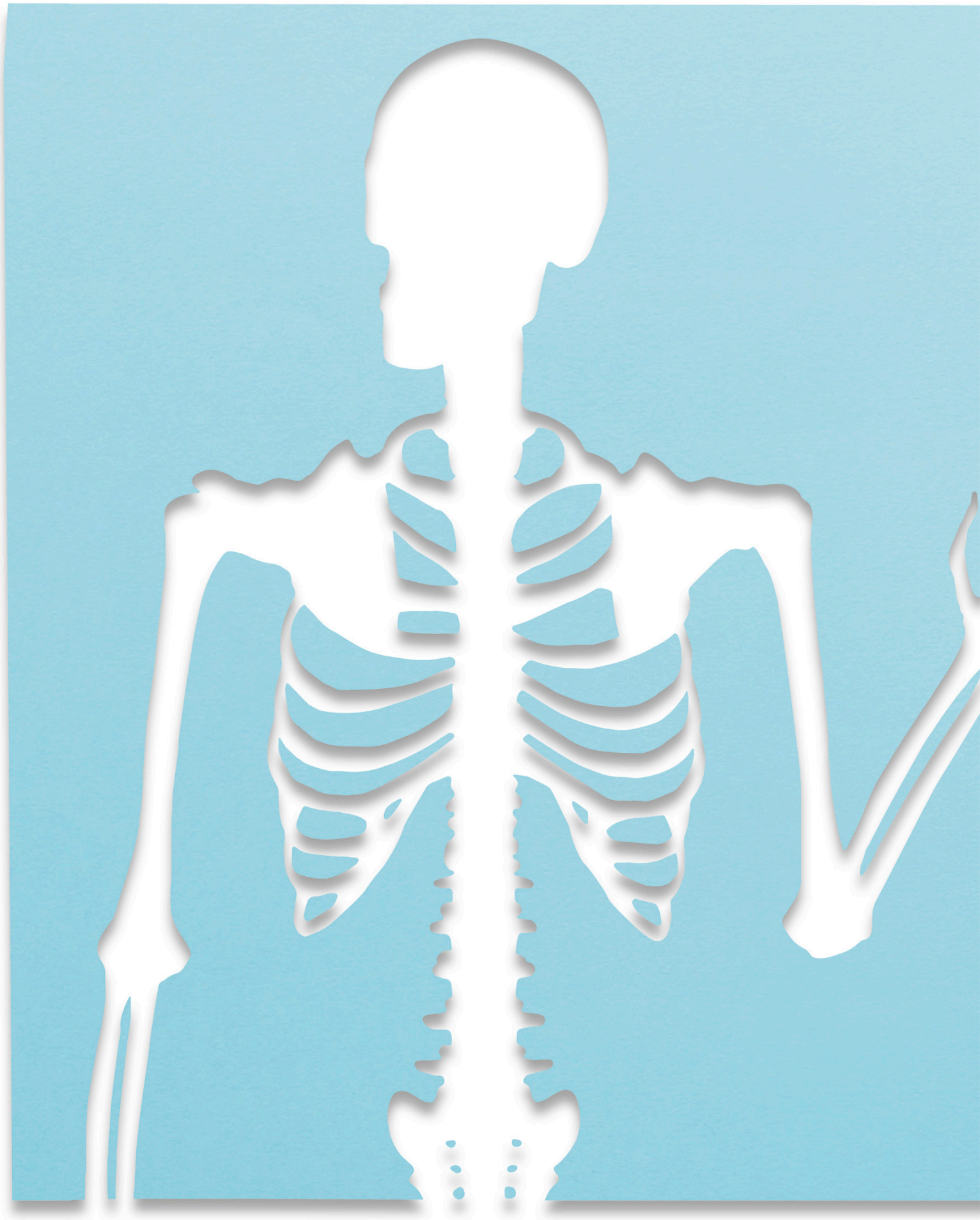
120 Growing older

122 Glossary


124 Index

128 Acknowledgements





Foreword

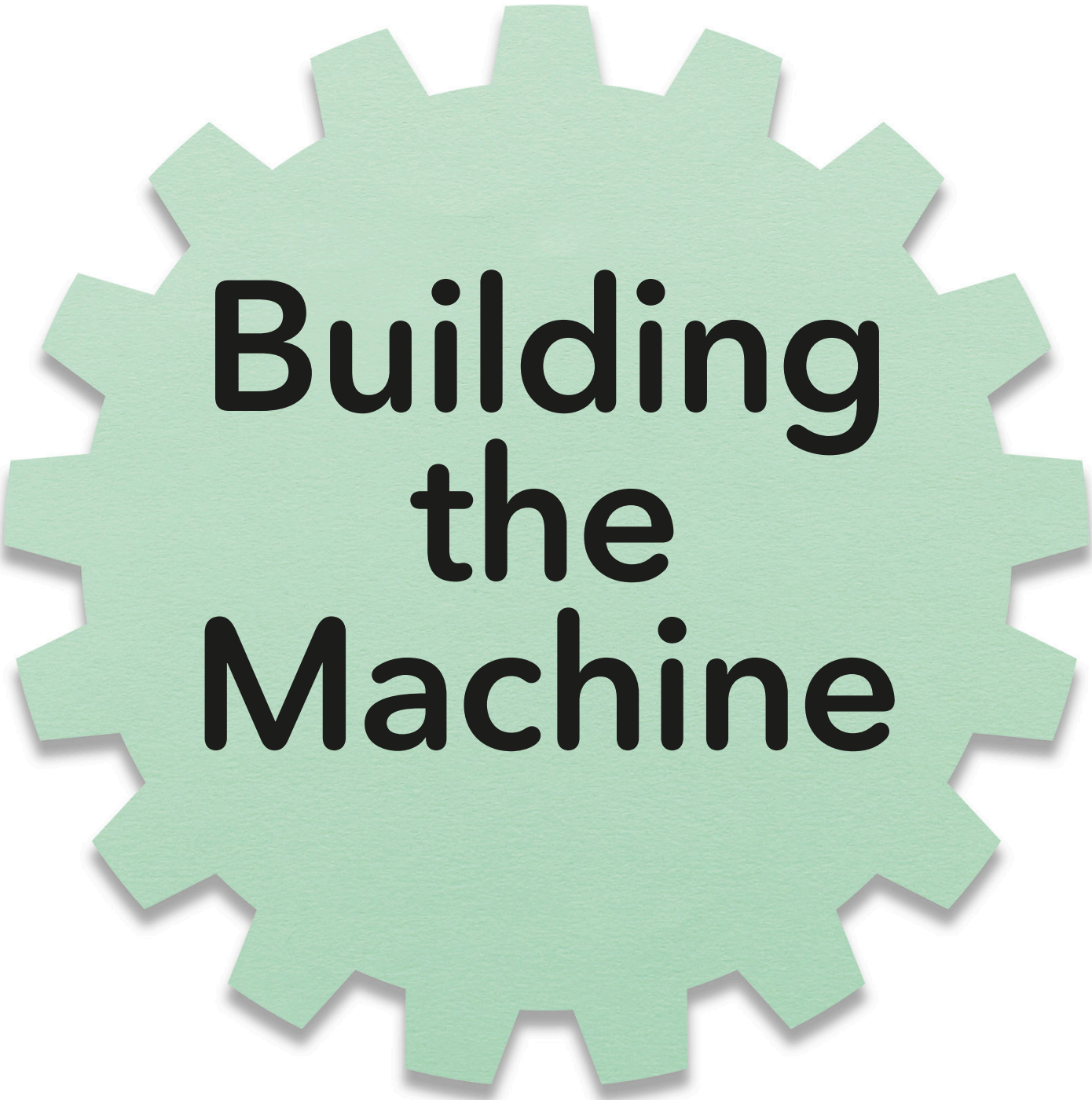


You own a most powerful and intricate machine. No skilled engineer or craftsman anywhere can make anything as complex or precious. This machine is your own body. And unlike other machines, it can make the most delicate and complicated movements, and can feel, think, and love. And, remarkably, it grows.

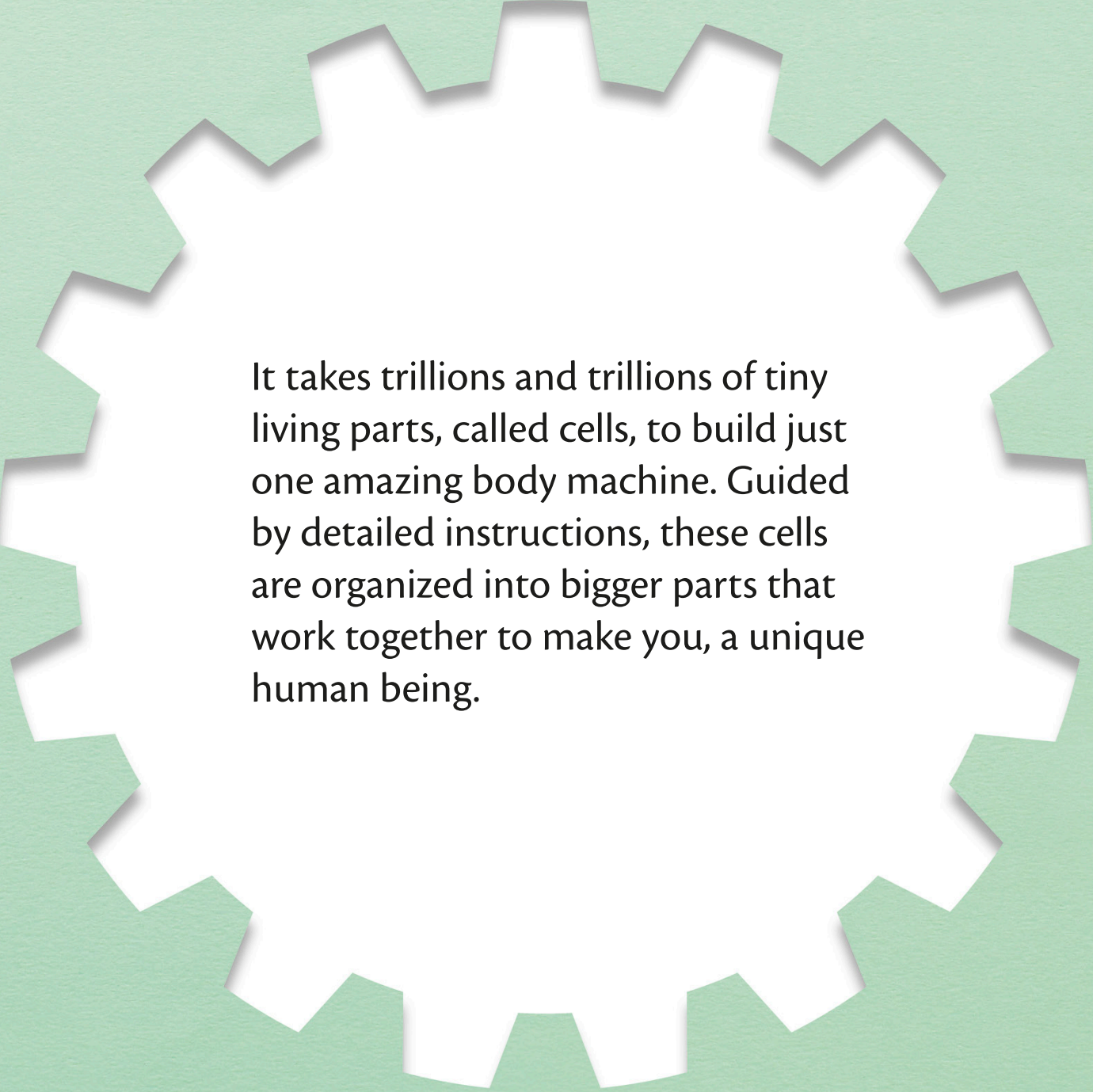
This machine of yours is controlled by the brain, the most complicated structure known, far more powerful than the most advanced computer. And each person's brain is unique - making each one of us special. In that body is your heart, a pump only the size of an orange, but pumping around five litres (nine pints) of fluid each minute, day after day, usually for over 70 years without needing repair. No mechanic can manufacture anything as effective.

This book is about these and other organs in your body machine. All of them have amazed me ever since I went to school. Look after your special machine carefully; it is so very precious.

Robert Winston.



**Building
the
Machine**



It takes trillions and trillions of tiny living parts, called cells, to build just one amazing body machine. Guided by detailed instructions, these cells are organized into bigger parts that work together to make you, a unique human being.

Code of life

Every one of your cells contains the instructions needed to build and run your body machine. These instructions are called genes. Genes are found in tiny strands called chromosomes. There are 46 chromosomes in the control centre, or nucleus, of each cell.



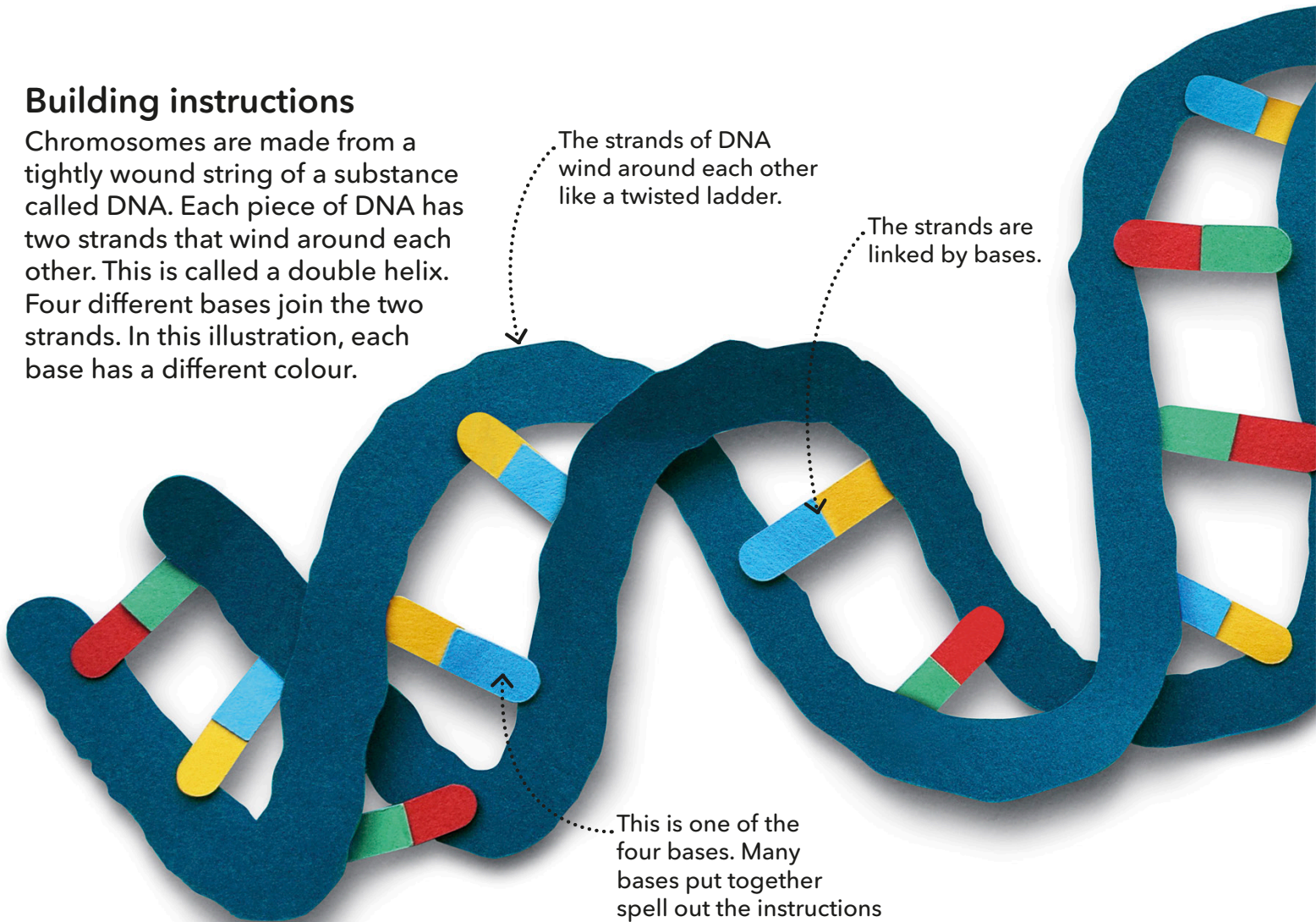
Building instructions

Chromosomes are made from a tightly wound string of a substance called DNA. Each piece of DNA has two strands that wind around each other. This is called a double helix. Four different bases join the two strands. In this illustration, each base has a different colour.

The strands of DNA wind around each other like a twisted ladder.

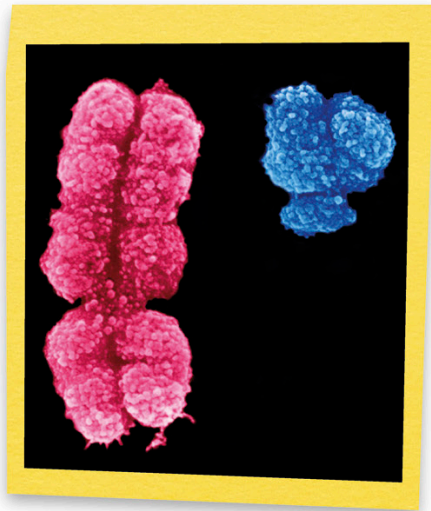
The strands are linked by bases.

This is one of the four bases. Many bases put together spell out the instructions for building a cell.

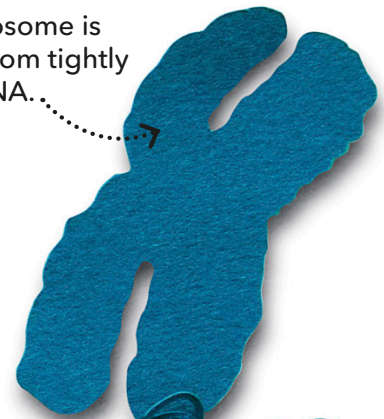


Boy or girl?

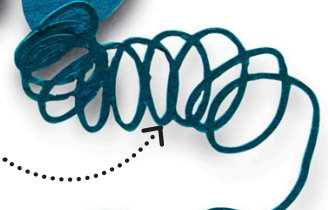
Every cell has 23 pairs of chromosomes. One pair, called the sex chromosomes, controls whether someone is male or female. Boys have one X (pink) and one Y (blue) chromosome, as shown here. Girls have two X chromosomes, and no Y.



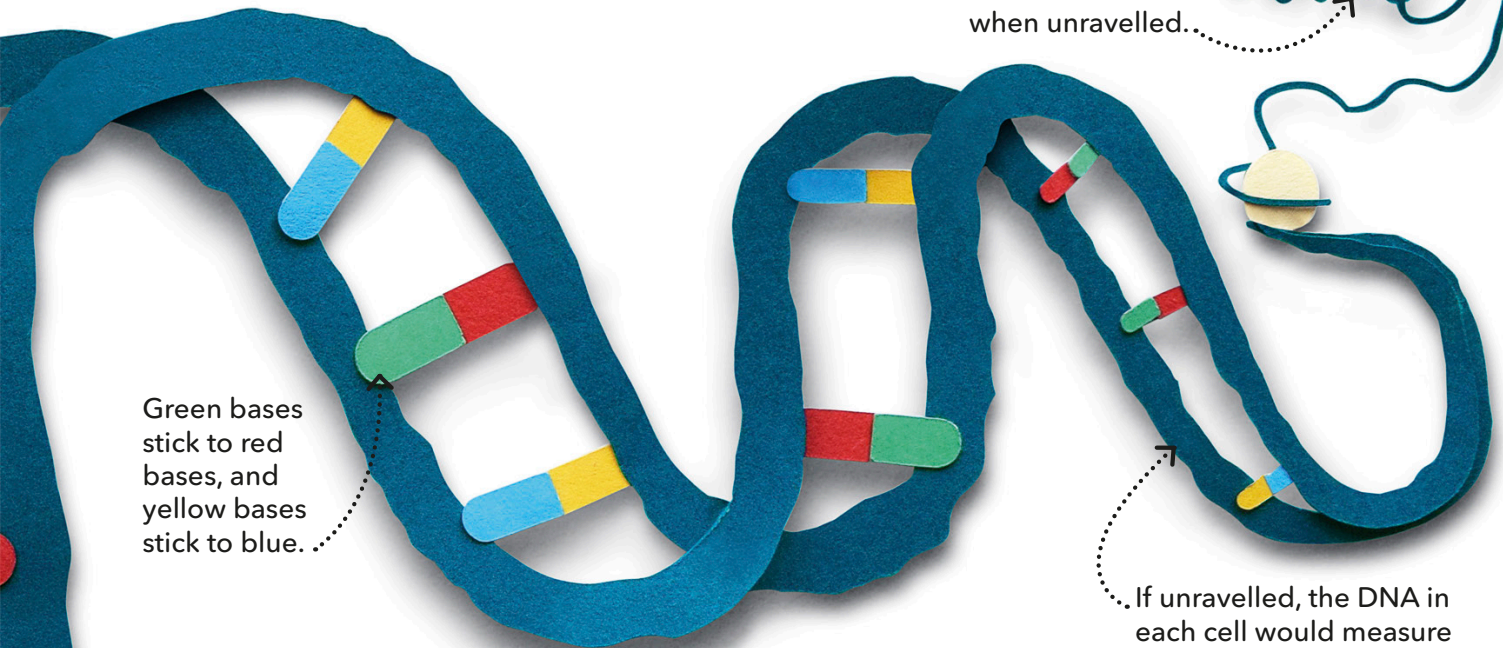
A chromosome is formed from tightly coiled DNA.



Here is what DNA looks like when unravelled.



Green bases stick to red bases, and yellow bases stick to blue.



If unravelled, the DNA in each cell would measure about 2.1 m (7 ft) long.



Two of a kind

These girls are identical twins. They look just like each other because they share exactly the same genes. However, each girl will live her own life and different things will happen to her, so she will develop her own unique personality.

One of a kind

Every one of your body's cells contains a set of instructions. Those instructions, called genes, are used to build your body and make you look human. They also give you a unique mix of features that makes you one of a kind.



The shape of your mouth...



Your skin colour



Whether or not you have freckles



The colour of your eyes



Your hair colour

Whether you can roll your tongue



Genes and inheritance

The way you look largely depends on your genes. You inherit these genes from your parents. There are slightly different versions of some genes. One might give you brown eyes, for example, while another would give you blue eyes. It is your particular mix of genes that makes you unique. Here are some features that are controlled by the genes you inherit.



Humans
have about
19,000
genes!



Whether you are
a girl or a boy



Whether your hair
is curly or straight



The features
and proportions
of your face

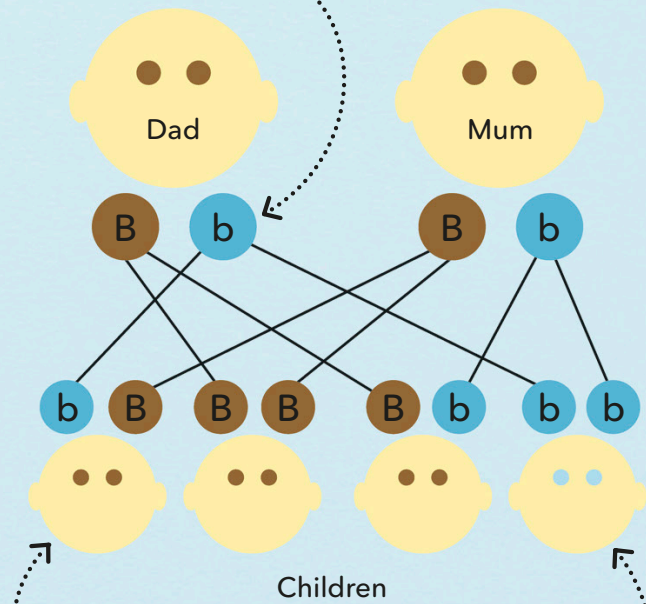


Whether your earlobes are
free or attached to the side
of your face

Passing it on

This is an example of how genes are passed on. Both parents have different versions of an eye-colour gene. A child receives one version from each parent. If the child inherits one or two brown-eye genes, they will have brown eyes. The child has to inherit two blue-eye genes to have blue eyes.

Although the dad has brown eyes, he also has the blue-eye gene.



The brown-eye gene
always beats the
blue-eye gene, so this
child has brown eyes.

A child will only
have blue eyes
if they have two
blue-eye genes.

Mini-machine

Your body is made up of trillions and trillions of tiny parts called cells. Cells come in many different shapes and they all have a different job to do. Every cell is like a tiny machine. It has many different parts, called organelles, that work together.

Little bags of fluid, called lysosomes, digest food and eat up rubbish or worn-out organelles inside the cell.

The Golgi body is an organelle that takes proteins made inside the cell and sends them to where they are needed.

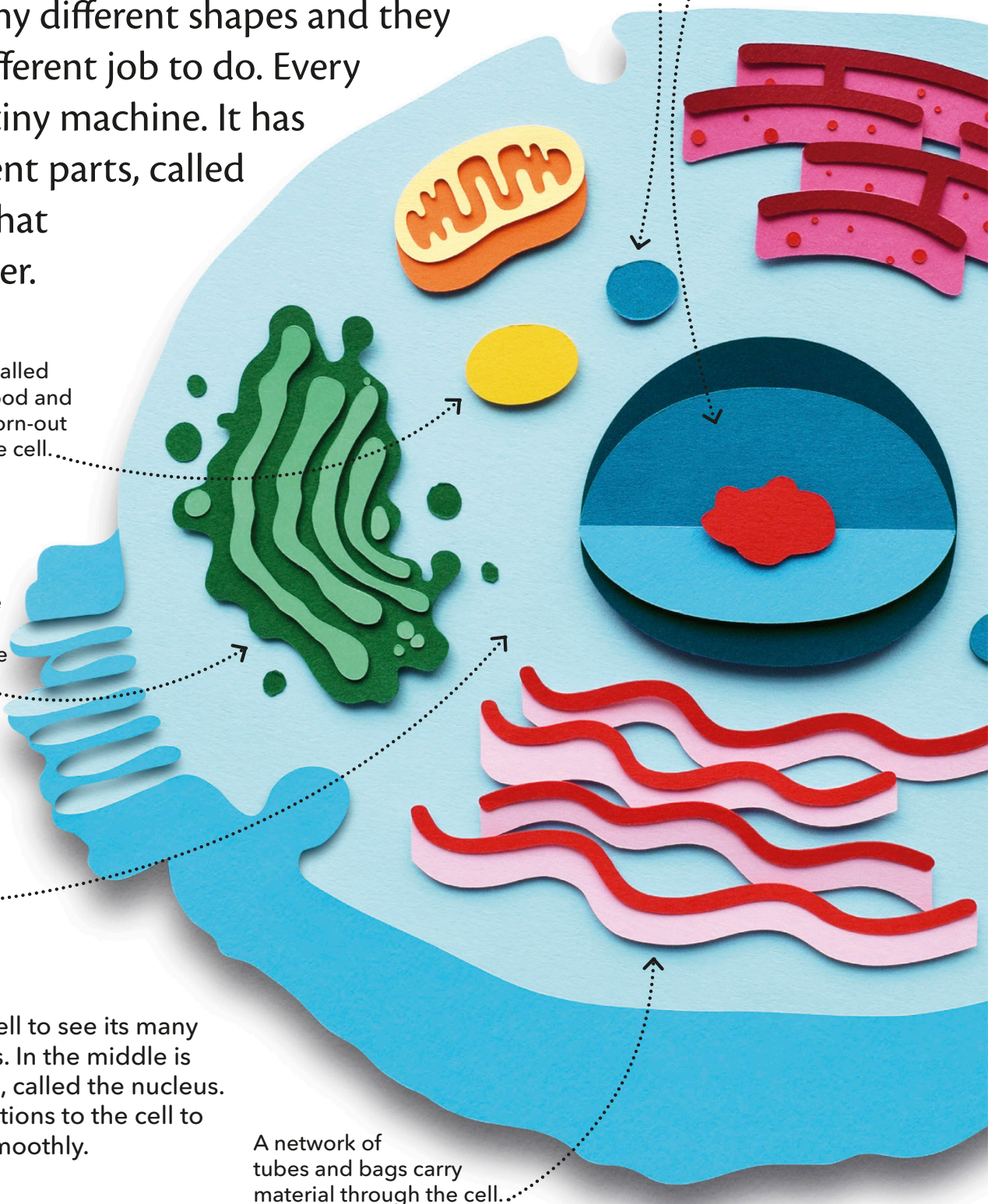
The cell is filled with clear jelly called cytoplasm.

Inside a cell

Look inside this cell to see its many tiny working parts. In the middle is the control centre, called the nucleus. This sends instructions to the cell to keep it running smoothly.

Bags that carry waste and water inside the cell are called vacuoles.

The nucleus is the cell's control centre.

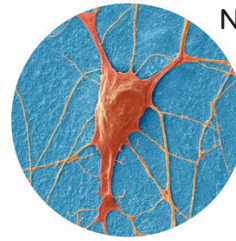


A network of tubes and bags carry material through the cell.

These tubes help build proteins that your body needs to work properly.



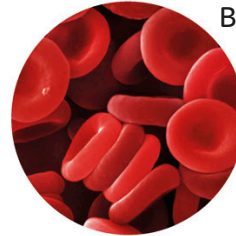
Muscle tissue is made of stringy cells, called fibres. It makes you move.



Nerve tissue carries messages around your body.



Fat tissue sits under your skin. Its round cells store energy and keep you warm.



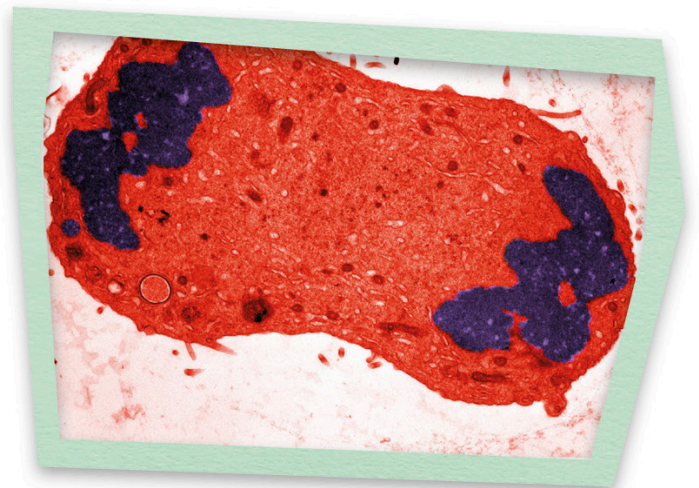
Blood is a liquid tissue. Its red blood cells carry oxygen to other tissues.

Join together

A group of similar cells that come together to do a particular job is called a tissue. These include muscle, nerve, fat, and blood tissues.



Tiny batteries, called mitochondria, power the cell.



Splitting up

Cells split in half to make new ones. The half-sized cells then grow to full size. You started life as a single cell, which divided again and again to make the trillions of cells in your body. Your cells divide all the time to replace worn-out ones.

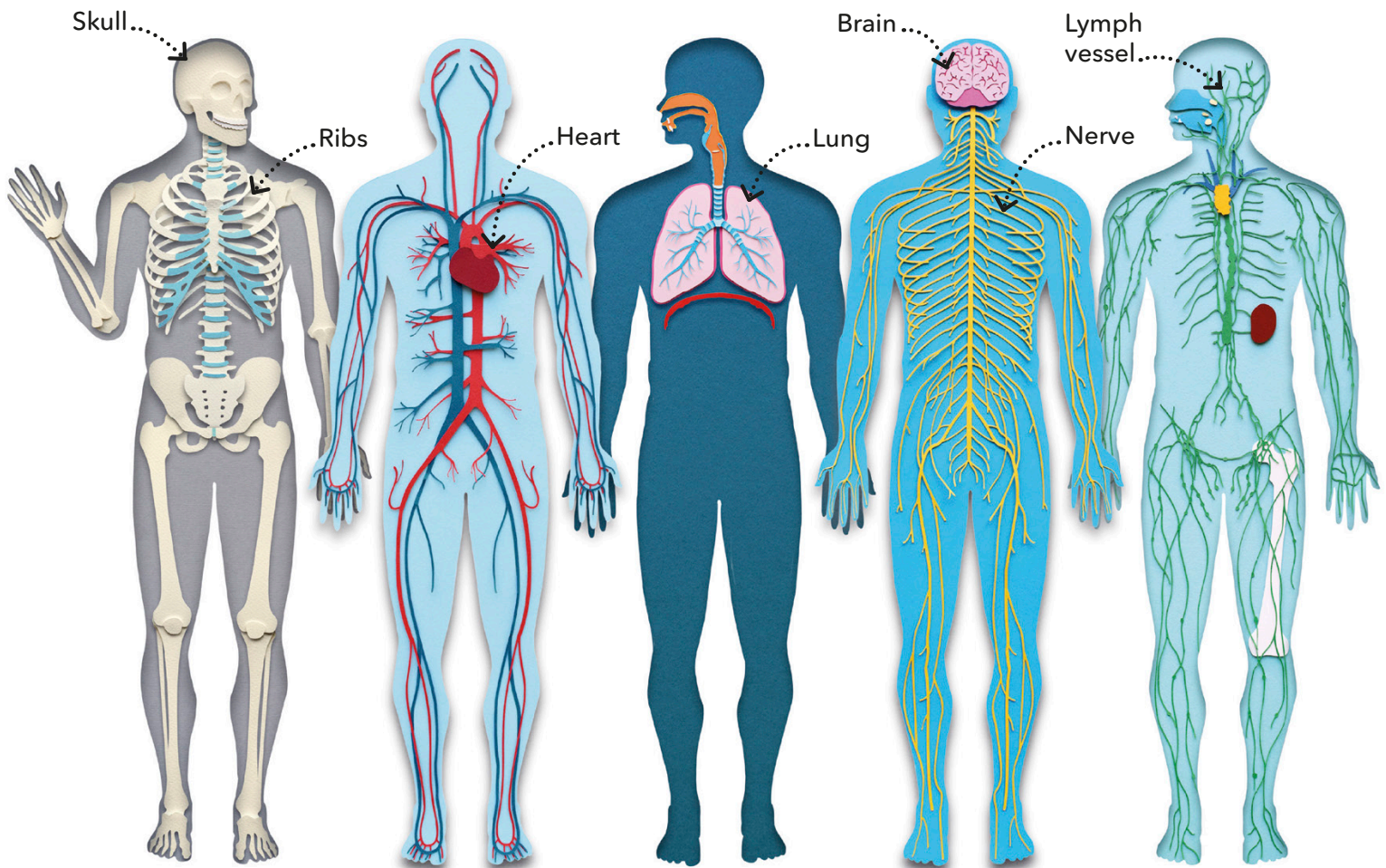
More than **2,000 dead skin cells** fell off you as you read this sentence!

Getting organized

The mass of living cells that make up your body do not work on their own. Cells with the same job form teams called tissues. Different tissues get together to make working parts called organs, such as the brain and stomach.

Body systems

Organs that are linked together, such as the heart and blood vessels, make a body system. Your body has 12 systems, and 10 are shown here. The other two are the skin and the reproductive system. Systems need each other to make the body work properly.



Skeletal system
Your skeleton supports the body, allows it to move, and protects organs.

Circulatory system
Pumped by the heart, blood carries food and oxygen in blood vessels.

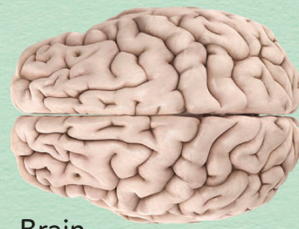
Respiratory system
This breathes in air to get the oxygen that is used by body cells.

Nervous system
The brain controls your body. It sends and gets messages along nerves.

Lymphatic and immune systems
Lymph vessels drain fluid from tissues. Defence cells destroy germs.

Working parts

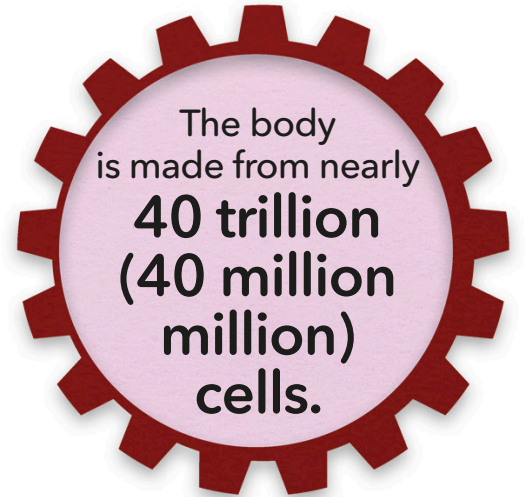
There are more than 2,000 working parts, called organs, in your body. Every organ has a particular job or jobs to do. Your brain, for example, controls your body, and lets you feel and see, think and remember. Your stomach plays a key part in breaking down the food that you eat.



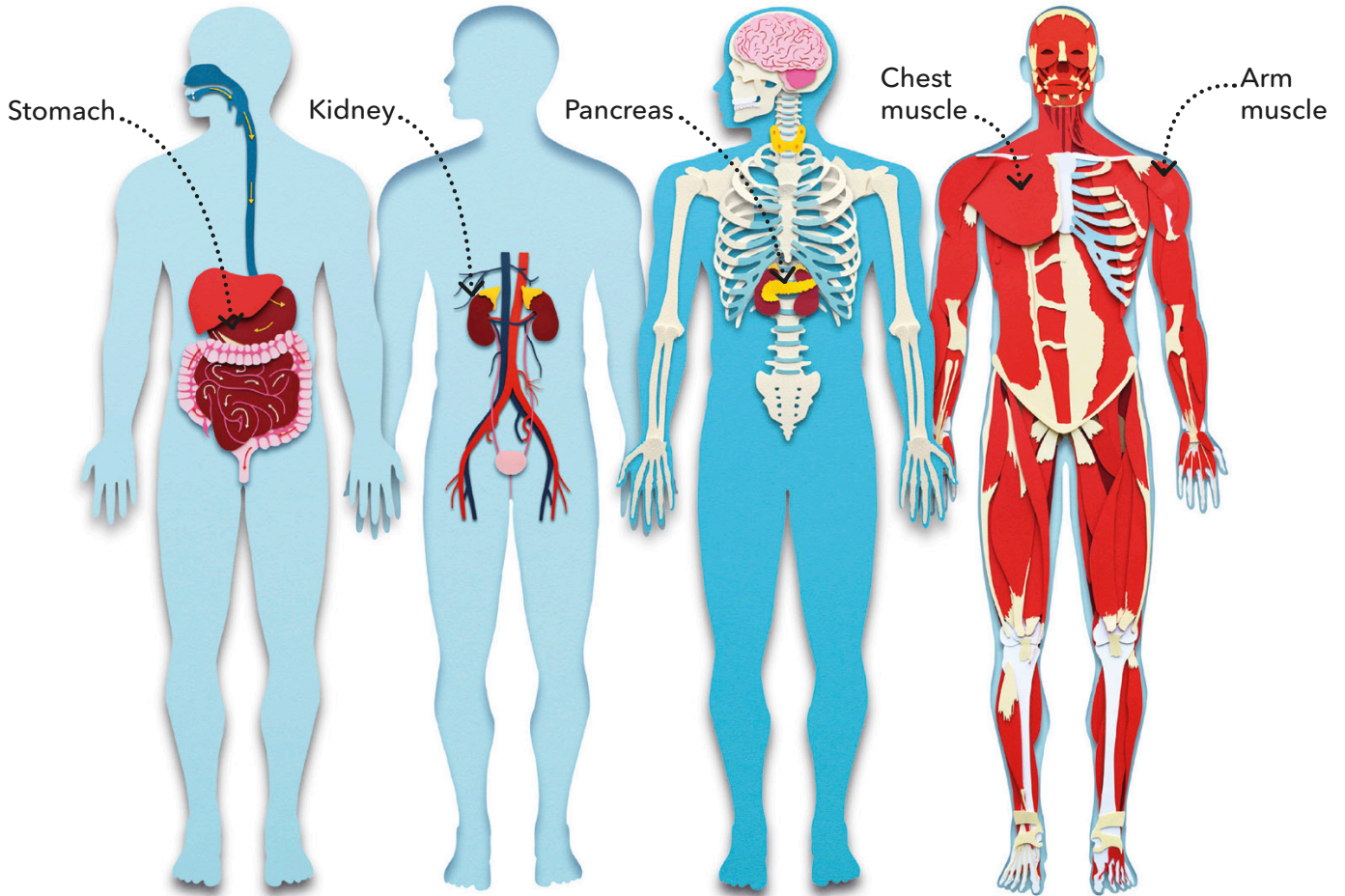
Brain



Stomach



The body is made from nearly **40 trillion (40 million million) cells.**



Digestive system
This digests food to release nutrients needed for energy, growth, and repair.

Urinary system
The kidneys filter blood. Waste and excess water leave the body as urine.

Endocrine system
These glands release chemical messengers, called hormones.

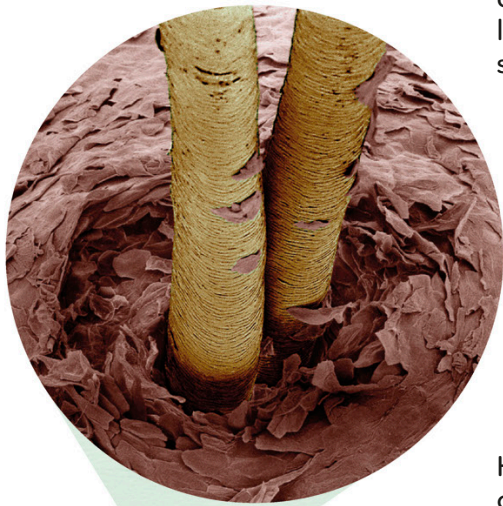
Muscular system
Muscles tighten, or contract, to pull bones so your body can move.

Body barrier

The skin is your body's biggest organ. It makes a barrier that covers and protects you. It keeps out germs, helps to regulate your temperature, and lets you feel your surroundings. It also helps protect you from the Sun's harmful rays, and constantly repairs itself.

Living layers

Your skin has two layers. A thin top layer called the epidermis provides protection, and is constantly worn away and replaced. The inner layer is called the dermis. It contains blood vessels, nerves, and sweat glands that help the skin carry out its work, and provides the cells which grow up into the top layer.



Tiny blood vessels, called capillaries, lie near the skin's surface.

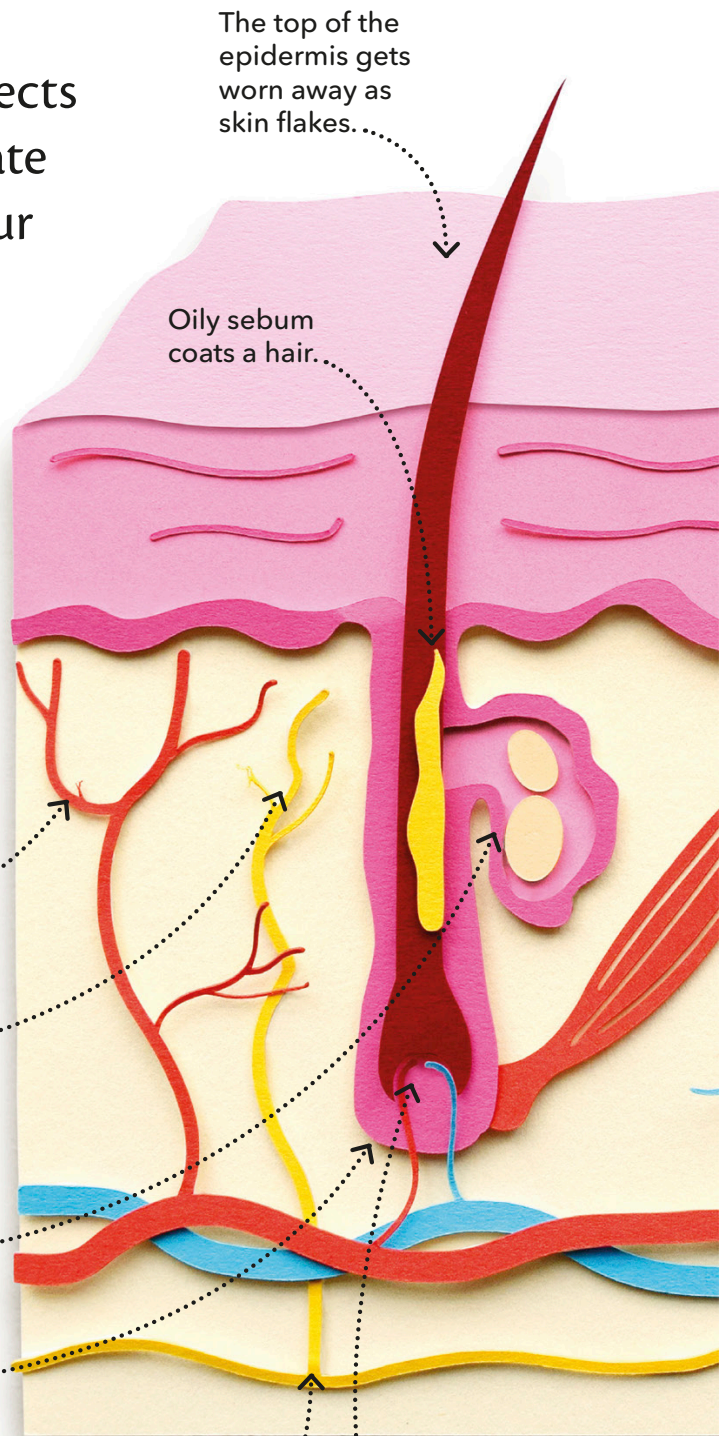
Nerve endings detect touch, heat, or pain.

This is a gland that releases an oily mixture called sebum. It softens skin and hair.

Hair grows out of a little pocket called a follicle.

Hair

This close-up picture shows two of the thousands of hairs that cover your head. Each hair is a bendy strand made up of dead cells. Hairs protect the skin on the head from harmful sun rays.

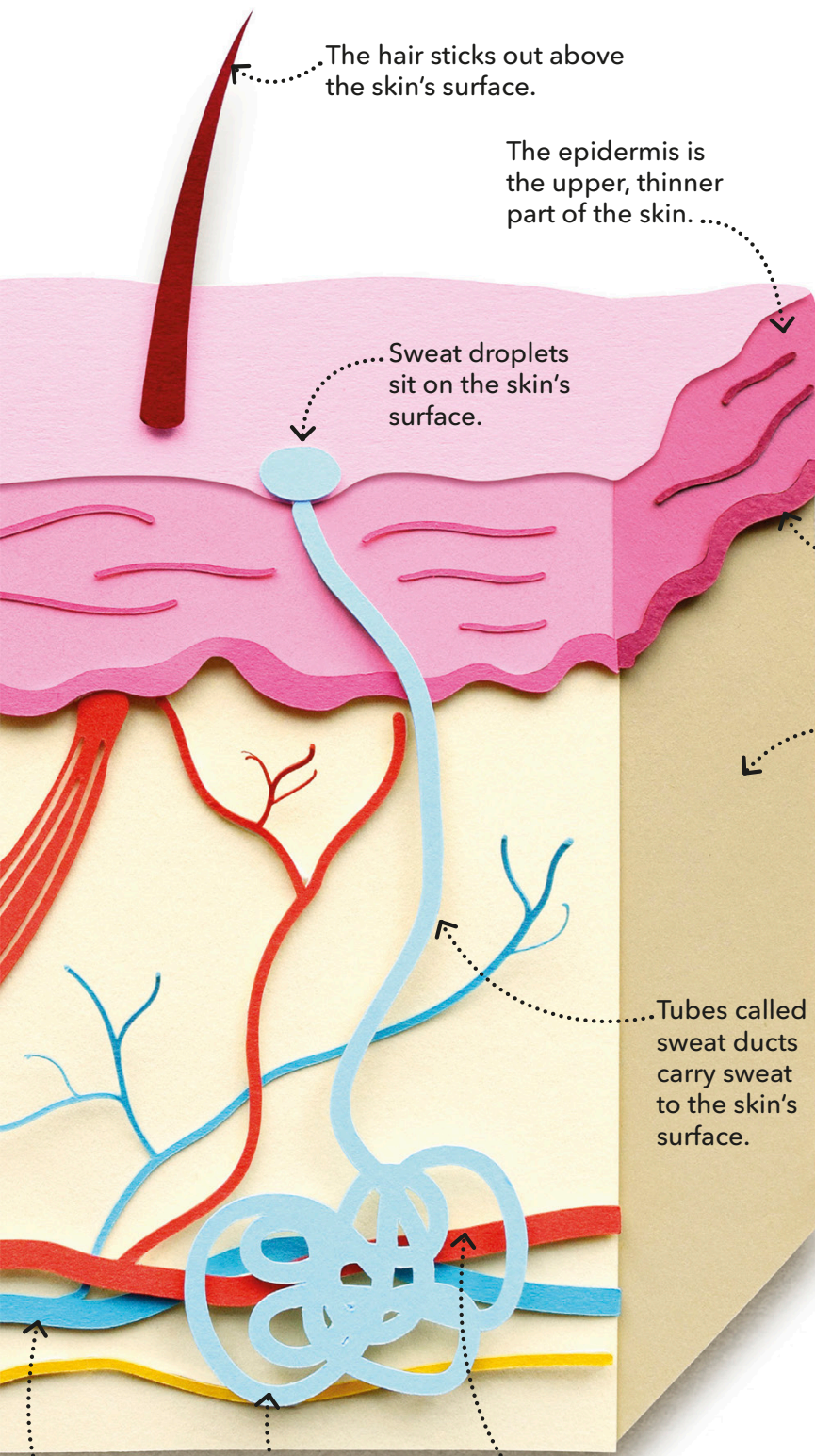


The top of the epidermis gets worn away as skin flakes.

Oily sebum coats a hair.

Nerves carry signals to the brain.

The hair grows upwards from the follicle.



The hair sticks out above the skin's surface.

The epidermis is the upper, thinner part of the skin.

Sweat droplets sit on the skin's surface.

This lower layer of the epidermis makes new skin cells.

The dermis is the lower, thicker part of the skin.

Tubes called sweat ducts carry sweat to the skin's surface.

A nail grows from its root in the skin.

Veins take away waste from skin cells.

Sweat glands let out watery sweat to help cool the body.

Large blood vessels, called arteries, carry oxygen and food to the skin cells.

Your body's thickest skin is on your palms and the soles of your feet.



Fingernails

These hard plates protect the sensitive tips of your fingers. Fingernails also help you grip small objects when you pick them up. When your nails are cut it does not hurt because, like hairs, they are made of dead cells.

Marvellous machine

Your body's cells, tissues, organs, and systems do not work separately. To create and run the marvellous machine that is you, they work together and support each other every second of the day and night.

Body parts

Your body has thousands of parts that have their own jobs to do. They also work together to keep the body alive and make it work efficiently. Here are some of your main body parts.

Your lungs suck in air and pass oxygen from it into your blood. Oxygen is carried to your cells and releases the energy that keeps you alive.....

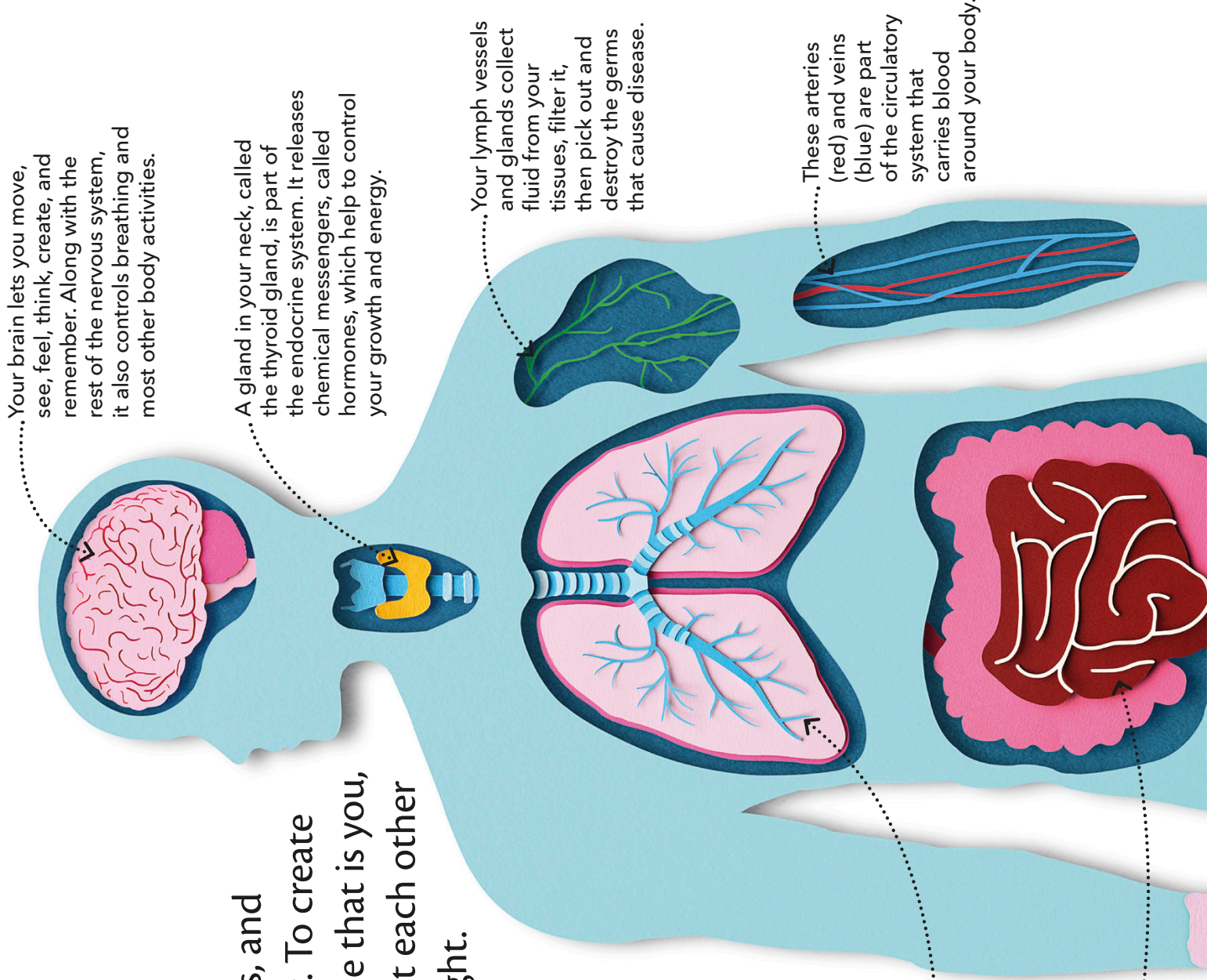
The intestines are part of your digestive system, which breaks down food into tiny pieces that your cells can use for energy, growth, and repair.....

Your brain lets you move, see, feel, think, create, and remember. Along with the rest of the nervous system, it also controls breathing and most other body activities.

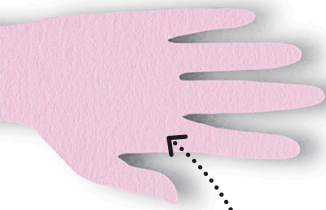
A gland in your neck, called the thyroid gland, is part of the endocrine system. It releases chemical messengers, called hormones, which help to control your growth and energy.

Your lymph vessels and glands collect fluid from your tissues, filter it, then pick out and destroy the germs that cause disease.

These arteries (red) and veins (blue) are part of the circulatory system that carries blood around your body.



The skin is a tough, waterproof layer that covers your body and protects it from germs, injury, and sunlight. It also helps keep your insides warm.



Build a body

Your body is built from basic substances called elements. The most common ones are oxygen, carbon, hydrogen, nitrogen, calcium, and phosphorus. Other elements include sodium, chlorine, and iron. Elements often combine. For example, oxygen and hydrogen combine to make water.



Carbon, also found in diamonds, builds big molecules inside you.



Nitrogen, found in air, helps to make body-building proteins.



Calcium, also found in chalks, helps build bones and keeps muscles working.



Phosphorus, also found in match tips, makes teeth and bones strong.



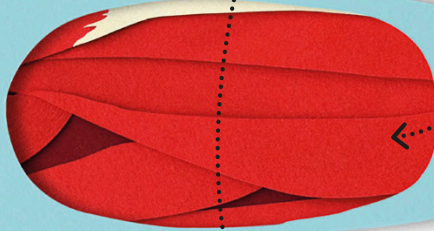
Sodium and chlorine combine to make salt, a key part of blood.



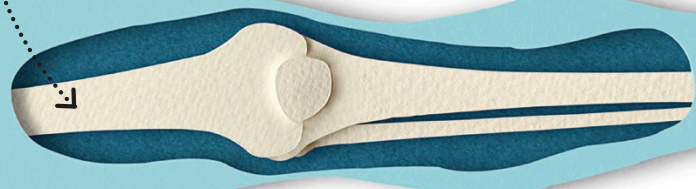
Iron, also found in nails, helps make blood red and carry oxygen.



Bones form the skeletal system, the slightly flexible framework that supports your body and allows it to move. The skeleton protects soft organs.



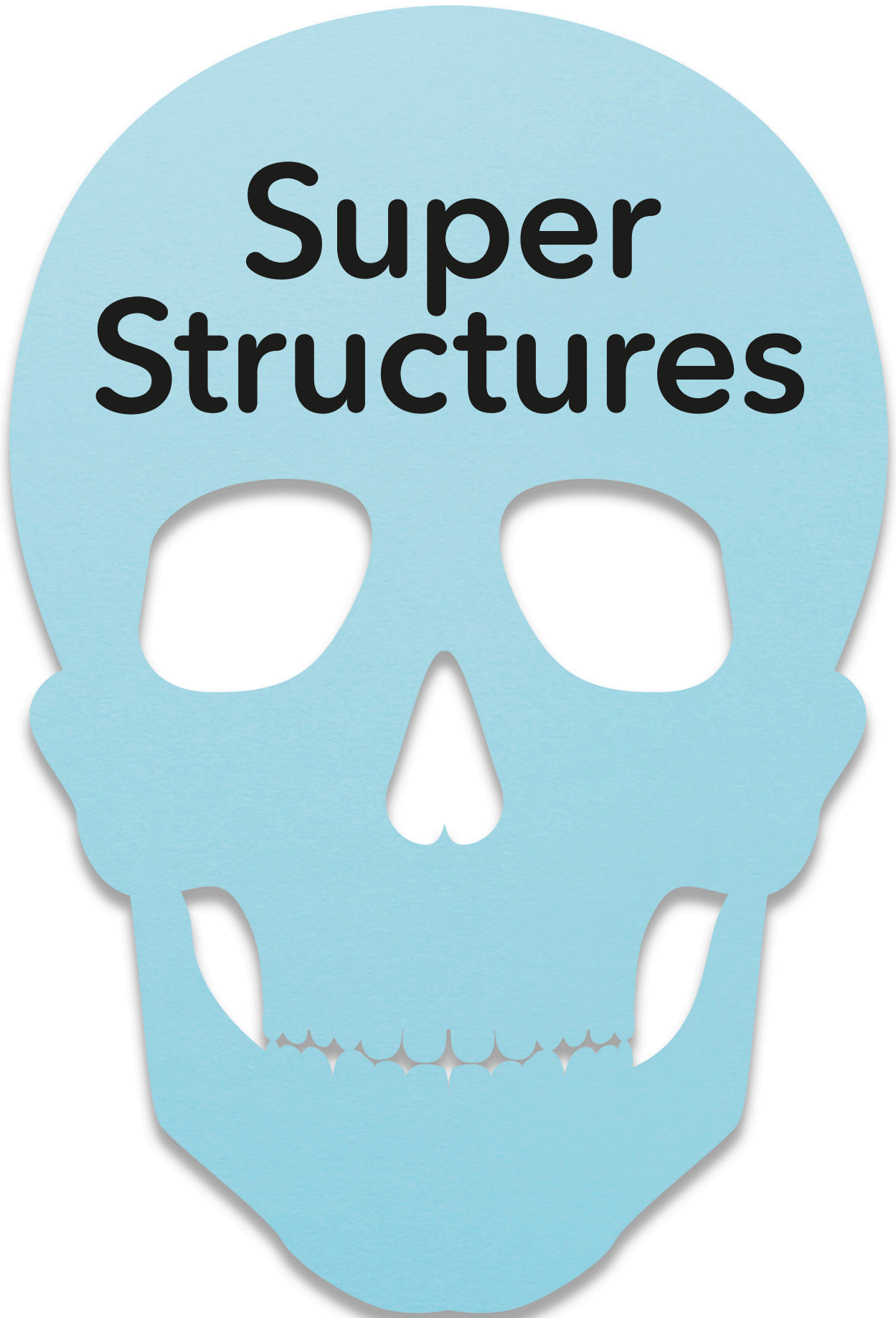
Muscles pull on bones and move your skeleton when instructed to by the brain. This allows you to walk, jump, or wave. Muscles also help shape your body.



Water,

the most important substance in your body, makes up **over half** of your weight.

Super Structures



Without strong bones and powerful muscles, your body would collapse in a heap. Together, these super structures shape and support your body, protect your insides, and allow you to perform all kinds of movements, from smiling to kicking a ball.



Framework

Without a skeleton, your body would collapse in a heap! This flexible framework supports and shapes your body, and allows it to move. Your skeleton also protects your organs.

Skeleton bones

Your skeleton's bones are connected by joints that let your body move around. More than half of your bones are in your hands and feet. These bones help you to perform complex movements, such as gripping a pen.

There are
206 bones
in an adult
skeleton, but you
were born with
more than
300.

Your skull protects your brain and gives shape to your face.

Your jaw is hinged near your ears. It allows the lower jawbone to move up and down, so that you can talk and eat.

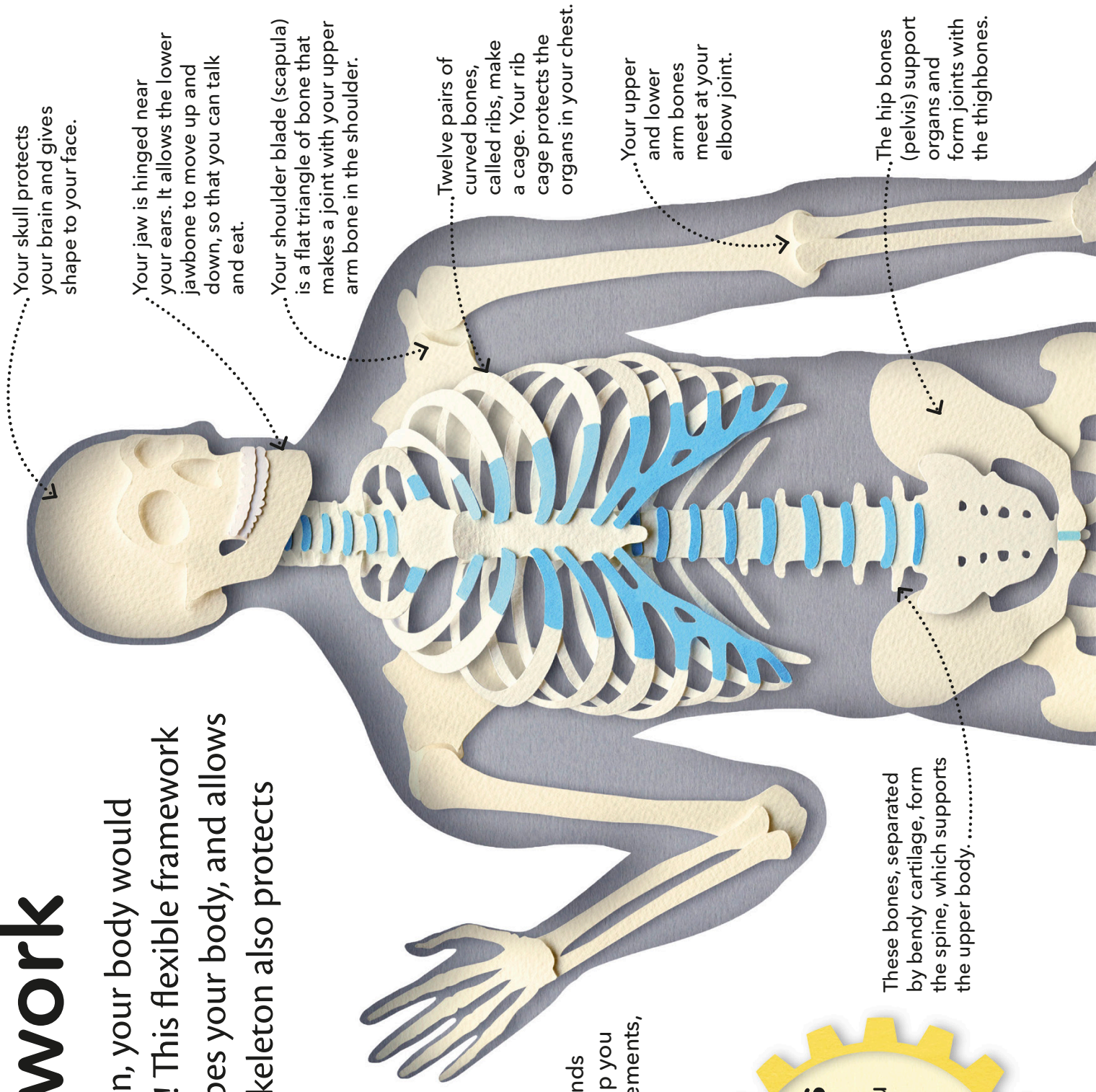
Your shoulder blade (scapula) is a flat triangle of bone that makes a joint with your upper arm bone in the shoulder.

Twelve pairs of curved bones, called ribs, make a cage. Your rib cage protects the organs in your chest.

Your upper and lower arm bones meet at your elbow joint.

The hip bones (pelvis) support organs and form joints with the thighbones.

These bones, separated by bendy cartilage, form the spine, which supports the upper body.

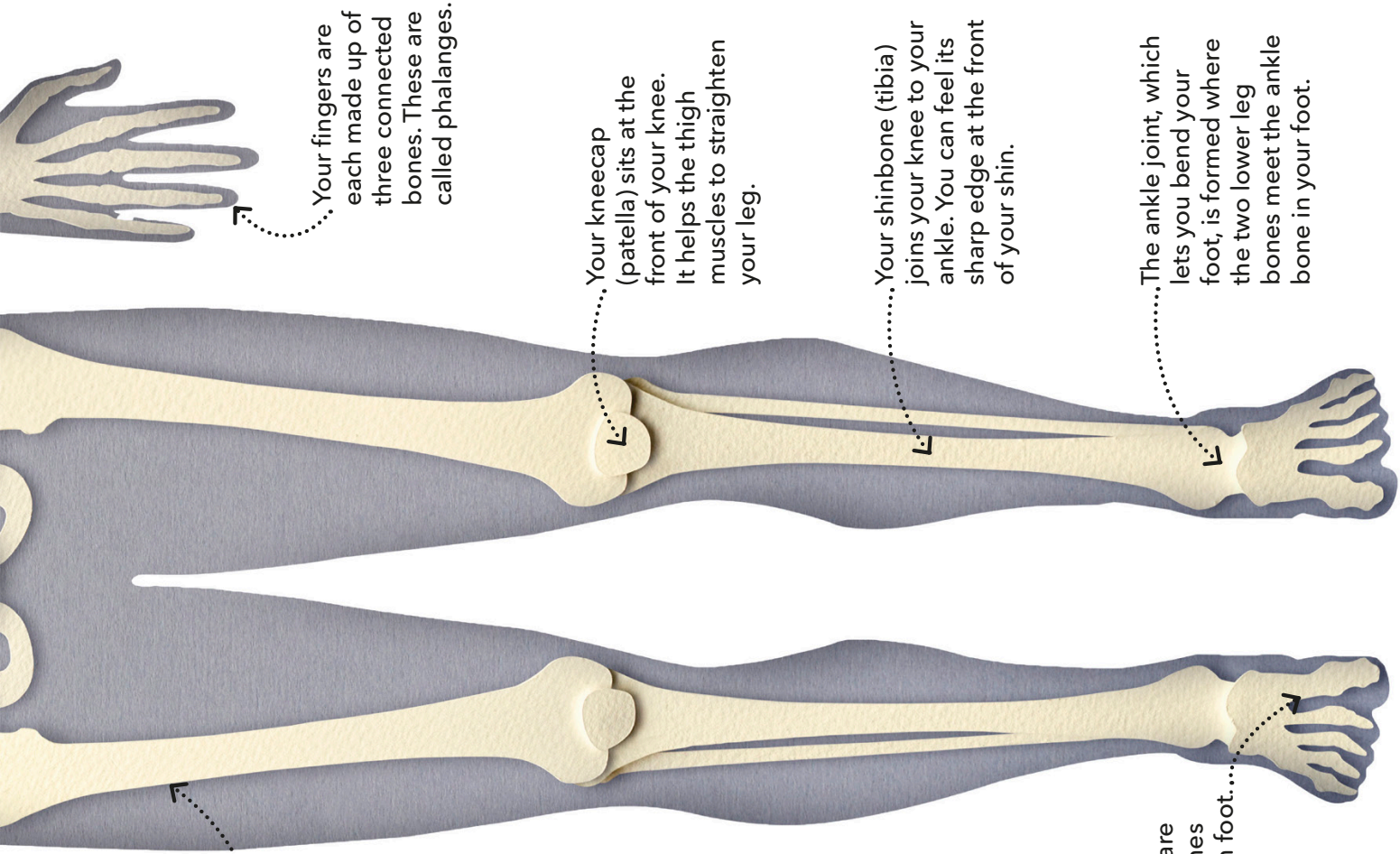


Your thighbone (femur) connects the hip (pelvis) to your knee. It is the longest bone in the body.



Look inside

You can feel your bones under your skin, but to see them you need to use a special type of camera, called an X-ray machine. Bones, such as these hand bones, show up very clearly in X-rays, so doctors use them to check for broken bones.



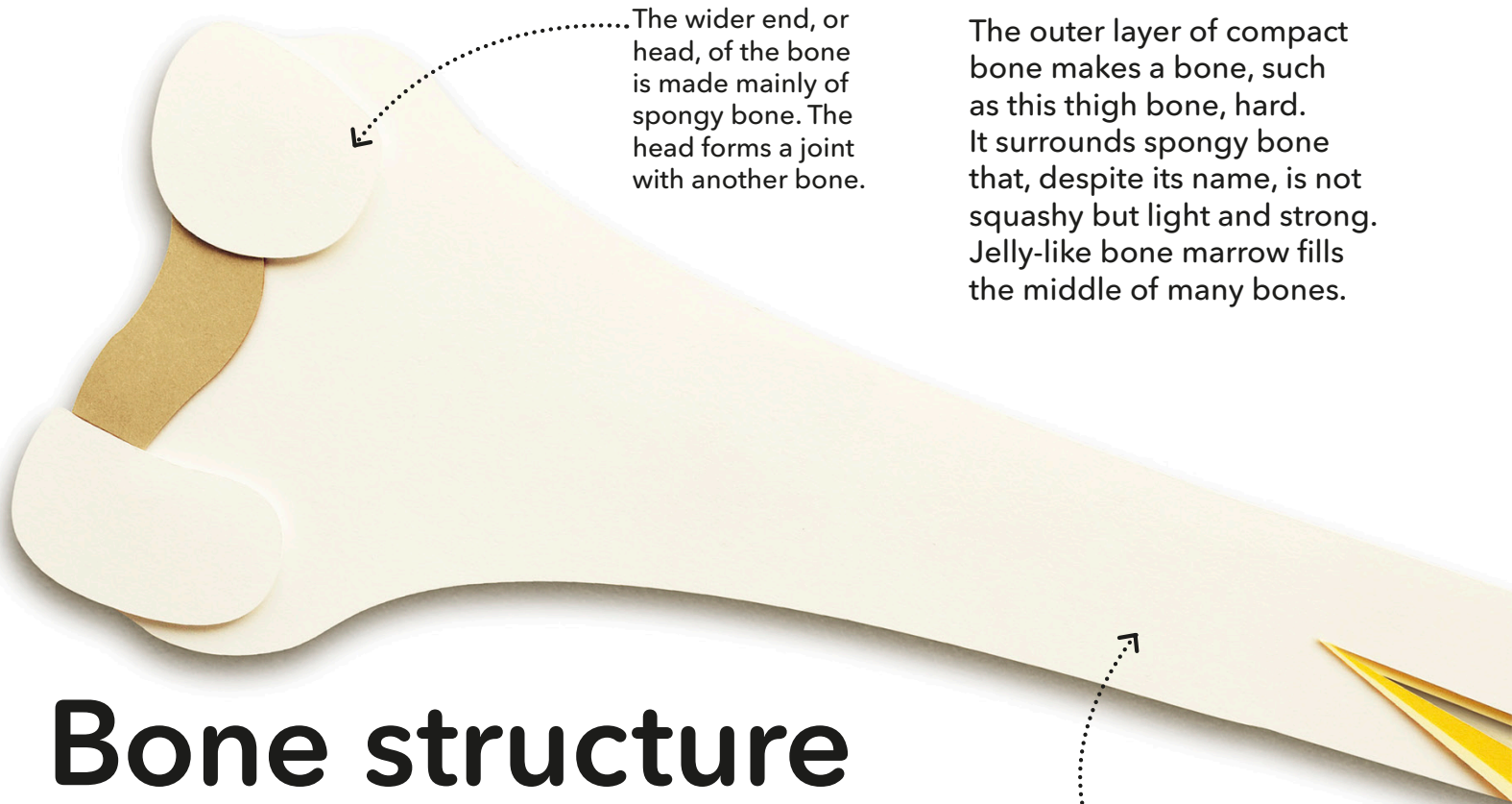
Your fingers are each made up of three connected bones. These are called phalanges.

Your kneecap (patella) sits at the front of your knee. It helps the thigh muscles to straighten your leg.

Your shinbone (tibia) joins your knee to your ankle. You can feel its sharp edge at the front of your shin.

The ankle joint, which lets you bend your foot, is formed where the two lower leg bones meet the ankle bone in your foot.

There are 26 bones in each foot.



The wider end, or head, of the bone is made mainly of spongy bone. The head forms a joint with another bone.

Inside a bone

The outer layer of compact bone makes a bone, such as this thigh bone, hard. It surrounds spongy bone that, despite its name, is not squashy but light and strong. Jelly-like bone marrow fills the middle of many bones.

Bone structure

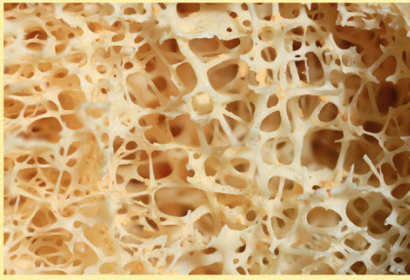
If your bones were solid, you would be too heavy to move. But if you cut open a bone, you would see that there are both solid parts and spaces. All bones share the same special structure. They are light enough not to weigh you down, but strong enough to support your body.

The shaft of a long bone connects its two heads. It is made mostly of compact bone and bone marrow.

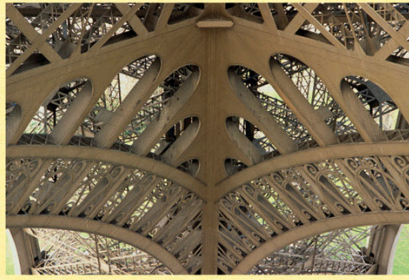


Blood factory

Here is a close-up view of bone marrow, a tissue that is found inside many bones. Bone marrow makes new blood cells. These replace older ones that are worn out. The red dots in this picture are red blood cells.



Spongy bone



Metal arch

Super structures

Spongy bone gets its strength from its honeycomb-like structure of bars, or struts, that cross over each other. This criss-cross pattern has been copied in buildings and structures, such as this arch.

Compact bone covers the outer part of the bone. It is made of tiny rods that give it strength and hardness.

Bone marrow, which fills the centre of the bone, makes blood cells that enter the blood.

The spaces in spongy bone also contain bone marrow.

The tough "skin" that protects a bone is called the periosteum. It helps, along with the tendons, to connect the bone to the muscles that move it.

Spongy bone fills most of the head of the bone. It has lots of little hollows that make the bone lighter.

Your bone marrow makes **two million** red blood cells every second.

Growing and mending

Bones are living organs that contain blood vessels, nerves, and bone cells. They first appear when a baby is inside its mother, and continue growing until about the age of 20. Bones can repair themselves if they break.

Growing bones

At first, a baby's bones are made from a tough but flexible material called cartilage. As the bones grow, the cartilage is replaced by harder bone. As you can see from these X-rays, cartilage continues to be replaced by bone as the child grows.



Seven-year-old child

Here, the wrist bones, and the bones of the palm and the fingers, are steadily growing as cartilage is replaced by bone.



Two-year-old child

Here, the wrist bones (pink) are made mostly from cartilage.



The **bones** broken most commonly are in the fingers, wrists, and ankles.

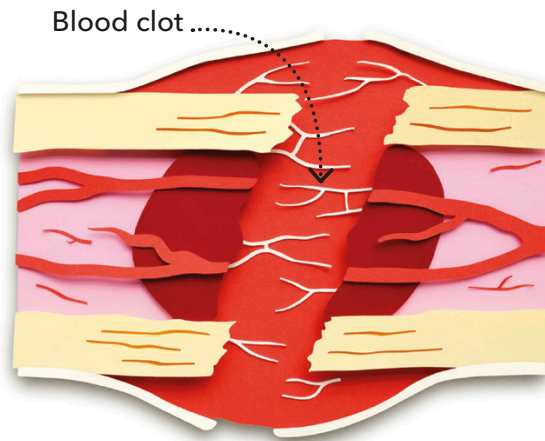
Auto-repair

Although bones are strong, they sometimes break or crack. If this happens, a bone starts to repair itself straight away. Within months it will be almost like new. Sometimes, casts or pins are used to hold bones together so they heal properly.

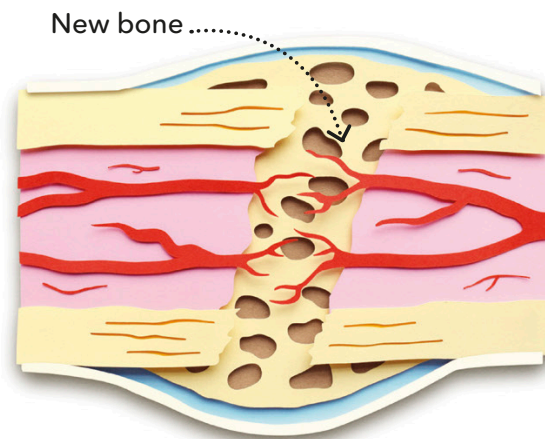


Adult hand

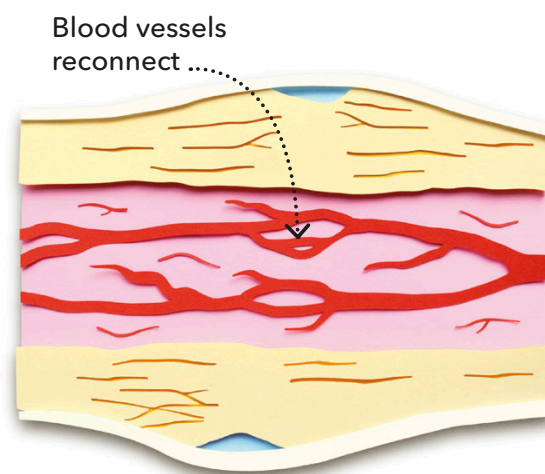
This adult hand has eight wrist bones, along with the fully grown palm and finger bones.



One to two hours
A blood clot forms between the ends of the broken bone to stop bleeding. White blood cells arrive to mop up any invading germs.



Three weeks
Bone-building cells move into the space between the broken ends and build a "bridge" of spongy bone. The bone cannot yet support weight.



Three months
The bone is repaired. The spongy bone "bridge" has been replaced by hard compact bone. Blood vessels in the bone marrow connect together across the break.

Skull and spine

Both your skull and your spine, or backbone, form an important part of your skeleton. Your skull protects your brain and sense organs, and shapes how you look. It sits on top of your spine, the flexible column that holds your body upright.

There are **29 bones** in your head, including six tiny ear bones that help you hear.

Brain box

Your skull is made of 22 bones. All bones, apart from the lower jaw bone, are locked together. This makes your skull super strong. Eight skull bones form the domed box that surrounds and protects your brain. The other 14 bones shape your face and hold your teeth.

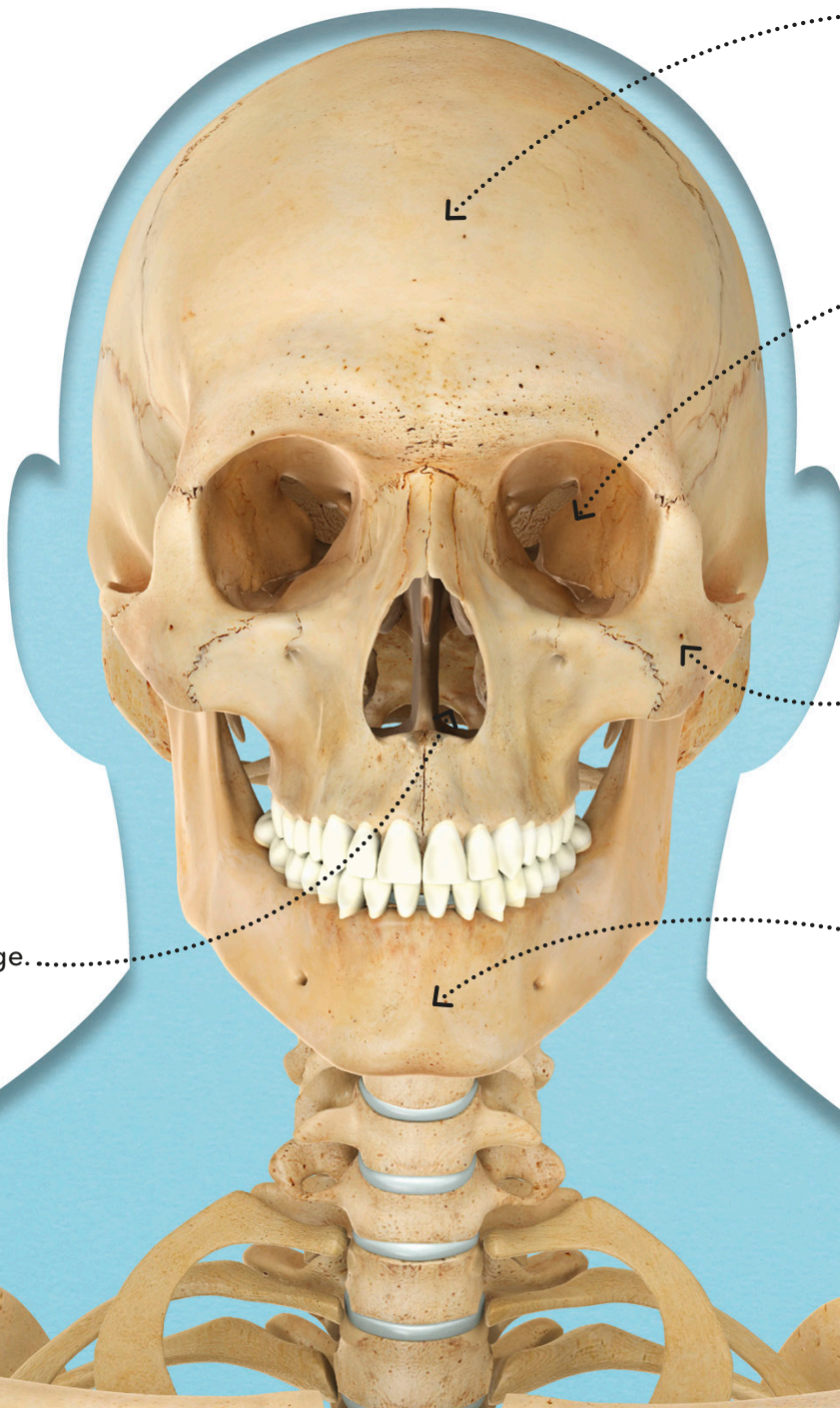
Your nose is mostly cartilage.

The frontal bone shapes your forehead and is one of the bones that protects your brain.

An eye socket, or orbit, surrounds and protects each eye. It is formed from seven skull bones.

The cheekbone, or zygomatic bone, is part of your eye socket.

The lower jaw is the only skull bone that moves. It lets you eat, drink, breathe, and speak.



Seven neck, or cervical, vertebrae support your head. They let it nod, shake, and turn.

A disc made of pliable cartilage sits in between each pair of vertebrae.

Twelve chest, or thoracic, vertebrae form joints with your ribs, the curved bones that shape your chest.

In your lower back are five large lumbar vertebrae. These bones support most of your body's weight.

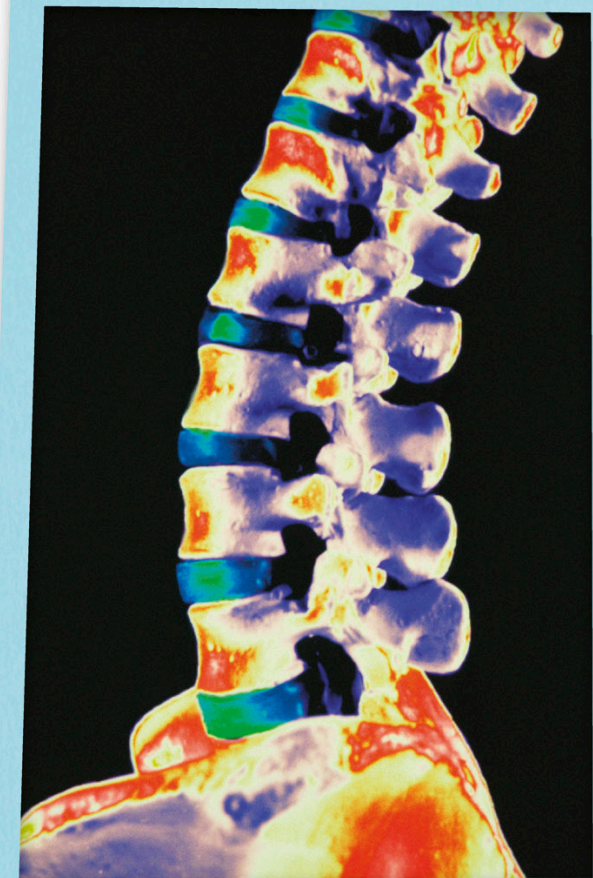
The sacrum, made of five bones stuck together, anchors your hips, or pelvis, to the rest of the spine.

You have a tail, but it is inside your body! The tailbone, or coccyx, is made of four small bones that are stuck together.

Flexible backbone

Your S-shaped spine is a chain of many odd-shaped bones called vertebrae.

There is a small amount of flexibility between each pair of vertebrae. Added together, these small movements make the whole spine very flexible, allowing it to bend and twist.



Shock absorber

This X-ray shows the cartilage discs (blue/green) that are sandwiched between vertebrae. These discs are tough but springy. When you run or jump, the discs squash slightly to cushion you from any harsh jolts.

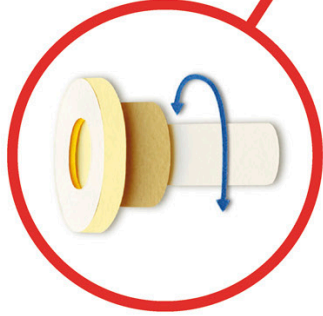
Moving parts

Joints are where your bones meet. Although some are fixed solidly, most of your joints move freely. Without them your body would be stiff and rigid, making walking, running, waving your arms, or twiddling your toes impossible.

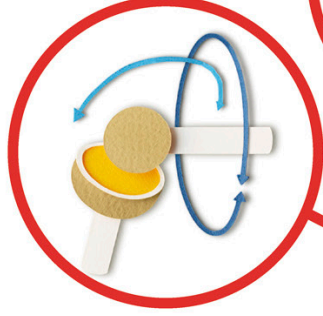
Types of joint

You have several types of free-moving joints in your body. Each type allows certain body parts a range of movements. The type of movement depends on how bone ends fit together in the joint.

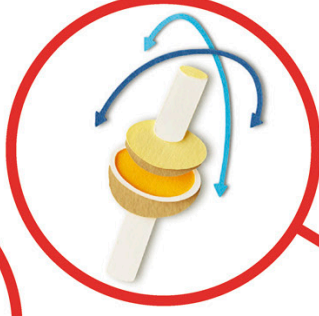
In this pivot joint, at the top of the spine, an upper bone turns around the lower bone. This allows the head to shake from side to side.



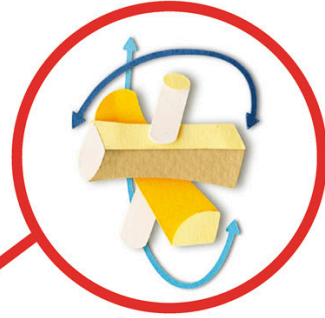
Your shoulder's ball-and-socket joint allows the arm to move freely in most directions. There is also one at the top of each leg.



In the joint in the wrist, the curved ends of two bones fit together. It allows the hand to move up and down and from side to side.

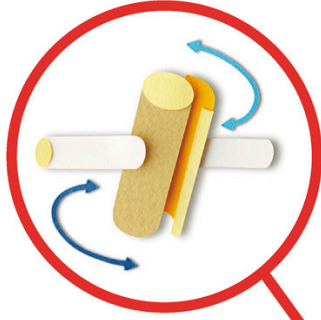


A flexible joint in the thumb can tilt in any direction, but not twist.

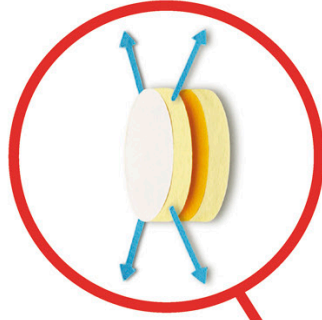




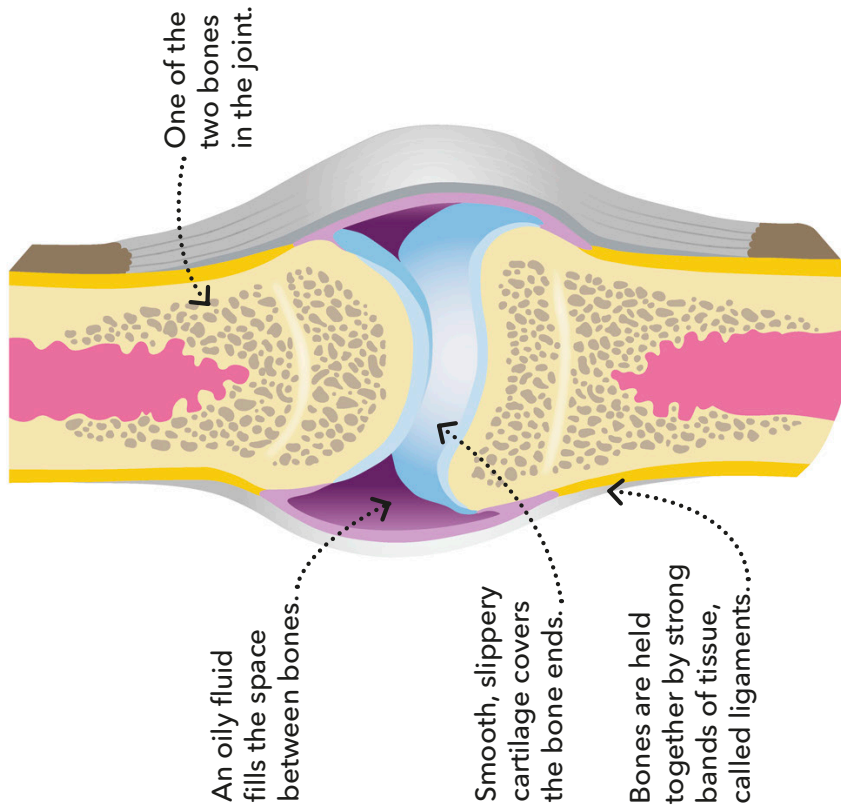
The hinge joint in the knee works like a door hinge and can only move backwards or forwards to let the knee bend or straighten.



In the ankle, joints let the flat ends of two bones slide against each other. These allow small gliding movements that help to support the foot.



The **smallest** joints are the synovial joints in **the ear**, between tiny bones that help you hear.



An oily fluid fills the space between bones.

Smooth, slippery cartilage covers the bone ends.

Bones are held together by strong bands of tissue, called ligaments.

One of the two bones in the joint.

Joining up

Here you can see how a joint holds bones together. The ends of the bones are covered by a shiny flexible material, called cartilage, and separated by an oily liquid. This makes the joint slippery and allows the bones to move smoothly.

Moving machine

Whether walking, talking, or smiling, your body machine is constantly on the move. Muscles make those moves happen.

Using fuel from food, muscles get shorter, or contract, to pull your bones. Other muscles pump your blood or help you eat and breathe.

Body muscles

The muscles that move your skeleton are found in layers under your skin. Here you can see surface muscles on the left and deeper muscles on the right. Some are named, along with the movements they produce. More than 640 skeletal muscles shape your body and make up half of your weight. Muscles are connected to your bones by tendons.

The biceps muscle pulls a bone in your forearm to bend the arm at the elbow.

The frontalis wrinkles your forehead and raises your eyebrows when you are surprised.

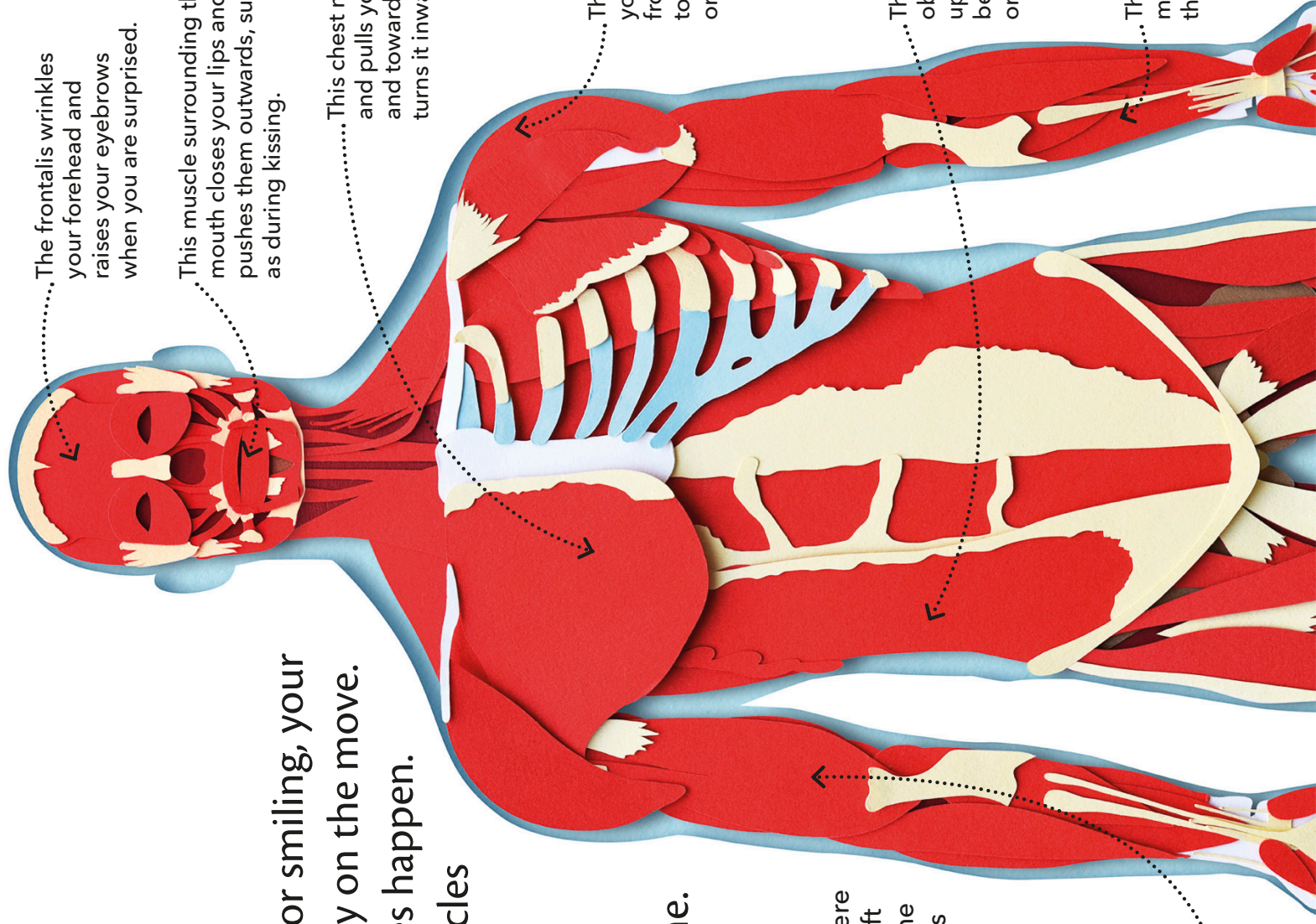
This muscle surrounding the mouth closes your lips and pushes them outwards, such as during kissing.

This chest muscle bends and pulls your arm forwards and towards your body, and turns it inwards.

The deltoid raises your arm away from your body to the front, side, or backwards.

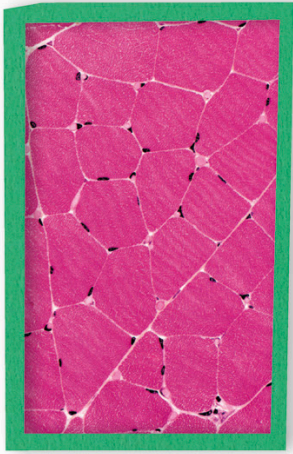
The external oblique twists your upper body and bends it forwards or sideways.

This forearm muscle bends the fingers.

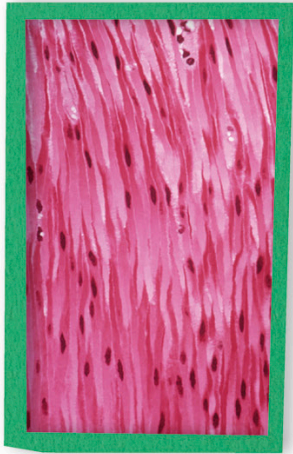




Heart muscle



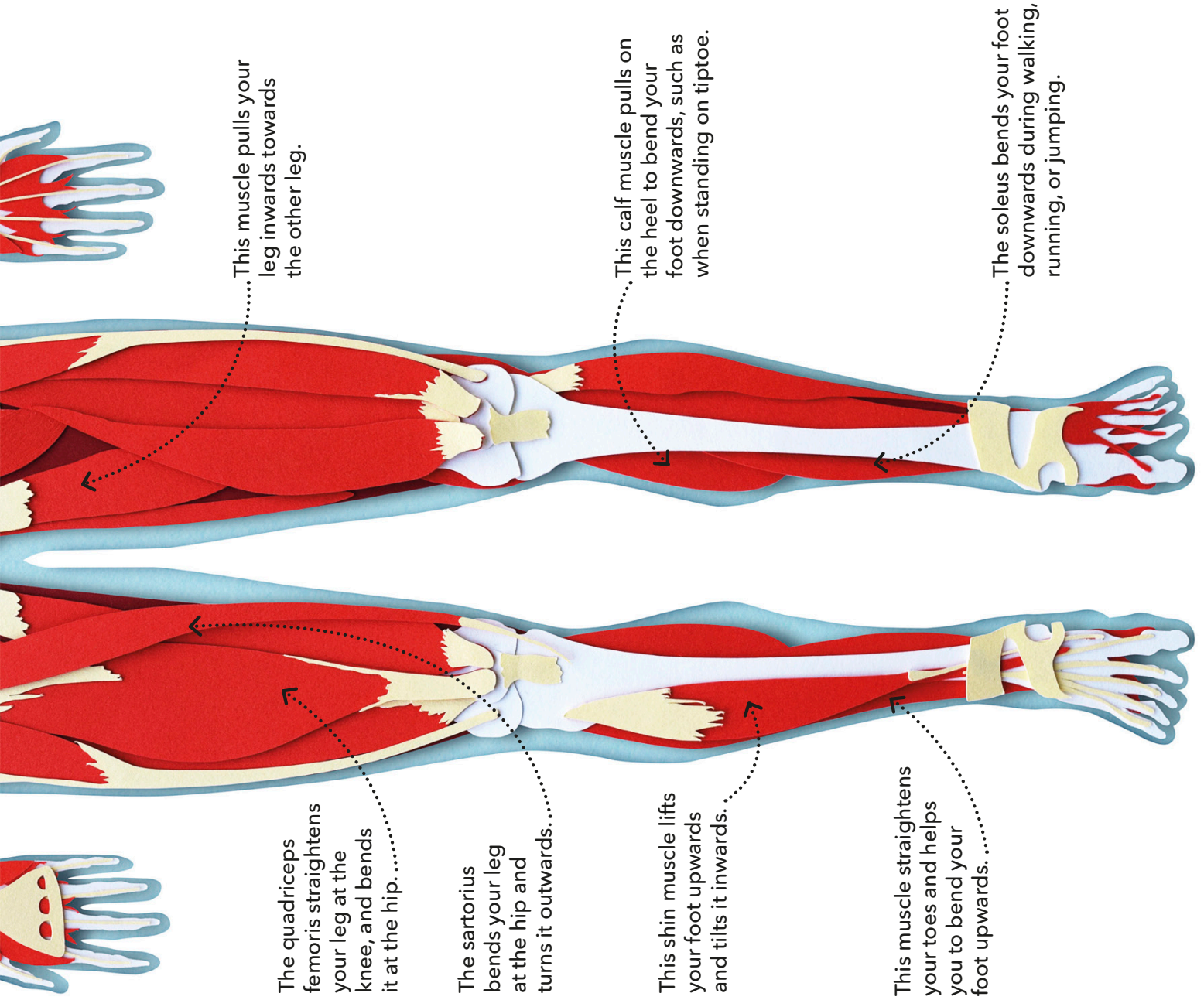
Skeletal muscle



Smooth muscle

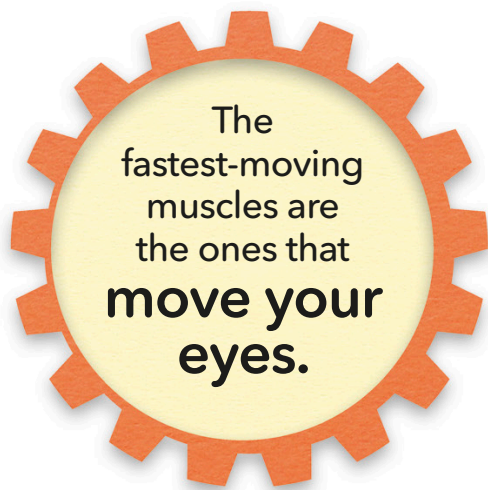
Marvellous muscle

These microscopic views show the three types of muscle. Heart muscle has branching fibres (cells) that keep your heart beating. Skeletal muscle has long, thread-like fibres that pull your bones. Smooth muscle squeezes hollow organs, such as your stomach.



Give it some muscle

The muscles that move your body are called skeletal muscles. They work by pulling the bones of your skeleton. But skeletal muscles can only pull, not push. So making a body part move in two directions needs different muscles that pull in opposite directions.



The fastest-moving muscles are the ones that **move your eyes.**

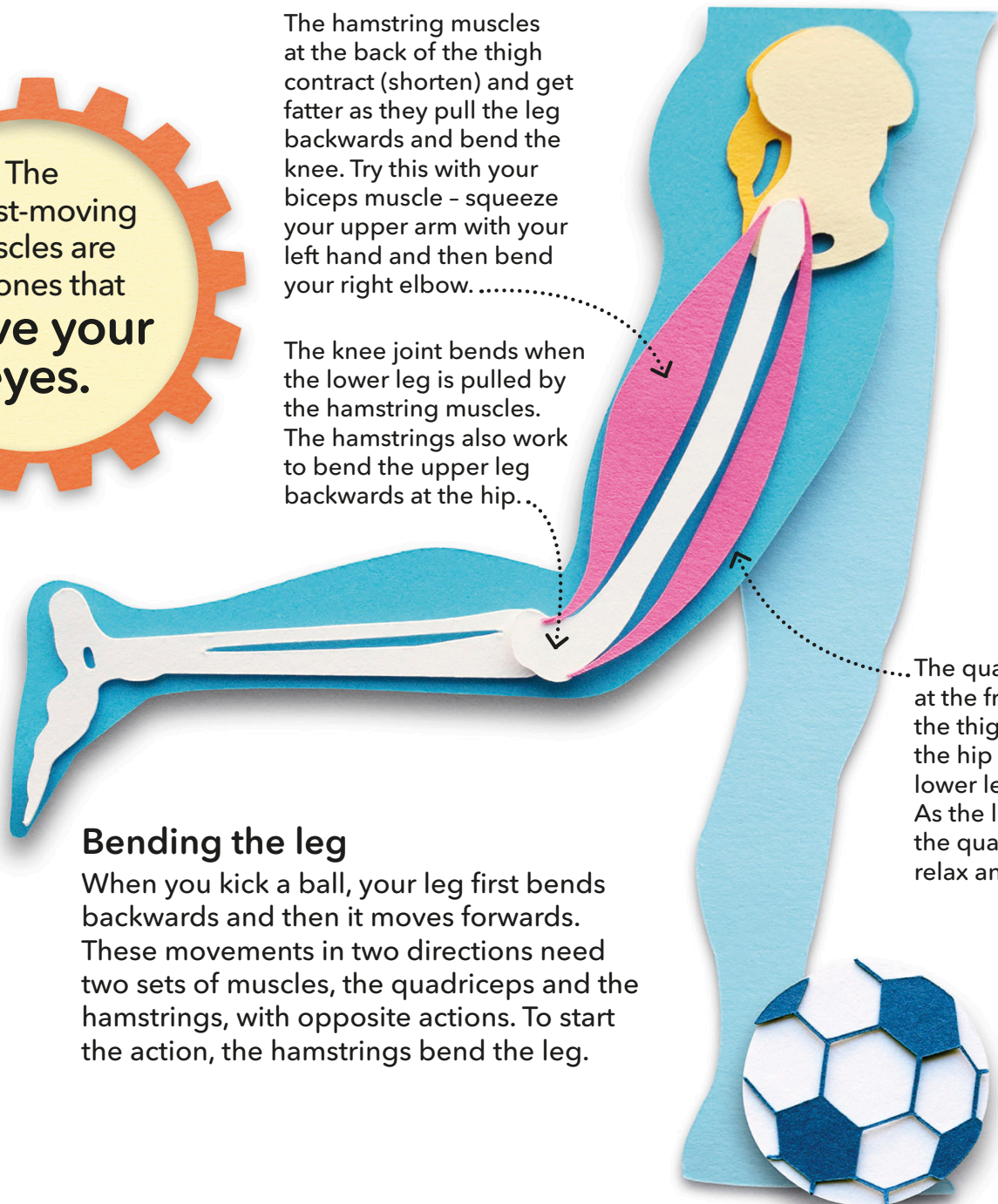
The hamstring muscles at the back of the thigh contract (shorten) and get fatter as they pull the leg backwards and bend the knee. Try this with your biceps muscle - squeeze your upper arm with your left hand and then bend your right elbow.

The knee joint bends when the lower leg is pulled by the hamstring muscles. The hamstrings also work to bend the upper leg backwards at the hip.

The quadriceps at the front of the thigh connect the hip to the lower leg bone. As the leg bends, the quadriceps relax and stretch.

Bending the leg

When you kick a ball, your leg first bends backwards and then it moves forwards. These movements in two directions need two sets of muscles, the quadriceps and the hamstrings, with opposite actions. To start the action, the hamstrings bend the leg.



Straightening the leg

The job of straightening the leg belongs to the powerful quadriceps. By going against the action of the hamstrings, they straighten the leg at the knee. They also swing the leg forwards by straightening the leg at the hip. Now your foot can hit the ball with its full force.



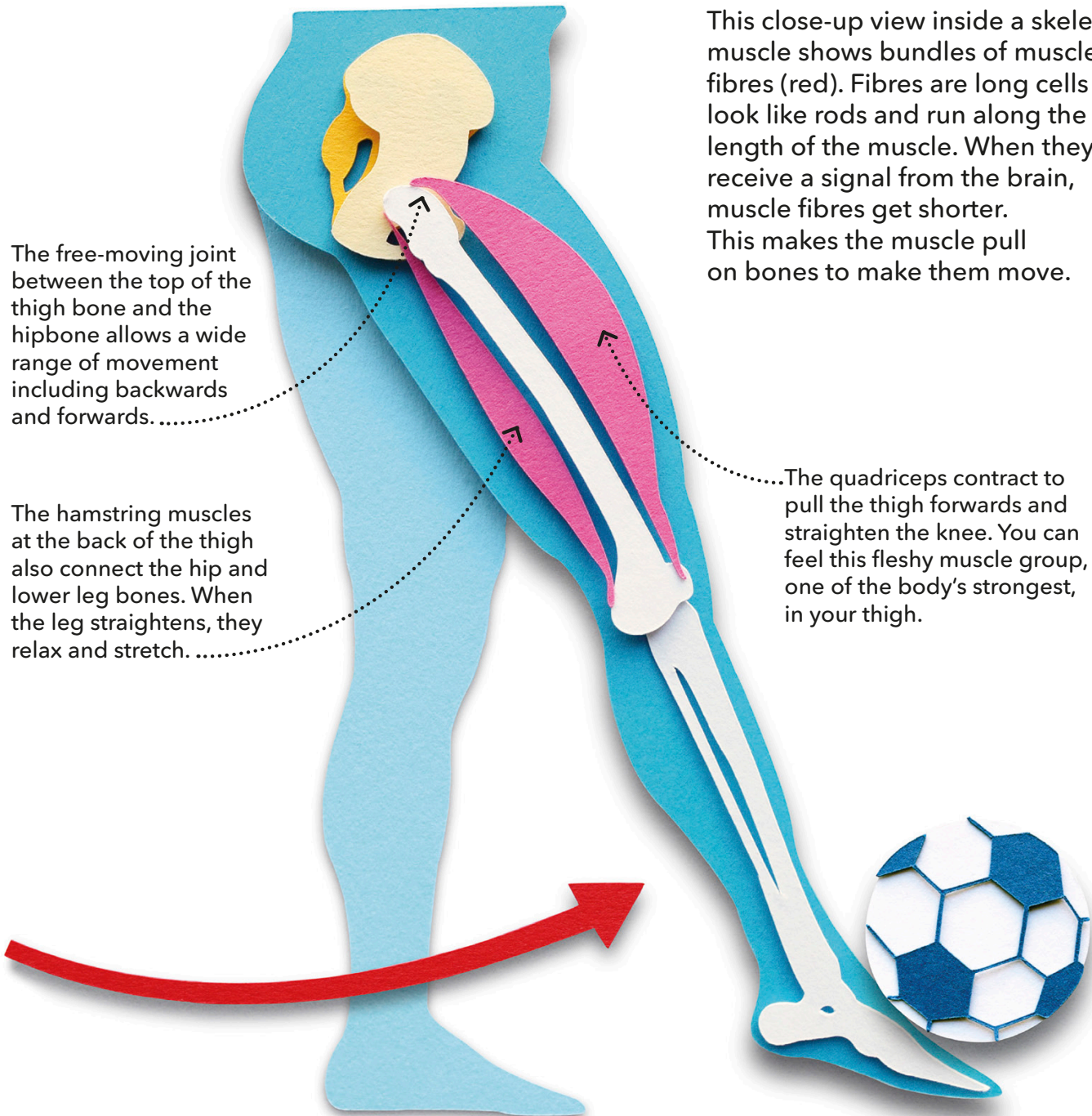
Inside a muscle

This close-up view inside a skeletal muscle shows bundles of muscle fibres (red). Fibres are long cells that look like rods and run along the length of the muscle. When they receive a signal from the brain, muscle fibres get shorter. This makes the muscle pull on bones to make them move.

The free-moving joint between the top of the thigh bone and the hipbone allows a wide range of movement including backwards and forwards.

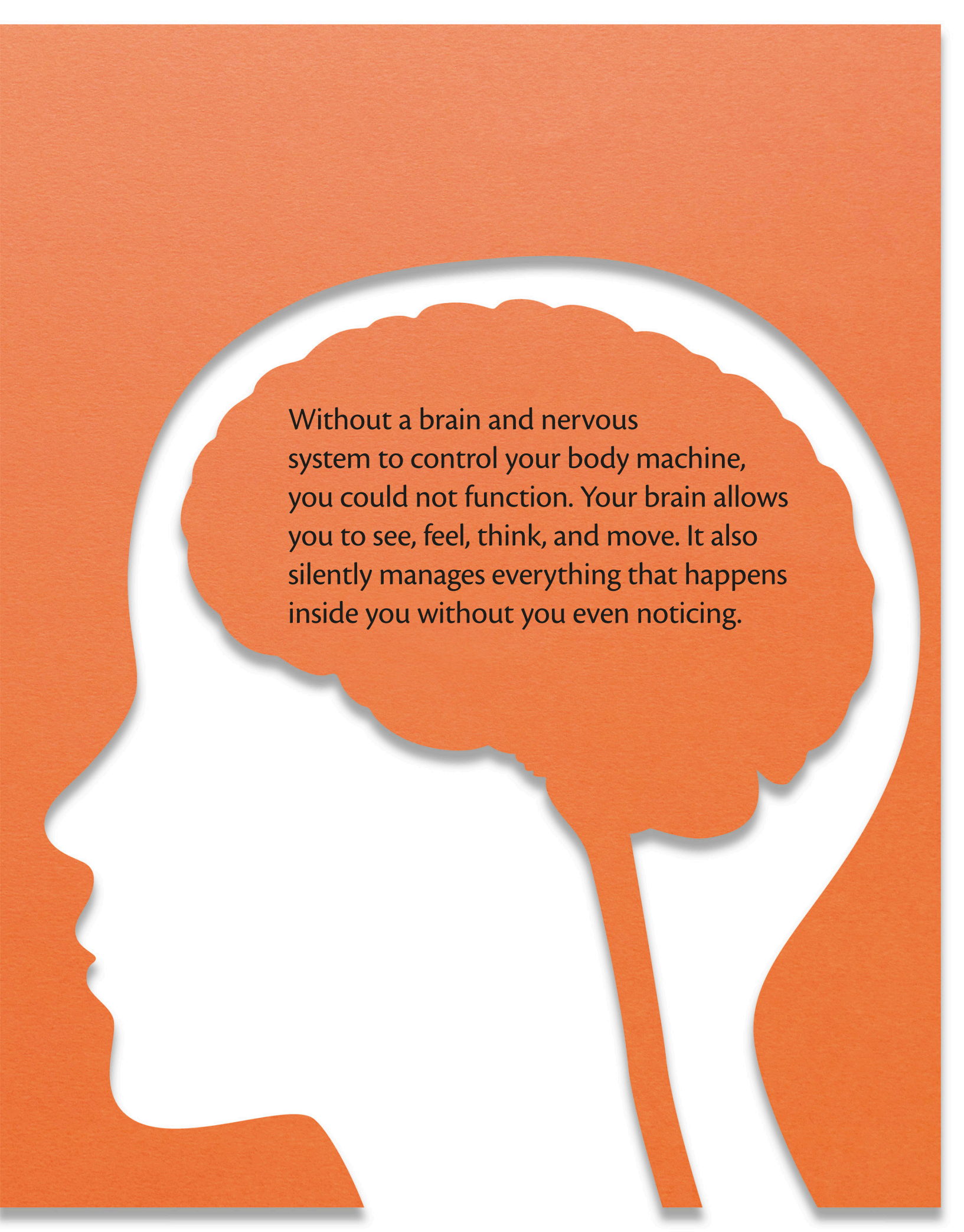
The hamstring muscles at the back of the thigh also connect the hip and lower leg bones. When the leg straightens, they relax and stretch.

The quadriceps contract to pull the thigh forwards and straighten the knee. You can feel this fleshy muscle group, one of the body's strongest, in your thigh.





Control Centre



Without a brain and nervous system to control your body machine, you could not function. Your brain allows you to see, feel, think, and move. It also silently manages everything that happens inside you without you even noticing.

Nerve network

Whether it's running or seeing, or thinking or breathing, almost everything your body machine does is controlled by your nervous system. It works really quickly because nerve cells carry messages that flash at high speed through the brain, spinal cord, and nerves.

Wired up

The brain and the spinal cord are in control of your nervous system. They receive signals and send out instructions through a network of nerves. Each nerve contains bundles of long nerve cells. They carry signals to and from every part of your body.

The longest nerves in the human body are **more than 1 m (3 ft) long.**

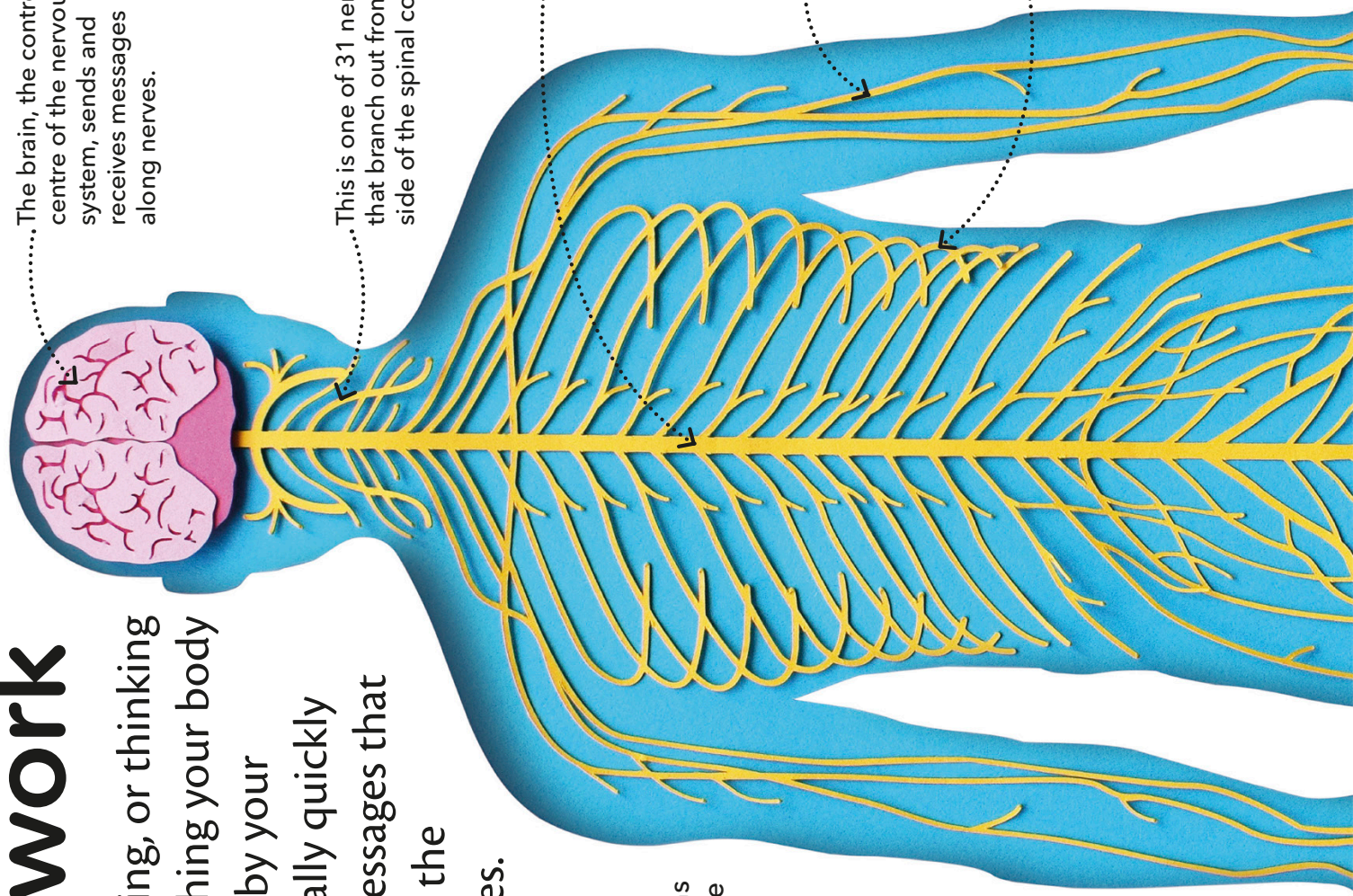
The brain, the control centre of the nervous system, sends and receives messages along nerves.

This is one of 31 nerves that branch out from each side of the spinal cord.

The spinal cord carries signals between the brain and the rest of the body.

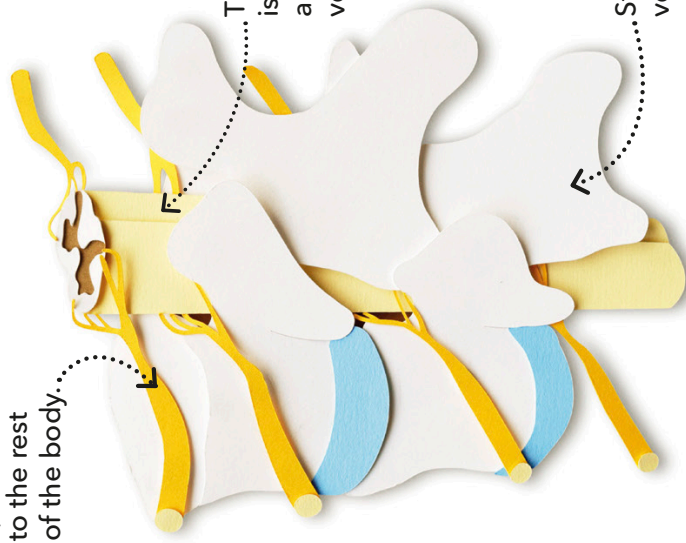
The radial nerve connects to the skin and muscles of the arm.

There are twelve pairs of intercostal nerves that carry messages to the rib muscles, which allow you to breathe.



This nerve carries signals to and from the middle fingers of the right hand.....

Spinal nerves connect the spinal cord to the rest of the body.



The spinal cord is no thicker than a finger but is very important.

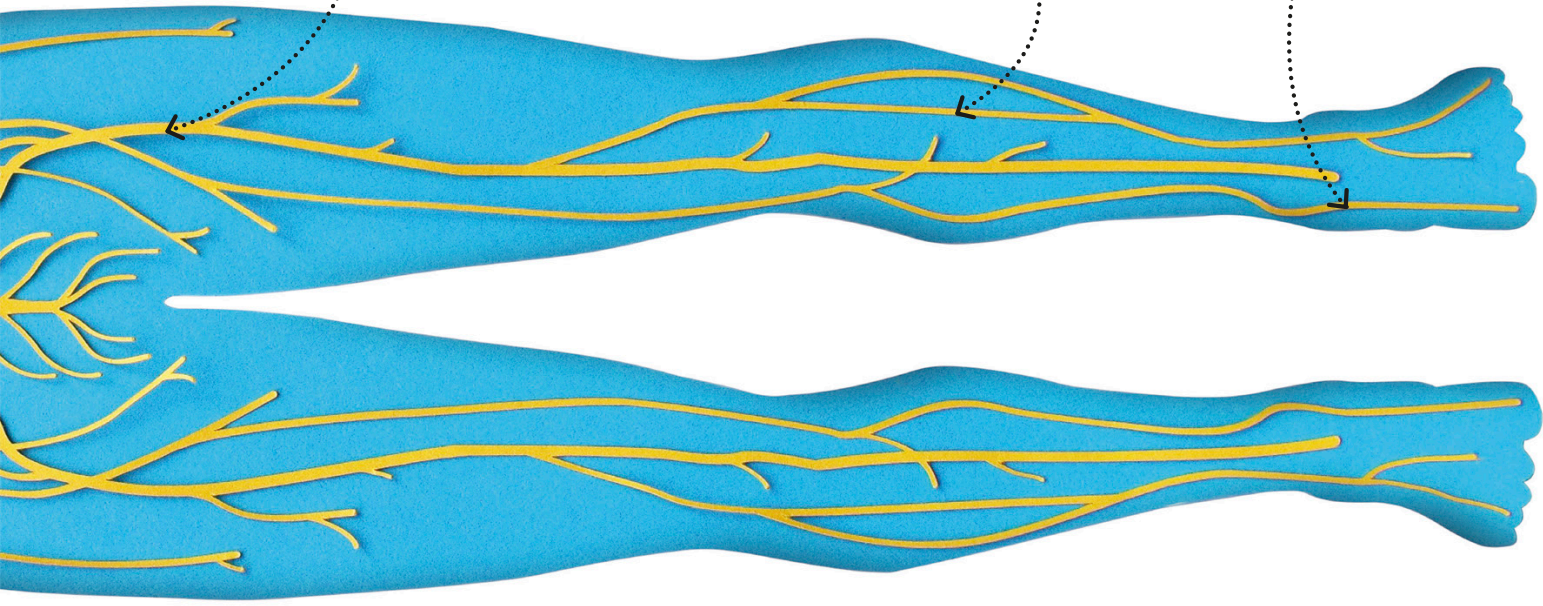
Stacked-up vertebrae in the spine form a tunnel around the spinal cord.

Spinal cord

Starting from your brain, your spinal cord runs down your back. To protect it from damage, it is surrounded by the bones of the spine. It carries messages to and from your brain and body. It also controls quick reflexes, such as pulling your hand away from something hot or sharp.



The sciatic nerve, the thickest and longest nerve in the body, sends messages to the leg, including the muscles that make you walk.

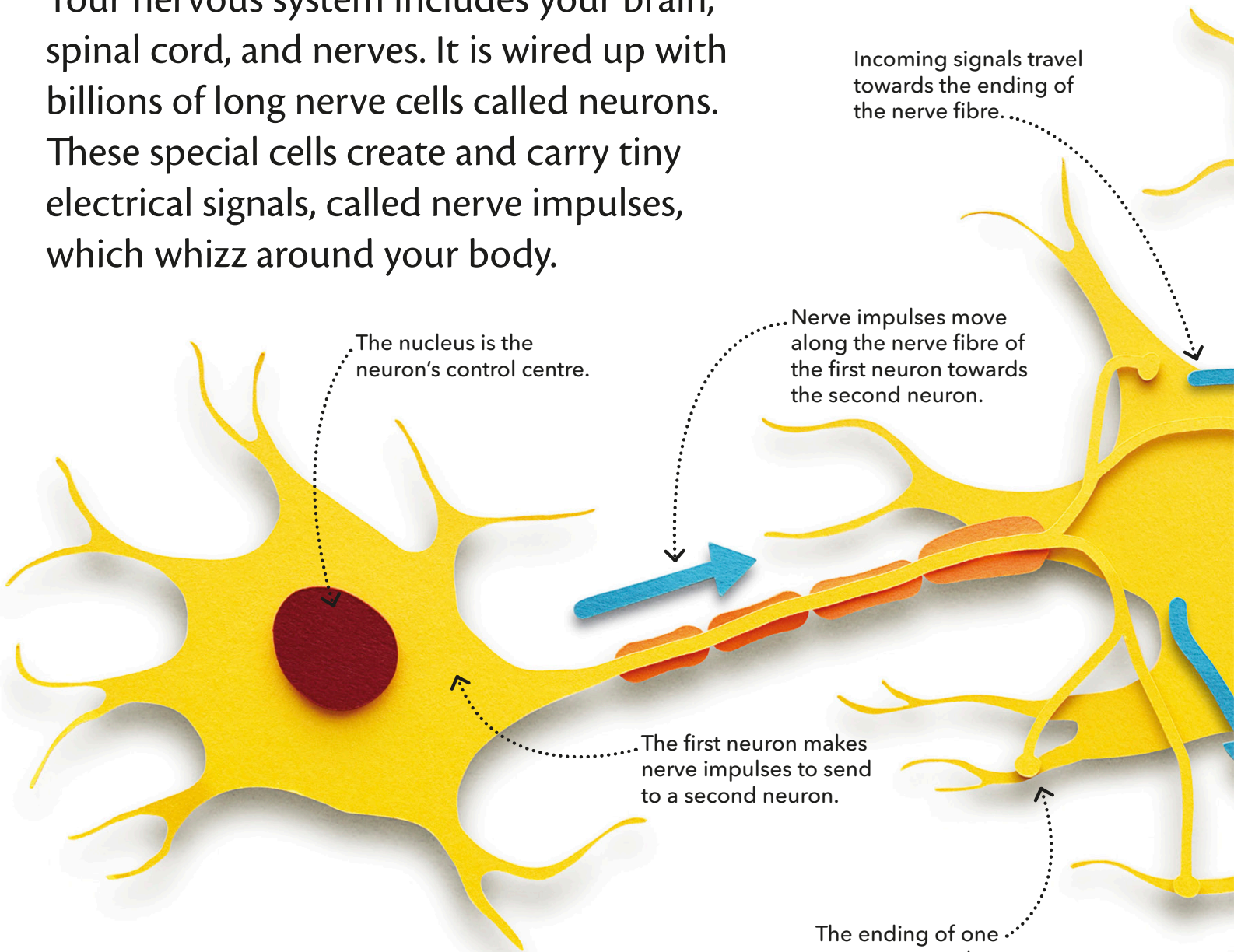


The peroneal nerve provides sensation in the lower leg, and carries the signals that tell the foot to bend.

This is one of the nerves that carries messages to and from the toes.

Wired up

Your nervous system includes your brain, spinal cord, and nerves. It is wired up with billions of long nerve cells called neurons. These special cells create and carry tiny electrical signals, called nerve impulses, which whizz around your body.



Incoming signals travel towards the ending of the nerve fibre.

The nucleus is the neuron's control centre.

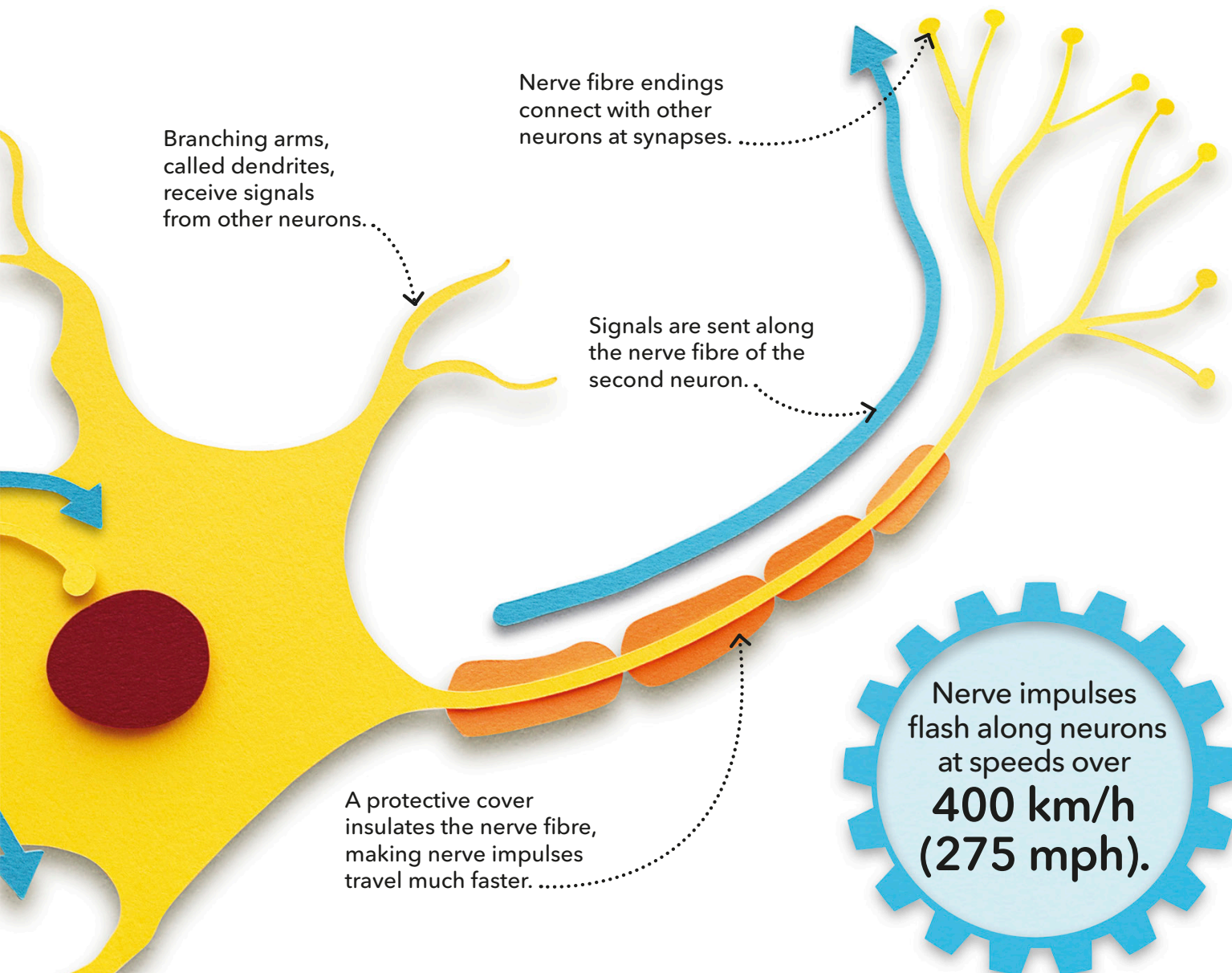
Nerve impulses move along the nerve fibre of the first neuron towards the second neuron.

The first neuron makes nerve impulses to send to a second neuron.

The ending of one neuron meets the dendrite of another neuron at a gap, called a synapse.

Nerve impulses

Each neuron is in contact with lots of other neurons in your brain, creating a massive network for sending and receiving messages. Those messages take the form of nerve impulses that travel, in one direction, along one neuron before being picked up by another neuron. Where neurons meet, at gaps called synapses, chemicals carry signals across the gap.



Branching arms, called dendrites, receive signals from other neurons.

Nerve fibre endings connect with other neurons at synapses.

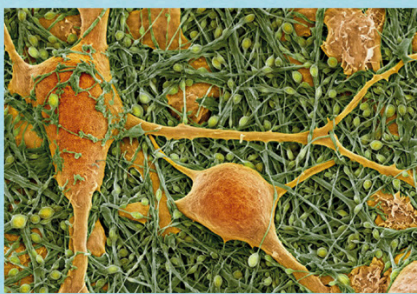
Signals are sent along the nerve fibre of the second neuron.

A protective cover insulates the nerve fibre, making nerve impulses travel much faster.

Nerve impulses flash along neurons at speeds over **400 km/h (275 mph)**.

Living computer

A computer does all sorts of jobs for us. Your brain is like a living computer, remembering, processing information, and sending out instructions. But it is better and far faster than a computer. Nerve cells in the brain send millions of messages to each other every second.



Your brain contains billions of nerve cells that form a connecting network.



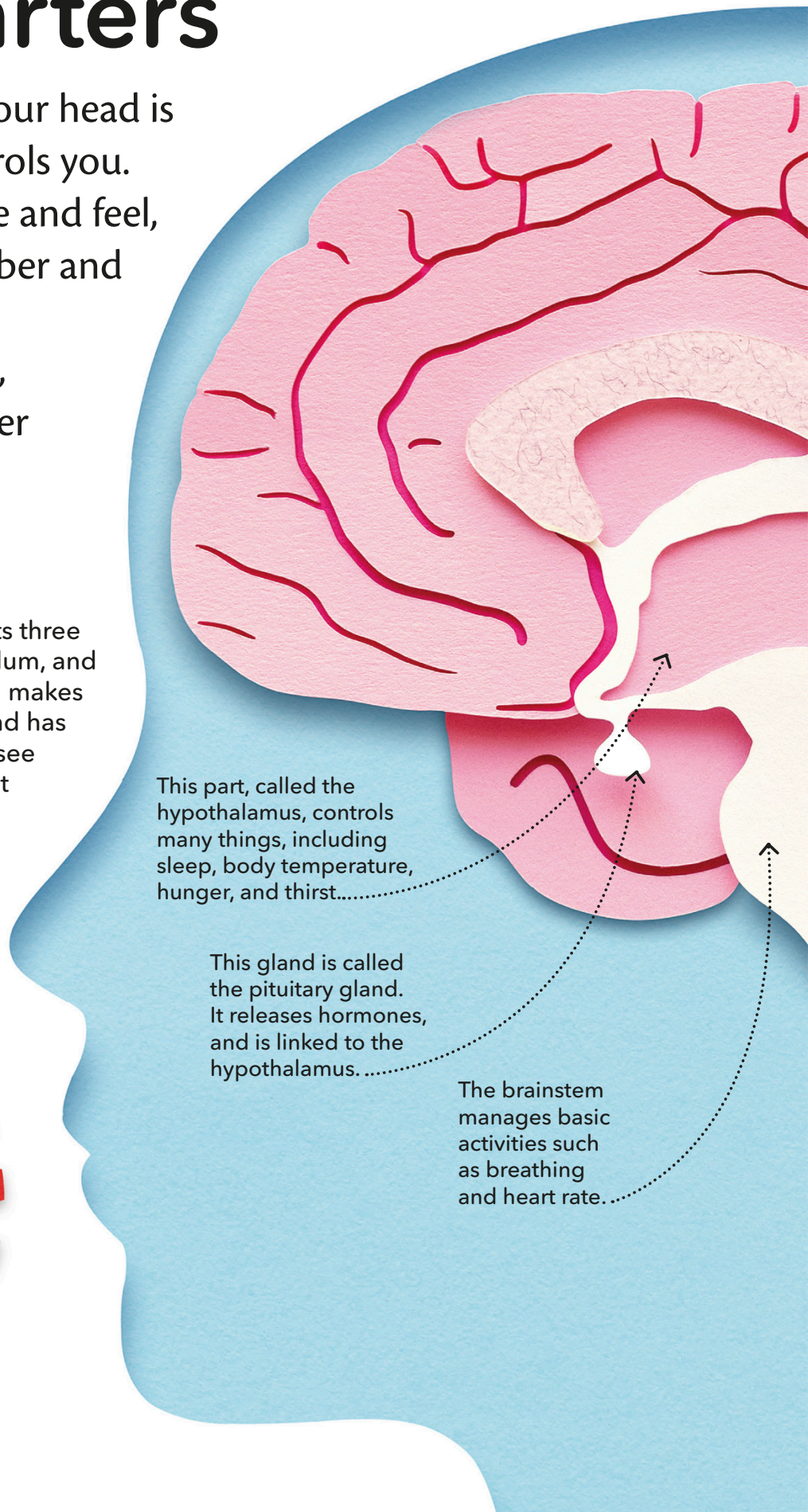
The black chip is a key part of a computer that, like your brain, processes information but is far less complicated.

Headquarters

Locked securely inside your head is the soft organ that controls you. Your brain lets you move and feel, think and speak, remember and imagine. It also, silently, manages your heart rate, breathing and many other essential activities.

Inside the brain

This brain is sliced in half to show its three main parts - the cerebrum, cerebellum, and brain stem. The powerful cerebrum makes up the largest part of your brain, and has left and right halves. Here you can see the inside of the right half. The right half of the cerebrum controls the left side of the body, the left half controls the right side of the body.



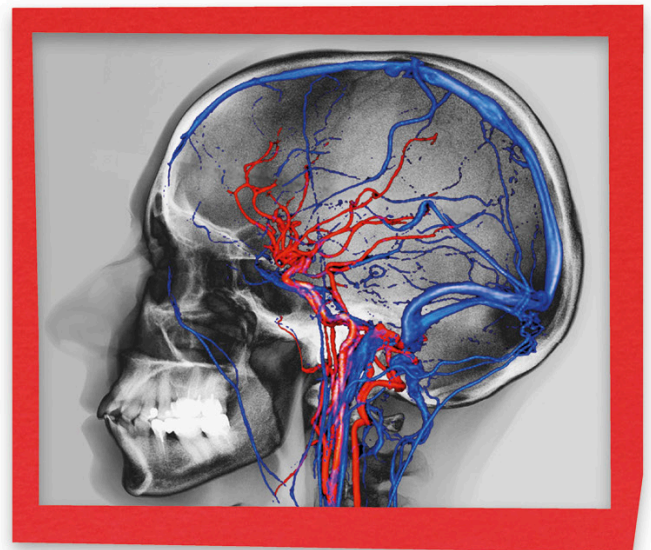
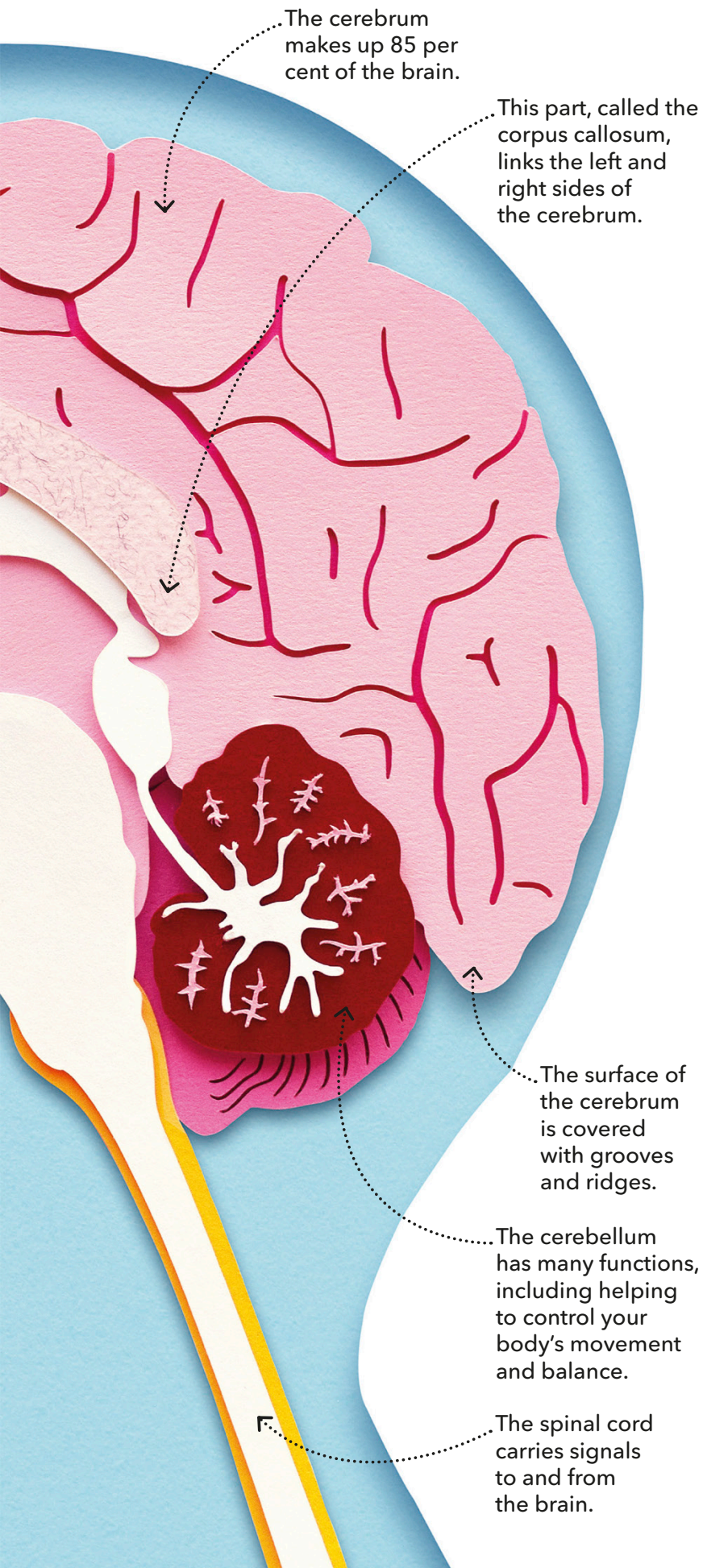
This part, called the hypothalamus, controls many things, including sleep, body temperature, hunger, and thirst.....

This gland is called the pituitary gland. It releases hormones, and is linked to the hypothalamus.....

The brainstem manages basic activities such as breathing and heart rate.....



The human brain is the most **complex organ** in the living world.



Feed me

Here you can see the arteries (red) that carry food and oxygen to the brain, and the veins (blue) that remove its wastes. Food and oxygen give the brain the energy it needs to work. If that supply is stopped, even for a few minutes, the brain may be damaged or even die.



Brain protectors

Your brain is soft, like a mushroom, and would be damaged if not protected from knocks and blows. Your skull does that by providing a hard case around your brain, just as this hard baseball hat protects its wearer from injury. The brain is also protected by fluid which surrounds it and absorbs hard knocks.

Mind map

The most important part of your brain is the cerebrum, in particular, its thin, wrinkly outer layer, called the cerebral cortex. Here, billions of nerve cells linked by trillions of connections make your body work and make you, you.

Brain at work

This brain map shows how each area of the cerebral cortex has its own job. Some areas receive signals from the body. Others send instructions to the body. Some analyse and make sense of messages. Different areas of your cortex interact so you can understand, decide, think, move, feel, and remember. Parts of the cortex can grow large with constant use - so, for example, musicians often have a larger auditory (hearing) cortex.

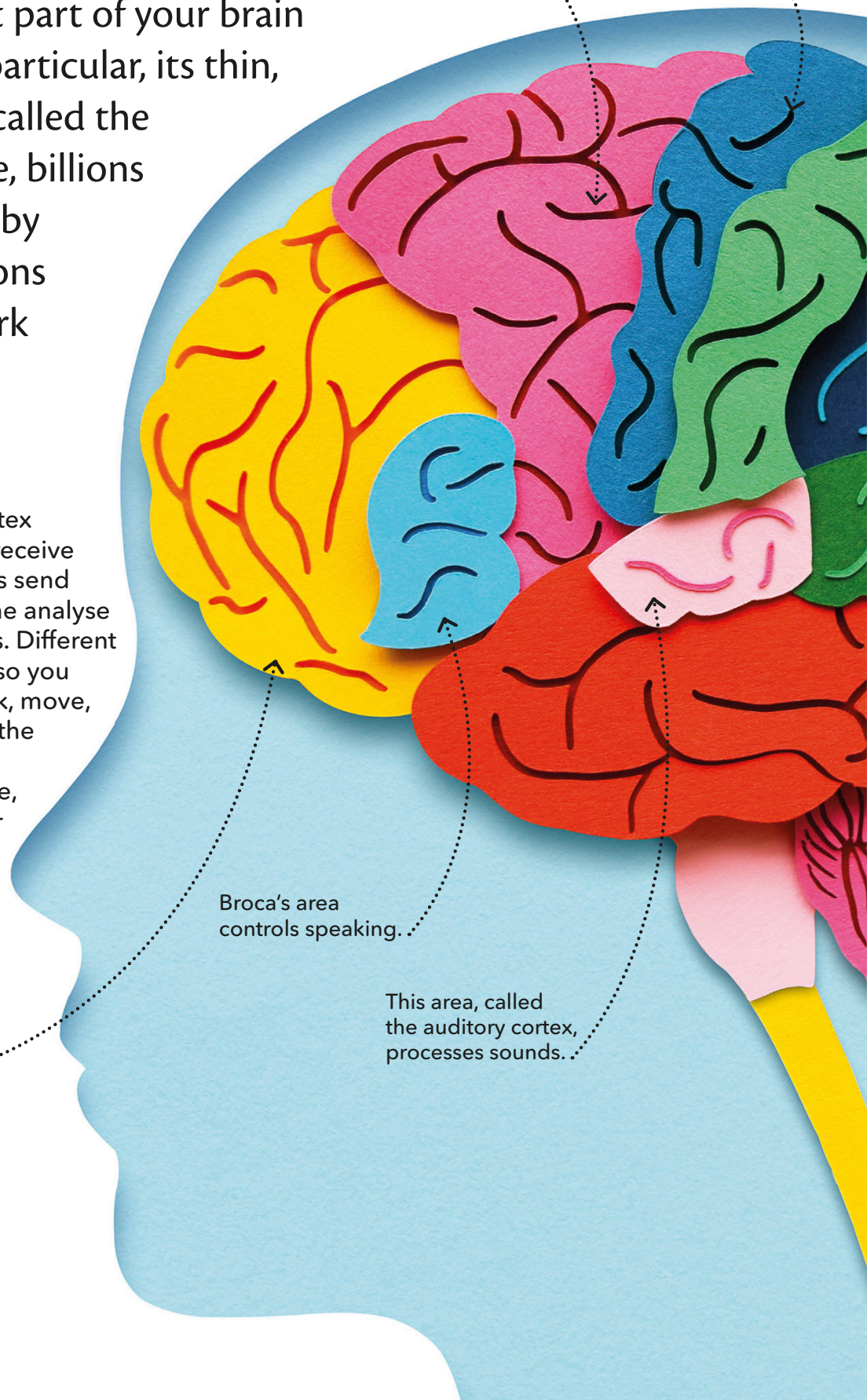
This area, called the prefrontal cortex, is involved with personality, and with thinking, learning, and understanding.

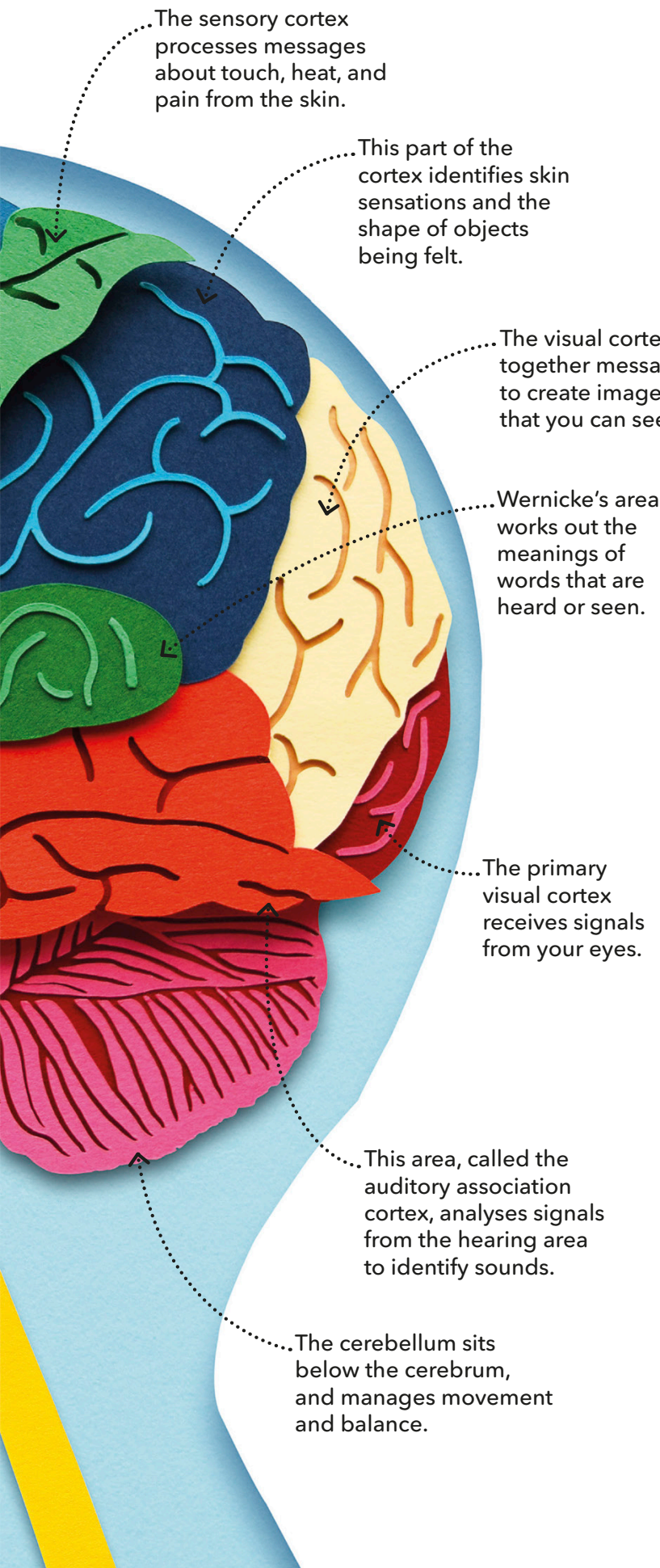
The premotor cortex controls skilled movements, such as riding a bike.

The motor cortex tells your skeletal muscles to produce body movements.

Broca's area controls speaking.

This area, called the auditory cortex, processes sounds.

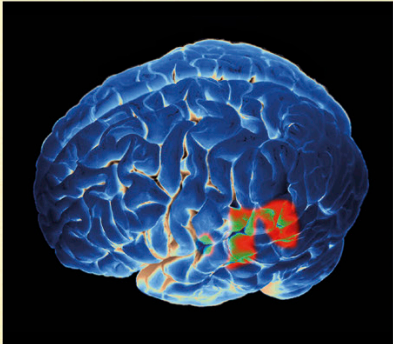




The **125 trillion** connections between brain cells create a huge, super-fast communication network.



The active part of the cortex shown here includes Broca's area, which controls speech.



A fraction of a second after the brain's hearing areas detect sounds, another part works out what is being said.

Seeing the brain

These two brain scans show the active parts of a person's cerebral cortex lit up in red and green, firstly when a person is speaking, and secondly when understanding the words that were spoken.

Sleep mode

Everybody needs sleep. During a lifetime, people spend one-third of each day asleep. Without sleep, your body machine would not survive. Sleep gives your body a chance to relax and recover, and gives your brain time to sort out the day's events.

Fast asleep

When you sleep, your breathing and heart rate slow down. At first you go into a deep sleep, and it is difficult to wake up. Then you pass into dreaming sleep, when your brain is busier and you dream. These stages of sleep happen several times each night.



Your ears ignore everyday sounds but pick up sudden, strange noises.

Your eyelids close, and your eyes do not move much, except during dreaming sleep.

The fleshy flap at the back of your mouth may vibrate and cause snoring.

Dream machine

Almost everyone dreams, but no one really knows why. Dreams often involve strange, mixed-up images of people and events that would not happen in real life. When you dream, your body's muscles, apart from your eye muscles, stop working. Because of this, you cannot act out your dream.



People often dream about being chased.



A feeling of falling through the air is common in dreams.

How much sleep do you need?

The number of hours we spend asleep gets less as we get older. Babies spend more than half their day asleep. School-age children need between nine and eleven hours. Adults need up to nine hours, and they need less sleep as they age.



Newborn babies 14-17 hours



Children 9-11 hours



Adults 7-9 hours



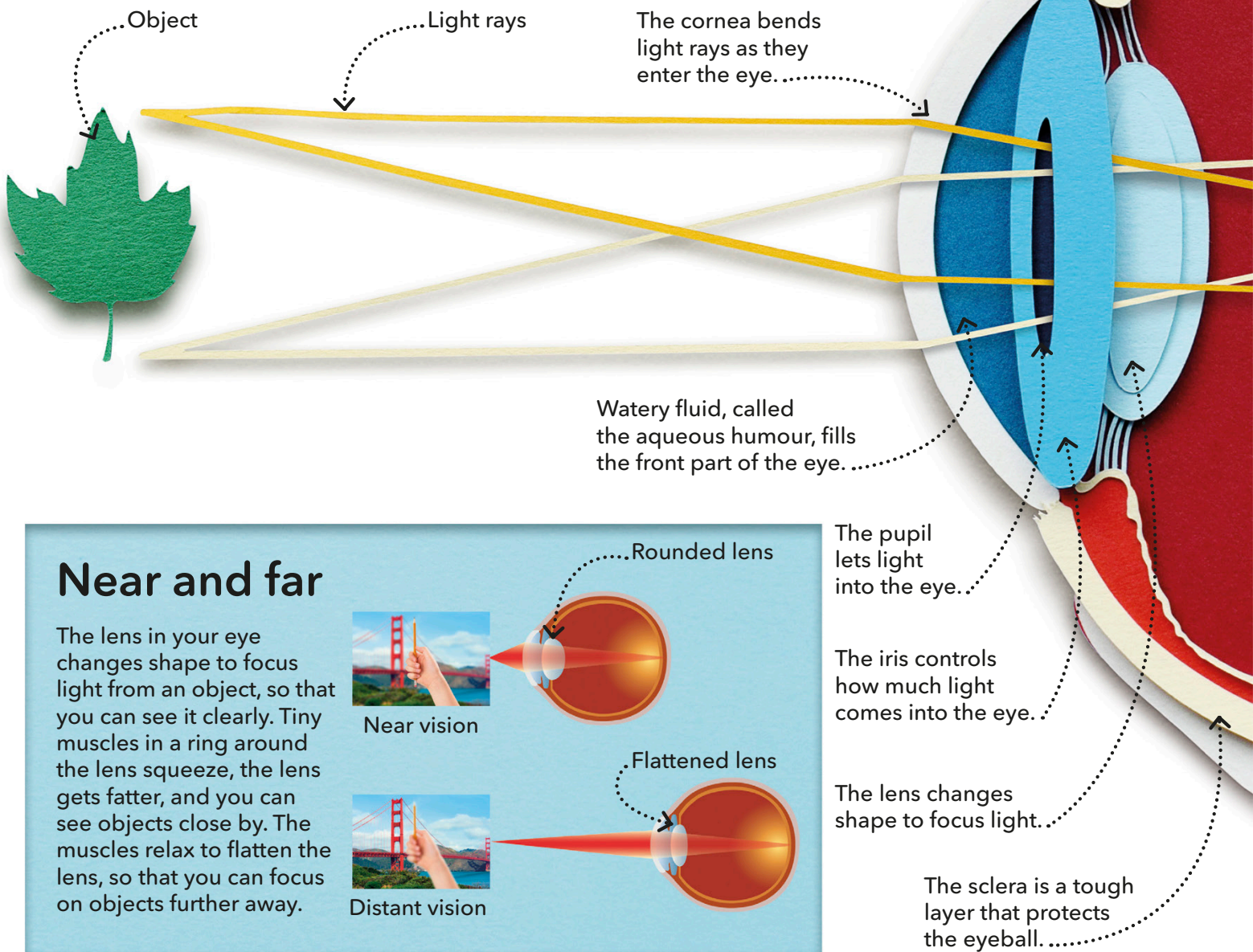
Older people 7-8 hours

Seeing

Most of what you know about the world comes to you through your sense of sight. Your eyes pick up light from objects. They pass this information to your brain, so you can see the world around you.

How we see

Light rays enter your eye through a window called the cornea. The rays pass through a hole called the pupil and enter the lens. The lens changes shape to focus the light at the back of the eye, making an upside-down image. When signals from the eyes reach the brain, it creates an image that is the right way up.



Near and far

The lens in your eye changes shape to focus light from an object, so that you can see it clearly. Tiny muscles in a ring around the lens squeeze, the lens gets fatter, and you can see objects close by. The muscles relax to flatten the lens, so that you can focus on objects further away.



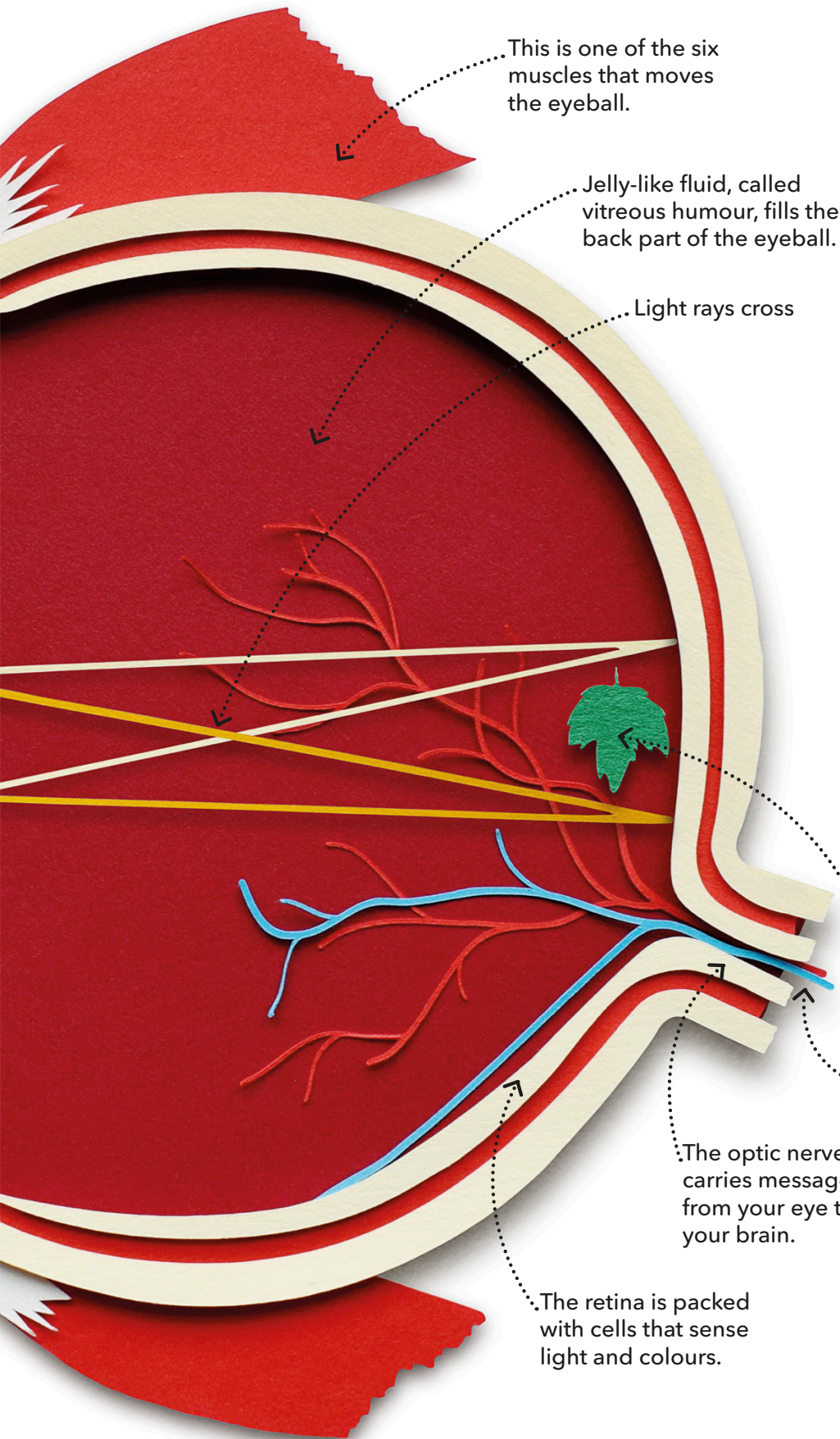
Near vision



Distant vision

Rounded lens

Flattened lens



This is one of the six muscles that moves the eyeball.

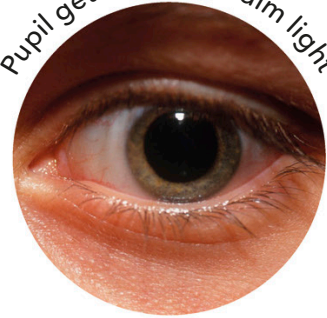
Jelly-like fluid, called vitreous humour, fills the back part of the eyeball.

Light rays cross

Pupil gets smaller in bright light



Pupil gets bigger in dim light



Light control

The pupil is the hole in the iris that controls how much light enters your eye. In bright light it gets smaller to protect the nerve cells in your eye. The pupil gets bigger when it is darker to let more light in. This is how you are able to see clearly.

An upside-down image of the object you are looking at is made on the retina.

Blood vessels

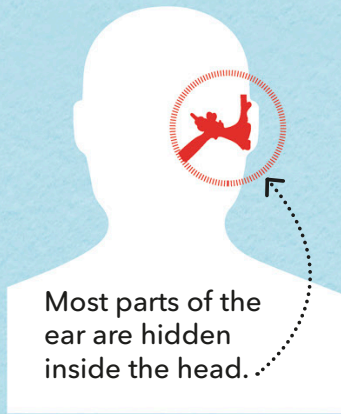
The optic nerve carries messages from your eye to your brain.

The retina is packed with cells that sense light and colours.



Just **one-sixth** of the eyeball can be seen from the outside.

Hearing



From the rustle of leaves to the roar of a jet plane, you can hear a wide range of sounds. Sounds are made when something vibrates and sends ripples through the air. Those ripples make vibrations in your ears that are turned into sounds by your brain.

This nerve carries signals about sounds from the cochlea to the hearing part of the brain.

These three tubes are filled with fluid, so they pick up movements of the head and help the body stay balanced.

These three linked bones are called ossicles. They carry sounds from the eardrum to the cochlea.

The cochlea is coiled like a snail's shell and detects sounds.

The eardrum vibrates when it is hit by sounds.

This tube connects the ear to your throat and nose. It lets in air, making your ears "pop" to clear away any blockage.

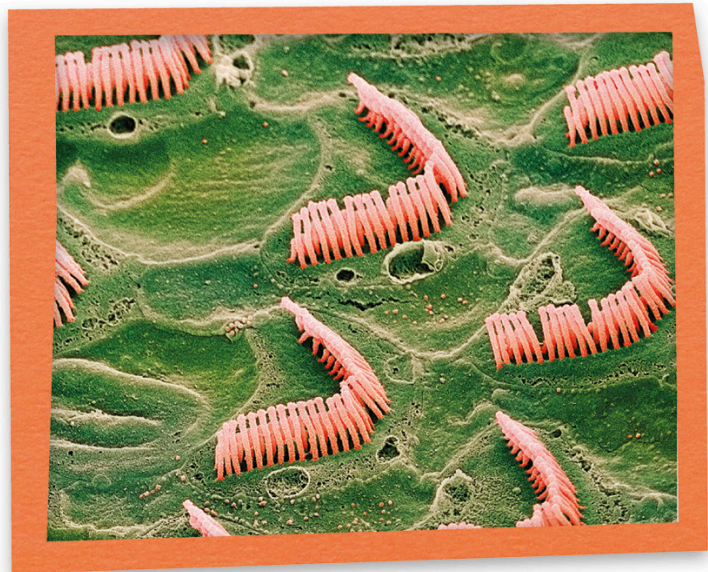
Inside the ear

The only part of your ear that you can see is the outer flap. The rest is tucked inside your skull. Sounds from the outside world make vibrations that reach the coiled cochlea deep in the ear. Here vibrations are turned into nerve signals that go to the hearing area of your brain.



The ear canal carries sounds to the eardrum.

The ear flap directs sounds from outside into the ear canal.

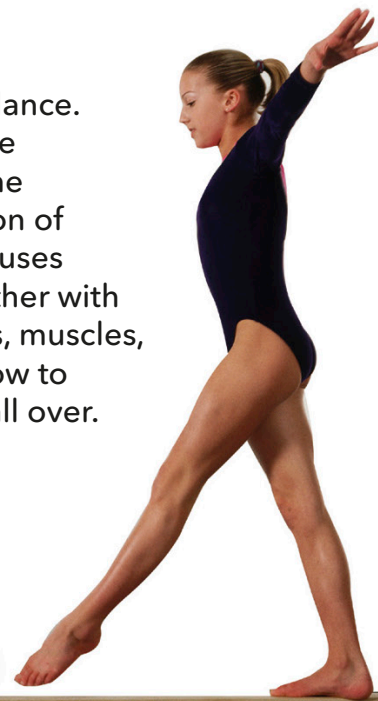


Sound detectors

The cochlea contains tiny, V-shaped tufts of "hairs" (the pink strands above). They sit on top of special hair cells that detect sounds. Sound vibrations passing through the cochlea bend the "hairs". This makes the hair cells send signals to the brain, so you hear sounds.

Balancing act

Your ears help you balance. Next to the cochlea are sensors that pick up the movement and position of your head. Your brain uses this information, together with signals from your eyes, muscles, and feet, to tell you how to move so you do not fall over.



The **smallest bone** is inside your ear and is the size of a **grain of rice**.

Taste and smell

The smell of baking bread, the scent of flowers, and the taste of ice cream are all picked up by your senses of taste and smell. As well as working on their own, these two senses work together so that you can enjoy lots of different flavours.

Mouth and nose

Special receptors on your tongue sense taste. Receptors that pick out smells are in a space behind your nose, called the nasal cavity. Your tongue senses five tastes: sweet, sour, bitter, salty, and a savoury taste called umami. Smell receptors can pick up many different smells.

Air breathed in through your nostrils carries smells into your nasal cavity.

Your brain tells you what the tastes and smells are.

Smell receptors pick out smells in the air you breathe in.

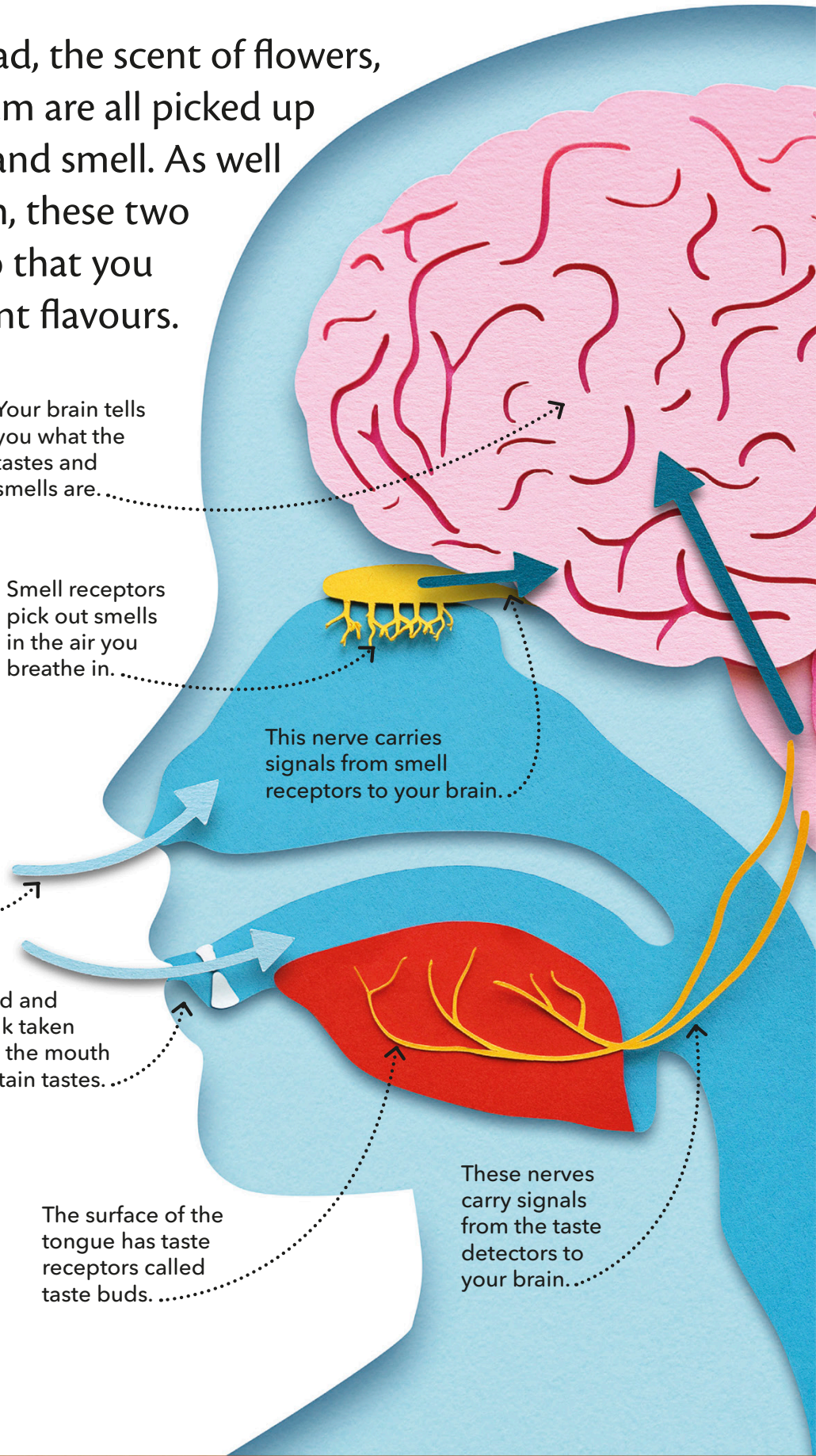
This nerve carries signals from smell receptors to your brain.

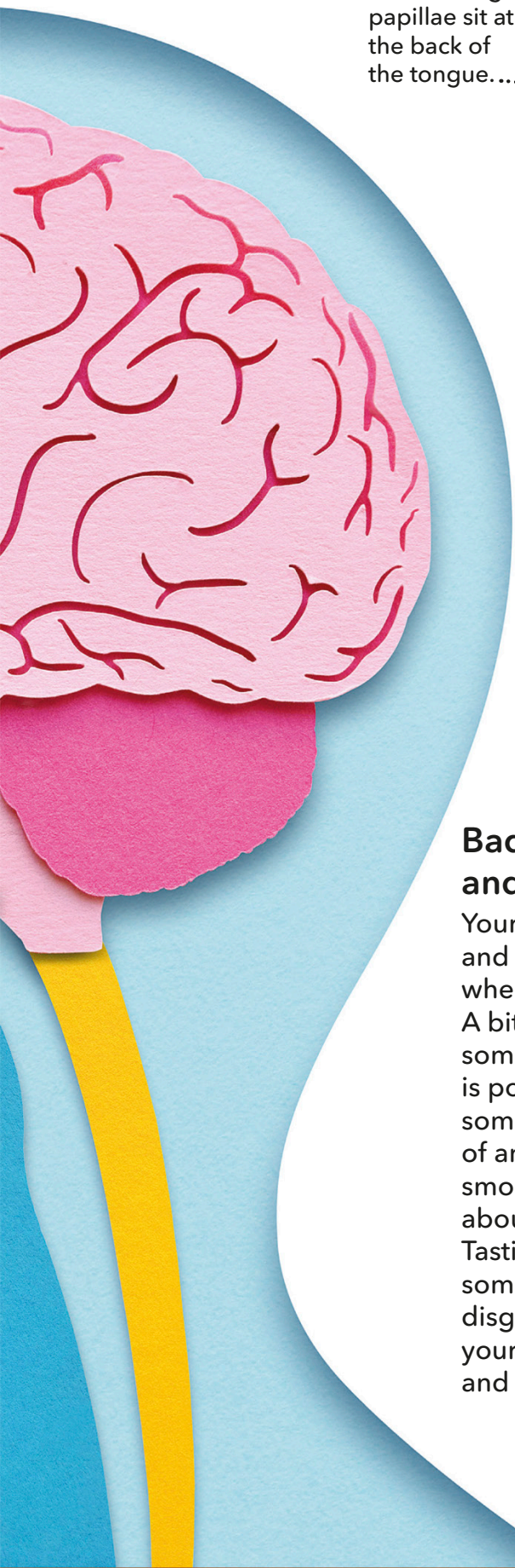
Food and drink taken into the mouth contain tastes.

The surface of the tongue has taste receptors called taste buds.

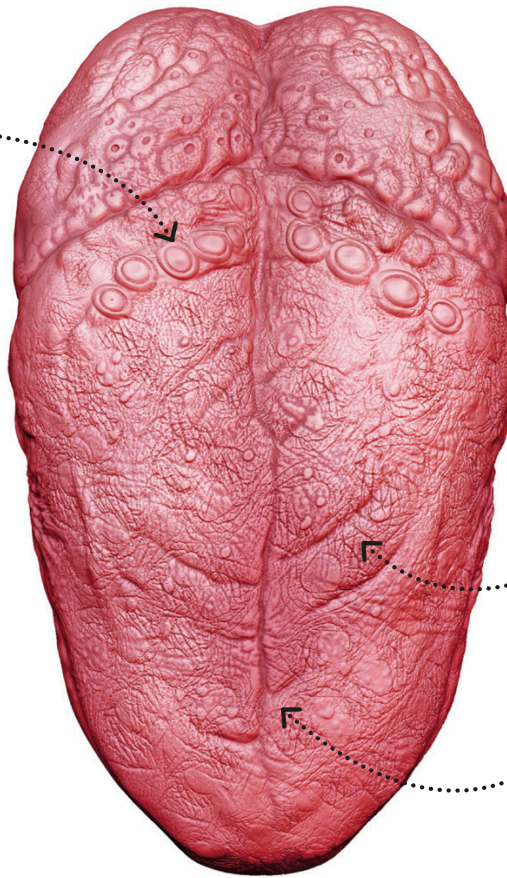
These nerves carry signals from the taste detectors to your brain.

We can pick out **millions** of different smells, but only have five **different tastes.**





A row of big papillae sit at the back of the tongue.



Tasting tongue

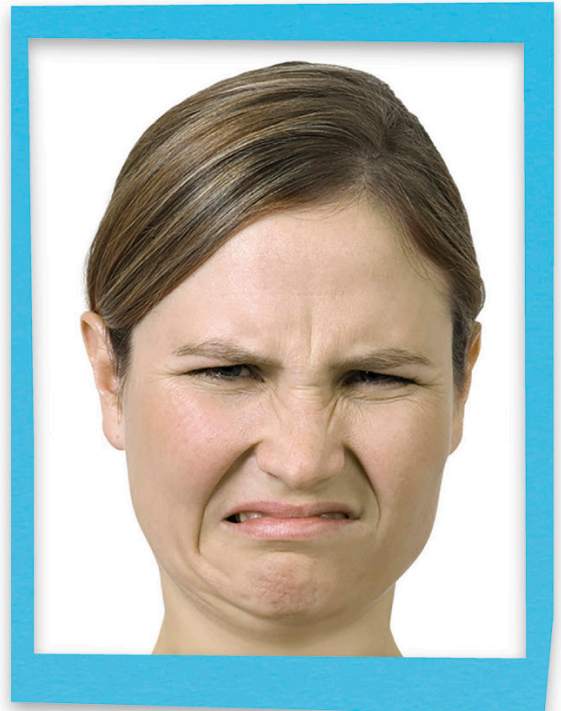
Look in a mirror and you will see that your tongue is covered in tiny bumps. They are called papillae and there are three different types, as shown here. The big papillae and those that are mushroom-shaped have taste buds that detect the five tastes in food and drink.

Mushroom-shaped papillae are dotted all over the tongue.

Spiky papillae grip food while you are chewing.

Bad tastes and smells

Your senses of smell and taste can tell you when something is wrong. A bitter or sour taste can sometimes mean that food is poisonous, although some poisons do not taste of anything. A smell of smoke may warn you about possible danger. Tasting or smelling something really disgusting makes your nose wrinkle and lips curl.



How you feel

There are millions of tiny nerve cells, called touch receptors, in your skin. They detect changes in the texture, pressure, movements, and temperature of your surroundings. They send signals to your brain that allow you to sense the world around you.

How sensitive?

This odd-looking figure is called a homunculus. It has been used for many years to show how parts of the body vary in their sensitivity. Some body parts, such as the lips and the tongue, are shown really big to reflect how they are particularly sensitive to touch.

Ears, as shown by their size, are sensitive to touch.

Lips are very sensitive, especially to touch and cold.

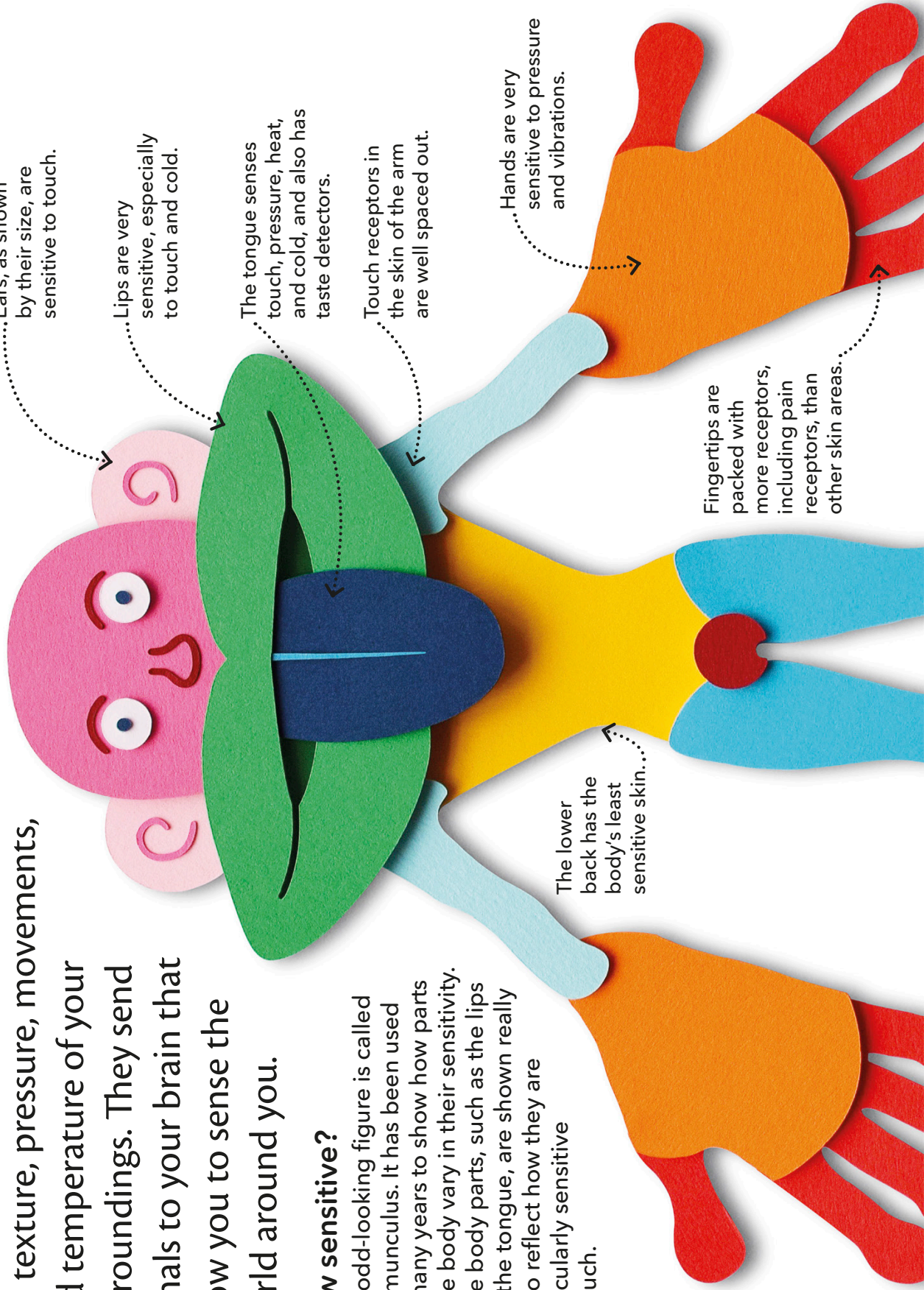
The tongue senses touch, pressure, heat, and cold, and also has taste detectors.

Touch receptors in the skin of the arm are well spaced out.

Hands are very sensitive to pressure and vibrations.

Fingertips are packed with more receptors, including pain receptors, than other skin areas.

The lower back has the body's least sensitive skin.



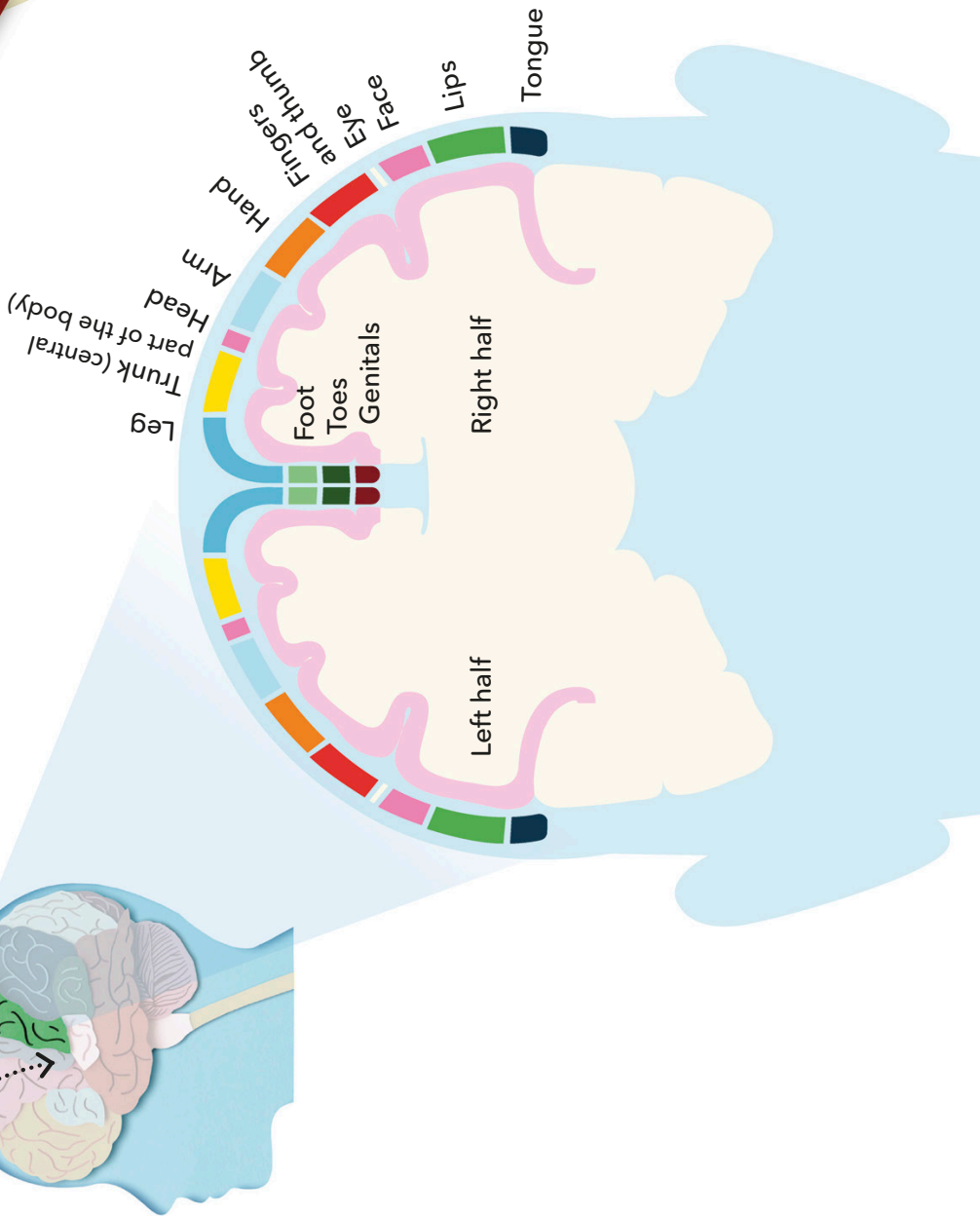
Fingertips

can feel tiny bumps on a surface that are less than 1 mm (0.03 in) high.

The toes are sensitive, but not as much as the fingertips.....

The left half of the cerebrum receives signals from the right side of the body.....

Sensory cortex



Brain connections

Signals from the skin are sent to the brain's sensory cortex. This picture shows the two halves of the brain's cerebrum and which parts of the brain link with which parts of the body. It shows that more sensitive body parts take up more space in the sensory cortex.

Chemical messengers

The body machine has two control systems. As well as the nervous system, there are chemical messengers called hormones. Hormones mostly travel in the blood. They alter how specific cells and tissues work to influence growth, digest food, use energy, and many other processes.

Hormone makers

In this picture you can see some of the glands that make hormones. Organs, including the stomach and kidneys, also release hormones. Together these glands and organs make up the endocrine system.

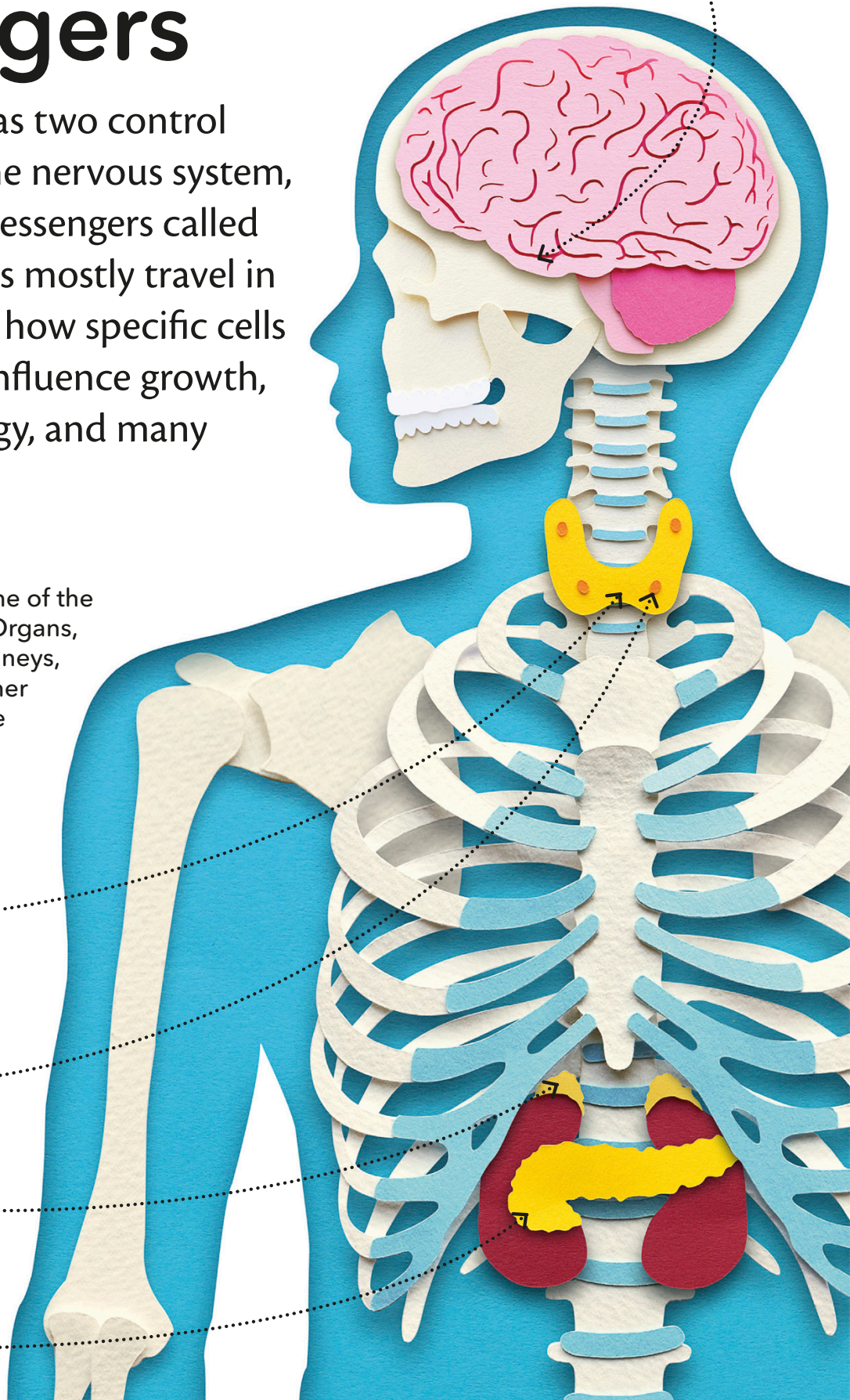
The thyroid gland releases a hormone that makes cells work faster, and helps control body weight and temperature.

The four parathyroid glands make a hormone that controls levels of calcium, a chemical needed for healthy bones.

The adrenal glands release several hormones including adrenaline, which gets the body ready for action.

The pancreas releases hormones that control the amount of glucose in your blood.

Tucked under the brain, the pituitary gland is very important. Many of its nine hormones circulate in the blood to control other glands like the thyroid.





Cuddle chemical

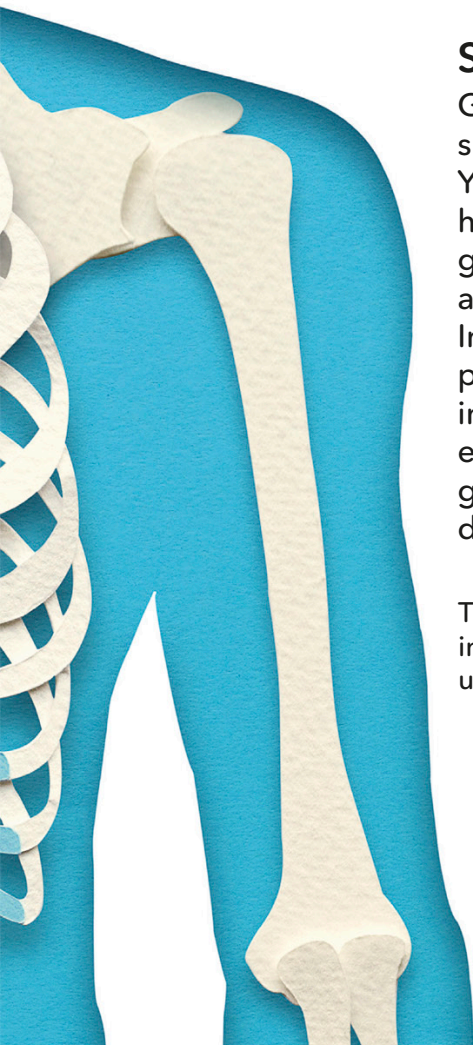
Some hormones help with reproduction and birth. Oxytocin is one of the hormones released by the pituitary gland. It helps a woman to give birth to her baby by making her womb (uterus) squeeze, or contract. Oxytocin also helps create a close bond between a mother and her baby. For that reason it's called the "cuddle chemical".

When your **stomach is empty**, it releases a hormone that makes you feel hungry.

Sugar control

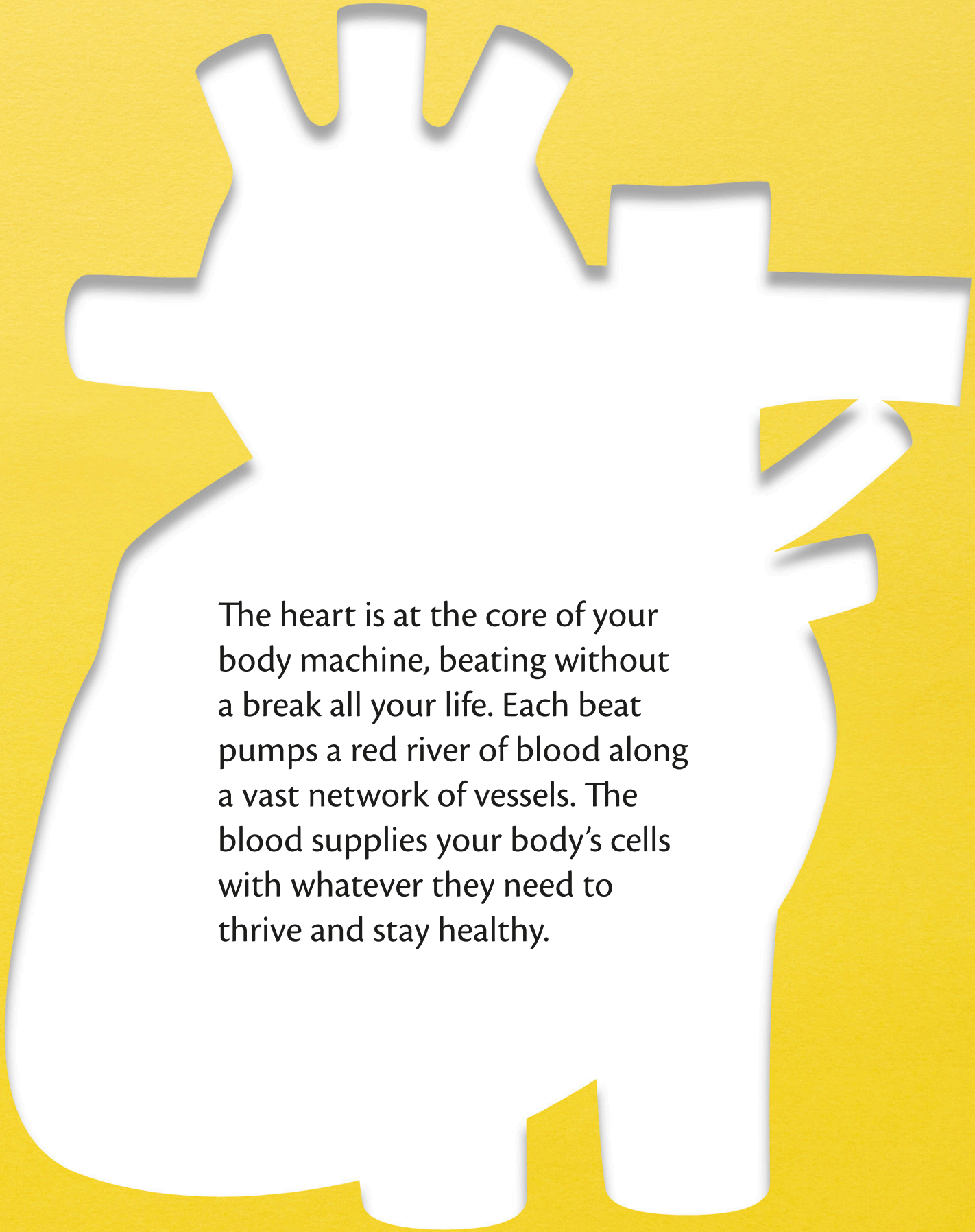
Glucose is a sugar that supplies your cells with energy. Your pancreas makes several hormones, including insulin and glucagon. These two control the amount of glucose in the blood. In people with diabetes, the pancreas releases too little insulin. Diabetics need to take extra insulin to stop blood glucose levels becoming dangerously high.

This boy has diabetes. He is injecting himself with insulin using a special injector pen.....



A large, stylized yellow silhouette of a heart with several protrusions and indentations, resembling a handprint or a complex organic shape. The text "Heart and Blood" is centered within the silhouette in a bold, black, sans-serif font.

**Heart
and
Blood**



The heart is at the core of your body machine, beating without a break all your life. Each beat pumps a red river of blood along a vast network of vessels. The blood supplies your body's cells with whatever they need to thrive and stay healthy.

Blood flow

An amazing network of branching tubes, called blood vessels, carries blood all around your body. This blood supplies your body's cells with the food and oxygen they need to keep you alive. Blood is pumped along the blood vessels by your heart.

Around the body

Here you can see some of the blood vessels that carry blood from your heart to all body parts and back again. Arteries (red) transport blood on its outward journey from the heart. Veins (blue) carry blood on its return trip.

There are
**100,000 km
(60,000 miles)**
of blood vessels in
your body - enough to
stretch around
the world twice!

This vein, called the jugular vein, carries blood from the head and brain towards the heart.

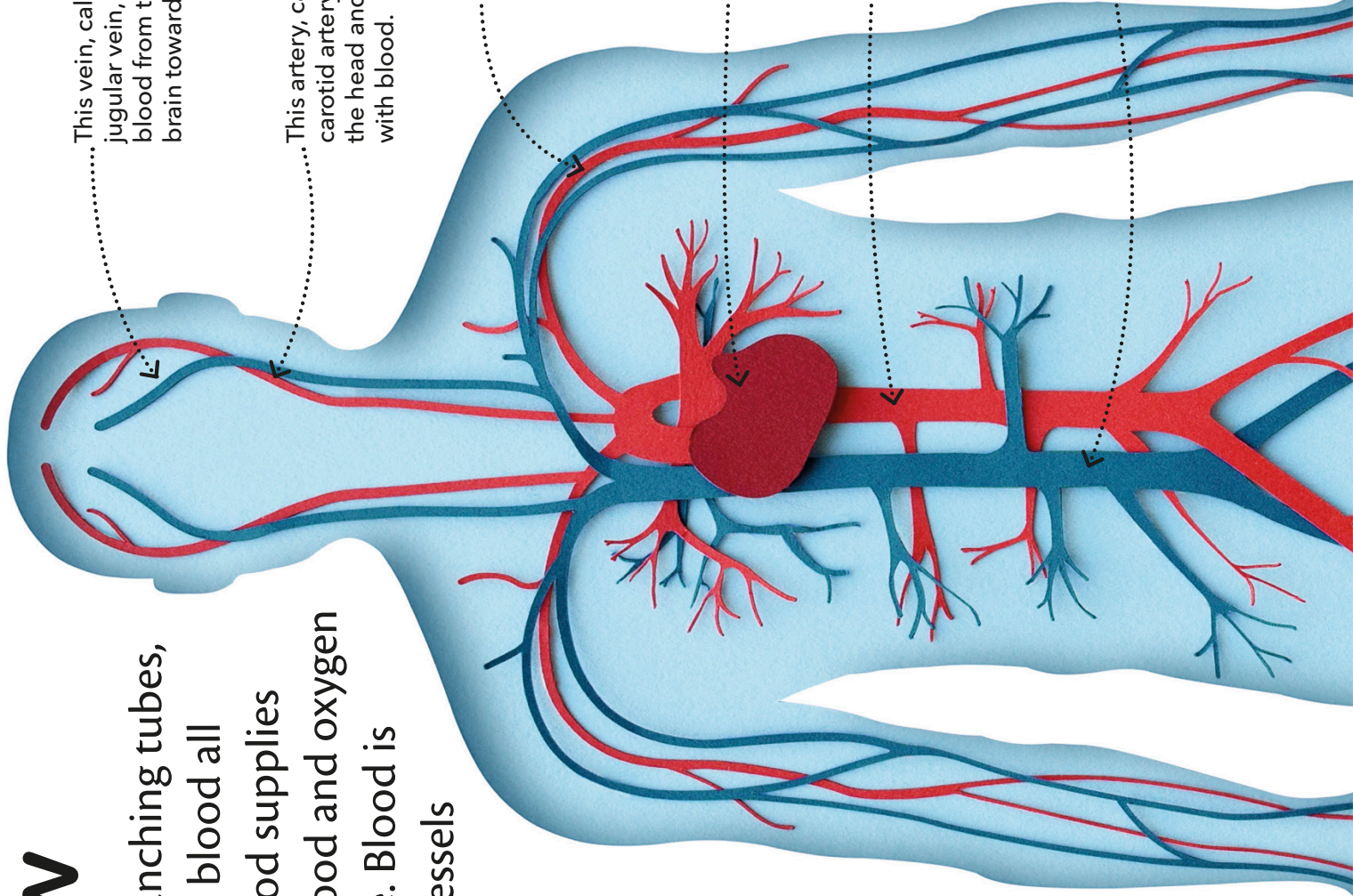
This artery, called the carotid artery, supplies the head and brain with blood.

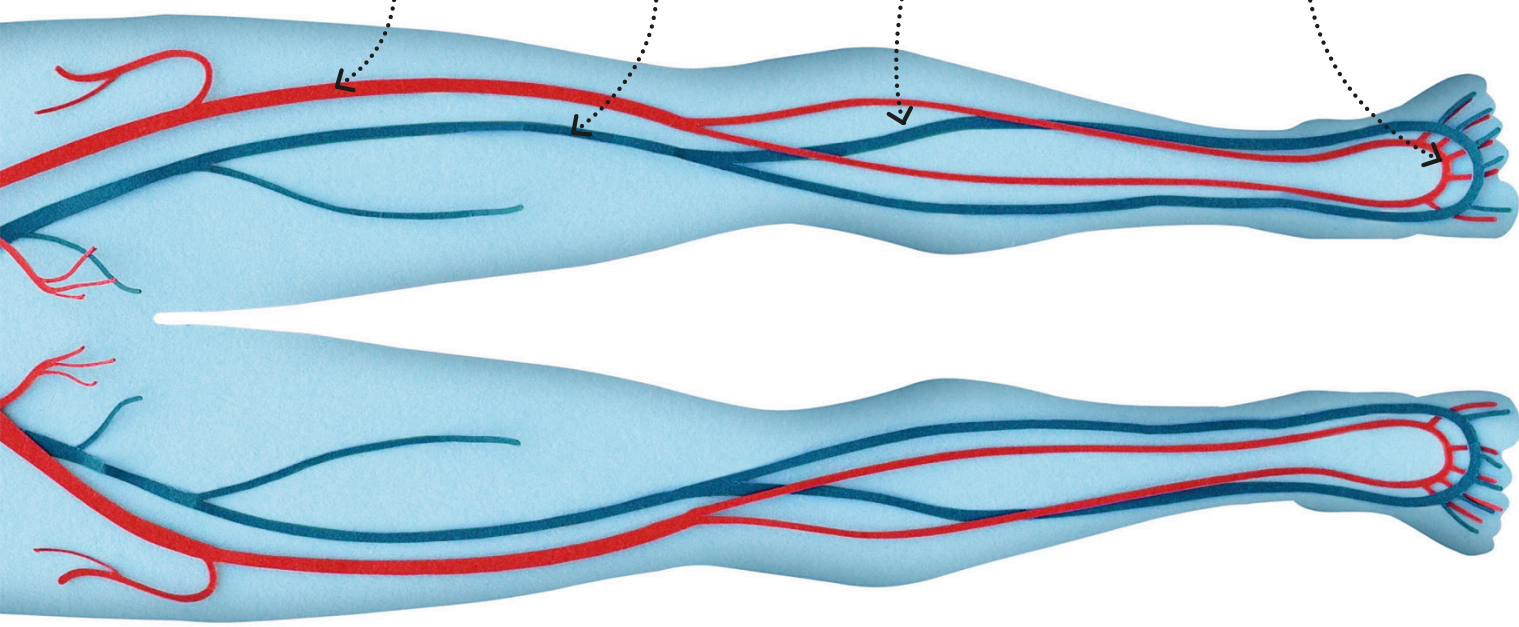
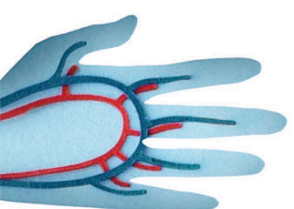
The brachial artery carries blood that is rich in oxygen to the muscles and other parts of the arm.

The heart pumps blood along blood vessels.

The main artery leaving the heart is called the aorta. It is bigger than the width of an adult thumb.

This large vein, called the inferior vena cava, returns blood from the lower body to the heart.



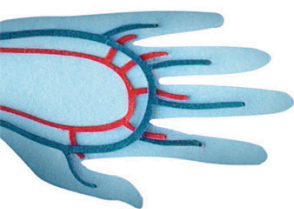


The femoral artery carries blood to the muscles and other parts of the thigh.

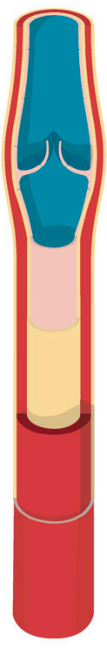
The femoral vein takes blood that is poor in oxygen back to the heart from the thigh.

The anterior (front) tibial vein carries blood from the lower leg and foot.

These arteries supply blood to the feet and toes.



Artery
Arteries have a thick, elastic wall that gets wider when the heart pumps blood through it.



Vein
Veins have a thinner wall than arteries and have valves to stop blood flowing backwards.



Capillary
Capillaries are the smallest type of blood vessel. A capillary's wall is just one cell thick.

Blood vessels

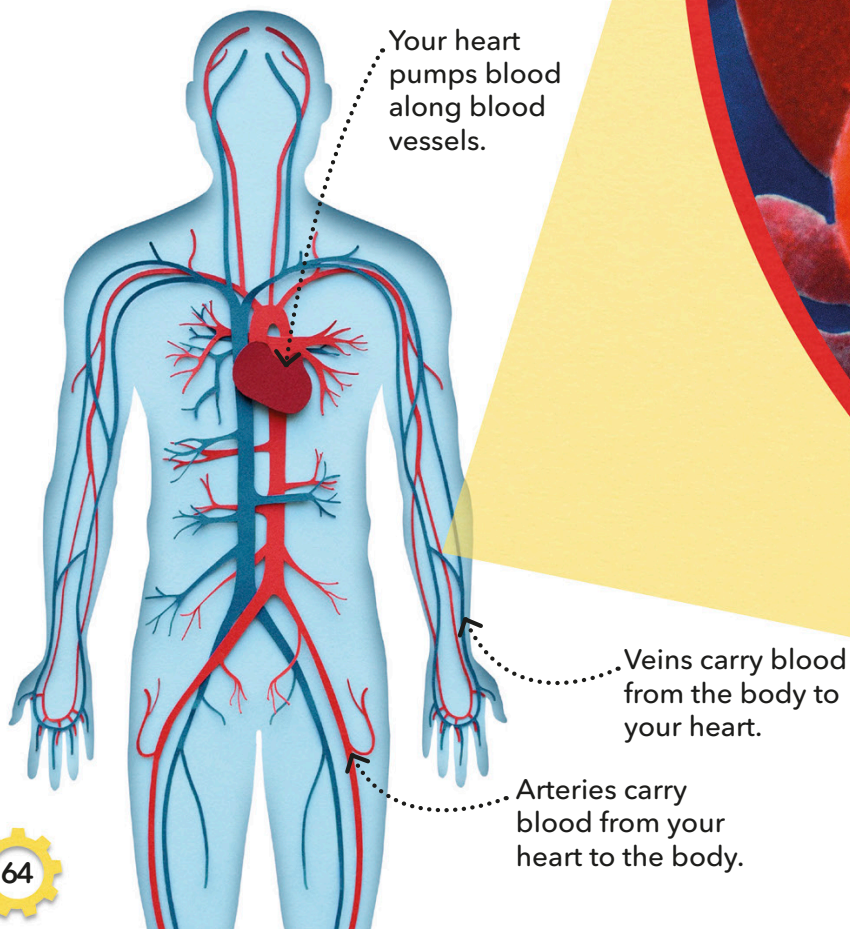
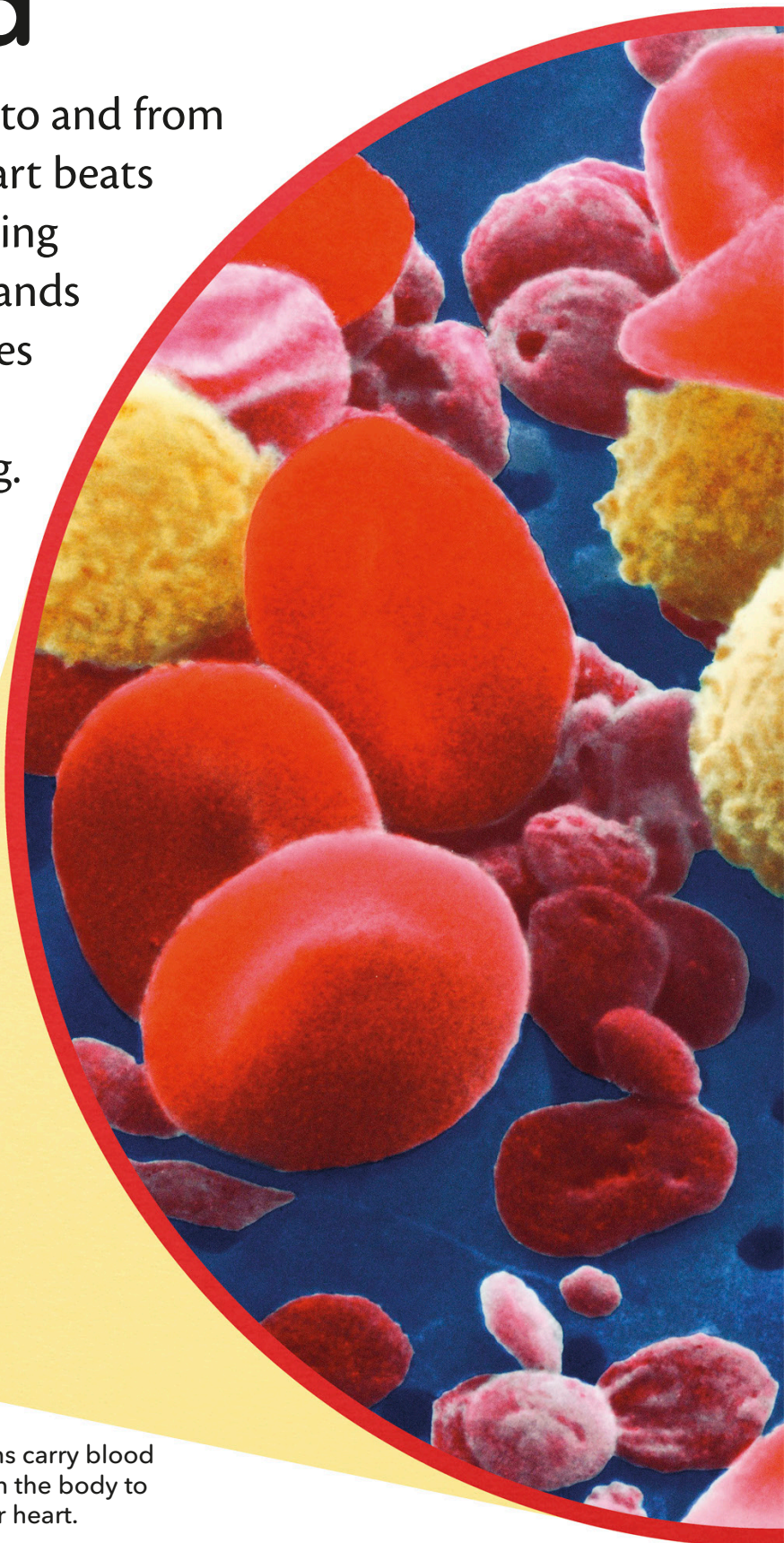
There are three different types of blood vessel. Arteries carry blood that is rich in oxygen away from your heart. Veins carry blood that is low in oxygen towards your heart. Tiny capillaries (too small to show in the main picture) connect arteries and veins, and give food and oxygen to cells.

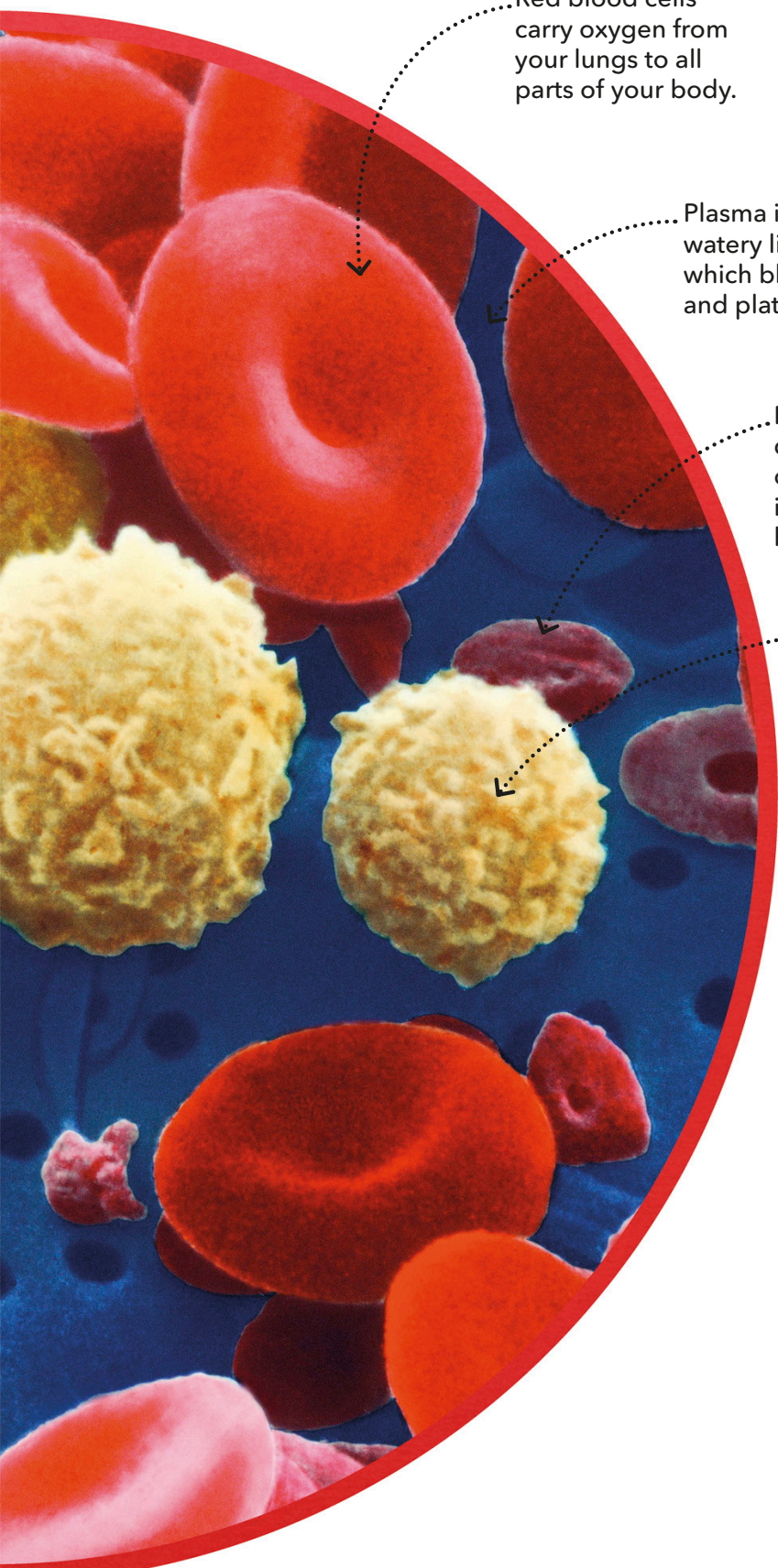
In the blood

Your blood vessels carry blood to and from all of your body's cells. Your heart beats constantly to pump this red, living liquid around your body thousands of times each day. Blood supplies your cells with everything they need to keep your body working.

Blood cells

Your blood is made up of different types of cells. They float in a watery liquid called plasma. Red blood cells are the most common type of cell. They make blood red and carry oxygen. White blood cells fight germs. Small cell pieces, called platelets, help your blood to clot if you are wounded.



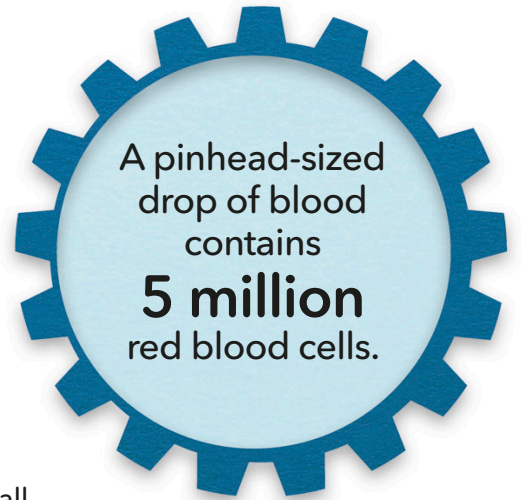


Red blood cells carry oxygen from your lungs to all parts of your body.

Plasma is the watery liquid in which blood cells and platelets float.

Platelets are small disc-shaped pieces of cell. They plug holes in damaged blood vessels by forming a clot.

White blood cells defend your body by destroying germs that cause disease.



A pinhead-sized drop of blood contains **5 million** red blood cells.



Thicker blood

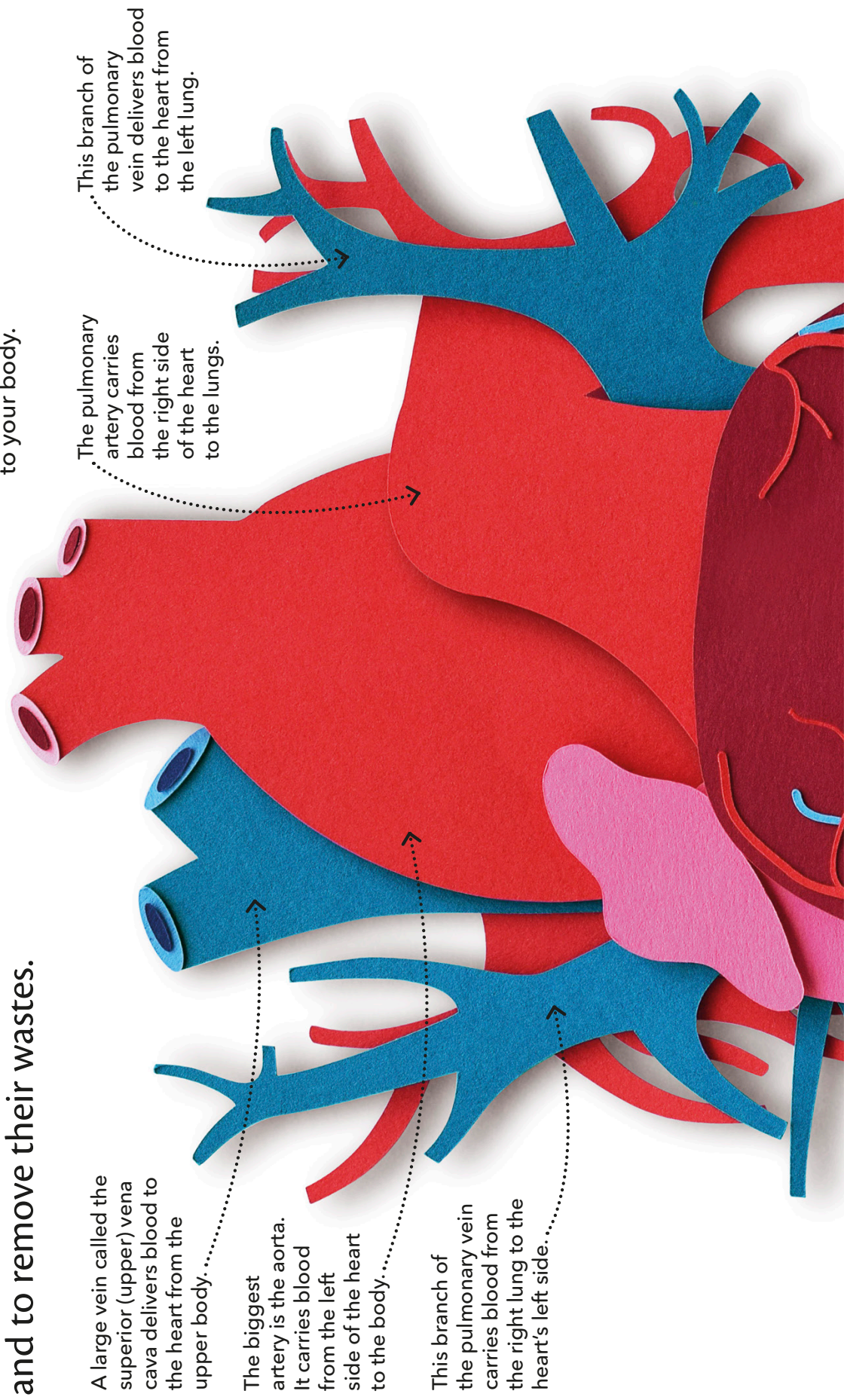
High up in the mountains, air contains less oxygen than at sea level. People who go mountain climbing struggle to breathe in enough oxygen at first. But gradually their bodies make extra red blood cells to get more oxygen from the air. These extra cells make their blood a bit thicker.

Heartbeat

The same size as a fist, your heart is a powerful, muscular pump that pushes blood around your body. It beats without resting to supply your body with oxygen, nutrients and other essentials, and to remove their wastes.

Receiving and sending

Your heart is two pumps in one, with separate right and left sides. The right side receives blood from the body and sends it to the lungs to pick up oxygen. The left side receives blood from your lungs and sends it to your body.



A coronary artery supplies blood rich in oxygen to the heart's muscular wall.

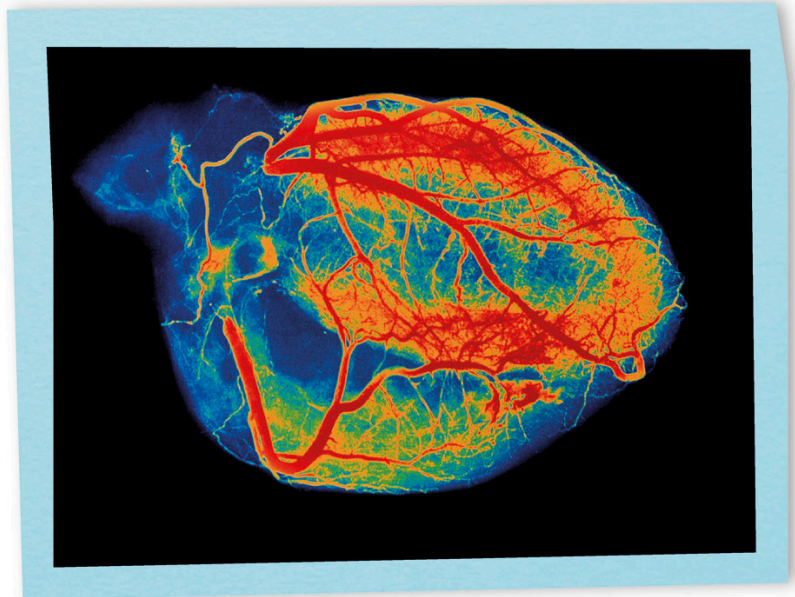
A second large vein called the inferior (lower) vena cava carries blood to the heart from the lower body.

This branch of the pulmonary artery carries blood to the left lung.

The heart's thick wall is made of muscle cells that tighten to make it beat without ever tiring.

Engine fuel

Just like a car's engine, your heart needs fuel and oxygen to keep it beating. These are carried by coronary arteries that wrap around the heart and send branches into its muscular wall. You can see them, in red, on this angiogram, a special type of X-ray.



Your

heart beats
about **100,000**
times each
day without
a break.

Feel the beat

Every beat of your heart lasts less than one second. During each beat, blood that is low in oxygen (blue) enters the right side of the heart and is pumped to the lungs. At the same time, blood that has lots of oxygen (red) enters the left side and is pumped to the body.

The heart at work

Every time your heart beats, it pushes blood out and around your body. When the body needs more oxygen, such as during exercise, the heart beats faster. It can treble its speed. Here are the three stages of a heartbeat.

Blood that is low in oxygen flows into the heart from the upper body.

Blood that is rich in oxygen flows into the heart from the lungs.

Blood flows into the heart from the left lung.

Valve between the left atrium and the ventricle is closed.

Right atrium tightens to squeeze blood downwards.

Valve between the right atrium and the ventricle opens.

Oxygen-poor blood pours into the right ventricle.

The flap, or valve, between the atrium and the ventricle is closed.

Blood low in oxygen passes into the heart from the lower body.

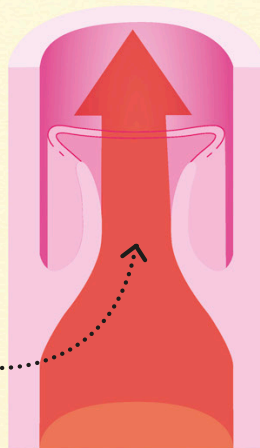
First stage
Blood flows into the left and right atria (the upper chambers of the heart).

Second stage
The atria contract to push blood into the lower chambers, or ventricles.

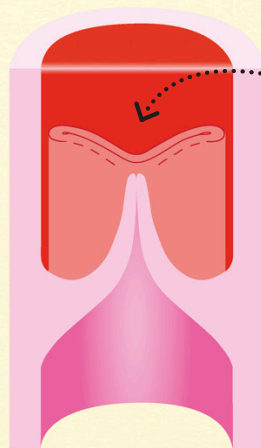
No way back

There are tiny flaps called valves inside your heart that make sure that blood flows in one direction out of the heart during each heartbeat. When the heart tightens, the valves are forced open and blood flows through. When the heart relaxes, the valves close to stop blood flowing backwards.

Blood gushes through the open valve when the heart pumps.

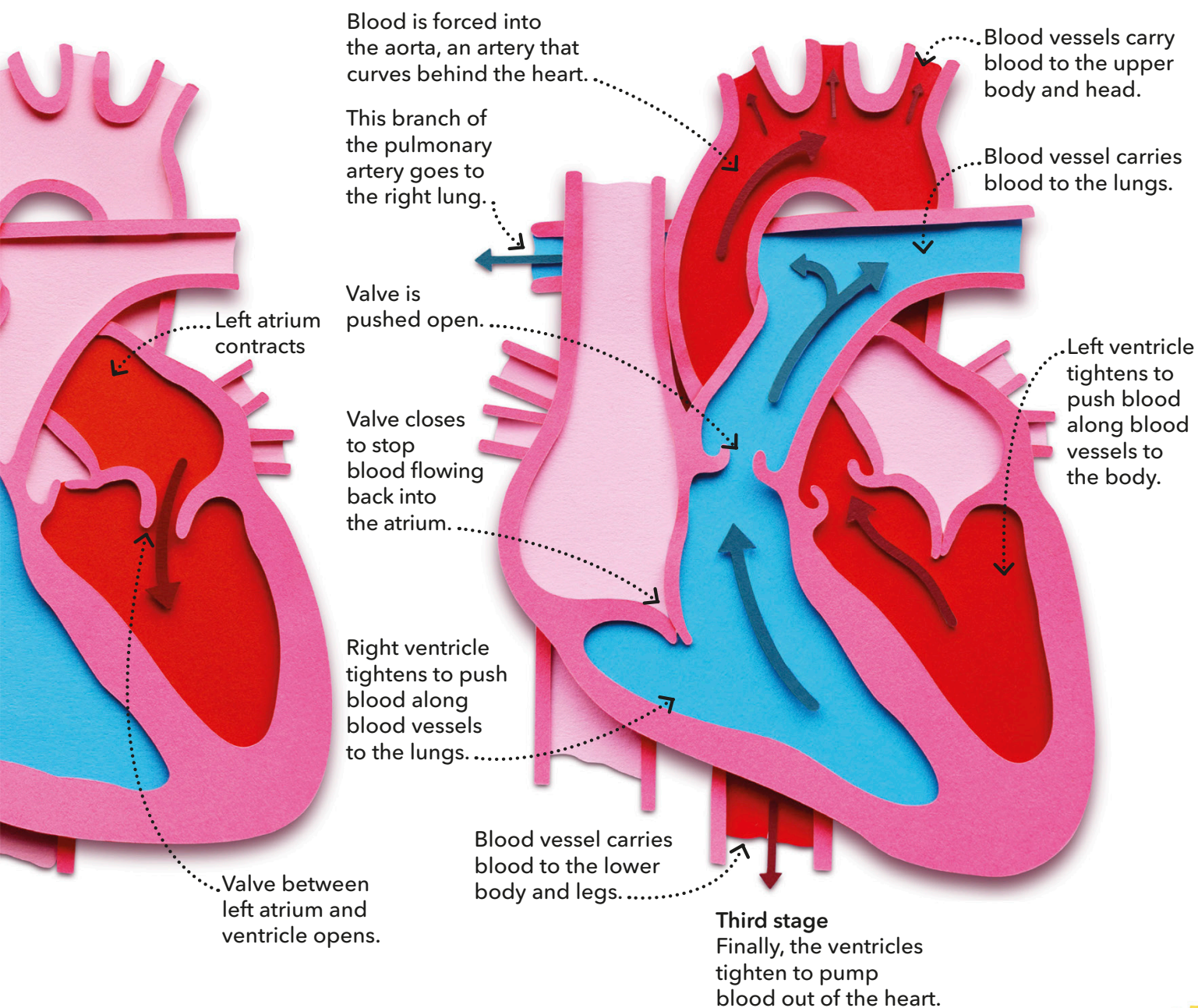


Valve open



Valve closed

Blood is trapped by the closed valve when the heart relaxes, and cannot flow back.



Blood is forced into the aorta, an artery that curves behind the heart.

This branch of the pulmonary artery goes to the right lung.

Blood vessels carry blood to the upper body and head.

Blood vessel carries blood to the lungs.

Left atrium contracts

Valve is pushed open.

Left ventricle tightens to push blood along blood vessels to the body.


Valve closes to stop blood flowing back into the atrium.

Right ventricle tightens to push blood along blood vessels to the lungs.

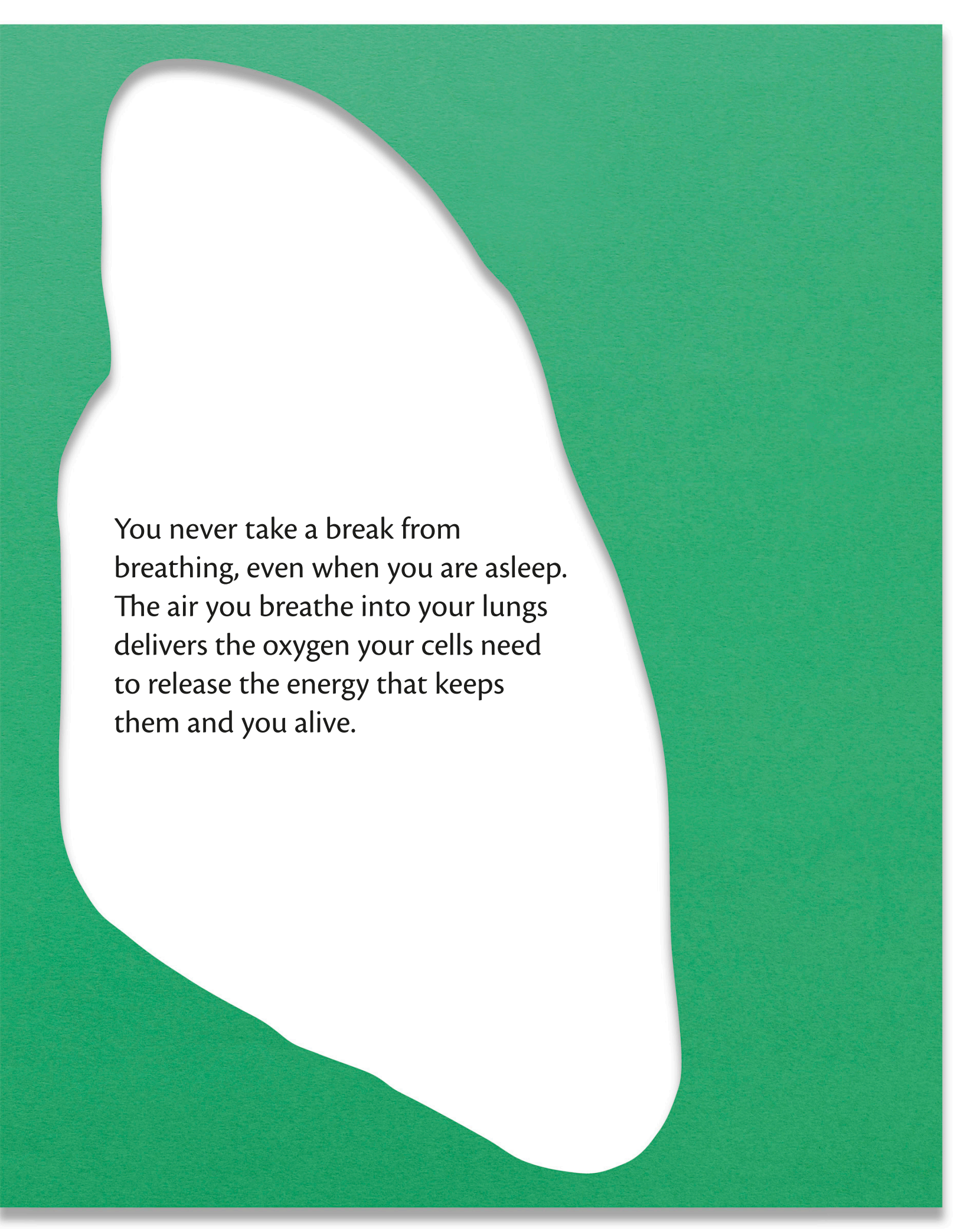
Valve between left atrium and ventricle opens.

Blood vessel carries blood to the lower body and legs.

Third stage
Finally, the ventricles tighten to pump blood out of the heart.



Lungs and Breathing

A white, irregularly shaped area on a green background containing text.

You never take a break from breathing, even when you are asleep. The air you breathe into your lungs delivers the oxygen your cells need to release the energy that keeps them and you alive.

Air supply

Your body's cells need a constant supply of oxygen. They use it to release the energy that keeps them working. As you breathe in oxygen, you also breathe out carbon dioxide, using your respiratory system.

Nose to lungs

Your respiratory system consists of the airways and two lungs. Air rich in oxygen is breathed in through your nose, throat, and windpipe, called the trachea. It then passes inside the lungs along a network of airways. Air containing carbon dioxide is breathed out in the opposite direction.

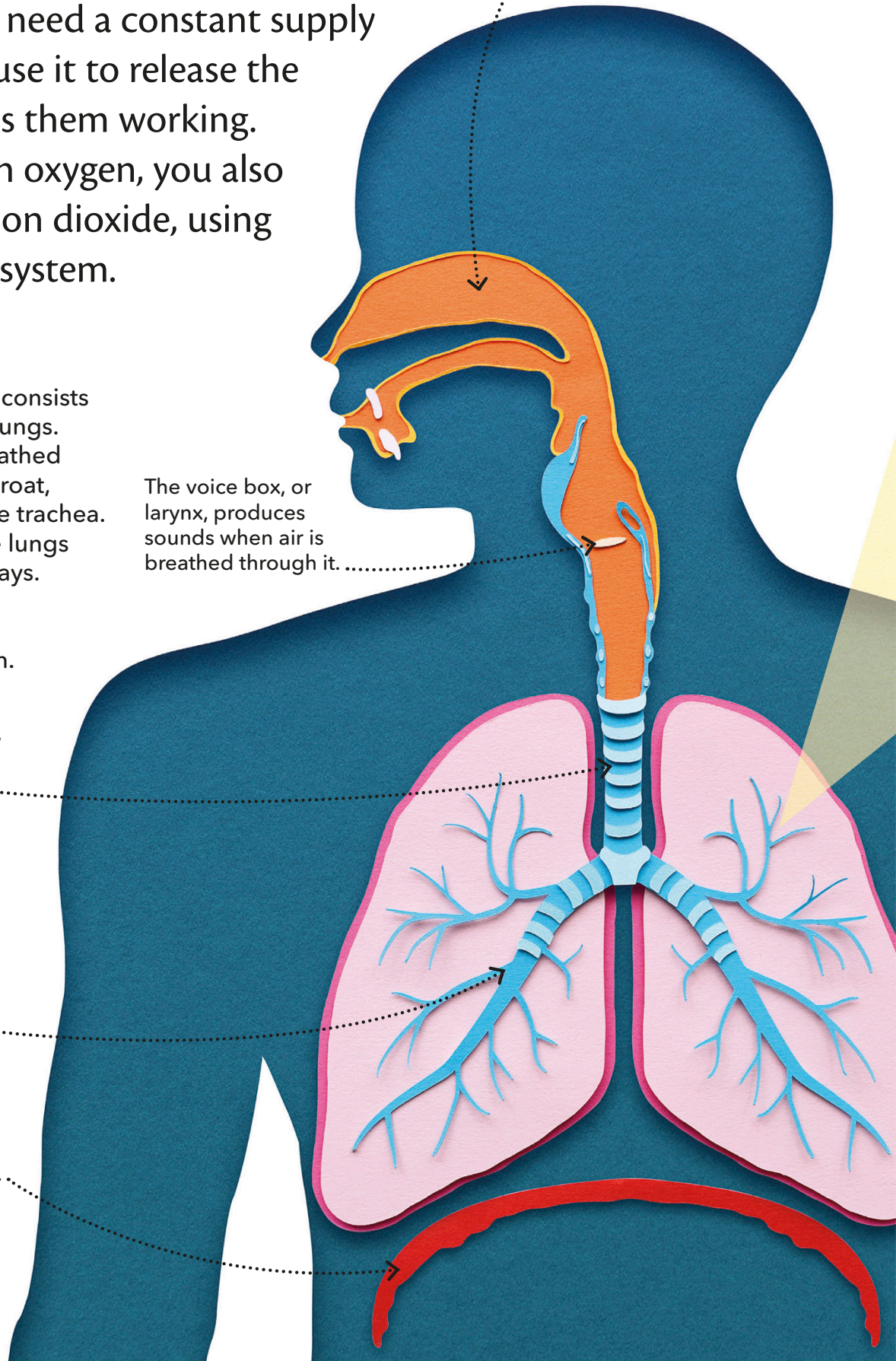
The windpipe, or trachea, is the tube that carries air to and from the lungs.

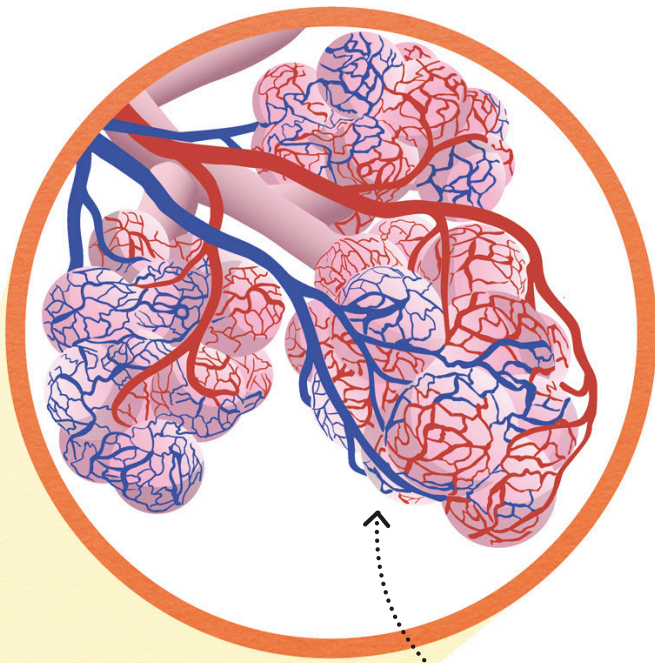
An airway called a bronchus branches from the trachea and divides into smaller branches, called bronchioles.

This muscle is called the diaphragm - it separates the chest and abdomen, and helps with breathing.

The nasal cavity warms, moistens, and cleans air as it is breathed in.

The voice box, or larynx, produces sounds when air is breathed through it.





Air bags

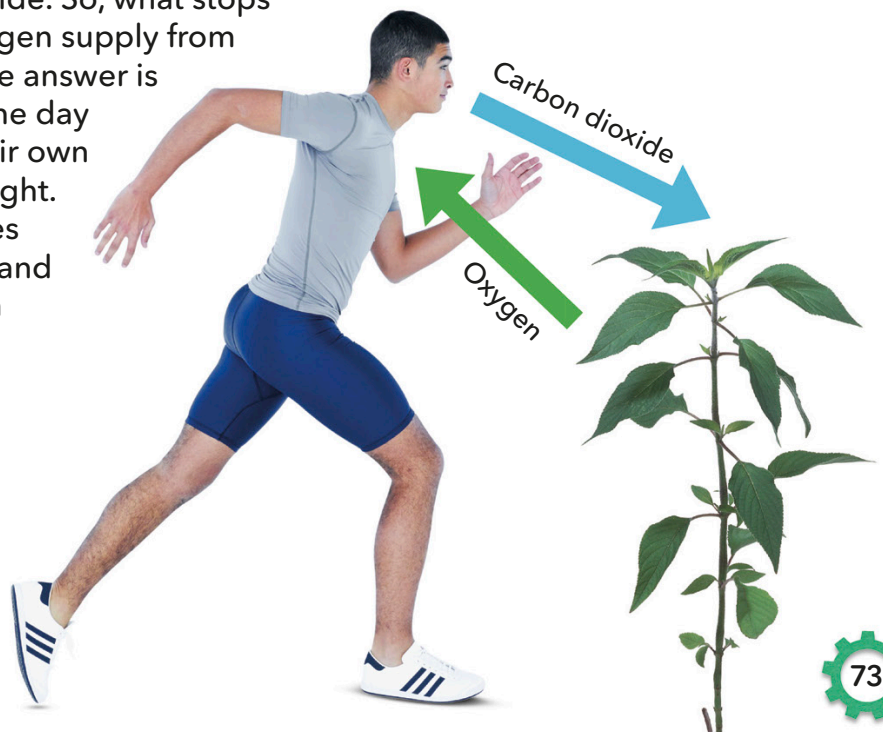
Each of your lung's 30,000 bronchioles ends in bunches of tiny air bags. These are where oxygen enters your blood and carbon dioxide comes out. Together, the air bags in both lungs provide a massive surface 50 times that of your skin, through which oxygen is quickly swapped for carbon dioxide.

The network of blood capillaries surrounding air bags delivers oxygen-poor blood (blue) and carries away oxygen-rich blood (red).



Oxygen supply

You breathe in oxygen and breathe out carbon dioxide. So, what stops the planet's oxygen supply from running out? The answer is plants. During the day plants make their own food using sunlight. This process uses carbon dioxide and releases oxygen into the air.



Take a breath

Day and night, without a break, you breathe air into your lungs. Air contains oxygen, which your body needs. You breathe out stale air, containing waste carbon dioxide. Breathing makes sure that your body's cells have a non-stop supply of oxygen, and are not affected by carbon dioxide.

In and out

Your lungs cannot move on their own to make you breathe. A curved muscle, called the diaphragm, helps with this. It works together with muscles between your ribs to get you breathing in and out.

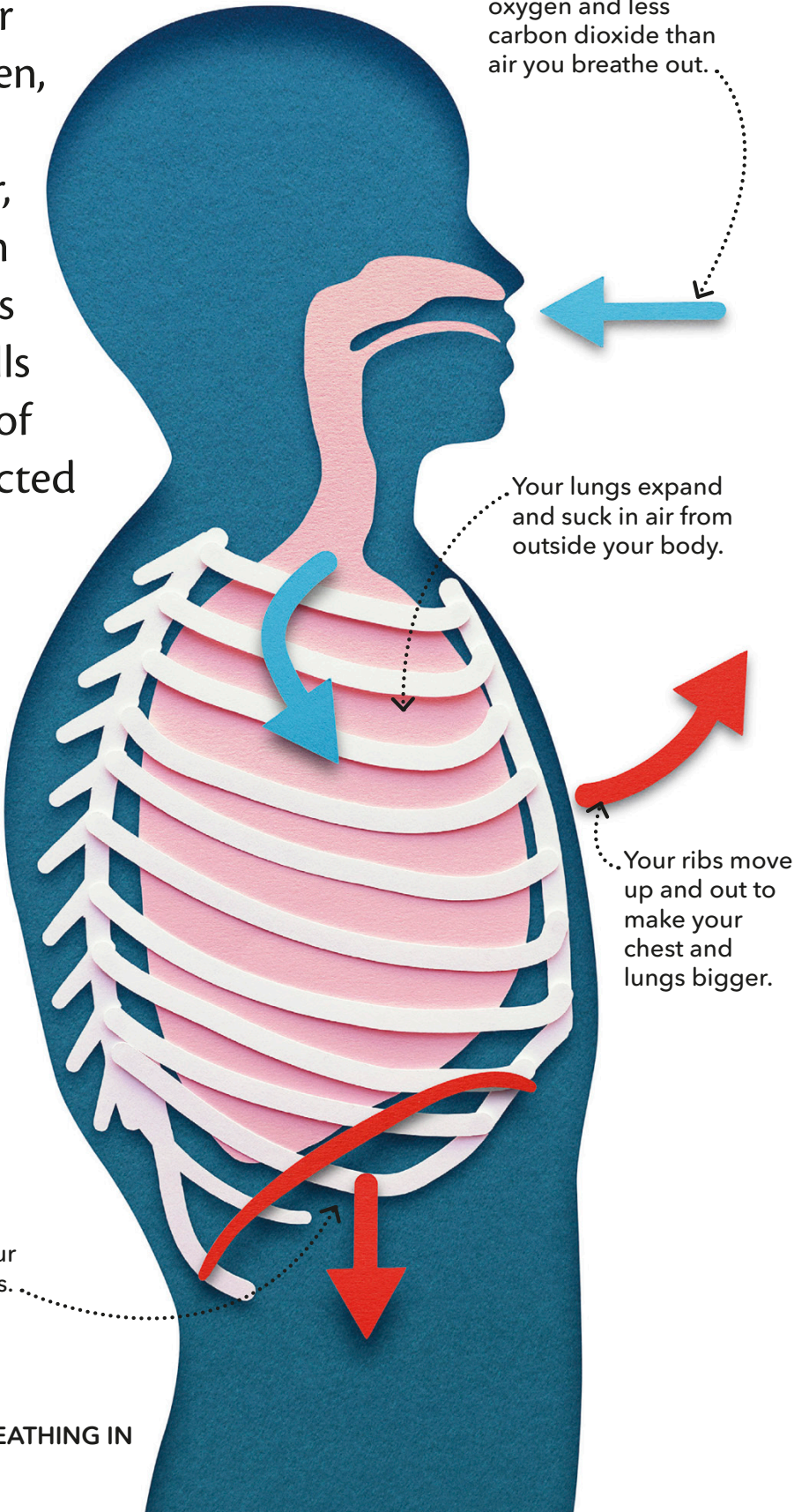
The diaphragm tightens, flattens, and stretches your lungs downwards.

Air that you breathe in through your nose and mouth has more oxygen and less carbon dioxide than air you breathe out.

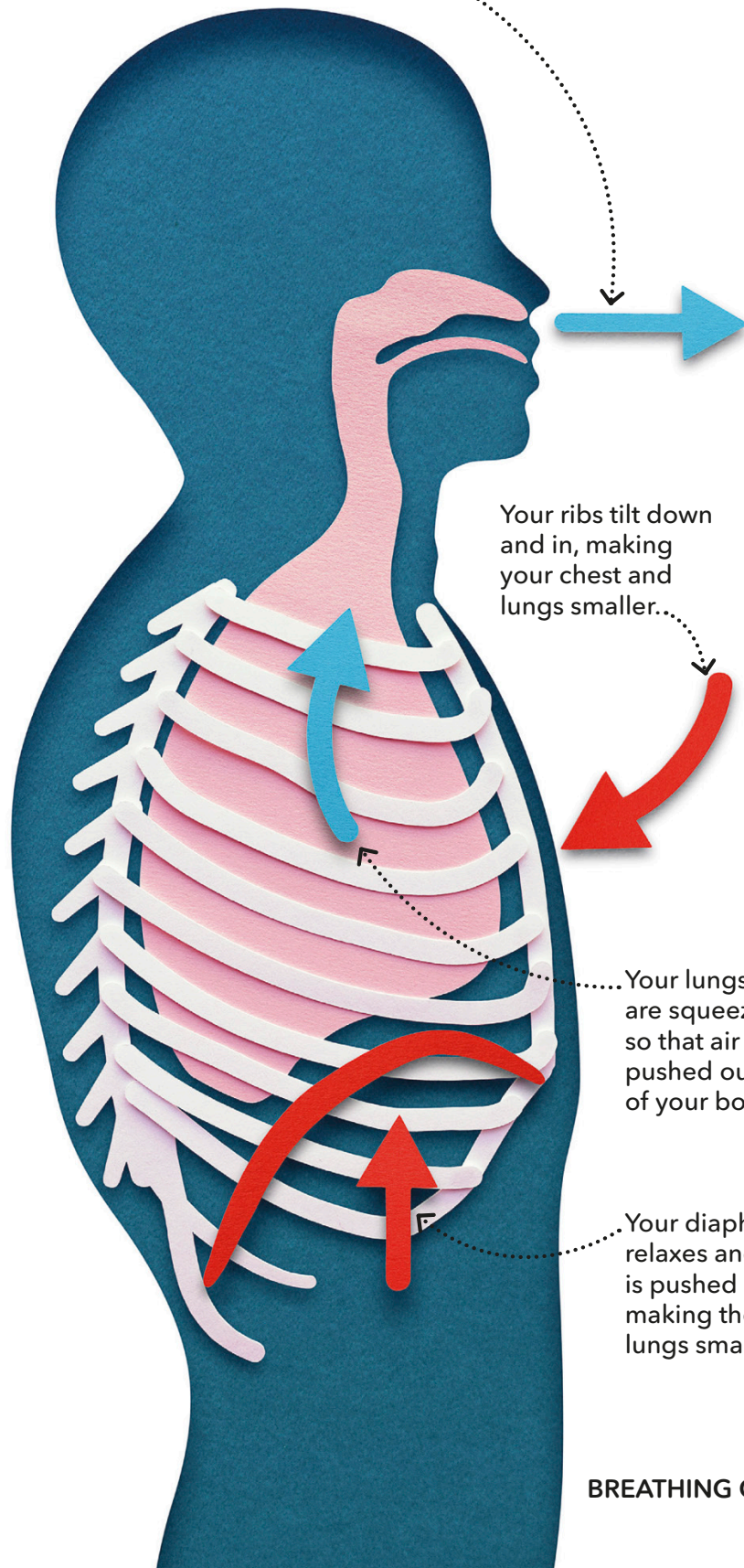
Your lungs expand and suck in air from outside your body.

Your ribs move up and out to make your chest and lungs bigger.

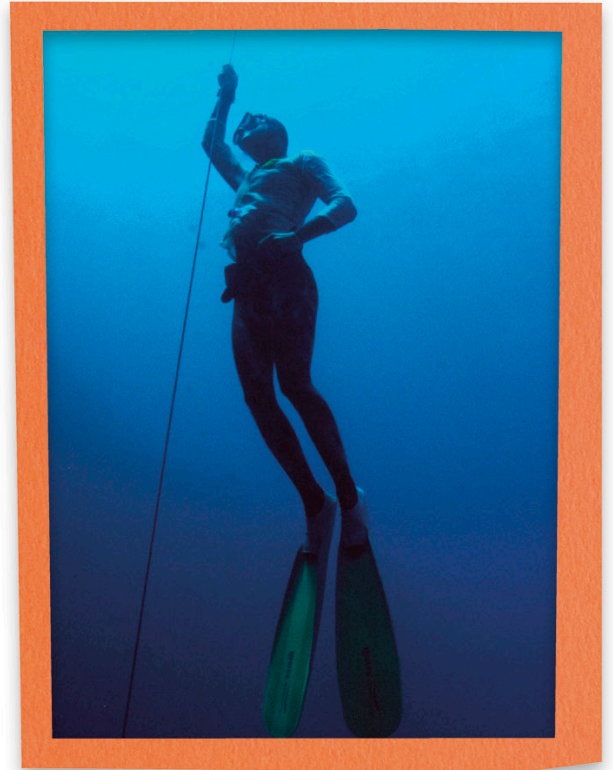
BREATHING IN



Air you breathe out contains less oxygen and more carbon dioxide than air you breathe in.



BREATHING OUT



Hold it

Unlike fish, humans cannot breathe underwater. But some of us can stay underwater for a minute or so by holding our breath. Some people, called freedivers, can hold their breath for much longer and can dive to great depths of more than 200 m (700 ft).

You breathe
in and out
around
20,000
times each day.

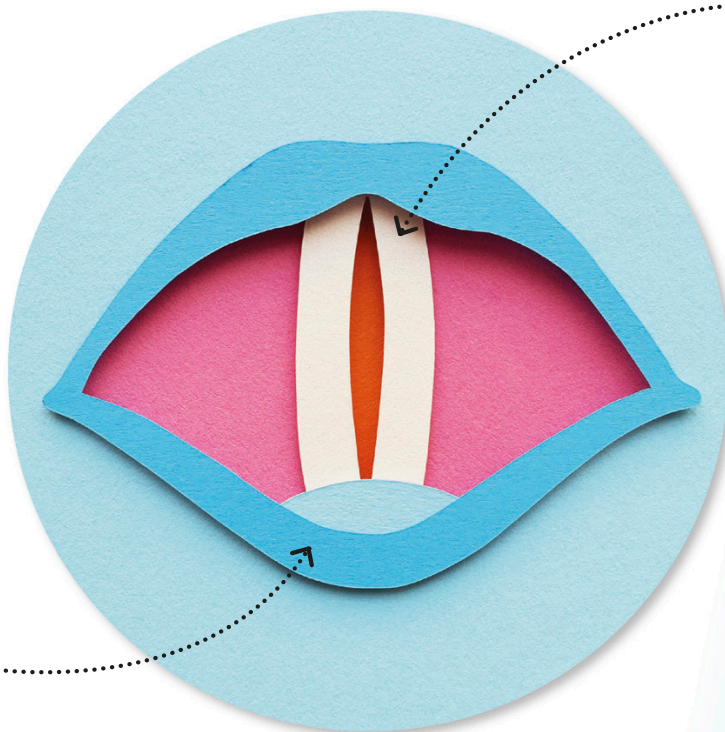
Making noise

Only humans can communicate using speech. The sounds of speech are made by forcing bursts of air between folds in your throat called vocal cords. These sounds are then shaped into words by the mouth.

Making sounds

Your vocal cords stretch across your voice box in your throat. When they are pulled together, air forced between them makes them vibrate and produce sounds. These sounds are amplified by the voice box and the spaces, or cavities, in your throat and nose.

Muscles pull the voice box to tighten and close the vocal cords.



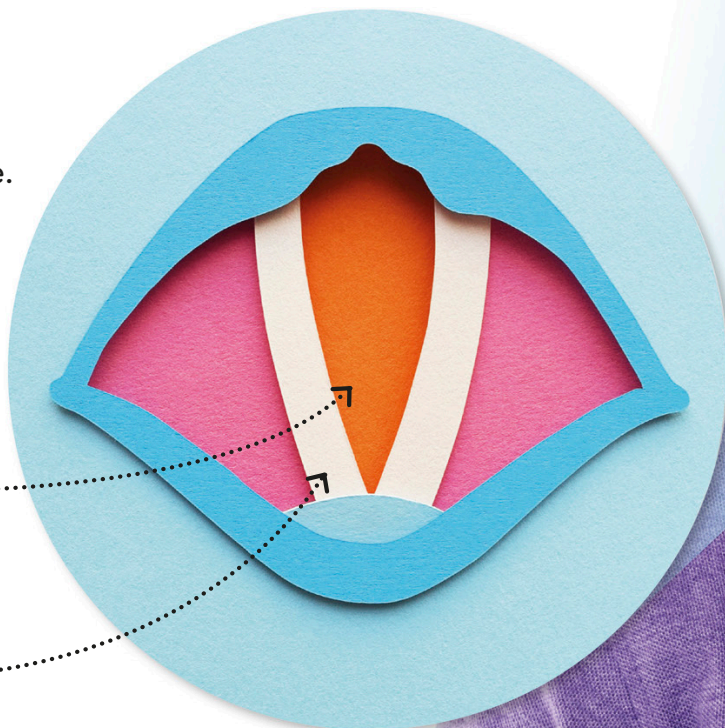
Vocal cords are pulled close together so that air from the lungs passes through a small gap.

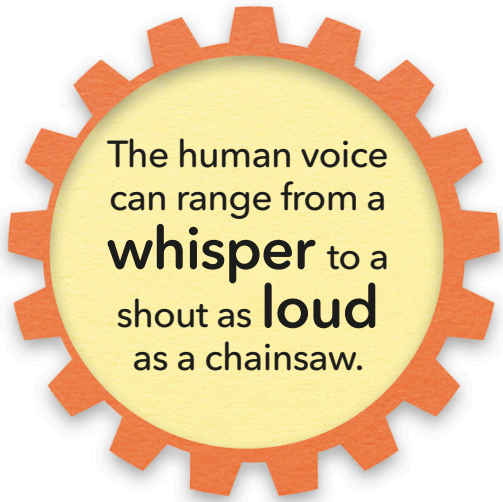
Breathing

When muscles in the wall of the voice box relax, the vocal cords open and separate. This allows air to move freely to and from the lungs along the windpipe.

The windpipe carries air to and from the lungs.

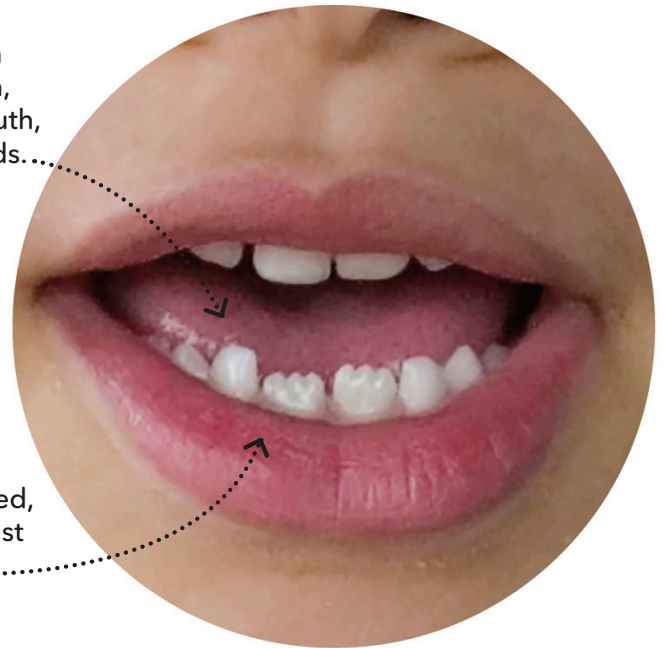
Vocal cords are relaxed and fully open during normal breathing.





The human voice can range from a **whisper** to a shout as **loud** as a chainsaw.

Your tongue can touch your teeth, roof of your mouth, or pull backwards...



Your lips can be pressed together, rounded, or pushed against the teeth.

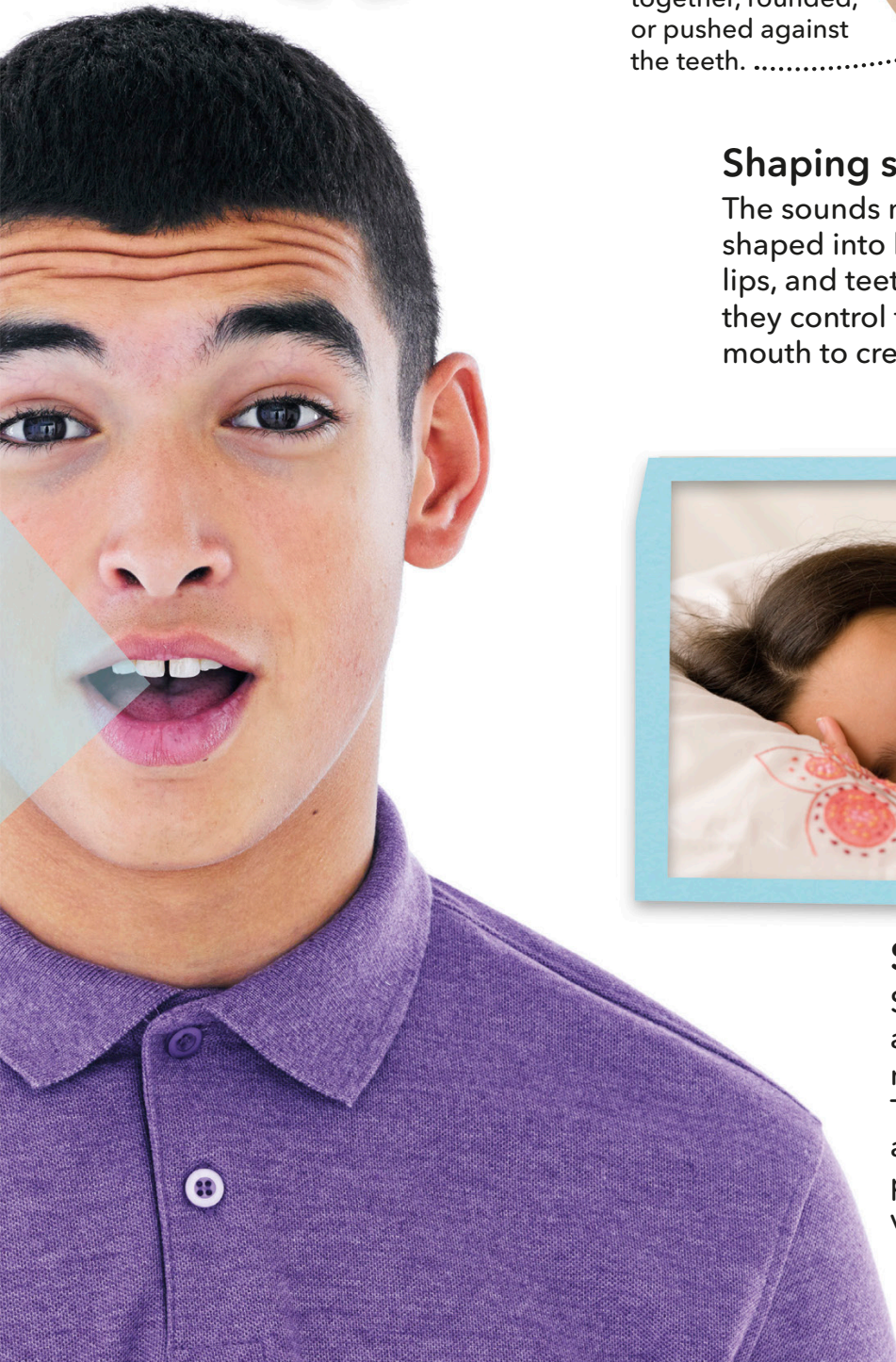
Shaping speech

The sounds made by your vocal cords are shaped into letters and words by your tongue, lips, and teeth. Under orders from your brain, they control the movement of air out of your mouth to create a full range of sounds.



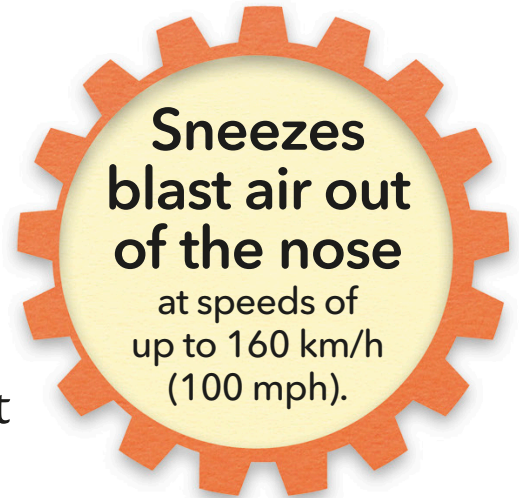
Snoring

Some people snore when they are asleep. Muscles relax, making the nasal passages and throat narrower. This slows down the movement of air to and from the lungs. As a result, parts of the nose, mouth, and throat vibrate, causing the person to snore.



Out of control

Sneezing, yawning, and hiccups are some of the breathing movements that you cannot easily control. They are automatic reflex actions. Some of these actions help keep you healthy. Others, such as yawning, have no clear purpose, but may help you get more oxygen in your body to wake you up.



Sneezing

A sneeze sends a noisy blast of air through your nose. It clears out itchy dust or germs. Sneezing happens when, after a sudden intake of breath, air is forced out of your lungs and upwards through your nose. Coughing clears your throat in a similar way.

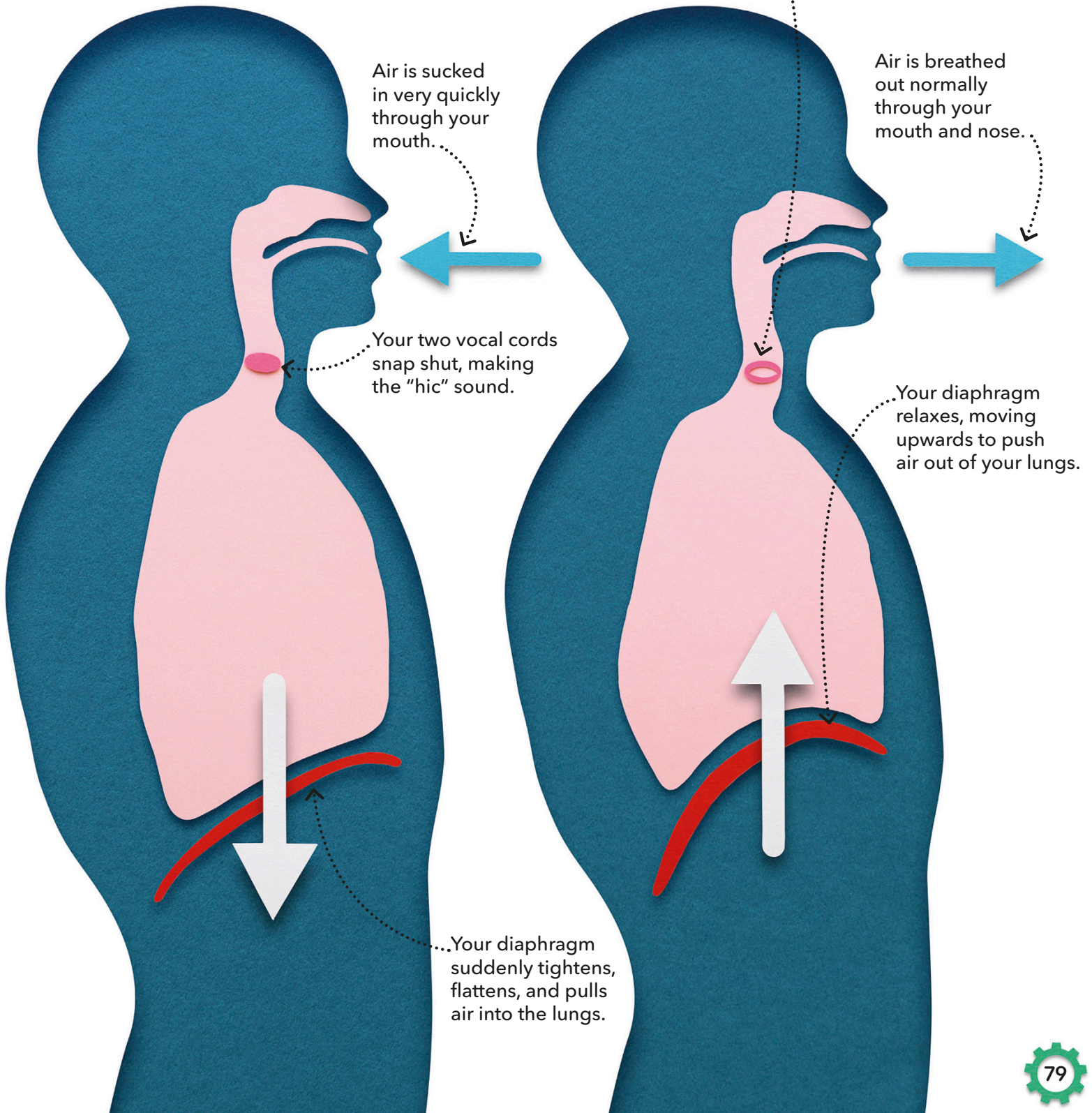
Yawning

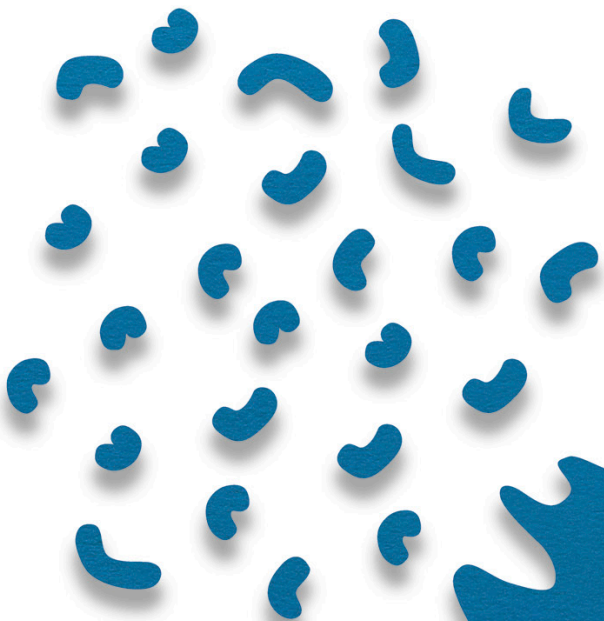
We all yawn, but we do not know why. It might be because we are tired or bored, or we might need to get extra air into our bodies. What we do know is that if you yawn, people around you will often yawn too!



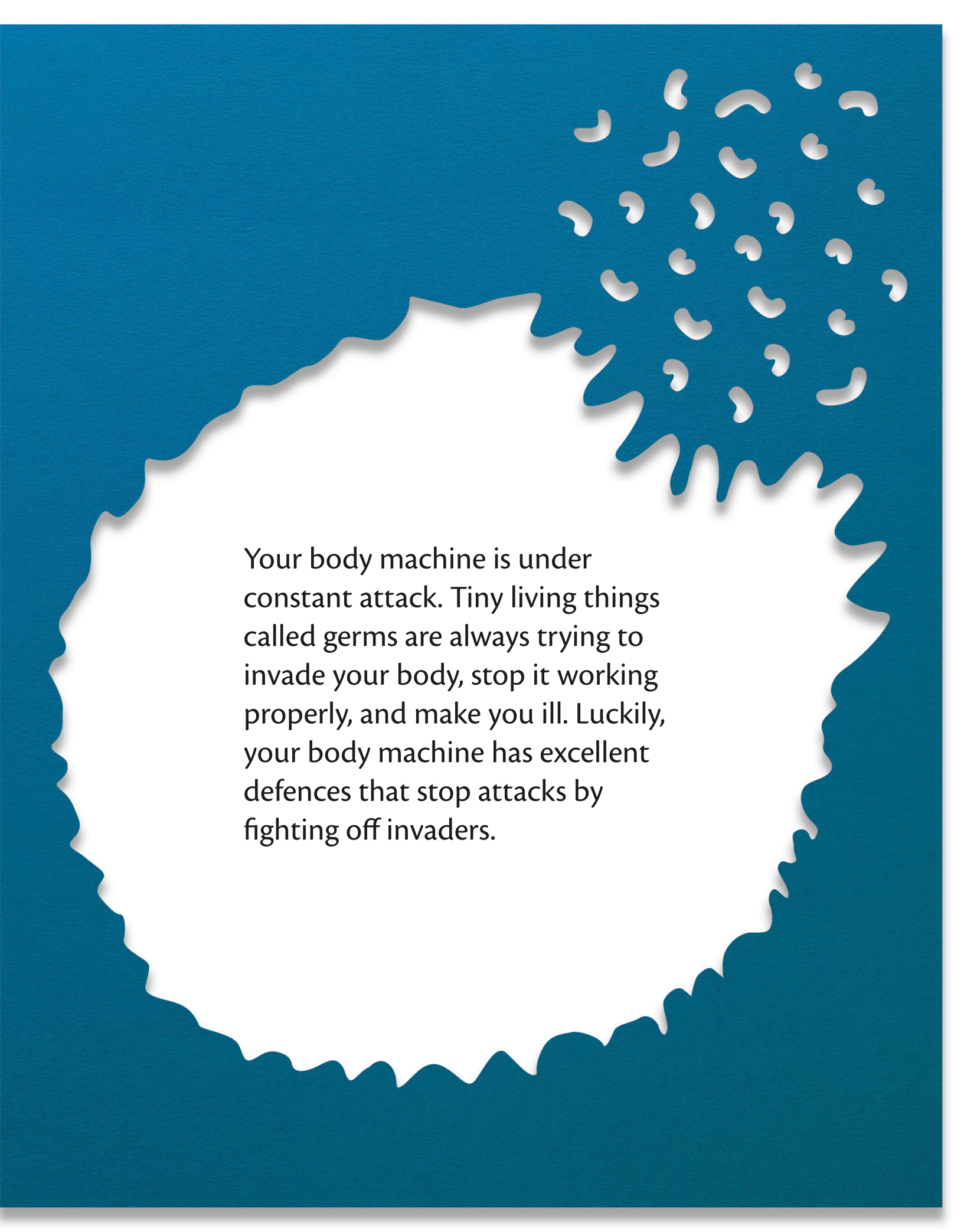
Hiccups

The pictures below show what happens when you have hiccups. A muscle called the diaphragm tightens and air is sucked into your lungs. Your vocal cords slap together making a "hic". You might get hiccups if you eat too quickly.





Under Attack



Your body machine is under constant attack. Tiny living things called germs are always trying to invade your body, stop it working properly, and make you ill. Luckily, your body machine has excellent defences that stop attacks by fighting off invaders.

Body defences

Your body has clever ways of keeping you healthy. Your skin, for example, forms a barrier to stop germs getting inside you. Any germs that do get inside are tracked down and destroyed by white blood cells. Many of these cells live in your blood stream and lymphatic system.

Lymphatic system

The tubes that make up your lymphatic system are called lymph vessels. They drain fluid, called lymph, from all parts of your body. As it travels, the lymph passes through tiny swellings in the lymph vessels, called lymph nodes. White blood cells inside the nodes pick out and destroy foreign bacteria.

A lymph node is a small swelling on a lymph vessel that filters lymph.....

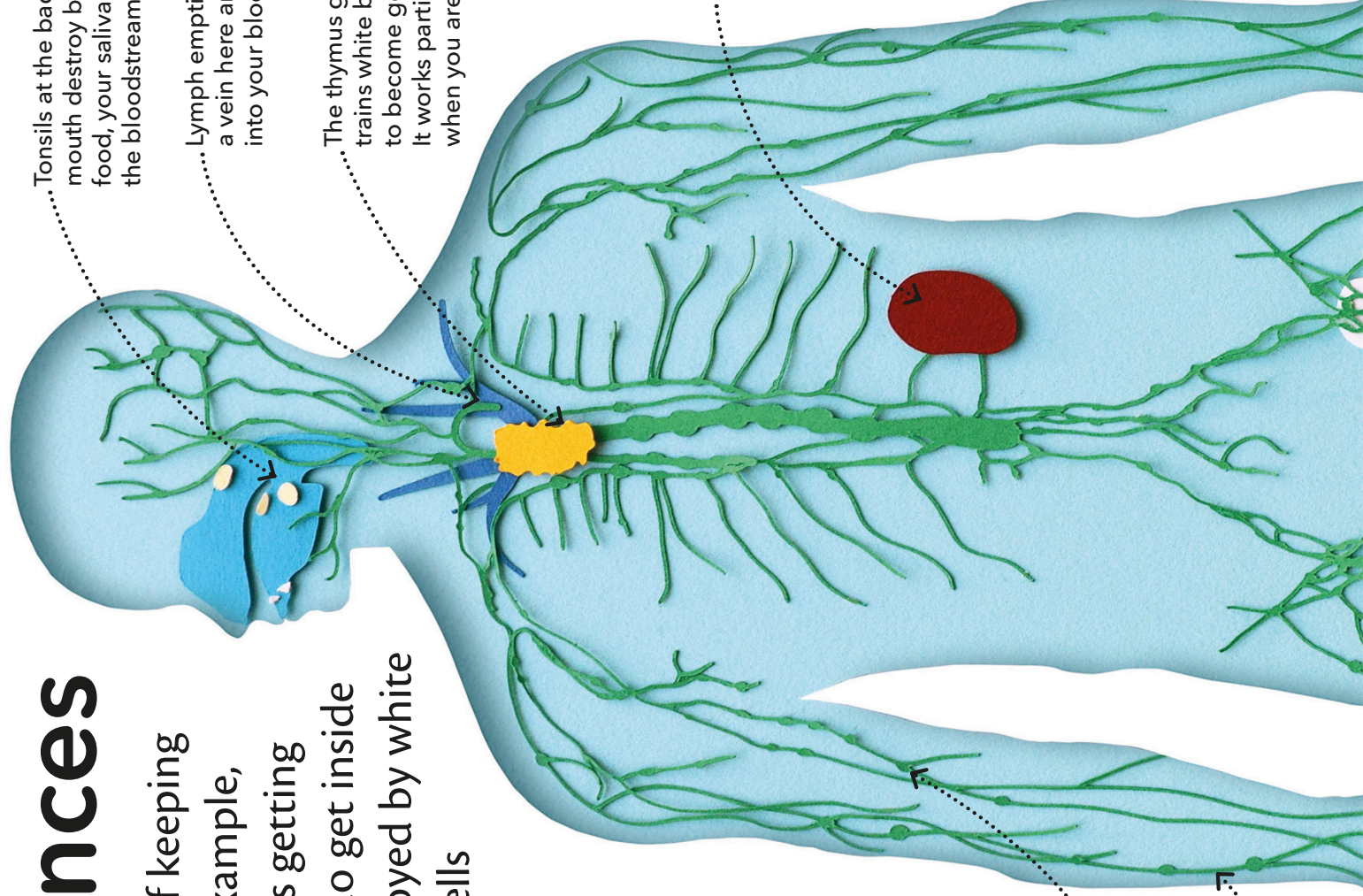
Lymph vessels are tubes that drain lymph from all parts of the body.....

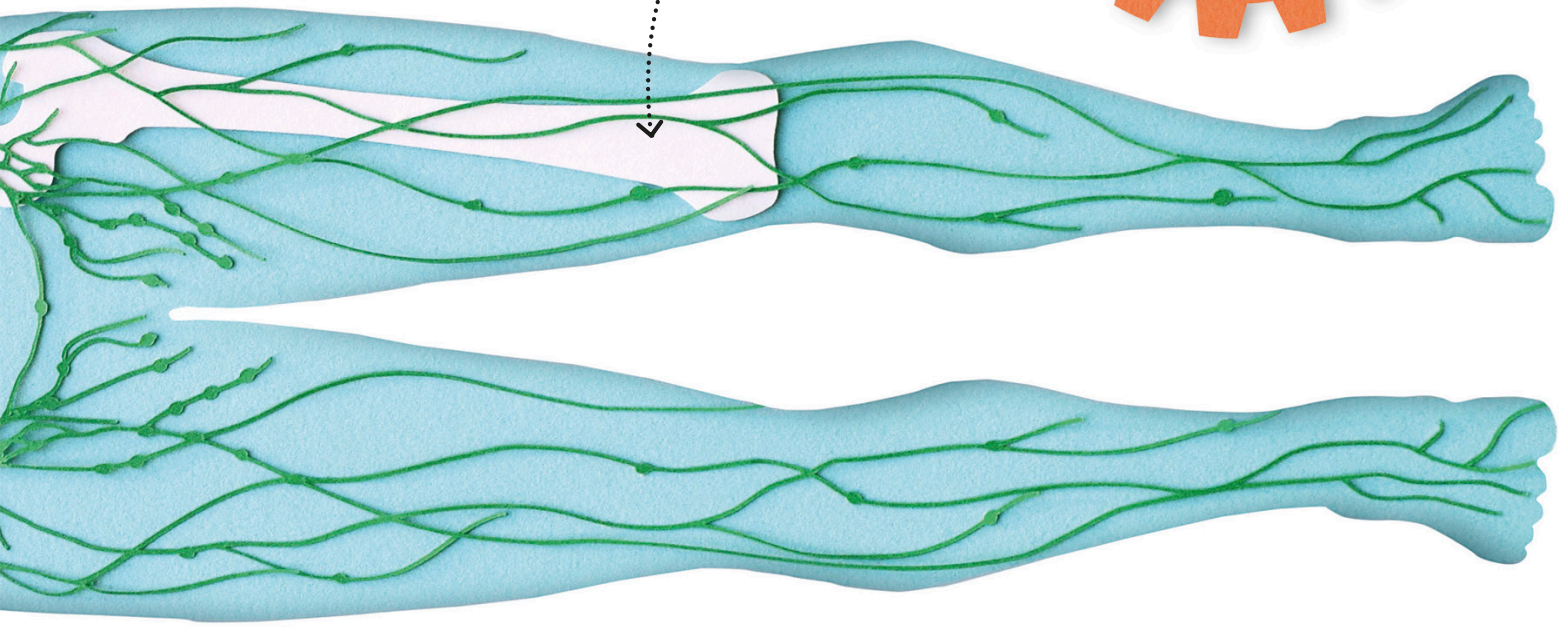
Tonsils at the back of your mouth destroy bacteria in food, your saliva, and in the bloodstream.

Lymph empties into a vein here and flows into your blood.

The thymus gland trains white blood cells to become germ killers. It works particularly hard when you are growing.

Your spleen is an organ that contains germ-killing white blood cells. It also makes red and white blood cells.





Sweat glands deep in your skin make sweat and release it onto the skin's surface.

Sweat spreading over the skin's surface helps to kill harmful germs.



Bone marrow is inside bone. It makes red blood cells and also the white blood cells that kill germs.

Your skin is home to billions of **friendly bacteria** that help protect you from disease!

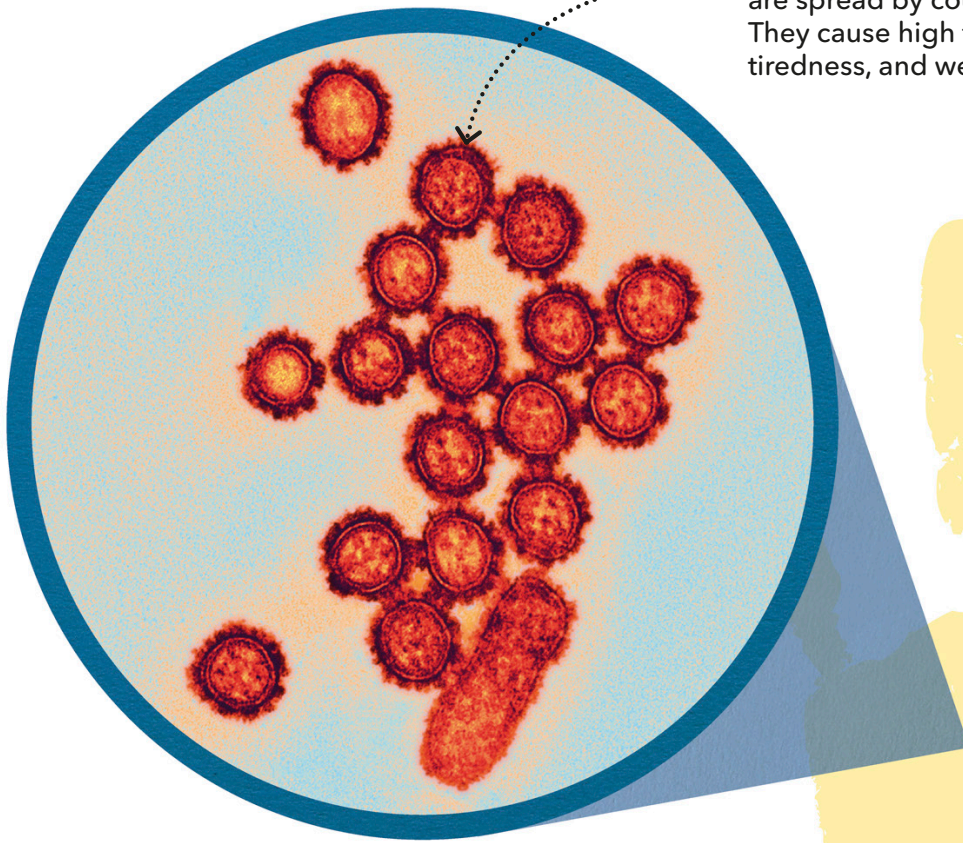
Skin and sweat

As well as stopping germs getting inside you, your skin also makes sweat, which contains germ-killing chemicals. If your skin is cut, these chemicals will quickly attack and kill any invading germs.

Germs and disease

All around us there are millions and millions of tiny living things, too small to be seen. Most are harmless. Some, called germs, can cause disease. They get inside your body, multiply, and stop it working normally.

These tiny influenza (flu) viruses are spread by coughs and sneezes. They cause high temperature, tiredness, and weakness.



Vile viruses

Viruses are the tiniest of all germs. They cause colds and flu as well as more serious diseases, such as measles and mumps. Viruses invade cells inside the body. They turn the cells into factories that produce even more viruses. Then the body's defence forces fight back and destroy them.



Dirty hands spread bacteria and viruses, such as when one person with a cold virus touches another person, and so spreads the virus.



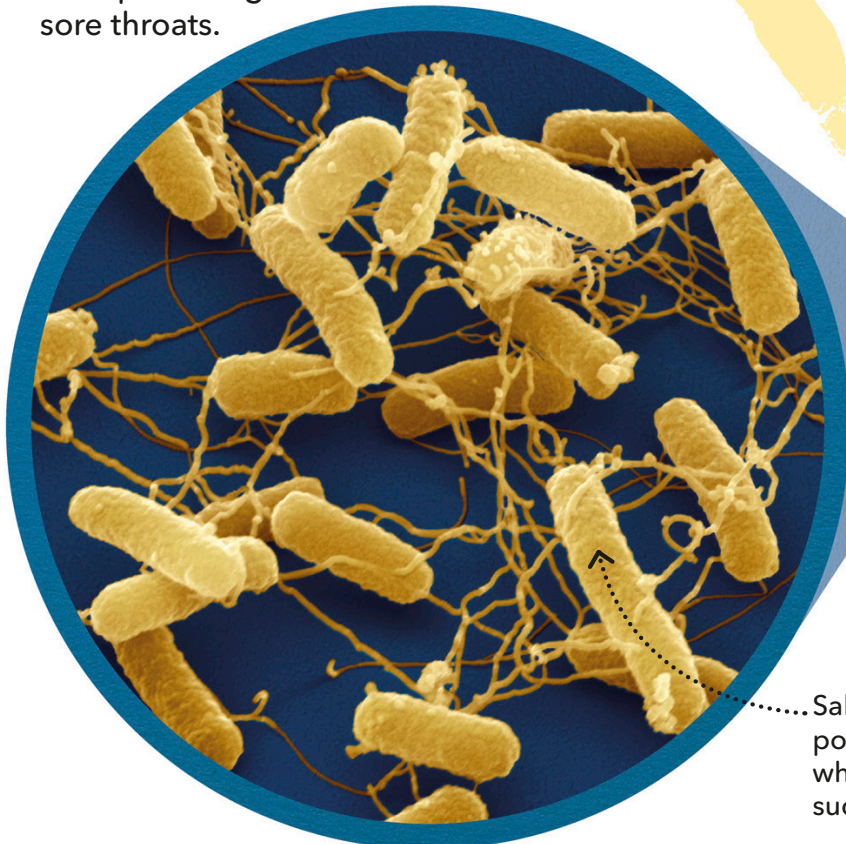
Biting bugs

Some diseases are spread by biting insects. This female mosquito is piercing a person's skin to feed on blood. Germs from her body are injected into the blood. Mosquitoes pass on several diseases including malaria, which can cause death if not treated quickly.

About **150**
different types of
bacteria **live on**
your hands.

Bad bacteria

Bacteria are bigger than viruses, but smaller than your body's cells. Many bacteria are harmless or even helpful. But if bad bacteria invade your body they release poisons called toxins. These can cause illnesses such as food poisoning or sore throats.



..... Salmonella bacteria cause food poisoning and get into the body when someone eats infected food such as infected eggs or chicken.

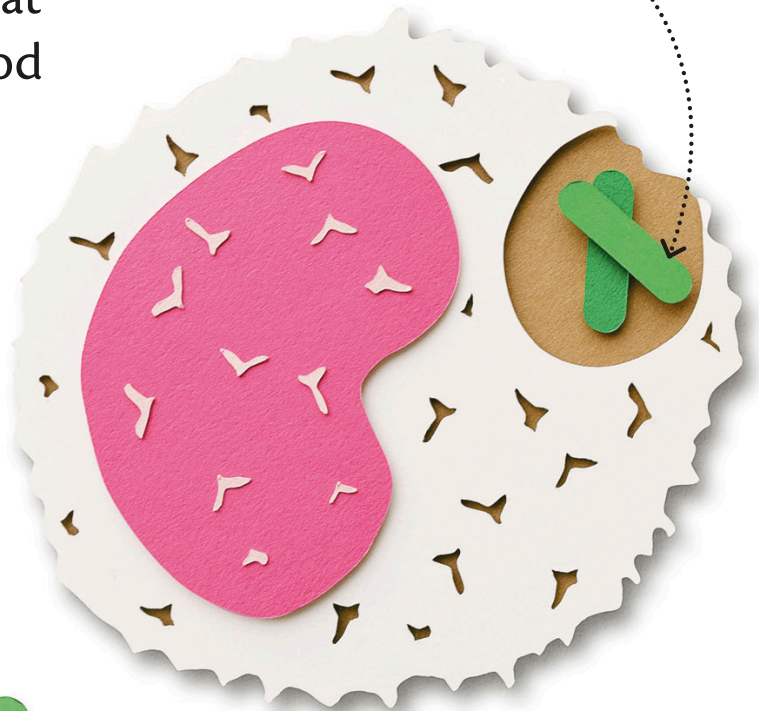
Battle plan

Your body has a secret army that works unseen to protect it from germs that cause disease. Billions of white blood cells patrol the body, ready to do battle with invading germs. Germs include tiny, one-celled creatures called bacteria.

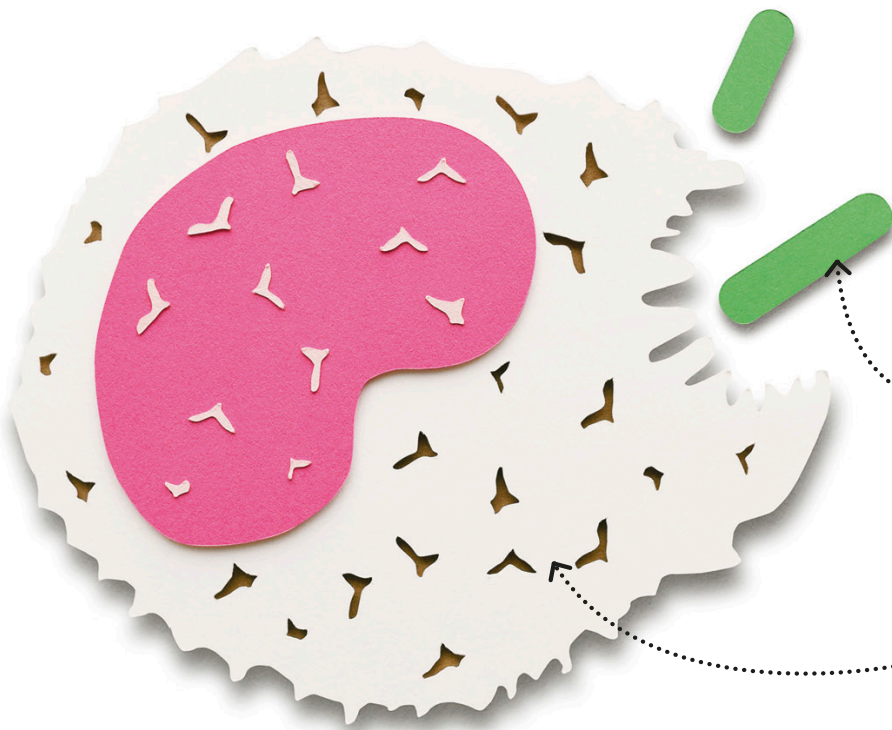
Germ eaters

Many white blood cells are germ eaters. They travel around your body following germs. Here a germ eater, called a macrophage, prepares to grab and eat two bacteria before they can split and multiply to make an invading army.

Captured bacteria are soaked in powerful chemicals that kill them.



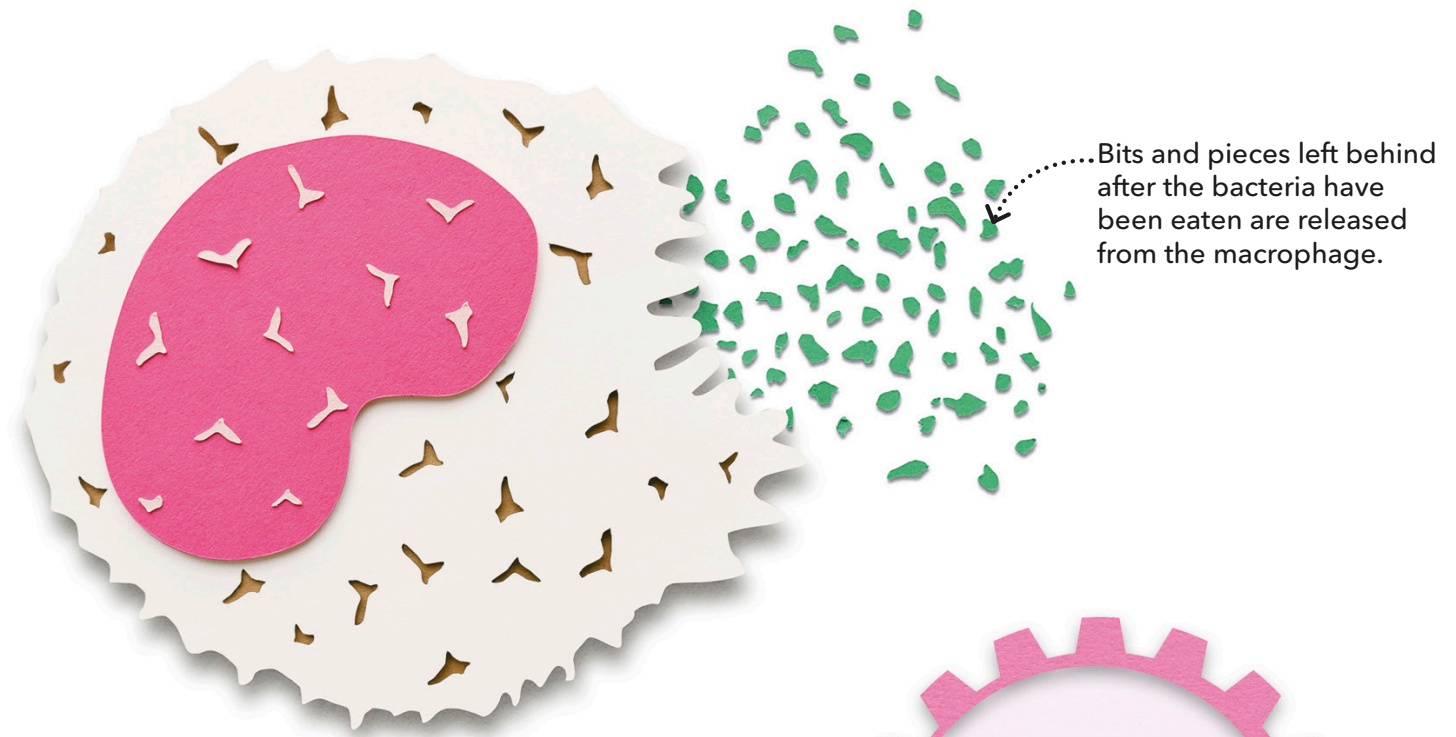
The bacteria are engulfed by the macrophage and trapped in a bag called a vesicle. They are then soaked in germ-killing liquid and destroyed.



The bacteria that cause disease are much smaller than a macrophage. They can divide very rapidly.

The macrophage checks the bacteria are "foreign" before surrounding them and pulling them inside it.

Macrophages are the largest white blood cells. Here a hungry macrophage makes contact with bacteria that have invaded the body. It changes shape so it can surround its enemies.



Bits and pieces left behind after the bacteria have been eaten are released from the macrophage.

Once the bacteria have been eaten, the macrophage throws out any unwanted waste. It then carries on searching for more germs.

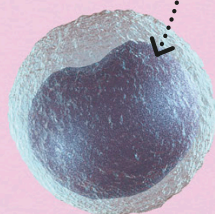


A macrophage
can eat
about 200
bacteria
before it dies.

Secret army

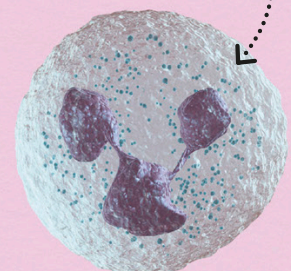
Several different types of white blood cell make up the secret army that defends your body day and night. You can see three of those types here. Both monocytes and neutrophils hunt and eat germs. Lymphocytes produce substances, which cause you to be immune to many infections.

Lymphocytes have a big nucleus.



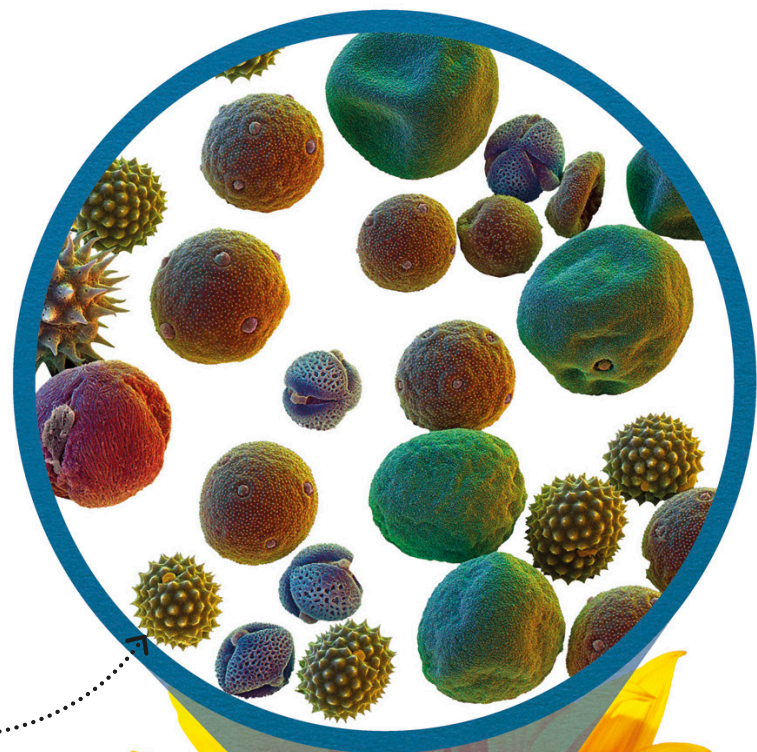
Monocytes become macrophages (germ eaters) when they leave your blood.

Neutrophils are the most common type of germ eater and help to control inflammation.



Allergies

Your immune system defends you by destroying germs and harmful substances that are “foreign” to your body. But in some people, the system can attack foreign things too vigorously. The reaction, called an allergy, can make you ill.



Each of these is a tiny pollen grain magnified many times.



Hay fever

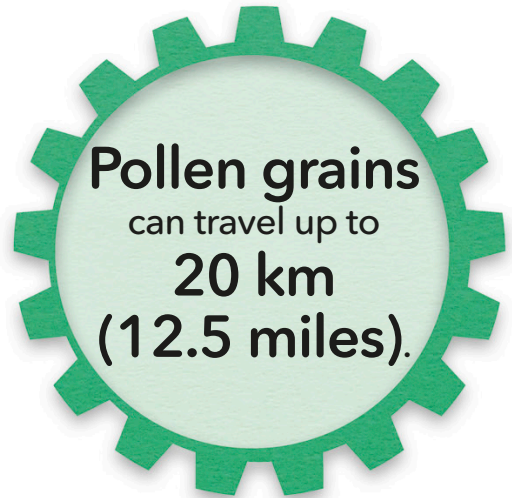
One of the most common allergies is hay fever. It is set off by breathing in tiny pollen grains from plants. If a sensitive person’s immune system attacks pollen grains, the lining of the nose and throat gets irritated. This causes sneezing, a runny nose, and itchy eyes.





Asthma

This affects the lungs and can be caused by an allergy to pollen, dust, or skin flakes. Asthma makes the airways inside the lungs narrow so that breathing becomes difficult. It can be treated using an inhaler, which helps widen the airways.



Pollen grains from the plant ragweed are a common cause of hay fever.

A boy with asthma uses an inhaler to get medicine into his lungs to help make breathing easier.



Wheat



Peanuts



Shellfish



Eggs




Milk

Food allergies

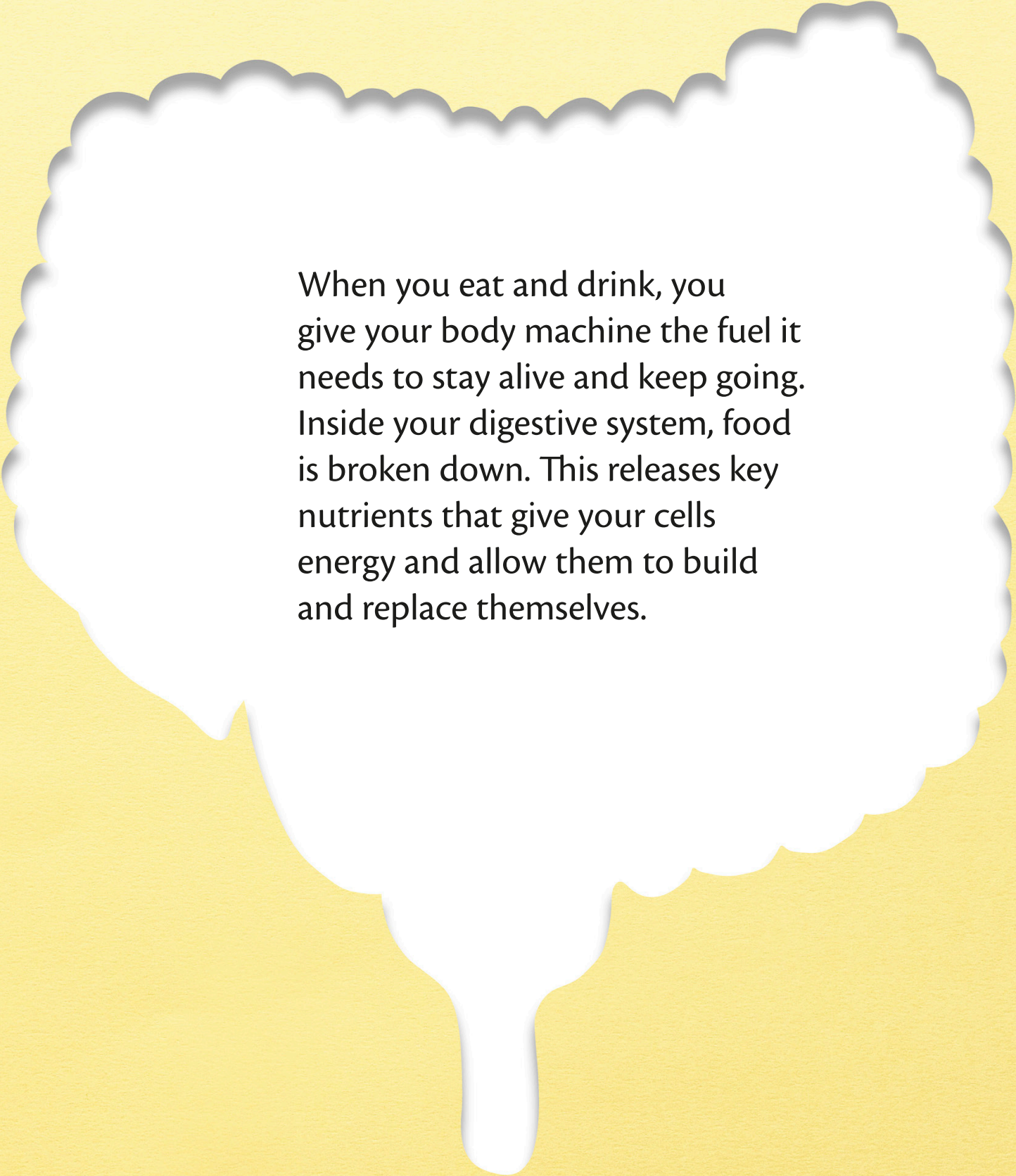
Allergies can be triggered by eating certain foods, such as the ones shown here. The effects may appear in minutes, or they might take hours. People can sometimes feel sick. More seriously, people can suffer swelling and breathing problems that may even need treatment by a doctor.



Cheese



**Fuelling
the
Machine**



When you eat and drink, you give your body machine the fuel it needs to stay alive and keep going. Inside your digestive system, food is broken down. This releases key nutrients that give your cells energy and allow them to build and replace themselves.

Filling up

Several times each day you feel hungry, so you eat some food. That food gives you energy, helps you grow, and repairs your body machine. But first the food you eat has to be broken down into tiny pieces. That is the job of your digestive system.

Digestive system

Your digestive system is a long tube that runs from your mouth, where food goes in, to the opening in your bottom (anus), where waste comes out. In between, food is broken down, or digested, by being chopped, crushed, and mixed with saliva, which contains chemicals called enzymes. Digestion releases simple substances, called nutrients, that your body can use.

As food enters your mouth, your lips close and your teeth cut and crush it into small pieces, preparing it for digestion.

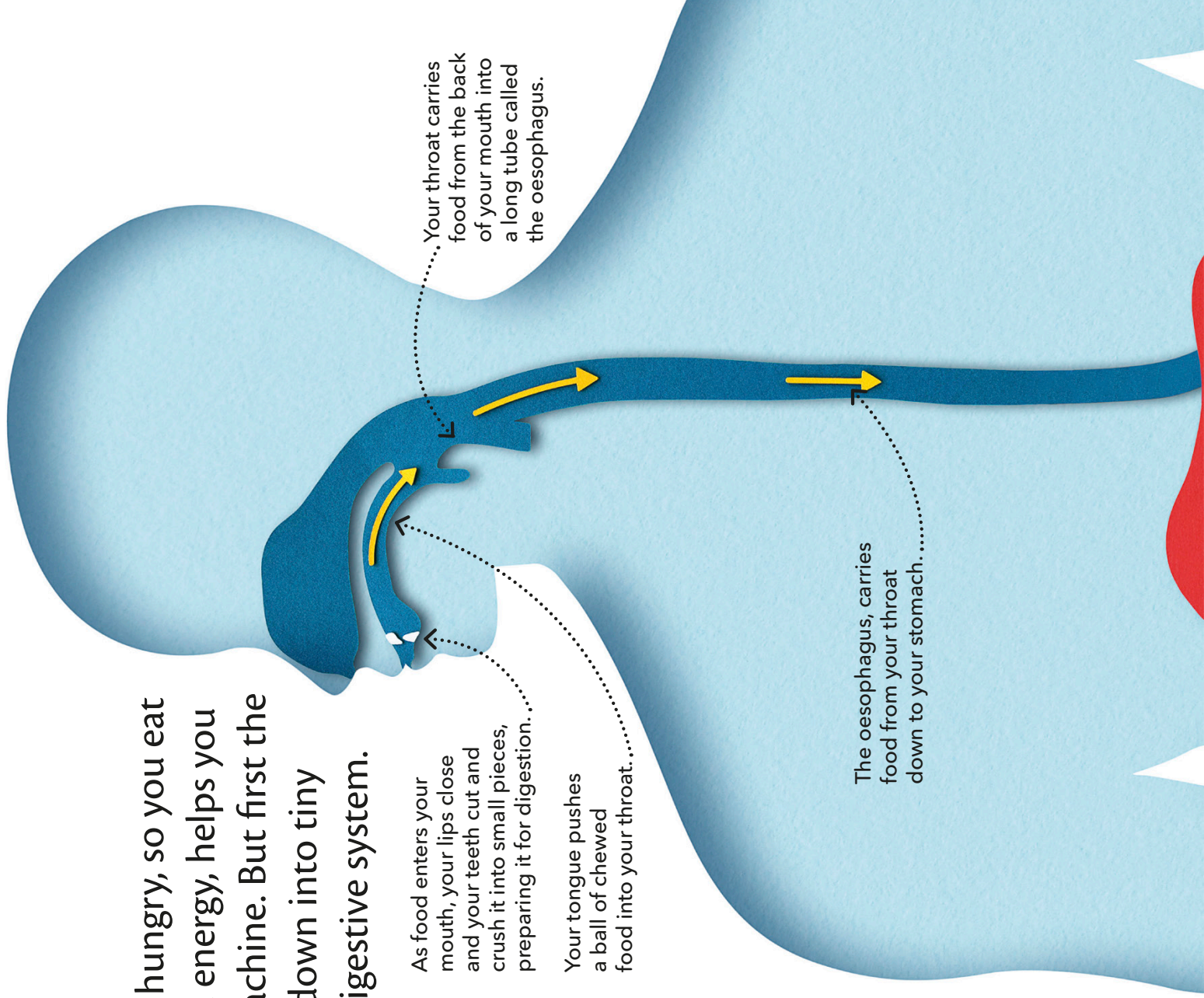
Your tongue pushes a ball of chewed food into your throat.

Your throat carries food from the back of your mouth into a long tube called the oesophagus.

The oesophagus, carries food from your throat down to your stomach.



During an average lifetime, a person eats and digests at least **20 tonnes (22 tons)** of food.



Your liver releases a liquid called bile that helps to break down the food in your small intestine.....

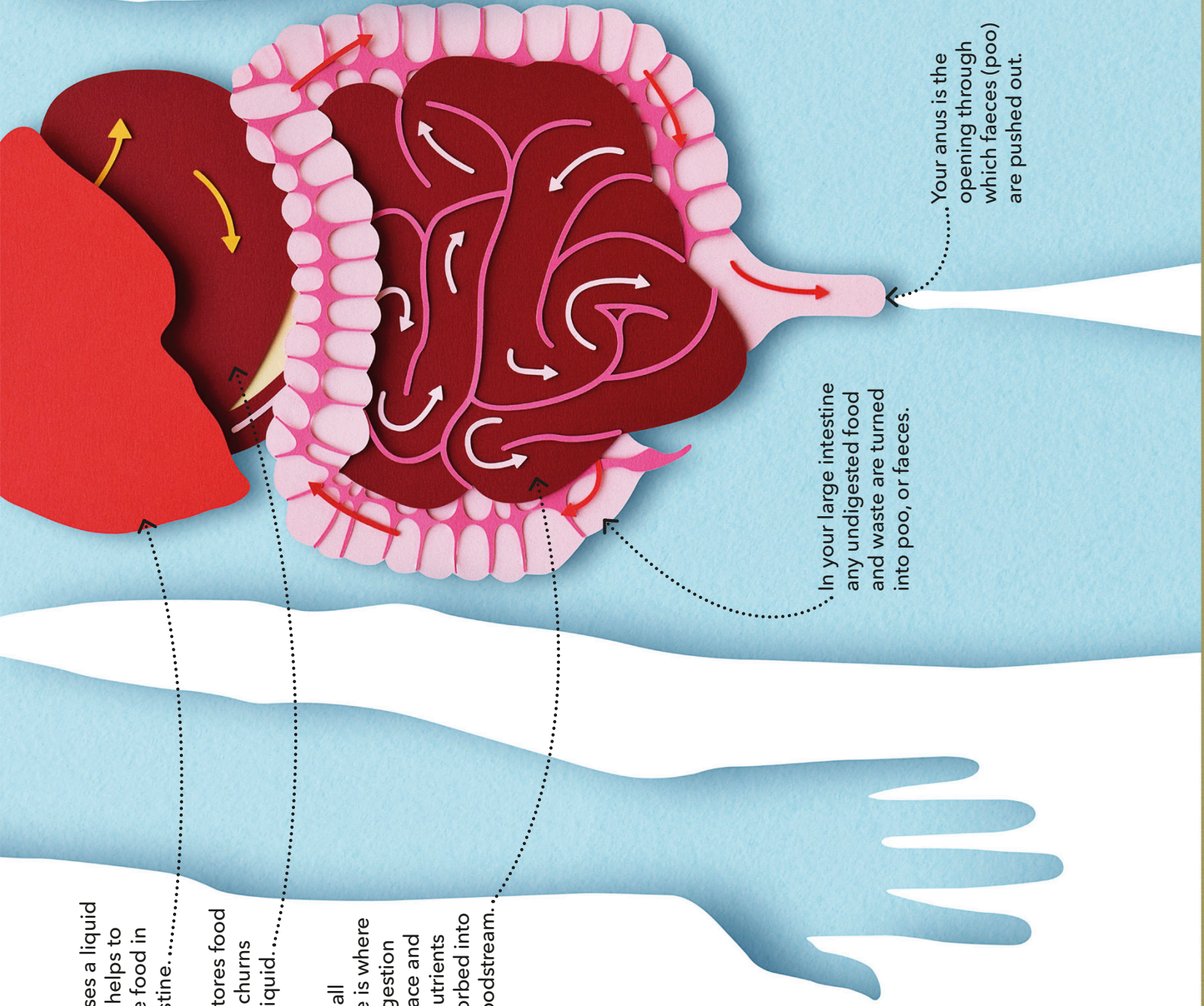
Your stomach stores food for a while and churns it into a soupy liquid.....

Your small intestine is where most digestion takes place and where nutrients are absorbed into your bloodstream.....



Food blender

A kitchen blender like this one uses sharp blades to cut food into tiny pieces and make it more liquid and mushy. Your teeth, tongue, and stomach do the same thing to food you eat, making it easier to digest.



In your large intestine any undigested food and waste are turned into poo, or faeces.

Your anus is the opening through which faeces (poo) are pushed out.

Open wide

Some animals, such as snakes, swallow their food whole. Humans cannot do that. Instead, inside your mouth, food is cut into small chunks, then ground up, mixed with saliva (spit), and swallowed.

Chew and swallow

When you eat, your teeth slice and chew food into small bits. The tongue moves food between your teeth and mixes it with slimy saliva. The ball of chewed food is pushed into your throat, swallowed, and travels to your stomach.

Your three sets of salivary glands release saliva into the mouth.

Food is squeezed down your throat into a long tube, called the oesophagus.

Your oesophagus carries food from your throat to your stomach.

Your windpipe, or trachea, carries air to your lungs.

The roof of your mouth is supported by bone.

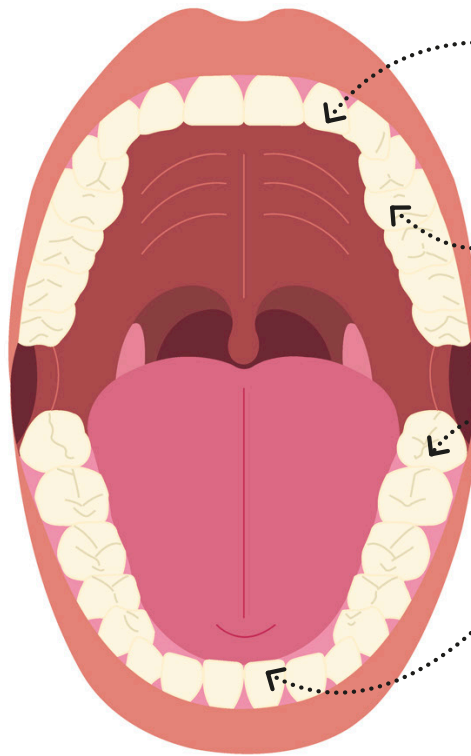
Chewed food is pushed against the roof of your mouth and into your throat.

Your muscly tongue mixes food with saliva, then pushes it into your throat.

A flap called the epiglottis shuts off your windpipe during swallowing. This stops you choking by preventing food going down the "wrong way".

Bite and crunch

This view inside a grown-up's mouth shows a full set of 32 teeth. It includes four different types of teeth, each with their own job to do. In each jaw there are four incisors, two canines, four premolars, and six molars. Younger children have 20 "baby" or "milk" teeth that are gradually replaced by adult teeth.



Canines are pointed teeth that grip and pierce food.

Premolars have two raised edges that help to crush food.

Molars are wide with a lumpy surface that grinds and crushes food.

Incisors are like knives that slice food into small chunks.



Your lips help to pull food into your mouth when you eat.

Your teeth are firmly anchored in your jawbones.



Cleaning your teeth

It is really important to brush your teeth to keep them healthy. Brushing removes old food, including sugar. If food is not removed, bacteria feed on the food that remains. Bacteria release acids that eat into the hard, white enamel covering your teeth, and cause tooth decay.

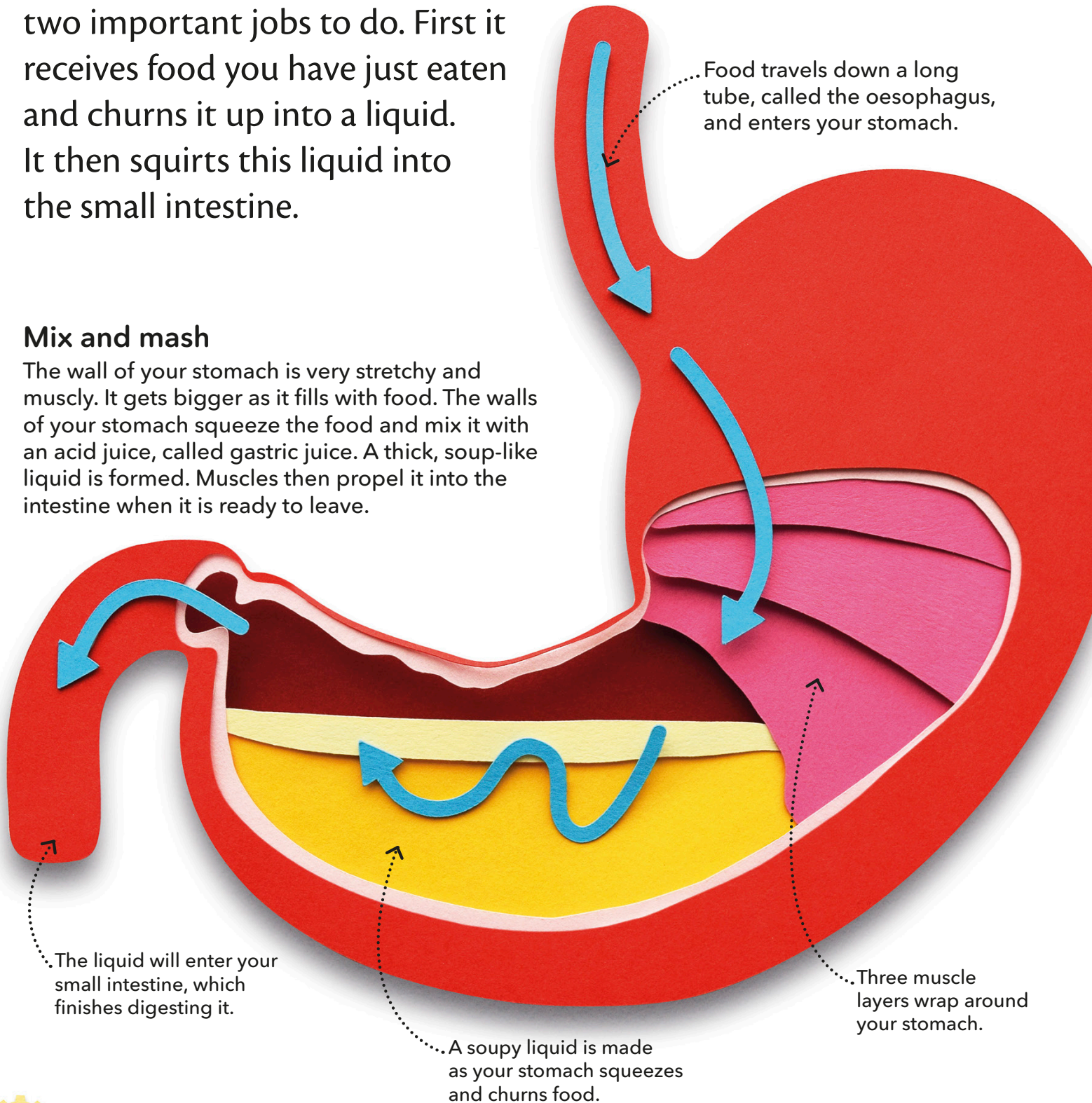
Tooth **enamel** is the **hardest** substance in your body.

In the stomach

Your stomach is a J-shaped bag that is tucked under your ribs. It has two important jobs to do. First it receives food you have just eaten and churns it up into a liquid. It then squirts this liquid into the small intestine.

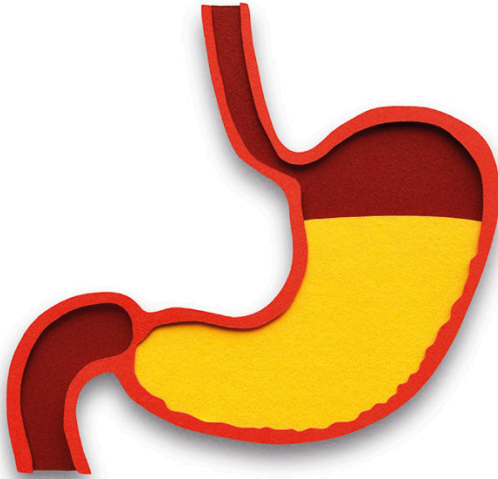
Mix and mash

The wall of your stomach is very stretchy and muscly. It gets bigger as it fills with food. The walls of your stomach squeeze the food and mix it with an acid juice, called gastric juice. A thick, soup-like liquid is formed. Muscles then propel it into the intestine when it is ready to leave.



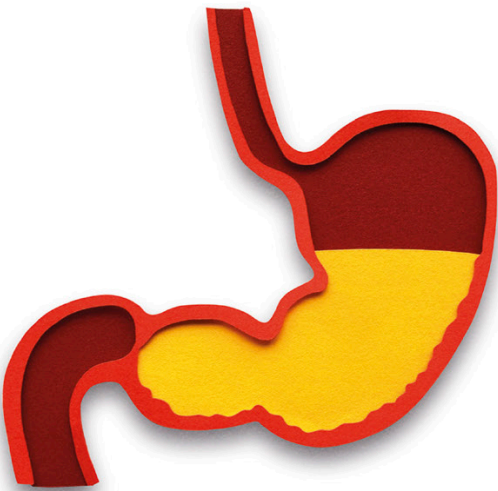
Store, churn, and release

Once you have eaten a meal, your stomach stores swallowed food for around three hours.



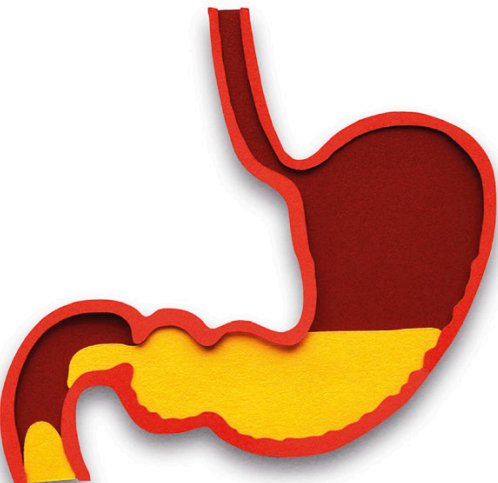
Filling

During a meal the stomach starts to fill up with chewed food and gets bigger as its wall stretches. Sometimes the gases caused by digestion go back up the oesophagus and cause you to burp or even belch.



Digestion

One to two hours after eating, food is part-digested by gastric juice and churned into creamy liquid.



Emptying

Three to four hours after eating, the end of the stomach opens and the creamy liquid enters the small intestine.

An adult's stomach can stretch to **20 times** its normal size after a meal.



Acid makers

This close-up view of the stomach's lining shows lots of holes. These are the entrances to the glands that release gastric juice into the stomach during digestion. Gastric juice contains strong acid that kills germs, and enzymes that digest proteins in food.

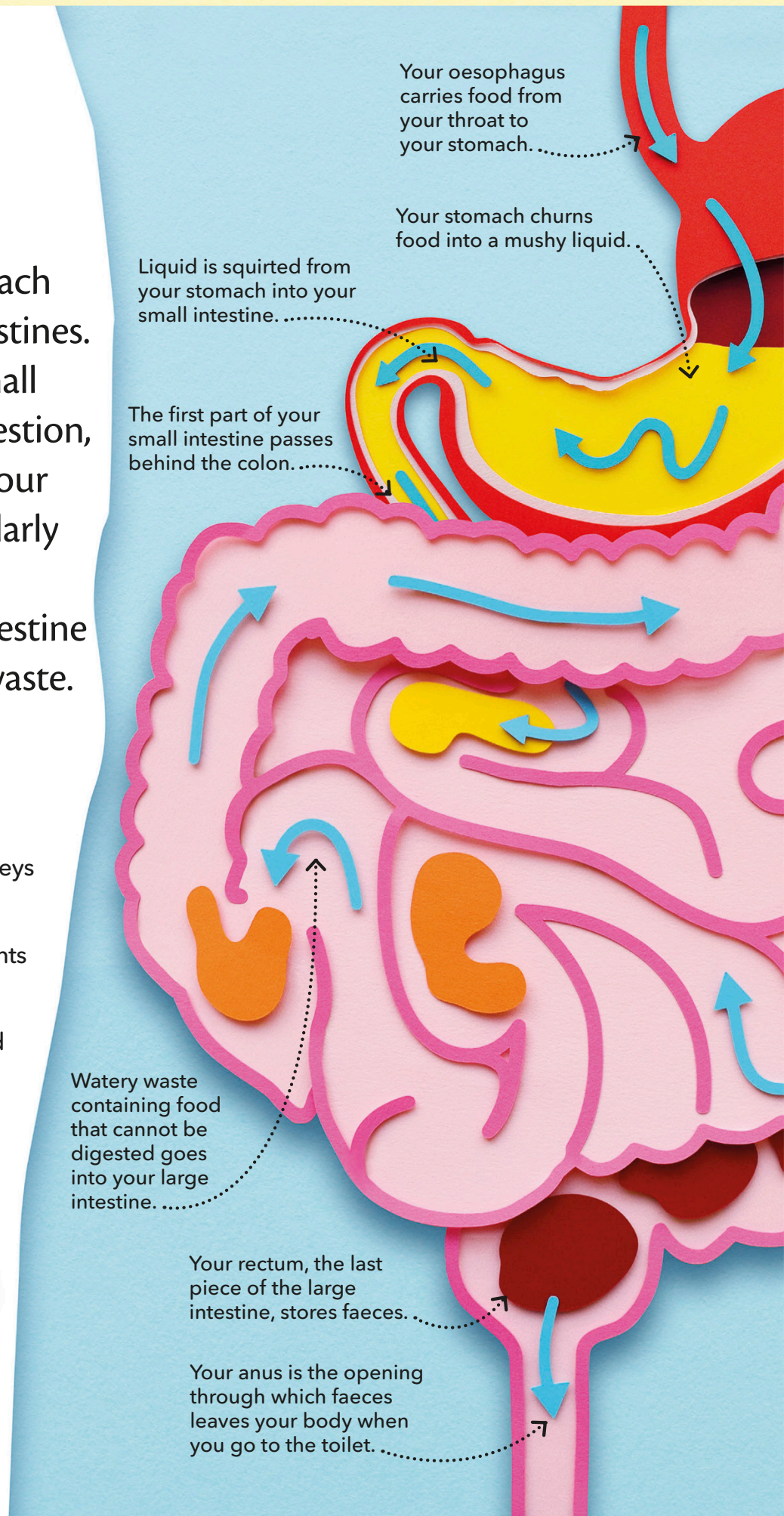
Tangled tubes

Coiled below your stomach are tubes called the intestines. The long and narrow small intestine finishes off digestion, soaking up everything your body needs. It is particularly important for digesting vegetables. The large intestine gets rid of any leftover waste.

Long journey

Food takes many hours to travel through your intestines. As it journeys through your small intestine it is broken down into simple nutrients that your body can use. The nutrients pass into your blood. Any leftover waste is turned into faeces (poo) by your large intestine and pushed out of your body.

An adult's **small intestine** is an incredible **6 m (20 ft)** long.



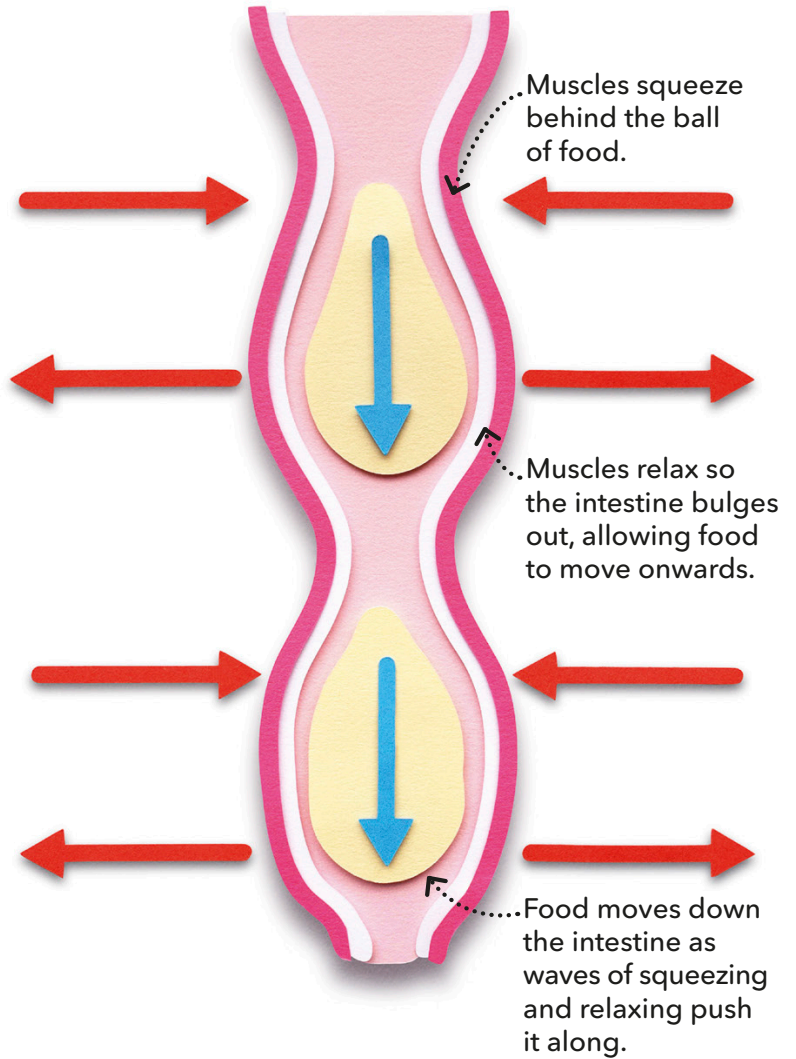
Keep squeezing

Food is squeezed along your digestive system by a process called peristalsis. Muscles tighten and relax in waves to push food through your intestines. It is a bit like using your fingers to squeeze toothpaste out of a tube.

The colon, the longest part of the large intestine, loops around the small intestine.

Water is soaked up from waste as it passes along the colon to form brown faeces.

Food is digested in your small intestine, where nutrients that your body needs enter the blood.



Villi lining

Magnified many times, these are villi, the tiny "fingers" that line your small intestine. These villi increase the surface area of the inside of your intestine, and this helps nutrients to be absorbed quickly. From here, nutrients pass into your blood and travel on to your body's cells.

Cleaning station

The liver is a very important chemical factory. Millions of cells inside this big organ keep your body machine working properly. The liver has around 500 different jobs. Amongst the most important are processing and “cleaning” the blood.

Inside your liver

This view inside your liver shows that it has two blood supplies. An artery delivers oxygen, while a vein brings in nutrients from the food you have just eaten. Your liver sorts the nutrients, storing some and sending the rest to your body's cells. It also destroys poisons and releases heat to keep you warm.

Branches of this vein carry blood rich in food to cells in your liver.

The gall bladder is a bag that stores bile, a liquid made in the liver that helps you digest fatty food.

The bile duct carries bile from your gall bladder to your small intestine.





The largest artery in the body is called the aorta. It carries blood from your heart to the rest of your body.

This vein carries "cleaned" blood out of your liver.

This artery delivers blood full of oxygen to your liver.

This vein carries blood rich in food from the digestive system to the liver.

Your liver
is the
**biggest
organ**
inside your body.



Sugar control

One of your liver's jobs is to store glucose, the sugar that gives your cells energy. If there is too little glucose in your blood, your liver releases more. If there is too much glucose, after you have a sugary drink for example, your liver stores the extra glucose.

The right fuel

To get the right fuel for your body, you should eat a sensible mix of different foods, so you stay healthy. Food supplies your body with the things it needs to give it energy, make it grow, and keep it alive.

Balanced diet

This guide shows you the general proportions of different foods that will give you a good balanced diet and keep you healthy. Water is important, too. It is found not only in drinks but also in most foods, especially fruit and vegetables.




Drinking water

Water makes up more than 50 per cent of your body, and is an essential part of your diet. Without water, your cells could not work, so your body machine would break down.


Vegetables are packed with vitamins and minerals to keep you healthy.....

Fruit contains lots of vitamins. It also provides sugars for energy, and fibre for a healthy digestive system.....






Bread, pasta, and rice contain carbohydrates, which give you energy.




Olives are the source of olive oil that, like other healthy oils and fats, helps to build cells.

Healthy oils


Eating small amounts of oils found in plants, such as olives, and oily fish, such as salmon, is really important for good health. These oils contain fatty acids, which help keep the brain and other organs working properly.



Fish, chicken, beans, lentils, nuts, and meat contain protein that is needed for growth and repair.



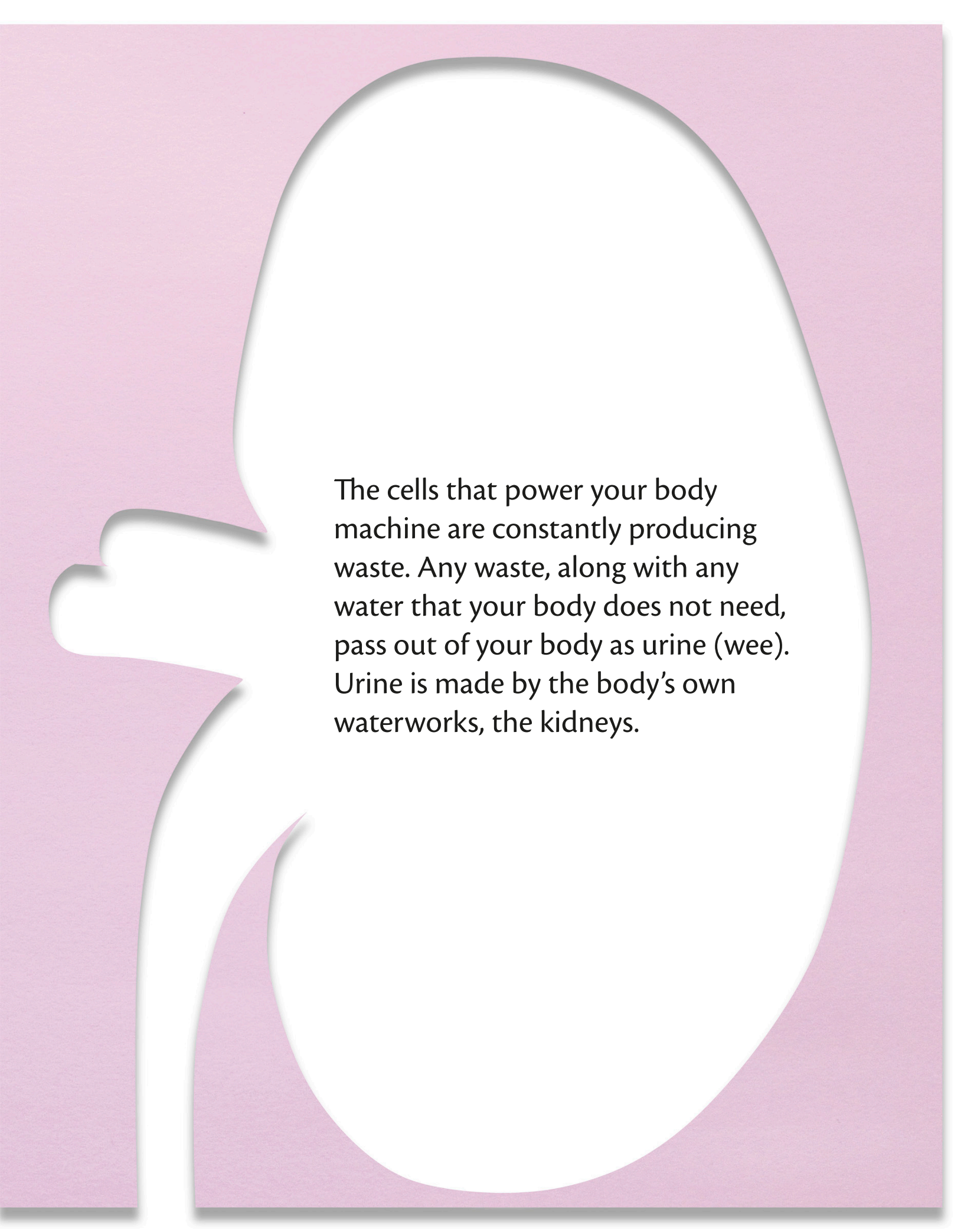
Milk and other dairy foods provide calcium, needed for healthy bones and teeth.



Dried **locusts** and some other **insects** contain lots of **protein**.



Waterworks



The cells that power your body machine are constantly producing waste. Any waste, along with any water that your body does not need, pass out of your body as urine (wee). Urine is made by the body's own waterworks, the kidneys.

Waste disposal

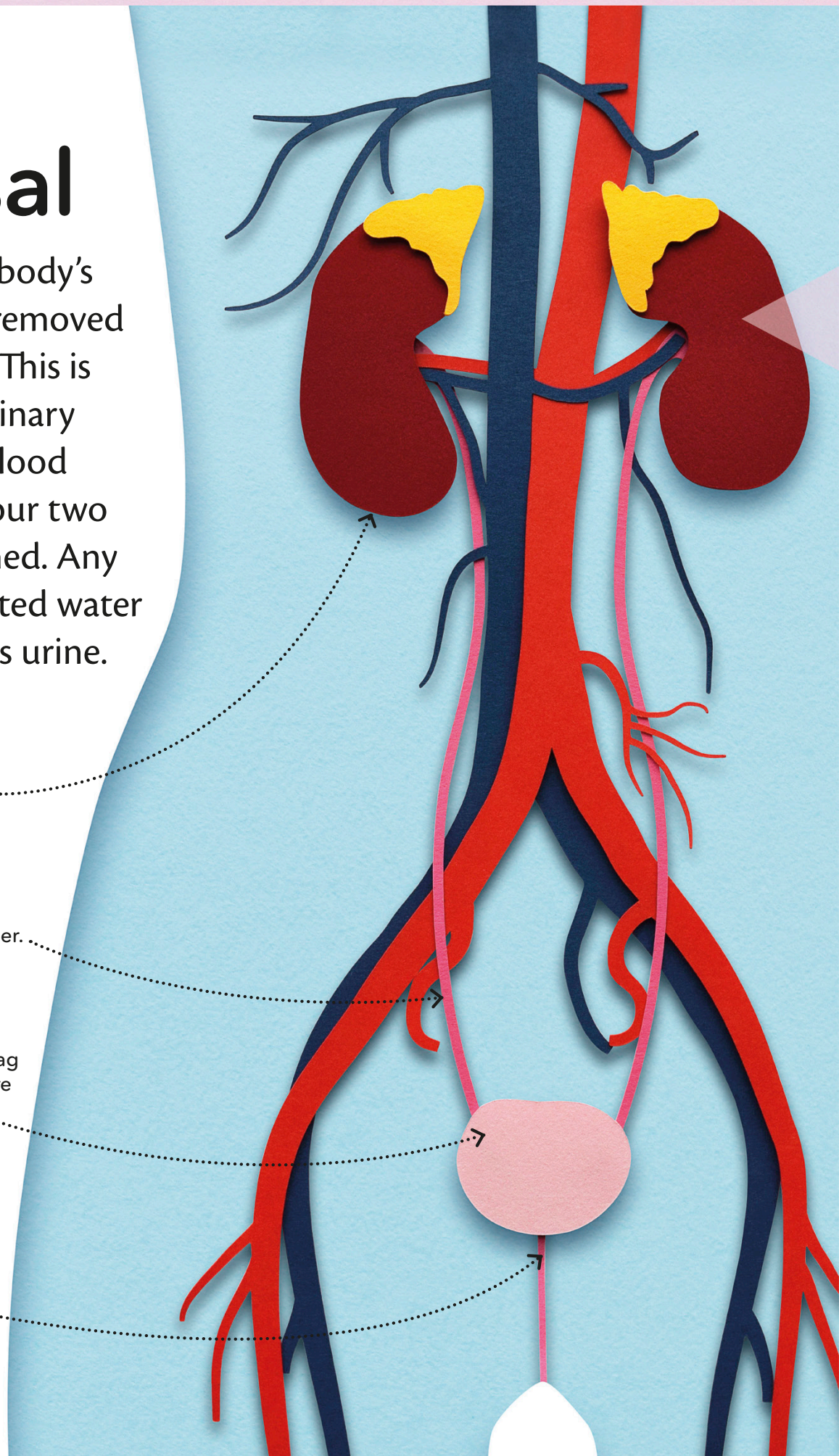
Waste from your body's cells needs to be removed from your blood. This is the job of your urinary system. As your blood passes through your two kidneys, it is cleaned. Any waste and unwanted water leave your body as urine.

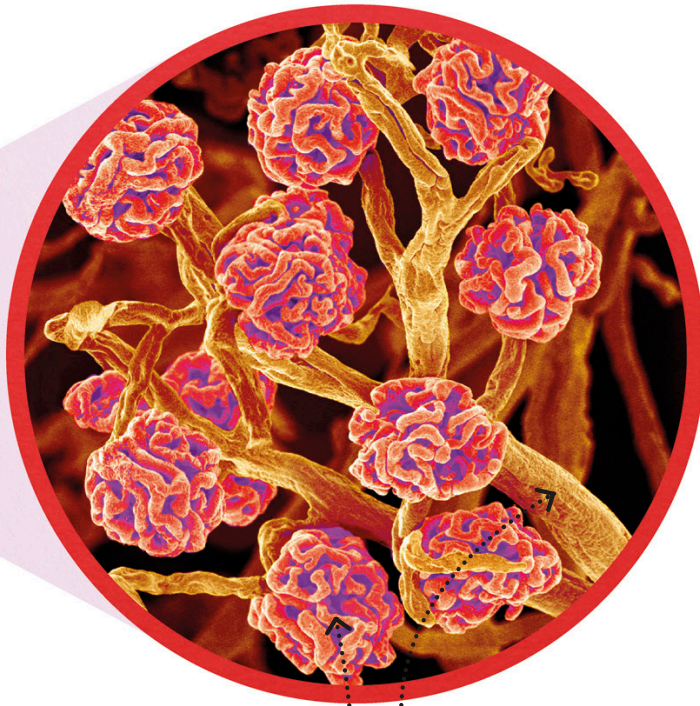
Your right kidney, and the left kidney opposite it, filter blood to make urine (wee).

A tube called the ureter carries freshly made urine from a kidney to your bladder.

Your bladder is a stretchy bag that stores urine until you are ready to go to the toilet.

Another tube, called the urethra, carries urine out of your body when you have a wee.



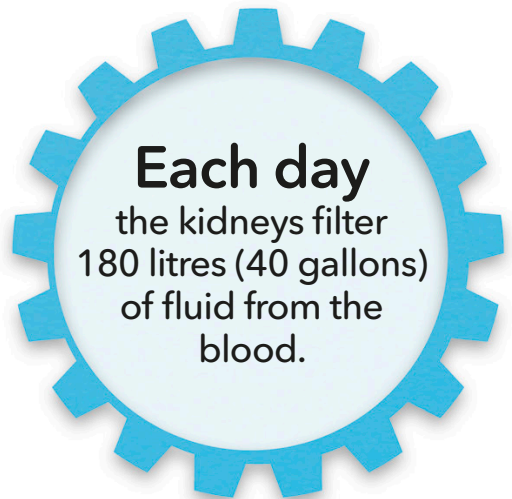


Fluid leaves the blood as it passes through these bundles of capillaries.

This is one of the branches of the artery that carries blood to be cleaned into the kidney.

Urinary system

Your urinary system is made up of two kidneys, two ureters, the bladder, and the urethra. While blood flows through the kidneys, fluid passes out of it. As that fluid flows through millions of special filters, substances that the body needs, such as sugars, return to the blood. Any remaining water and waste leave the kidney as urine.



Each day
the kidneys filter
180 litres (40 gallons)
of fluid from the
blood.

Dialysis machine

Sometimes a person's kidneys stop working properly. If this happens, they can be connected to a machine that cleans their blood for them. This is called a dialysis machine. As blood flows from the person, through the machine and back again, it is filtered and cleaned. Without dialysis that person would become very ill.

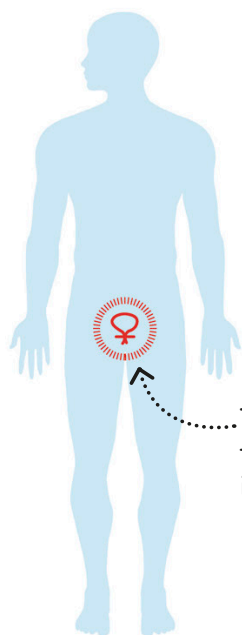


Full and empty

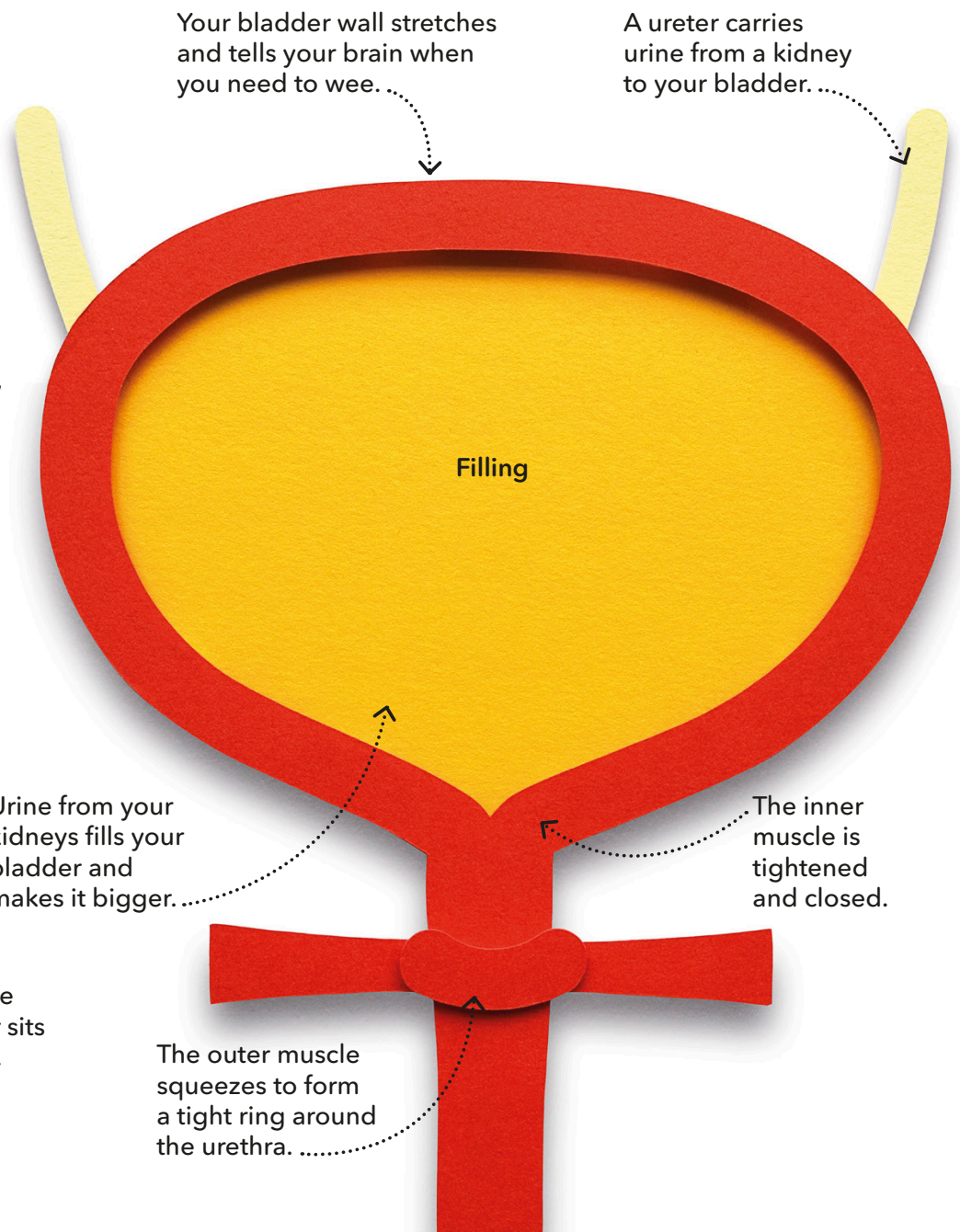
Your two kidneys produce a steady trickle of urine (wee) throughout the day. Without your bladder, urine would dribble out of the body, making life very uncomfortable. Your bladder stores urine, then releases it every few hours when you go to the toilet.

Store and release

Your bladder stretches as it fills up with urine. A tube at the bottom of the bladder, called the urethra, carries urine out of the body. Normally the urethra is closed by muscles, but when the bladder is full, those muscles relax and urine flows out.



.....This is where the bladder sits in the body.

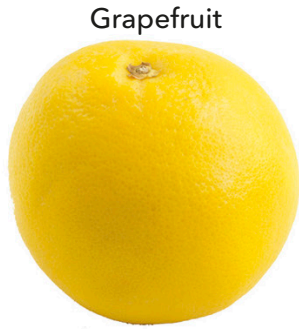




Plum



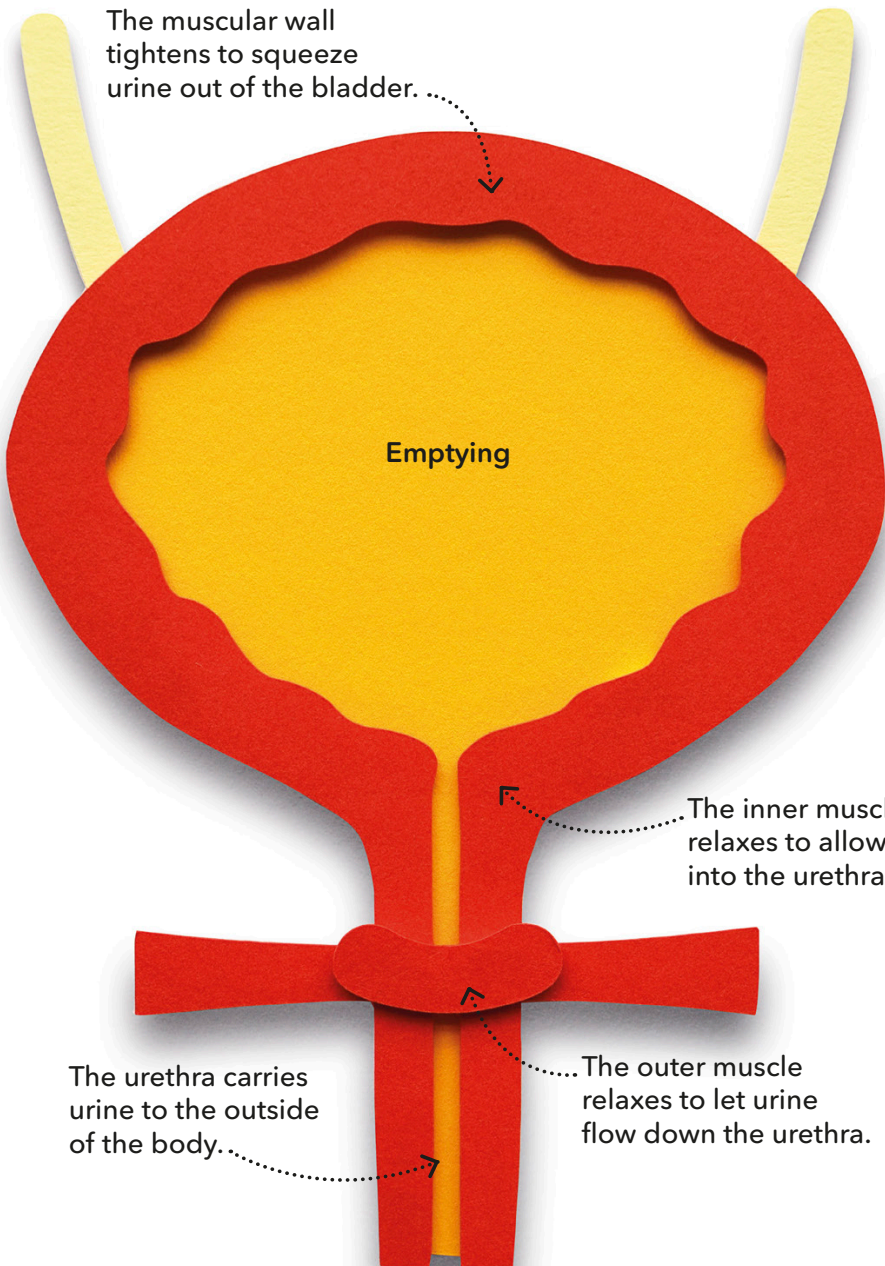
Orange



Grapefruit

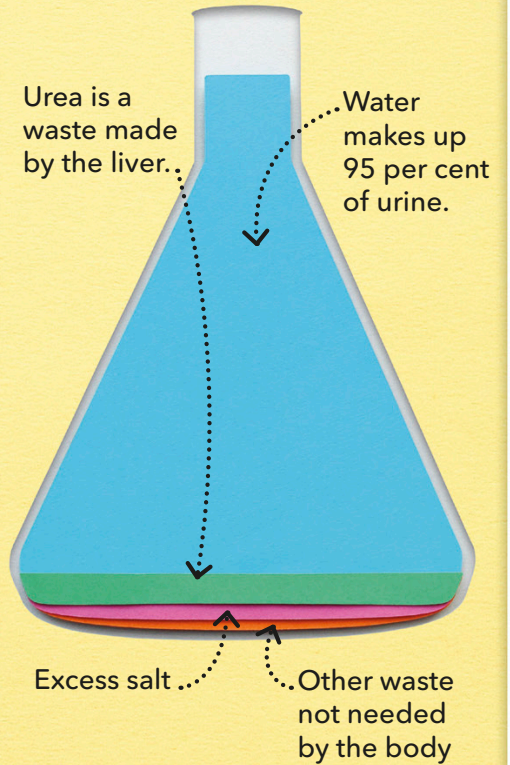
Super stretchy!

Your bladder can get bigger as it fills because its wall stretches. When empty, it is about the size of a plum. But as the bladder expands it can reach the size of an orange or even a grapefruit. By this time you would really feel the need to have a wee (urinate).



What is urine?

Urine is mostly water. Waste, such as urea and other substances that the body wants to get rid of, are dissolved in that water.



Each year,
a person
 releases enough
urine
 to fill two
bathtubs.

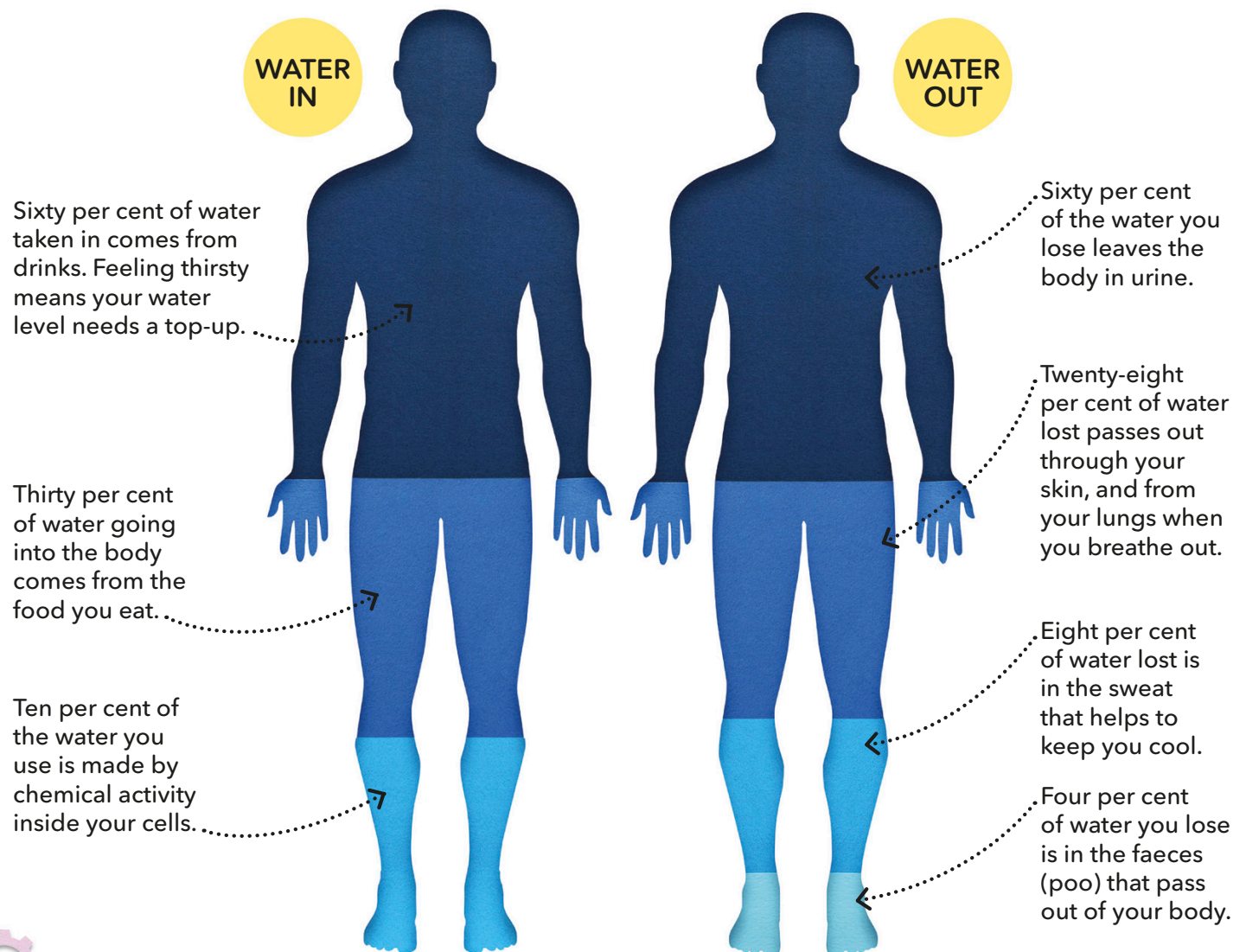
Water of life

You cannot live without water. It forms an essential part of your cells, tissues, and organs. Without water, they just would not work. Your brain controls the amount of water inside your body, so that it always stays the same.



Water balance

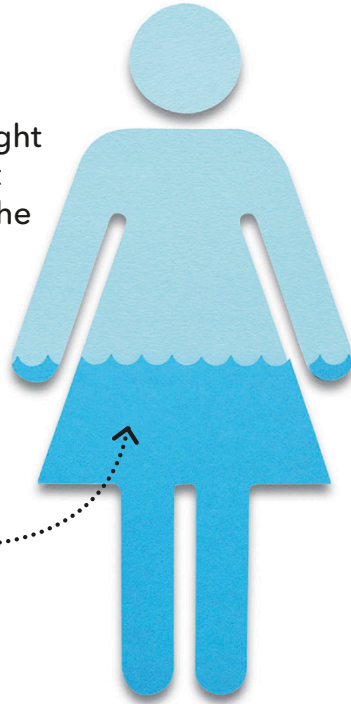
Every day your body loses water. You replace that lost water every time you drink or eat. The amount of water you take in and the amount you lose is carefully balanced. While amounts vary depending on exercise and other factors, this diagram gives an idea of how water balance works.



How watery are you?

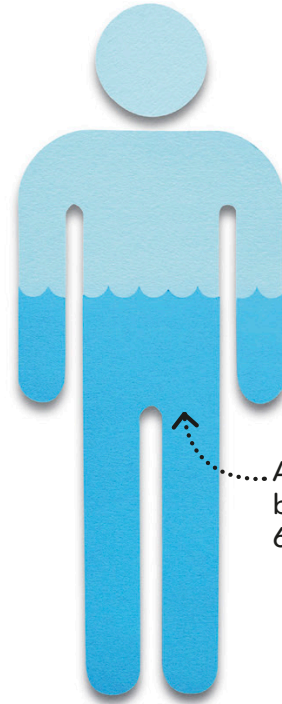
Up to 74 per cent, or three-quarters, of a baby's body weight is made up of water. As we get older, the amount of water in the body gets less. However, it still makes up half or more of a young adult's body weight.

A young woman's body is about 50 per cent water.



Female

A young man's body is about 60 per cent water.



Male



Work up a sweat!

When you run fast your muscles work really hard. The extra heat they release makes you hot and sweaty. As watery sweat is lost from your skin, it cools you down and keeps your body machine at just the right temperature. But the water you lose as sweat has to be replaced.

Fluid food

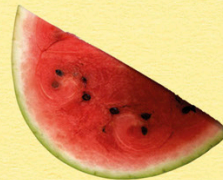
You get the water your body needs from food as well as from drinks. Even the driest crackers contain some water. Fruits and vegetables are especially rich in water. Here are some of the winners in the water league. Cucumber and watermelon are nearly all water!



Cucumber
96% water



Potato
79% water




Watermelon
96% water



Strawberry
92% water



**Life
Cycle**

A white silhouette of a baby in a fetal position, curled up with its head tucked back and arms tucked in. The silhouette is set against a solid blue background. The baby's head is at the top right, and its feet are at the bottom left. The overall shape is roughly oval, with the baby's body filling most of the space.

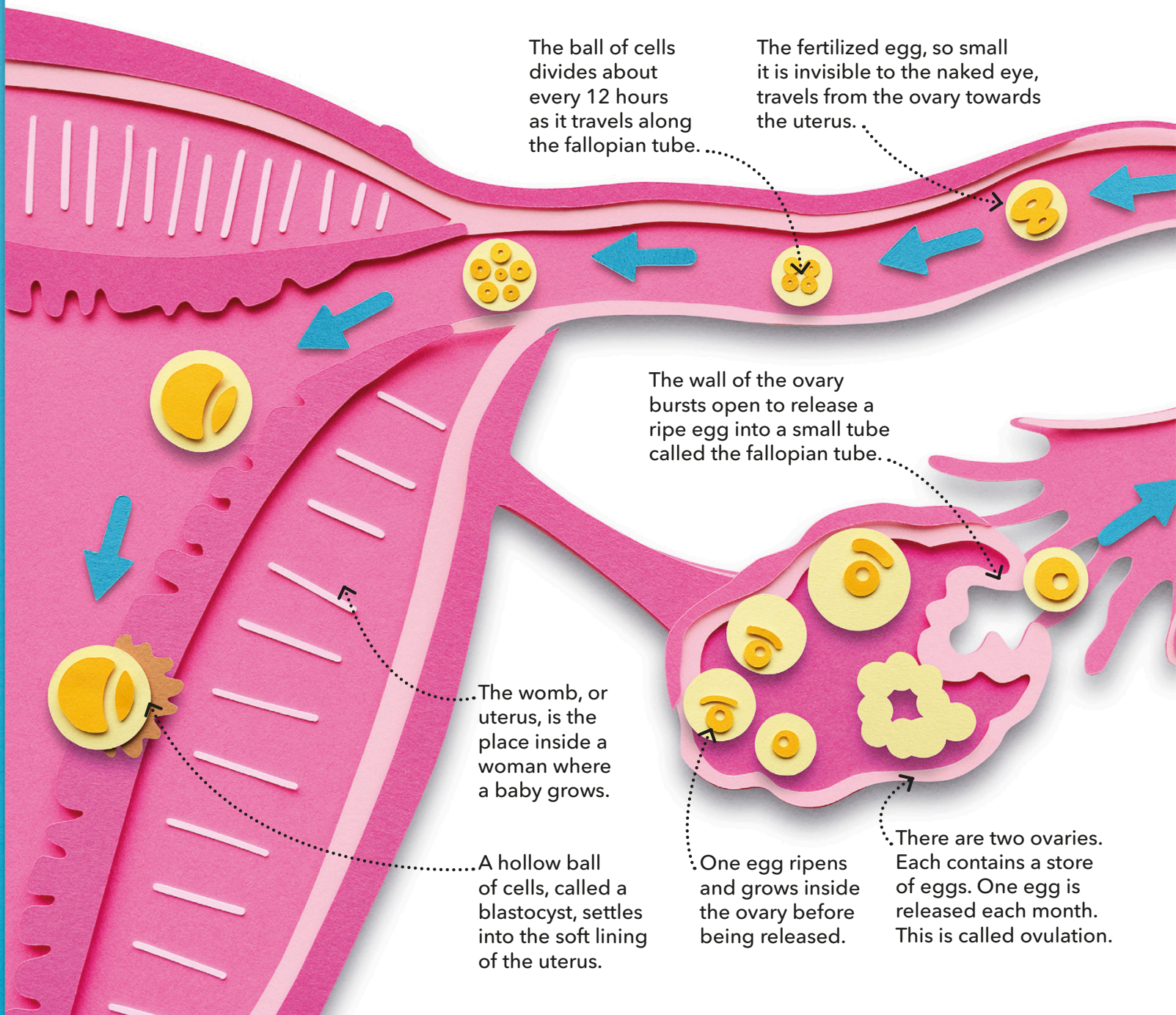
Each of us starts life as a single cell. Within months, that tiny speck has become a baby. Over the years, the baby grows and eventually becomes an adult. Adults may have their own babies, and so complete the life cycle.

Starting out

To make a baby, both a woman and a man are needed. The woman provides an egg cell, which joins up with a sperm cell made by the man. This is the start of the process that made you and all other humans.

An egg's journey

Each month, part of a woman's reproductive system, called the ovary, releases an egg that travels to her womb (uterus). If that egg meets a man's sperm on the way, the two join together, in a process called fertilization. The fertilized egg contains all the instructions needed to make a baby.



The ball of cells divides about every 12 hours as it travels along the fallopian tube.

The fertilized egg, so small it is invisible to the naked eye, travels from the ovary towards the uterus.

The wall of the ovary bursts open to release a ripe egg into a small tube called the fallopian tube.

The womb, or uterus, is the place inside a woman where a baby grows.

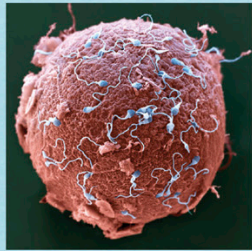
A hollow ball of cells, called a blastocyst, settles into the soft lining of the uterus.

One egg ripens and grows inside the ovary before being released.

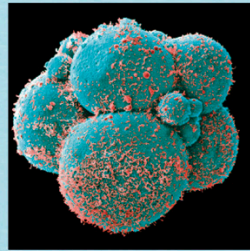
There are two ovaries. Each contains a store of eggs. One egg is released each month. This is called ovulation.

Divide and grow

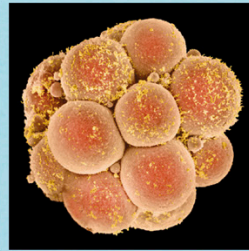
In the days after fertilization, the egg divides again and again. After a week, a hollow ball of cells has formed. Its inner part will develop into the embryo that eventually grows into a baby.



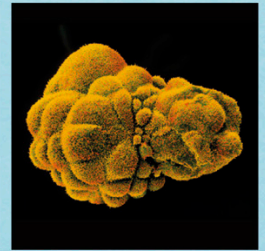
Sperm (blue) surround an egg. Just one sperm enters the egg to fertilize it.



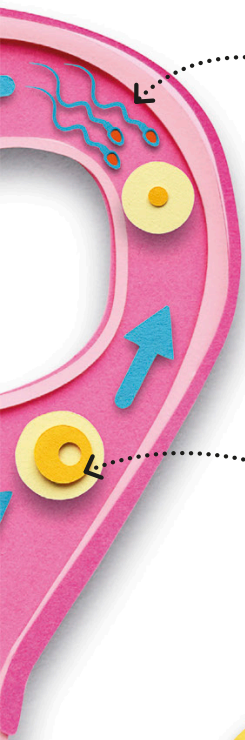
Three days after fertilization, the fertilized egg has divided three times to produce eight cells.



One day later, the cells have divided once more to form a ball of 16 cells.



Six days after fertilization, a ball of cells has formed. It settles in the uterus.



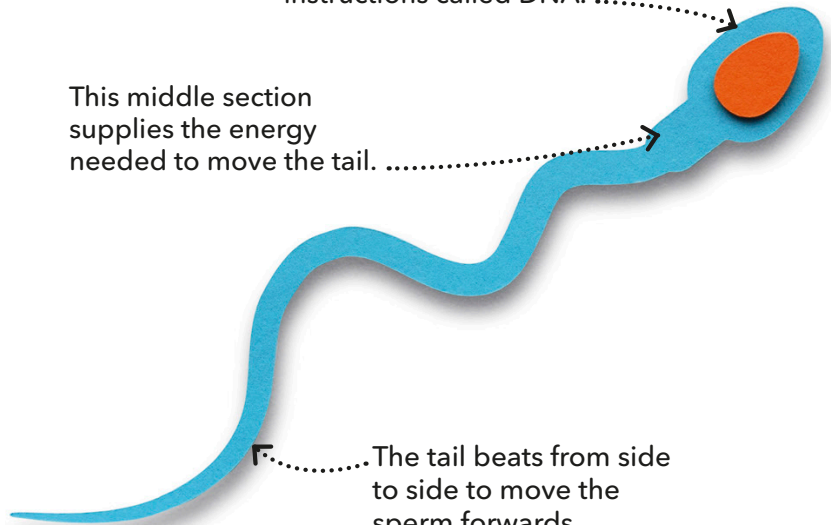
Sperm swim towards the egg and one sperm fertilizes it. This fertilized cell soon divides into two cells.

The released egg contains half the instructions needed to make a person.

The head contains the package of genetic instructions called DNA.

This middle section supplies the energy needed to move the tail.

The tail beats from side to side to move the sperm forwards.



You and everyone else started life as a single cell.

Super swimmers

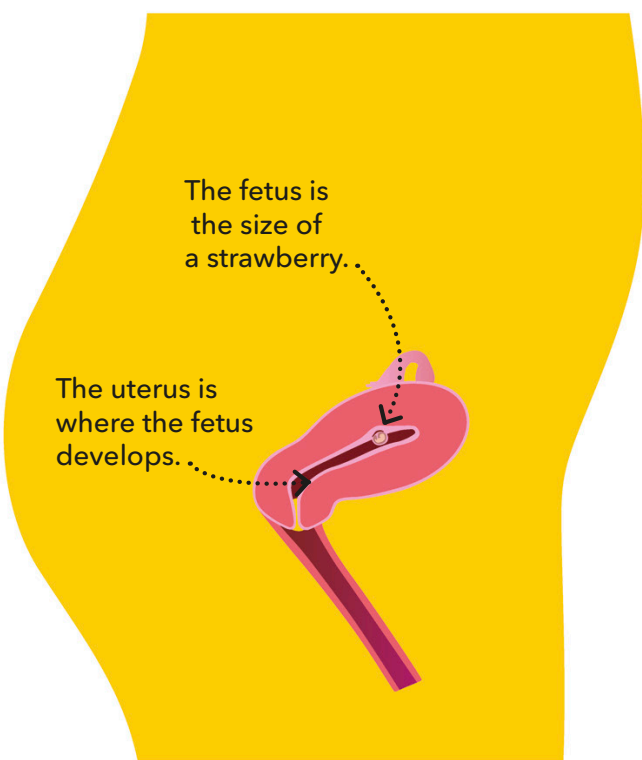
Sperm are unlike any other body cells. They look a bit like skinny tadpoles, and millions of them are made every day. They move by beating their tails. Sperm swim towards an egg, carrying half of the instructions needed to make a baby.

Growing a human

A few days after fertilization happens, a tiny ball of cells settles inside the womb (uterus). Over the next nine months, this ball of cells grows and develops into a new human being. This period of time is called pregnancy. During this time, the growing baby is protected and kept warm within a fluid-filled bag.

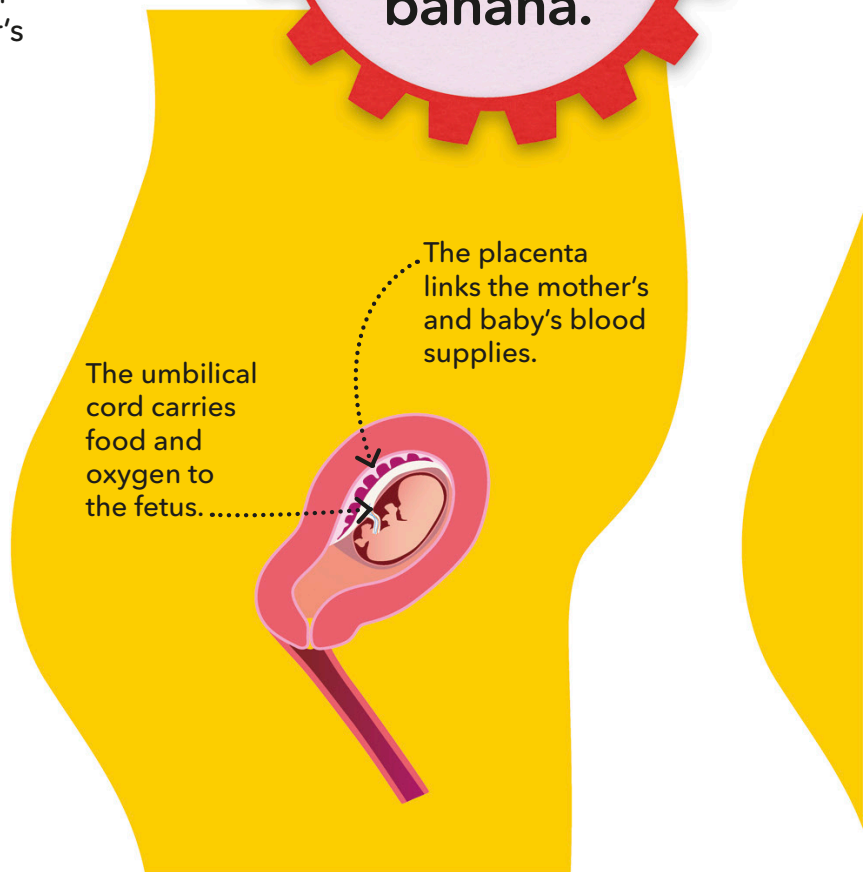
The developing fetus

Before he or she is born, the baby is called an embryo and then a fetus. As the weeks progress, the developing fetus looks increasingly human. A lifeline called the umbilical cord carries vital supplies of food and oxygen from the mother's blood to the fetus.



8 weeks

Eight weeks after fertilization the fetus' main organs are formed. The heart pumps blood, the bones have started to harden, and the arms and legs have grown.



12 weeks

Now the size of a lemon, the fetus looks more human, with the eyes closer together. The fetus can make simple arm and hand movements. The kidneys make urine.



Ultrasound

Doctors can check if a fetus is developing normally with an ultrasound scan. This uses very high-pitched sounds that we cannot hear and which are harmless. Sound waves beamed into a pregnant woman's uterus bounce back as "echoes". These are turned into moving images shown on a screen. The first organ we can generally see in a developing fetus is the beating heart at around 6-8 weeks.

As a probe sends sound waves into a woman's uterus, echoes from her fetus can be seen on the screen.

The uterus expands as the fetus grows.

The fetus floats in fluid that cushions it from bumps.

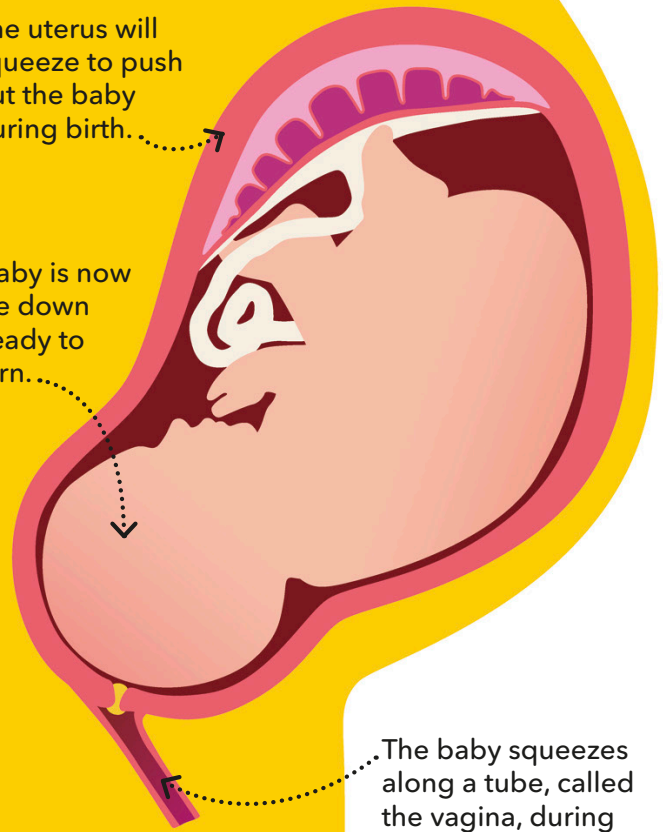


24 weeks

Over half way through pregnancy, the fetus can yawn and make faces. The fetus responds to sounds and the mother can feel him or her kicking.

The uterus will squeeze to push out the baby during birth.

The baby is now upside down and ready to be born.



The baby squeezes along a tube, called the vagina, during birth.

40 weeks

The fetus is now a fully grown baby. The lungs are well-developed and ready for the baby to take a first breath when he or she emerges into the world.

Bigger and stronger

After a baby is born, rapid growth takes place and continues for the first two years. Gradually, children become more skilled at moving and thinking. They learn to understand themselves and they make friends. From around 11 onwards, a child starts adolescence. A key part of this is puberty, when she or he grows rapidly and her or his body changes shape.

Child development

Children grow and develop at different rates, but here are some of the important stages from childhood to adolescence.



This girl is very active and playful.

5 years old

This child is over half her adult height. She can have a conversation, and is starting to read and write. She can run, jump, and kick a ball.



This boy has the skills to learn a musical instrument.

6 years old

This boy can sing, tell stories, ride a bike, read simple books, and write his own name. He enjoys playing with his friends.



This girl can balance on one leg.

9 years old

This child can hold her balance. She can play sport and dance. She thinks carefully about things. She makes firm friendships.

A two year-old
picks up
**10 or more
new words**
each day.



← This boy is strong, more self-aware, and independent.

↗ Muscles develop further.

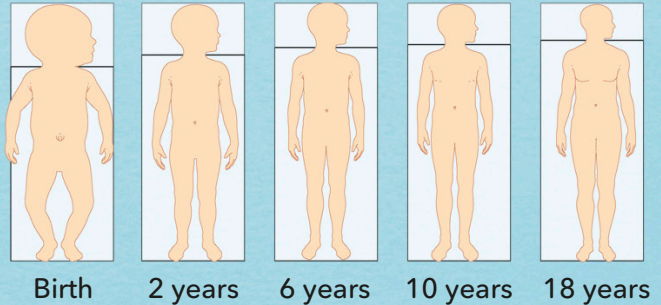
11 years upwards

This boy is now approaching adolescence and about to become an adult. He can speak and write well, and has a good memory. He enjoys team sports.

Changing shape

When you were a baby, your head was large in proportion to the rest of your body. That is because at first, the brain grows and develops very quickly. During childhood, the rest of your body gradually catches up, so that by the time you are a teenager your body proportions look much more like an adult's.

Head-body proportions



Puberty

Around the ages of 10-12 in girls and 12-14 in boys, the body grows and develops rapidly. The reproductive system also starts working. This stage is called puberty. One sign of puberty in a boy is growing facial hair, so he needs to start shaving.

Growing older

People change as they grow. Children develop and become teenagers. They then turn into young adults. Over time, people grow older. The body gradually slows down as it starts to wear out. The cells in the body do not divide so well, and other cells tend to die, making us a bit wrinkled and old looking.

Four women

Here are four women from different generations of the same family: a daughter, mother, grandmother, and great-grandmother. They show the changes that happen to the body as people get older.



Teenager

This girl is nearly fully grown. The period of change and development from childhood to adulthood is called adolescence.

Thirties

This woman's body has stopped growing. She has had a child. The woman is strong, healthy, and active.

Fifties

This woman shows signs of ageing, with stiffer joints and weaker muscles. Diet and exercise help her stay healthy.

With ageing, hair turns grey or white. This is because it loses a substance called melanin, which gives hair its colour.



Seventies

This woman's muscles and bones are weaker. But she does gentle exercise to keep healthy and enjoy life.



Wrinkles

People's skin naturally becomes wrinklier as they get older. The skin is thinner and drier than in younger people. There are also fewer of the tiny fibres in skin that give it both firmness and springiness. All these things combine to make wrinkles happen.

This X-ray of the hand of an older person with arthritis shows the finger bones bent to one side.



Jeanne Calment from France lived until she was 122, and is the oldest known human.

Stiff joints

People can become stiffer as they get older. Some people suffer from arthritis. This is a disease that affects the joints between bones, often in the hands, hips, and knees. Joints swell and become painful, making movement difficult. As this X-ray shows, arthritis can also push bones out of position.

Glossary



artery

Tube carrying blood rich in oxygen from the heart to the tissues

atrium

One of two chambers of the heart receiving blood from the lungs or elsewhere in the body

bacteria

Tiny living things, mostly helpful for health. Some cause disease, such as food poisoning or a sore throat

base

One of four key parts of DNA. Like letters in words, they can be put together to spell out instructions that control cells

bile

Fluid made in the liver and stored in the gall bladder, containing enzymes important for digestion

calcium

Mineral element found in many foods, including milk and vegetables. Calcium helps build bones, nails, and teeth

capillary

Tiny blood vessel carrying blood through the tissues from arteries to veins

carbohydrate

Substance, such as sugar or starch, that supplies energy

carbon dioxide

Gas given off by the body's cells as they consume energy. It is breathed out from the lungs

cartilage

Tough, flexible tissue in the nose, ears, ends of bones, and ribs. It helps the smooth, frictionless movement of joints

cell

One of the trillions of microscopic, living units that are the building blocks of the human body. Together, they form tissues

cerebrum

Part of the brain involved in activities such as thinking, memory, movement, and sensation

cochlea

Tubular structure deep in the ear that detects vibrations made from sound waves, converting them into electrical signals for the brain

chromosomes

One of 23 strands of DNA in a cell's nucleus, with most of the instructions needed to run the cell

dermis

Thick underlayer in the skin, containing blood vessels, sweat glands, and nerve endings

diaphragm

Big muscle separating the chest from the abdomen. Its role is to help breathing

digestion

Process in the stomach and bowel that breaks food up into smaller components for nutrition

DNA

Substance formed of two twisted strands, present in each chromosome

embryo

Earliest stage of a baby's development, before its organs are fully formed

enamel

Hardest part of the outside of a tooth

endocrine gland

Organ that releases hormones directly into the bloodstream

enzymes

Substances that speed up the breakdown of nutrients in digestion

epidermis

Thin, outer layer of skin

faeces

Solid waste left after food is digested. It also contains dead cells and bacteria

fat

Fat in foods is a source of energy. The body's fat cells also give it its shape and insulate it

fertilization

When the egg and sperm join to produce an embryo

fetus

The developing baby inside the womb

gene

Parts of the DNA forming coded instructions to control different cells.

germ

Tiny bodies, such as bacteria or viruses, which often cause diseases

gland

Organ that releases useful substances into the body, for example, the salivary glands that make saliva

glucose

Type of sugar that is an important source of energy for all cells

hormone

Substance that acts as a chemical message, controlling the activity of some cells

immune system

Bone marrow, white cells, thymus, spleen, and other organs that defend the body against foreign molecules and germs

intestine

Tube running from the end of the stomach to the anus

joint

Part of the skeleton where bones meet, which helps with movement

liver

The largest organ, which is important in filtering blood, dealing with waste and toxins, and helping digestion

lymph

Fluid from the immune system containing white blood cells, including lymphocytes. It circulates in lymph vessels (lymphatics)



macrophage

Specialized white cell that engulfs foreign particles and germs

metabolism

Chemical processes responsible, for example, for energy production and digestion

mineral

Substance, such as calcium or iron, needed in small amounts for health

mitochondrion

Tiny complex body inside cells that releases energy

muscle fibre

Long cell that shortens by contraction when muscles work

nerve

Long string of neurons, carrying impulses between the brain, the spinal cord, and parts of the body

neuron

Nerve cell

nutrient

Substance, such as protein, fat, or a vitamin, needed to provide essential fuel for growth and function

organ

Structure in the body made of specialized cells, such as the heart, kidney, stomach, or lung

organelle

Tiny structure in cells, such as a mitochondrion



oxygen

Gas in the atmosphere that supports life. It plays a vital part in energy metabolism

papilla

Tiny bumps on the tongue that detect taste

peristalsis

Waves of muscle relaxation and contraction, pushing food, cells, or fluid through various tubes in the body

plasma

Liquid containing blood cells, which forms the blood. It carries nutrients, hormones, and waste products.

protein

Essential part of a person's diet, found in meat, fish, eggs, and nuts. Proteins promote growth and build most of the body's tissues, including muscle

puberty

A time when changes occur in the body as a child starts to develop into a young adult

receptor

Part of a cell that receives and detects chemical signals, often from another cell

skeletal muscle

Type of muscle, found in the legs, arms, face, and chest, which helps you move. It is usually controlled voluntarily



smooth muscle

Type of muscle in many organs, including your bowel, blood vessels, and bladder, over which there is limited or no voluntary control

spleen

Organ near the stomach that makes blood cells and helps the immune system

synapse

Tiny gap between neurons, across which chemical signals pass. Brain cells have thousands of these connections

system

Group of linked organs working together. For example, the kidneys and bladder form the urinary system

tendon

Toughened connective tissue that connects muscles to bone

thymus

Organ in the chest, most active in children, making the cells of the immune system

tissue

Group of cells that function together

toxin

Substance that is harmful. Some bacteria release toxins

trillion

One million million (1,000,000,000,000)



ultrasound

High-pitched sound waves, undetectable by the human ear. Ultrasound echoes are used to create images of structures deep inside the body

urine

Watery waste made by the kidneys and stored in the bladder before being released

vein

Blood vessel carrying blood from the tissues towards the heart

ventricle

One of two muscular pumping chambers of the heart

vertebra

One of the small bones, running from the neck to the pelvis, which are linked to form the backbone

virus

Tiny, germ-invading cells. Viruses cause illnesses, including flu and chicken pox, but most viruses in the body are harmless

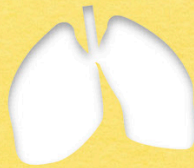
vitamin

One of around 13 substances, including vitamins A and C, needed in small amounts in food to ensure that the body stays healthy

X-ray

Radiation used to create shadows of bones and other organs in the body. Images on an X-ray photo can reveal internal damage and disease

Index



- A**
adolescence 119
adrenal glands 58
adrenaline 58
adults
bones 24, 29
growing older 120-21
head-body proportions 119
life cycle 113
sleep 49
stomach 97
teeth 95
water 111
ageing 120-21
air 74-5
air bags 73
allergies 88-9
altitude 65
angiograms 67
ankles 25, 28, 33
anterior tibial vein 63
anus 92, 93, 98
aorta 62, 66, 69, 101
arteries 19, 20, 45, 62-3, 64
arthritis 121
asthma 89
atria 68-9
auditory association cortex 47
auditory cortex 46
automatic reflex actions 78-9
- B**
babies
birth 117
bone growth 28
head-body proportions 119
human reproduction 114-17
life cycle 113
sleep 49
water 111
backbone see spine
bacteria
bad 85
defence against 86-7
friendly 83
spreading 84
tonsils 82
tooth decay 95
balance 47, 52, 53, 118
ball-and-socket joints 33
bases 10
biceps muscle 34
bile 93, 100
bile duct 100
birth 117
bites, insect 85
biting 95
bladder 108-9
blastocyst 114
blood 61
at altitude 65
circulation 20, 62-9
cleaning 100-101
hormones 58
nutrients 99
blood cells 15, 64-5
manufacture of 26, 27
blood clots 29
blood vessels 18, 19, 29, 62-3, 64, 65, 69, 101
body parts 20-21
body systems 16-17, 20
bone marrow 26, 27, 29, 83
bones 23
ageing 121
calcium 103
growing and mending 28-9
joints 32-3
skeleton 21, 24-5
skull and spine 30-31
structure 26-7
brachial artery 62
brain 17, 20, 39, 44-7
hearing 52
mind map 46-7
nervous system 16, 40-43
sight 50-51
skull 30, 45
sleep 48
speech 77
taste and smell 54
touch 56-7
urination 108
brain scans 47
brainstem 44
bread 103
breath, holding 75
breathing 71, 72-5
asthma 89
automatic reflex actions 78-9
speech 76
Broca's area 46, 47
bronchioles 72, 73
bronchus 72
- C**
calcium 58, 103
Calment, Jeanne 121
canine teeth 95
capillaries 18, 63, 73
carbon 21
carbon dioxide 72, 73, 74-5
cartilage 24, 28, 31, 33
carotid artery 62
cells 9, 14-15, 20
blood flow 62-5
division 15
energy 91
genes 10, 12
human reproduction 114, 115, 116
life cycle 113
number of 17
organs 16-17
oxygen supply 71, 72
tissues 16
viruses 84
waste 105
water 102, 110
cerebellum 44-5, 47
cerebral cortex 46, 47
cerebrum 44-7, 57
cervical vertebrae 31
cheekbone 30
cheese 89
chest 24, 31, 72, 74-5
chewing 94
chicken 103
children
changing shape 119
development 118-19
growing older 120
sleep 49
teeth 95
see also babies
chlorine 21
chromosomes 10-11
circulatory system 16, 20, 62-9
cochlea 52, 53
colds 84
colon 98, 99
communication 76-7
compact bone 26-7, 29
computers 43
cornea 50
coronary artery 67
corpus callosum 45
coughing 78, 84
crunching 95
cytoplasm 14
- D**
dairy foods 89, 103
danger, warnings of 55
defences, body 81, 82-9
deltoid 34
dendrites 43
dermis 18-19
diabetes 59
diaphragm 72, 74, 75, 79
diet
and ageing 120
balanced 102-3
see also food
digestive system 17, 20, 92-9, 102



discs 31
 disease 84-5, 86
 DNA 10-11
 double helix 10-11
 dreaming 48, 49
 drinks 91, 110
 see also water

E

ear canal 53
 ear flap 52, 53
 eardrum 52
 ears 56
 bones 30, 52, 53
 and brain 46
 hearing 52-3
 joints 33
 sleep 48
 eating 91, 92-7
 balanced diet 102-3
 see also food
 eggs
 allergies 89
 reproduction 114, 115
 elbow joint 24
 elements 21
 embryos 115
 enamel 95
 endocrine system 17, 20,
 58-9
 energy 45, 91, 92
 from food 102, 103
 enzymes 92
 epidermis 18-19
 epiglottis 94
 exercise
 and ageing 120, 121
 heartbeat 68
 external oblique 34
 eye sockets 30
 eyes 50-51
 and brain 47
 colour 12, 13
 muscles 36
 sleep 48

F

face 30
 faeces 93, 98, 99
 water in 110
 fallopian tubes 114
 fat cells 15
 fats, in food 100, 103
 fatty acids 103
 feet 24, 25
 female, genetics 11, 13
 femoral artery 63
 femoral vein 63
 femur 25
 fertilization 114, 115, 116
 fetus 116-17
 fibre 102
 fingernails 19
 fingers 25, 28-9
 fingertips 56, 57
 fish 103
 oils 103
 flu 84
 follicles 18
 food
 allergies 89
 bacteria in 82
 balanced diet 102-3
 blood 62, 63
 brain 45
 digestive system 21, 58,
 92-3
 eating 92-7
 for fetus 116
 muscles 34
 plants 72
 taste and smell 54, 55
 water in 110, 111
 food poisoning 85
 fractures 28-9
 freedivers 75
 frontal bone 30
 frontalis 34
 fruit 102

G

gall bladder 100
 gastric juice 96, 97
 genes 10-13, 115
 germs 81, 82-7
 body defences 82-3
 disease 84-5
 immune system 16, 88
 lymphatic system 16, 20
 skin 18, 21
 white blood cells 64, 65,
 86-7
 glands 17, 58
 glucagon 59
 glucose 58, 59
 Golgi body 14
 growth 28, 120
 and food 103
 growth hormones 58

H

hair 18, 19
 ageing 121
 colour 12
 facial 119
 hamstring muscles 36-7
 hands
 arthritis 121
 bacteria on 84
 bones 24, 25, 28-9
 dirty 84
 sensitivity 56
 hay fever 88, 89
 head
 bones 30
 head-body proportions
 119
 see also brain; skull
 hearing 52-3
 heart 61, 66-9
 beat 61, 67, 68-9
 circulatory system 16, 61,
 62-9
 heart muscle 35, 67
 heat 100
 hemispheres, brain 57

hiccups 79
 hinge joints 33
 hips 31
 arthritis 121
 homunculus 56-7
 hormones 20, 44, 58-9
 hunger 59
 hypothalamus 44

I

immune system 16, 88
 incisors 95
 inferior vena cava 62, 67
 inhalers 89
 inheritance 12-13
 insects
 bites 85
 protein in 103
 insulin 59
 intercostal nerves 40
 intestines 20
 large intestine 93, 98-9
 small intestine 93, 96, 97,
 98, 99, 100
 iris 50, 51
 iron 21

J

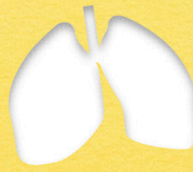
jawbones 24, 30, 95
 joints 32-3
 ageing 120, 121
 jugular vein 62

K

kidneys 17, 105, 106-7
 knee joint 33
 kneecap 25
 knees, arthritis 121

L

large intestine 93, 98-9
 larynx 72



leg muscles 36-7
 lens 50
 lentils 103
 life cycle 112-21
 lifespan 121
 ligaments 33
 light rays 50-51
 lips 56, 77, 92
 liver 93, 100-101
 locusts 103
 lumbar vertebrae 31
 lungs 20, 71
 asthma 89
 circulatory system 8, 66-9
 respiratory system 72-5
 sneezing 78
 snoring 77
 speech 76
 water loss 110
 lymph 82
 lymph nodes 82
 lymph vessels 16, 82
 lymphatic system 16, 20, 82
 lymphocytes 87
 lysosomes 14

M

macrophages 86-7
 malaria 85
 male, genetics 11, 13
 measles 84
 melanin 121
 milk 89, 103
 minerals 102
 mitochondria 15
 molars 95
 monocytes 87
 mosquitoes 85
 motor cortex 46
 mouth
 breathing 74
 digestive system 92
 eating 94-5
 hiccups 79

making sounds 76-7
 movement 23
 brain 39, 46, 47
 joints 32-3
 muscles 34-7
 mumps 84
 muscle cells 15
 muscle fibres 37
 muscles 21, 23
 ageing 120, 121
 movement 34-7
 skeletal 36-7
 muscular system 17

N

nails 19
 nasal cavity 54, 72
 nerve cells 15, 40, 43, 46, 56
 nerve endings 18
 nerve fibres 42, 43
 nerve impulses 42, 43
 nervous system 16, 20, 39, 40-43
 neurons 42, 43
 neutrophils 87
 nitrogen 21
 nose
 allergies 88
 breathing 72, 74
 hiccups 79
 sneezing 78
 snoring 77
 taste and smell 54-5
 nucleus 10, 14
 nutrients 91, 92, 98, 99, 100
 nuts 103

O

oesophagus 92, 94, 96, 98
 oils, healthy 103
 old age 120-21
 olive oil 103
 optic nerve 51

orbits 30
 organelles 14
 organs 16, 20
 protection of 21, 24
 ossicles 52
 ovaries 114
 oxygen
 blood cells 15, 64, 65
 for brain 45
 circulatory system 16, 62, 63, 66, 67, 68
 for fetus 116
 respiratory system 20, 71, 72-5
 oxytocin 59

P

pain 47
 pain receptors 56
 pancreas 58, 59
 papillae 55
 parathyroid glands 58
 pasta 103
 patella 25
 peanuts 89
 pelvis 24, 31
 periosteum 27
 peristalsis 99
 peroneal nerve 41
 personality 46
 phalanges 25
 phosphorous 21
 photosynthesis 73
 pituitary gland 44, 58, 59
 pivot joints 32
 placenta 116
 plants 73
 plasma 64, 65
 platelets 64, 65
 poisons 100
 pollen 88, 89
 poo see faeces
 potassium 21
 prefrontal cortex 46
 pregnancy 116-17
 premolars 95

premotor cortex 46
 primary visual cortex 47
 proportions, changing 119
 protein 15, 97, 103
 puberty 119
 pulmonary artery 66, 67, 69
 pulmonary vein 66
 pupils 50, 51

Q

quadriceps femoris 35, 36-7

R

radial nerve 40
 receptors
 taste and smell 54
 touch 56
 rectum 98
 red blood cells 26, 27, 64, 65
 reflexes 41
 repair, bones 28-9
 reproductive system 16, 114-17, 119
 respiratory system 16, 72-5
 retina 51
 ribs 24, 74, 75
 rice 103

S

sacrum 31
 saliva 94
 salmonella 85
 salt, excess 109
 sartorius 35
 scapula 24
 sciatic nerve 41
 sclera 50
 sebum 18
 senses
 hearing 52-3
 taste and smell 54-5



touch 56-7
 vision 50-51
 sensory cortex 47, 57
 sex chromosomes 11
 shaving 119
 shellfish 89
 shinbone 25
 shoulder blade 24
 sight 50-51
 skeletal muscles 34, 35, 36-7
 skeletal system 16, 21, 24-5
 skin 16, 18-19, 21
 ageing 121
 colour 12
 defence 82, 83
 sensory cortex 47
 sweat 110, 111
 touch 56, 57
 skin cells 15
 skull 24, 30, 45
 sleep 48-9
 small intestine 93, 96, 97, 98, 99, 100
 smell receptors 54
 smell, sense of 54-5
 smooth muscles 35
 sneezing 78, 84
 snoring 48, 77
 sodium 21
 soleus 35
 sounds 52-3, 76-7
 speech 76-7
 brain 46, 47
 development 119
 sperm 114, 115
 spinal cord 40, 41, 45
 spinal nerves 41
 spine 30-31
 spleen 82
 spongy bone 26-7, 29
 stomach 17
 digestive system 92-3, 94, 96-7, 98
 hormones 58, 59
 muscles 35
 sugars 102

super structures 22-37
 superior vena cava 66
 swallowing 94
 sweat 83, 110, 111
 sweat ducts 19
 sweat glands 18, 19, 83
 synapses 42
 systems, body 16-17, 20

T
 tailbone (coccyx) 31
 taste, sense of 54-5
 teenagers 120
 teeth 30, 77, 95
 calcium 103
 cleaning 95
 eating 92, 93, 94, 95
 temperature
 control 58
 raised 84
 thoracic vertebrae 31
 thought 39, 46
 throat
 allergies 88
 breathing 72
 coughing 78
 digestive system 92, 94
 making sounds 79
 snoring 77
 sore 85
 thymus glands 82
 thyroid gland 20, 58
 tibia 25
 tissues 15, 16, 20
 toes 57
 tongue
 digestive system 92, 93
 eating 94
 sensitivity 56
 speech 77
 taste 54, 55
 tonsils 82
 touch 47, 56-7
 viruses 84
 touch receptors 56
 toxins 85

trachea 72, 94
 twins, identical 11

U
 ultrasound scans 117
 umbilical cord 116
 understanding 46, 47
 urea 109
 ureter 108
 urethra 108, 109
 urinary system 17, 106-9
 urine 105, 106-9, 110
 uterus 114, 115, 116-17

V
 vacuoles 14
 vagina 117
 valves, heart 68-9
 vegetables 102
 veins 19, 20, 45, 62-3, 64
 ventricles 68-9
 vertebrae 31, 41
 vesicles 86
 villi 99
 viruses 84
 vision 50-51
 visual cortex 47
 vitamins 102
 vocal cords 76, 77, 79
 voice 77
 voice box 72, 76

W
 waste
 blood 66
 brain 45
 carbon dioxide 74
 digestive system 92, 93, 98
 macrophage 87
 urinary system 17, 105, 106-9
 water 21, 110-11
 digestive system 98, 99

drinking 102
 urine 109
 waterworks 104-11
 wee see urine
 weight
 control 58
 Wernicke's area 47
 wheat 89
 white blood cells 29, 65, 82, 83, 86, 87
 windpipe 72, 76, 79, 94
 womb 114, 115, 116-17
 wounds, healing 64
 wrinkles 121
 wrist bones 28

XYZ

X-rays 25, 28-9, 31, 67, 121
 yawning 78
 zygomatic bone 30

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