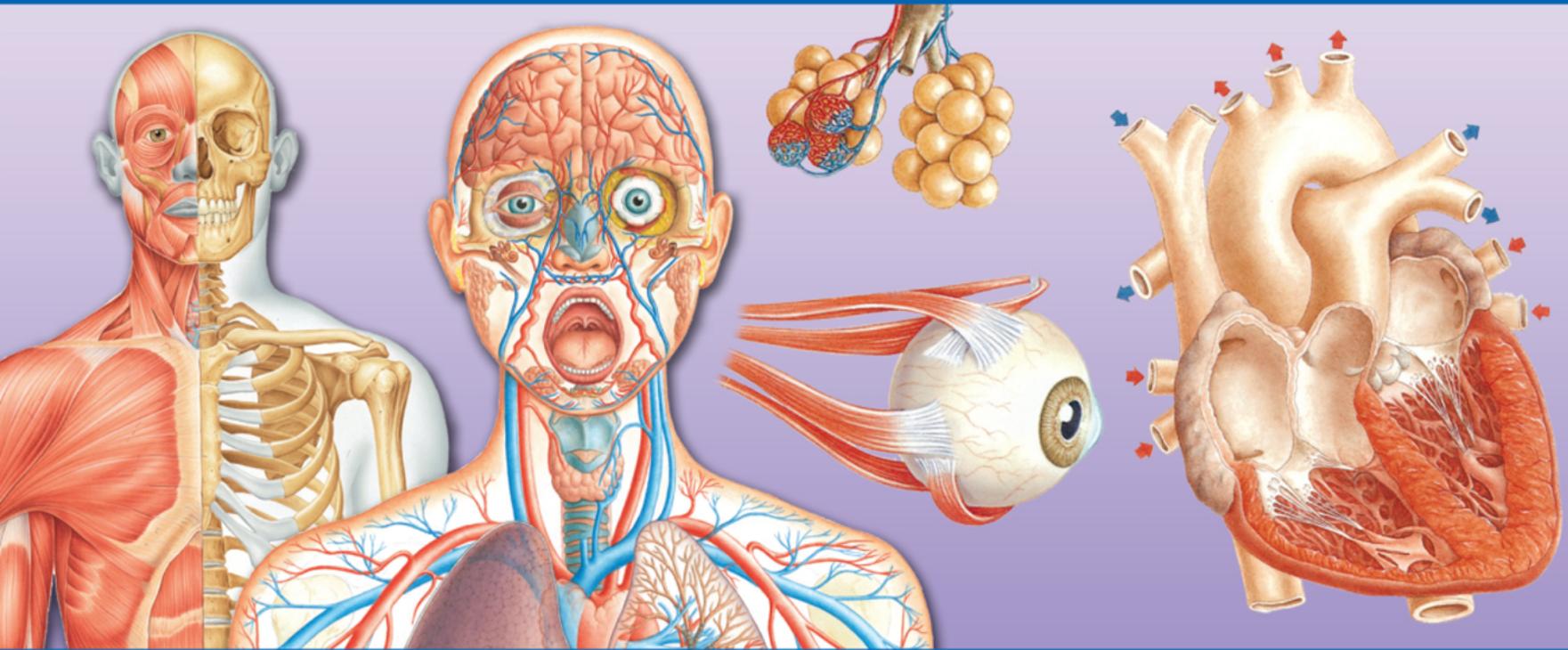
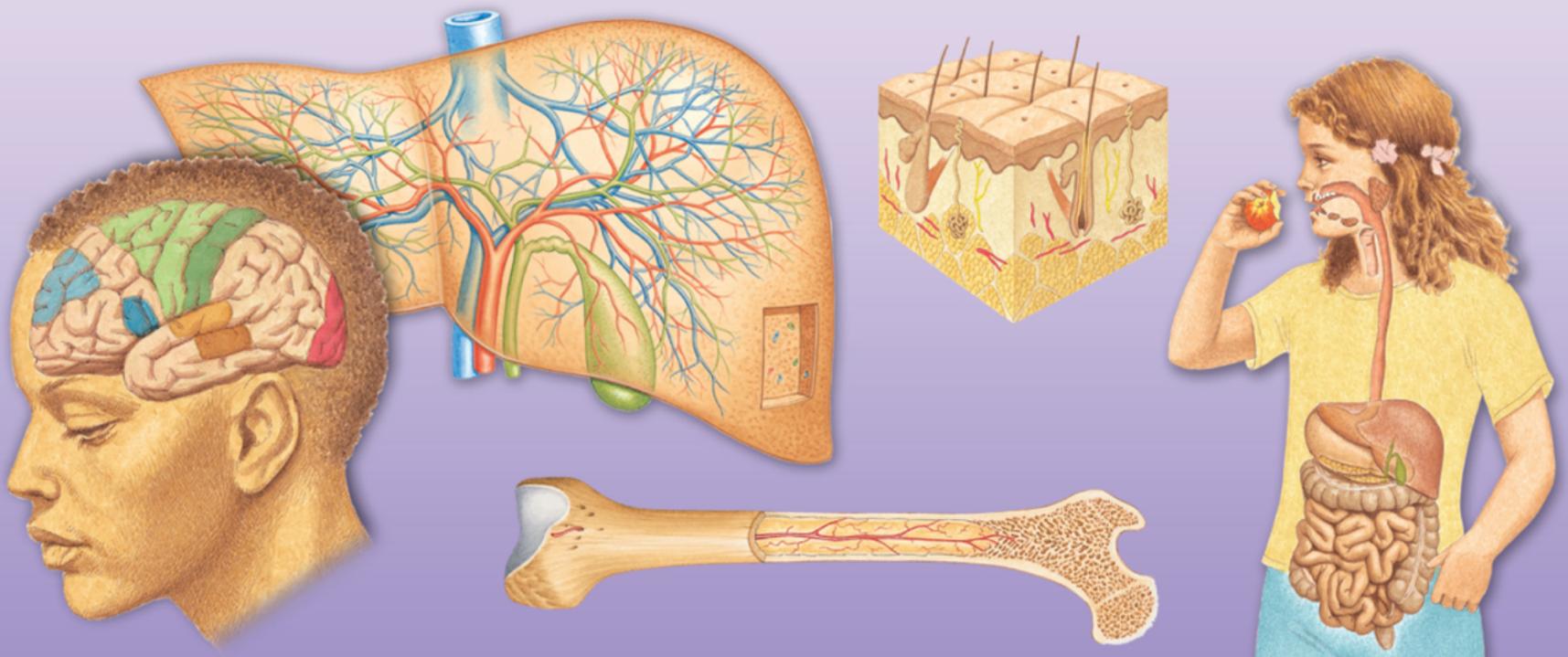


ILLUSTRATED ENCYCLOPEDIA



HUMAN BODY



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ILLUSTRATED ENCYCLOPEDIA

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HUMAN BODY

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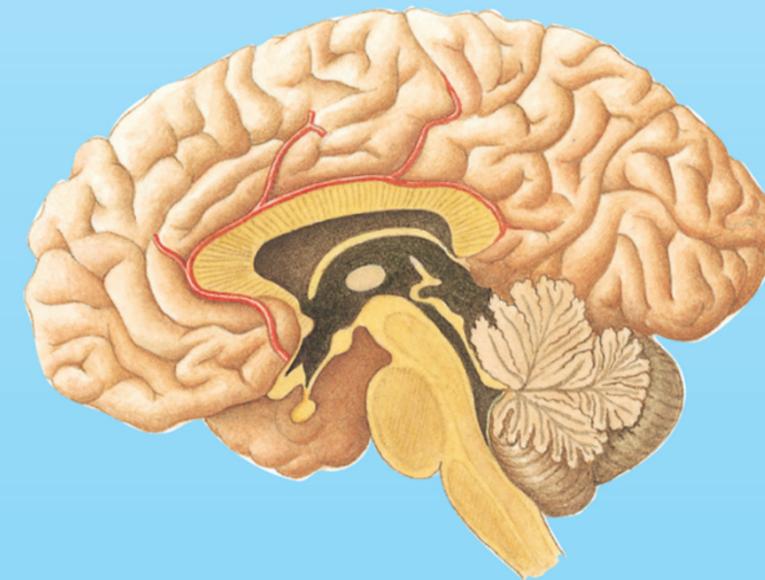
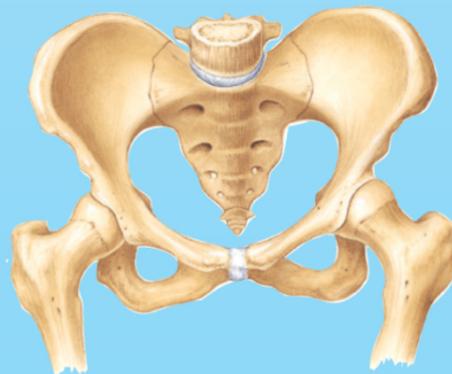
Consultant Richard Walker, writer and consultant

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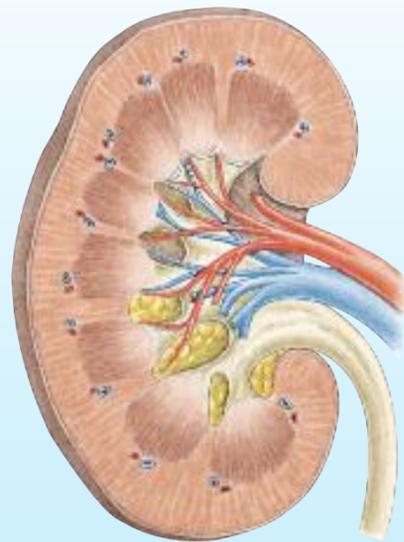
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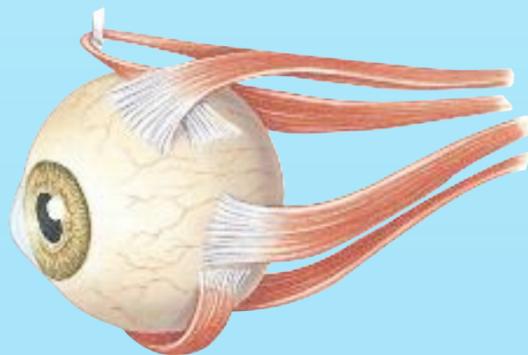
 Orpheus

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ABOUT THIS BOOK

Each double page contains a brief introduction, explaining the general subject, followed by key words arranged in alphabetical order. To look up a specific word, turn to the index at the back of this book: this will tell you which page to go to. If you want to learn more about a subject, take a look at the factfile, or follow the arrows to read related entries.



INTRODUCTION
This explains the general subject and provides some basic knowledge.

BOLD WORDS
These highlight useful words that do not have their own entry.

PAGE NUMBER
Page numbers are easy to find at the side of the page.

HEART & BLOOD

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Oxygen-rich blood (red) arrives in the heart through the pulmonary veins from the lungs. Oxygen-poor blood (blue) arrives through the venae cavae from the rest of the body (1). The ventricles then squeeze it and the blood is pushed out (2), either along the pulmonary arteries to the lungs, or along the aorta to the body.

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Venues and arterioles are linked by a dense network of smaller vessels called capillaries.

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FACTFILE

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- A drop of blood the size of a pinhead contains about 5 million red blood cells and between 7000 and 25,000 white blood cells. The number of white blood cells increases when the body is fighting an infection.

KEY WORDS AND ENTRIES
Key words are arranged alphabetically across each double page. Each entry provides a short explanation of what the key word means.

ARROWS
These arrows show you where to look up other words mentioned in the entry. For example, (•26) tells you to go forward to page 26 and (•6) tells you to turn back to page 6.

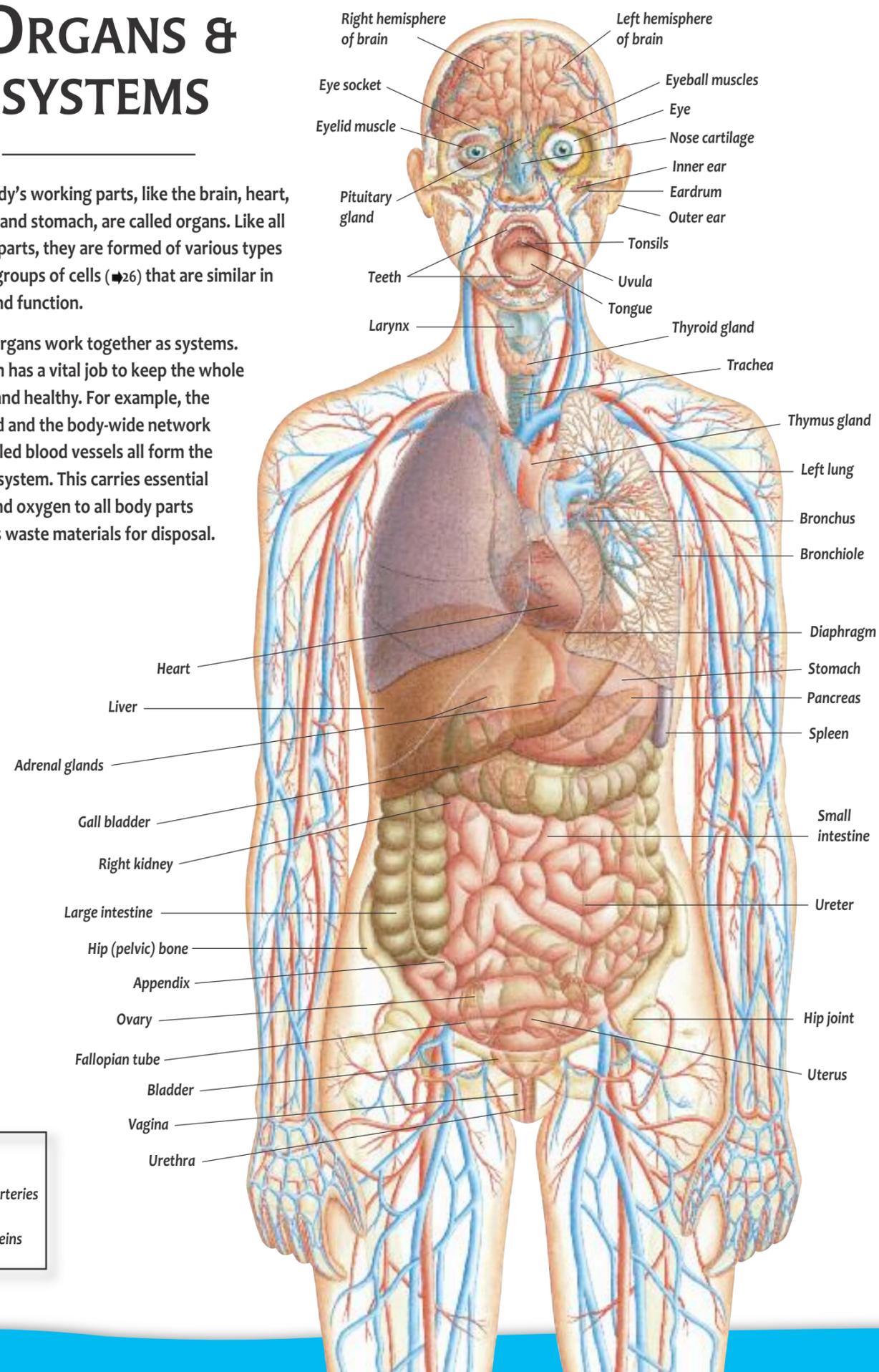
FACTFILE
The factfile provides extra information on the subject. Facts are presented in easy to read bullet points.

ORGANS & SYSTEMS

The body's working parts, like the brain, heart, lungs and stomach, are called organs. Like all body parts, they are formed of various types of tissue—groups of cells (▶26) that are similar in structure and function.

Groups of organs work together as systems. Each system has a vital job to keep the whole body alive and healthy. For example, the heart, blood and the body-wide network of tubes called blood vessels all form the circulatory system. This carries essential nutrients and oxygen to all body parts and collects waste materials for disposal.

6



KEY

- Arteries
- Veins

1



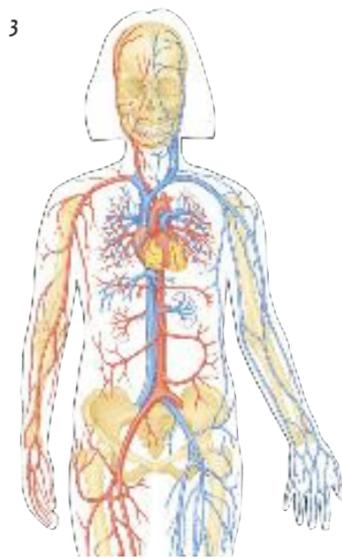
Skeletal system

2



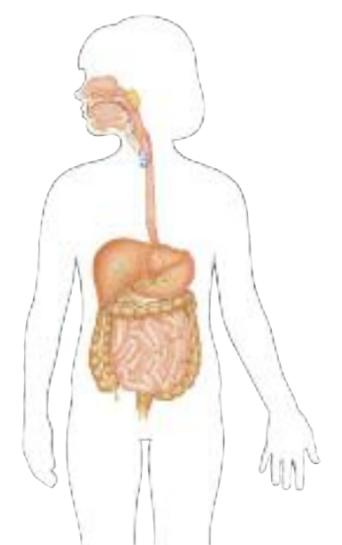
Muscular system

3



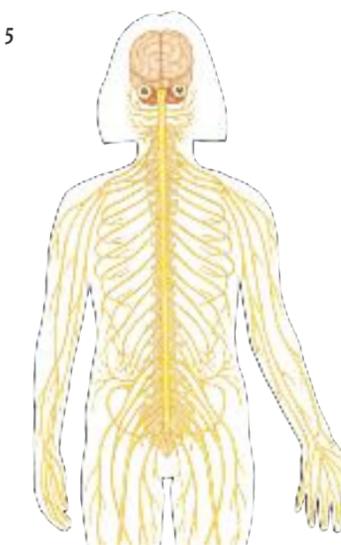
Circulatory system

4



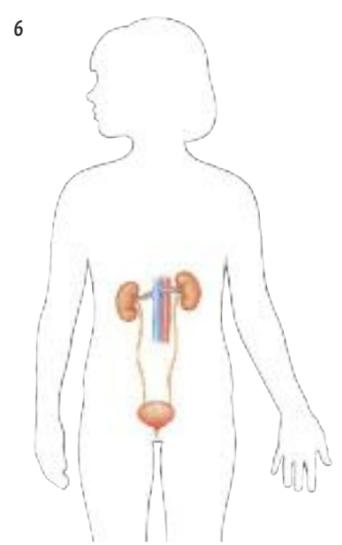
Digestive system

5



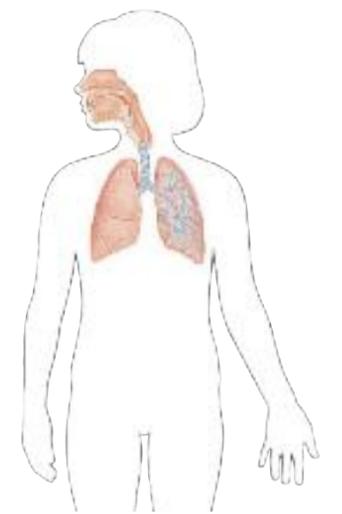
Nervous system

6



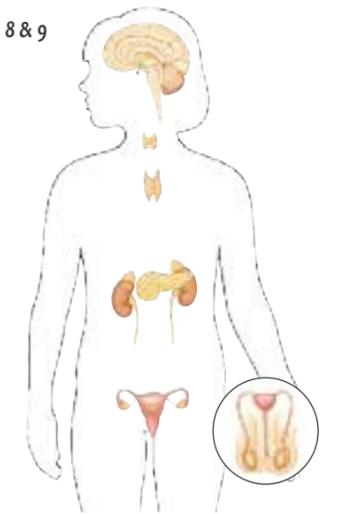
Urinary system

7



Respiratory system

8 & 9



Endocrine and reproductive systems

7

- 1 The skeletal system (▶22) supports the body.
- 2 The muscular system (▶20) enables movement.
- 3 The circulatory system (▶8) delivers nutrients and hormones to cells and removes their wastes.
- 4 The digestive system (▶12) breaks down food and absorbs nutrients into the bloodstream.
- 5 The nervous system (▶14) is the body's main control system.
- 6 The urinary system (▶12) removes wastes.
- 7 The respiratory system (▶10) takes in oxygen from the air and expels waste carbon dioxide.
- 8 The endocrine system (▶14) releases hormones that control several body processes.
- 9 The reproductive system (▶26) enables humans to produce offspring.

HEART & BLOOD

The heart is a large muscular organ in the chest that pumps blood around the body. Blood is a fluid that carries important substances to the body's tissues. It contains several different types of cells (▶ 26), each with a different job to perform. From the heart, blood travels through a network of tubes called blood vessels, collecting oxygen from the lungs (▶ 10) and nutrients from the digestive system (▶ 12), and delivering these to all body cells. Together, the heart, blood and blood vessels make up the circulatory system.

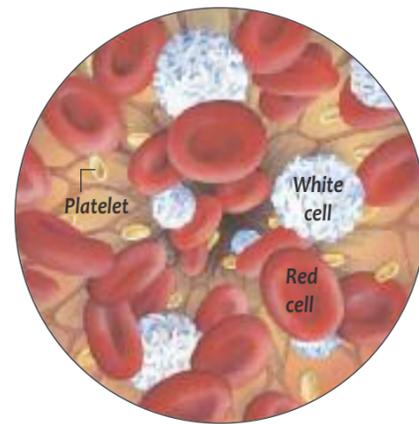
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Blood cells as seen under a powerful microscope.

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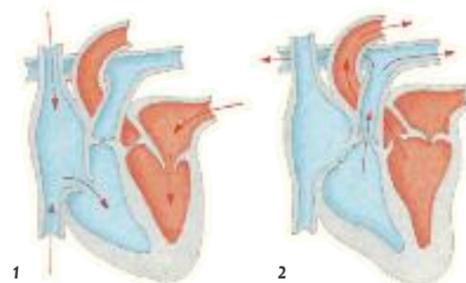
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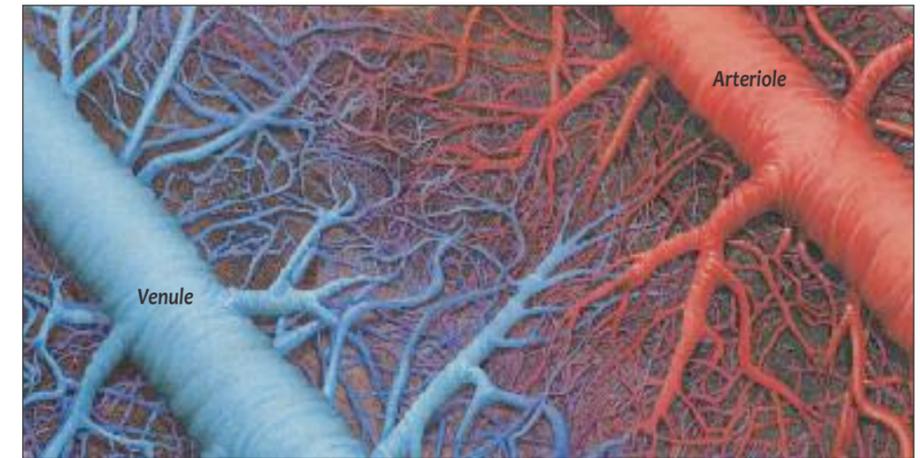
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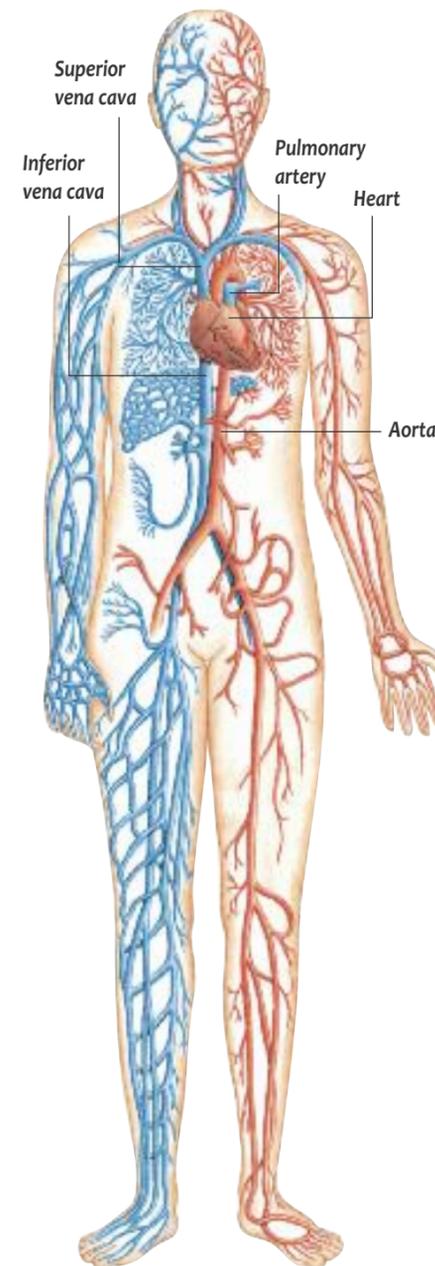


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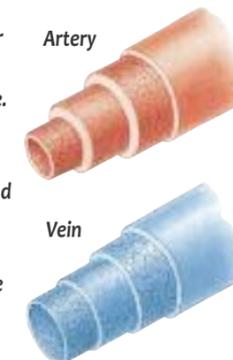
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BREATHING

Breathing, or respiration, is the process that takes oxygen into the body and gets rid of waste carbon dioxide. The set of organs involved in breathing make up the respiratory system. They include the nose, trachea, diaphragm and lungs. Breathing in draws air into the lungs, where oxygen passes into the bloodstream and is carried to every cell in the body. Meanwhile, the bloodstream transports carbon dioxide in the opposite direction, from the cells to the lungs, where it is breathed out. Breathing out also enables us to speak.

Alveoli Tiny air sacs, clustered at the end of the bronchioles and surrounded by capillaries (8). Oxygen passes easily through the thin walls of the alveoli into the blood in the capillaries.

Bronchus The airway connecting each lung to the trachea. Like the trachea, it is supported by cartilage (22). Inside the lungs, bronchi divide into smaller bronchi.

Bronchioles Branches of the narrowest bronchi. They end in tiny **respiratory bronchioles**, which end in alveoli.

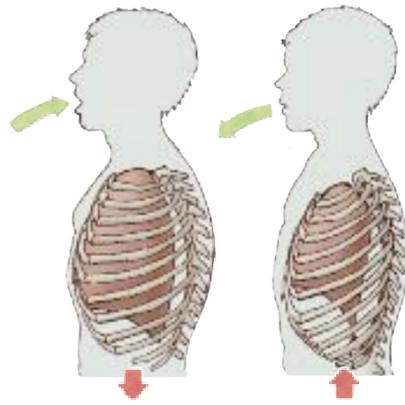
Carbon dioxide A gas produced by cells as they release energy from glucose (12). It is carried in the bloodstream to the lungs where it is breathed out.

Chest cavity The space enclosed by the ribs and diaphragm, containing the lungs and the heart.

Cilia Tiny "hairs" that line the airways. They bend from side to side, sweeping dust, dirt and germs trapped in mucus to the throat so it can be swallowed.

Inhaling: the diaphragm pulls down and the ribs move up.

Exhaling: the diaphragm lifts up and the ribcage moves down.



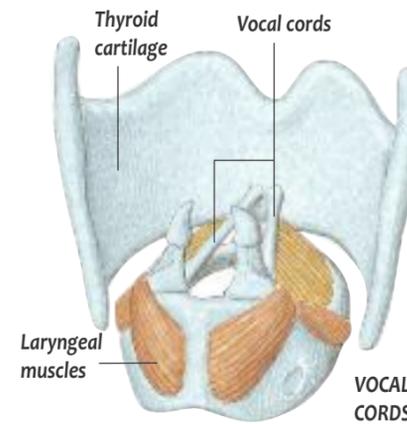
Diaphragm The sheet of muscle beneath the lungs that helps breathing. To inhale, the diaphragm pulls down, increasing the volume of the chest cavity and causing air to rush into the lungs. To exhale, it relaxes, moving up and pushing air out of the lungs.

Exhale To breathe out, expelling air from the lungs through the mouth or nose.

Inhale To breathe in, drawing air through the mouth or nose and into the lungs.

Intercostal muscles The muscles between the ribs (23). They contract (shorten) to lift the ribcage, increasing the volume of the chest cavity so that air rushes into the lungs. As they relax, the ribcage moves down, decreasing the volume of the cavity.

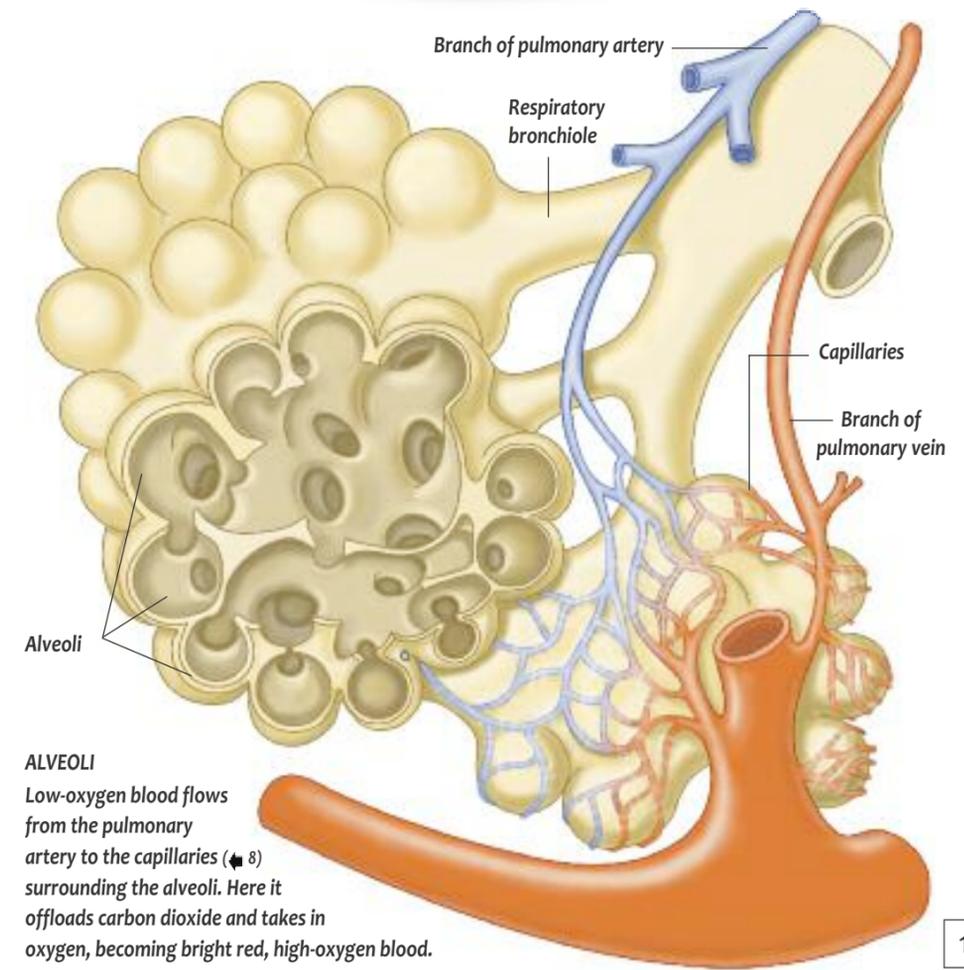
Larynx The small organ, also known as the **voice box**, that enables us to make sounds. It sits at the top of the trachea, where it contains the vocal cords.



Lungs The two spongy, sac-like organs in the chest cavity, through which oxygen enters the bloodstream.

Mucus A sticky liquid that protects the insides of hollow organs and traps dirt and germs. In the respiratory system, it lines the nose, throat, trachea and lungs.

Cilia in the lining of the trachea



ALVEOLI Low-oxygen blood flows from the pulmonary artery to the capillaries (8) surrounding the alveoli. Here it offloads carbon dioxide and takes in oxygen, becoming bright red, high-oxygen blood.

Oxygen A gas that makes up about one-fifth of the air around us. Oxygen is needed for a process called cell respiration that happens inside cells and releases energy from food.

Pleural membranes Two membranes that cover the surface of the lungs and line the inside of the chest cavity. In the narrow gap between the membranes there is a small amount of liquid. This helps the layers to slide against each other, reducing friction as the lungs inflate and deflate.

Trachea The airway connecting the lungs to the mouth and nose. It is supported by rings of cartilage (22) that keep it open.

Vocal cords Two folds of elastic tissue that stretch across the top of the larynx. To speak, muscles pull the cords together so there is only a narrow slit between them. Air rushing through the slit makes the cords vibrate, which produces sounds.

FACTFILE

- ★ At rest, an adult breathes in and out about 12 times each minute. Each breath takes in about 500 ml of air. After running a race, the same person may breathe 60 times each minute and take in more than two litres of air each time. This is because active muscles require more oxygen in order to release energy in their cells.
- ★ The left lung is slightly smaller than the right lung to make room for the heart.
- ★ The two lungs contain more than 300 million alveoli.
- ★ Unlike fish, people cannot breathe underwater. Scuba divers (below) carry their own air supply. The air in the tanks is compressed so that a lot fits into a small space.



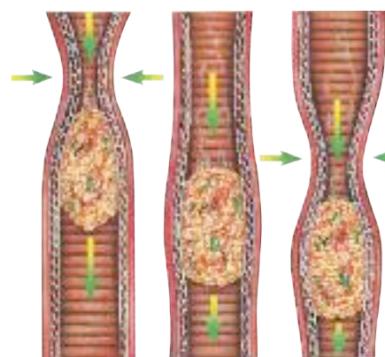
DIGESTION

Digestion is the process of taking in food and breaking it down into tiny particles, or nutrients (➡28), that can be absorbed into the blood and used by the body. Food provides all of the body's energy and warmth and helps it to grow and stay healthy. All of the body parts that take in and break down food are known as the digestive system, but digestion mainly takes place in the small intestine.

Amino acid One of the building blocks from which proteins (➡29) are made by the body's cells. During digestion, protein in food is broken down into amino acids.

Anus An opening at the end of the digestive tract through which faeces leave the body. It is surrounded by a ring of muscle which controls its opening.

12

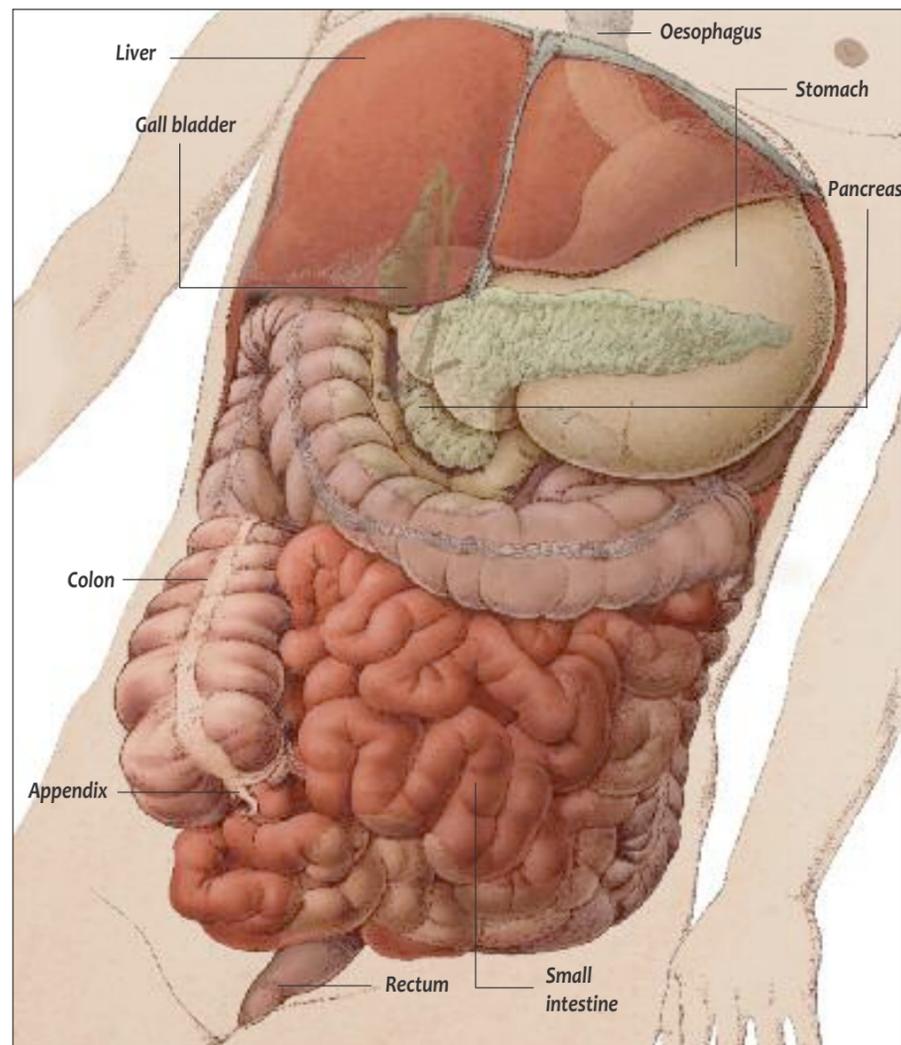


Food is pushed down the oesophagus by peristalsis.

Appendix A tiny tube at the end of the large intestine. It has no apparent use, though some scientists think it contains bacteria (➡28) useful to digestion.

Bile A thick, greenish fluid that helps break down fat in food. Bile is produced by the liver and is stored in the gall bladder.

Bladder The organ that collects and stores urine after it leaves the kidneys.



Colon The main part of the large intestine from which water is absorbed into the bloodstream from watery, undigested food. The remaining solid waste (faeces) is pushed towards the rectum.

Enzyme A substance that speeds up chemical reactions. Enzymes in the digestive system speed up the break down of food.

Faeces Solid food waste that cannot be digested. This is mostly vegetable and fruit fibre and harmless bacteria (➡28).

Gastric juice A liquid mixture of acid and enzymes, made by glands in the lining of the stomach. It helps to break down proteins (➡29).

Gall bladder A small, sac-like organ underneath the liver where bile is stored.

Glucose The main source of energy for the body. It is released from carbohydrates (➡28) in food during digestion and stored in the liver in the form of glycogen.

The muscular walls of the stomach squash food as it is mixed with gastric juices.



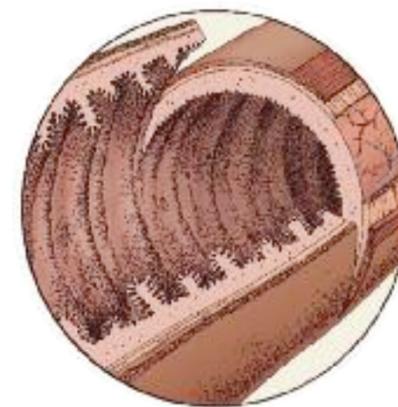
Glycogen A store of glucose found inside liver cells. Glucose is released from glycogen into the bloodstream, or removed from the bloodstream to make glycogen, according to the body's demands.

Hepatic portal vein The vein (➡8) that carries blood rich in nutrients from the small intestine to the liver.

Hepatic vein The vein (➡9) that empties blood from the liver into the inferior vena cava (➡9).

Intestines The continuous tube linking the stomach to the anus. It is divided into the small intestine and the large intestine.

Kidneys A pair of organs that contain millions of microscopic nephrons. These filter wastes and excess water and salts from the blood to make urine.



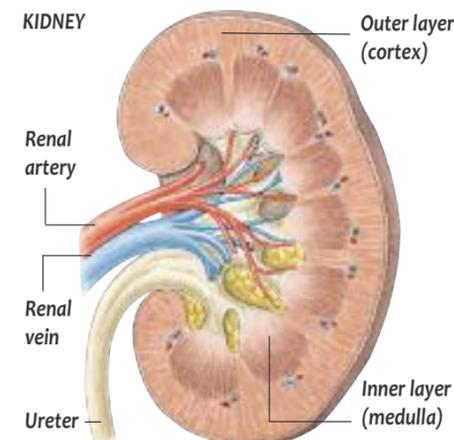
Villi in the lining of the small intestine

Liver A large organ that processes nutrient-rich blood from the small intestine, storing some nutrients and dispatching others. It also removes poisonous substances from the blood and makes bile.

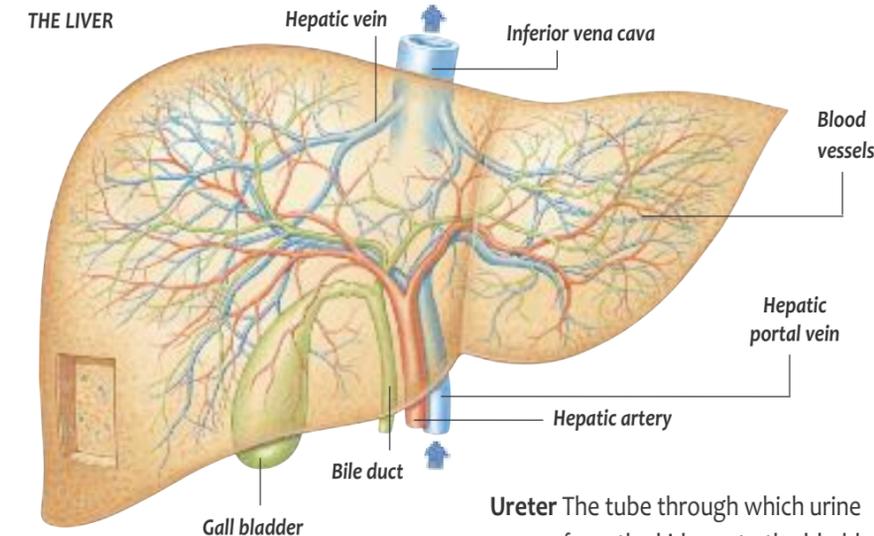
Oesophagus The tube through which food passes from the mouth to the stomach.

Pancreas An organ that produces enzymes and releases them into the intestines. It also makes some hormones (➡14).

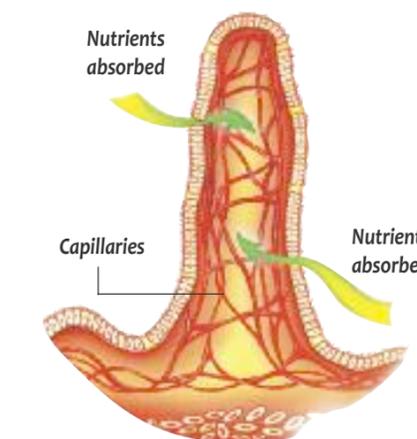
KIDNEY



THE LIVER



Peristalsis The squeezing action in the oesophagus, stomach and intestines, which pushes food along.



Nutrients pass from a villus into the bloodstream.

Rectum The last part of the large intestines, in which faeces are stored before they are passed out through the anus.

Small intestine A long tube linking the stomach to the large intestine. In the first section, the **duodenum**, bile and pancreatic juices continue the digestive process. Then, in the **jejunum** and **ileum**, digestion is completed and nutrients are absorbed into the bloodstream.

Stomach The organ where digestion begins in earnest. While enzymes in gastric juice digest proteins in food, its muscular walls churn food into a creamy paste.

Ureter The tube through which urine passes from the kidneys to the bladder.

Urethra The tube through which urine passes from the bladder out of the body.

Urinary system The organs that produce, store and remove urine, including the kidneys, ureters, bladder and urethra.

Urine A mixture of water, salts and waste substances, produced in the kidneys and stored in the bladder.

Villi Tiny projections lining the inside of the small intestine. They absorb nutrients from the intestine into the bloodstream.

13

FACTFILE

- ★ The entire digestive system, from the mouth to the anus, is nine metres long. It takes food between 18 and 24 hours to pass through the digestive system.
- ★ The average stomach is about the size of a fist, but can stretch to 20 times that size.
- ★ The small intestine is four times longer than the large intestine. Stretched out, it is almost six metres long. About 90% of digestion takes place in the small intestine.
- ★ At any one time, about a quarter of your blood is inside your liver.
- ★ Up to 180 litres of fluid from the blood passes through the kidneys in one day.
- ★ The liver is the largest internal organ.

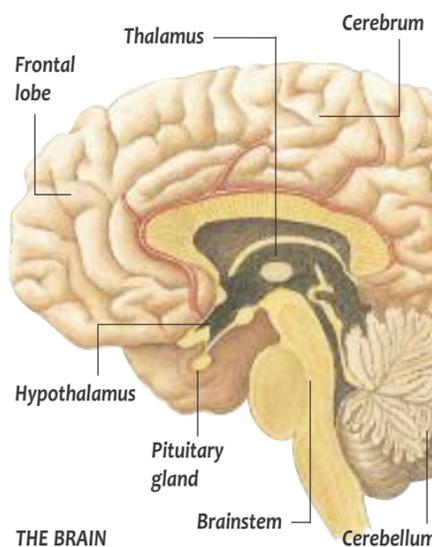
THE BRAIN

The brain is the large organ inside the skull that controls almost every aspect of the body, including feeling, thinking, moving and breathing. A column of nervous tissue, the spinal cord, extends downwards from, and relays messages to, the brain. The brain and spinal cord are linked to the rest of the body by cable-like nerves, which carry messages in both directions. The brain, spinal cord and nerves make up the nervous system. This works alongside the body's second control system, the endocrine system, to ensure body activities are co-ordinated.

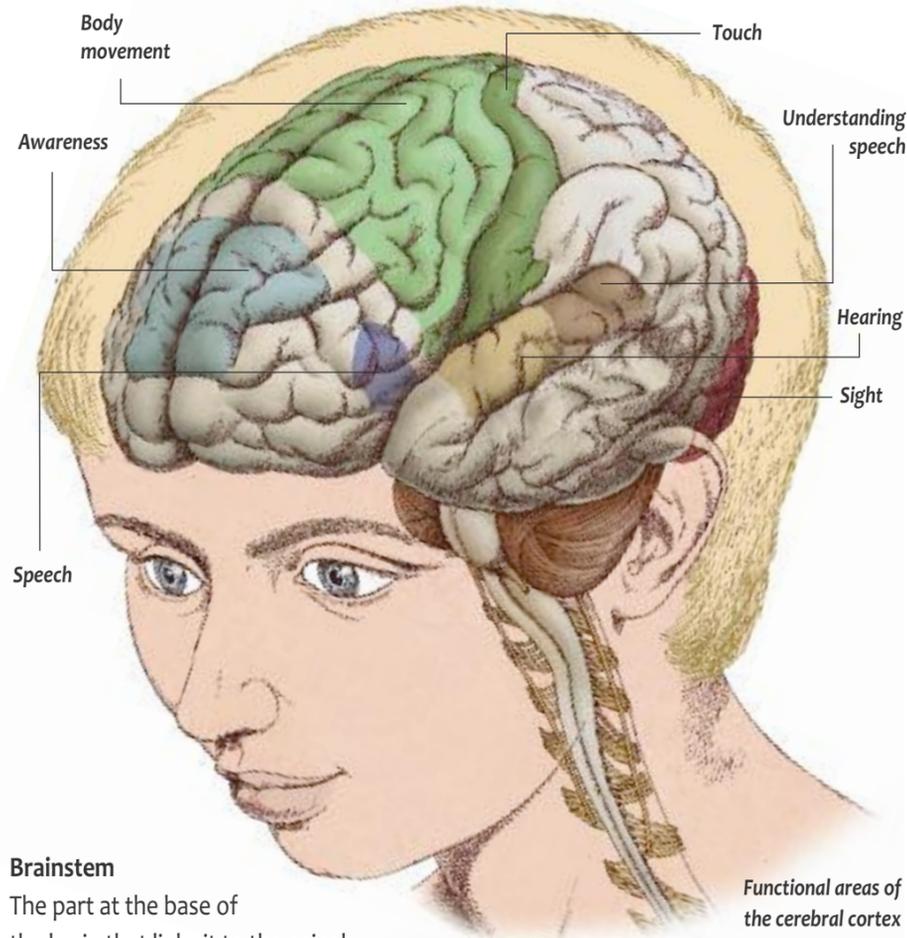
Adrenal glands A pair of endocrine glands that produce hormones in response to stress, including **adrenaline**, which makes the heart beat faster, preparing the body for action.

Automatic nervous system (ANS) Part of the nervous system that automatically controls processes such as heartbeat, breathing and digestion.

Axon The long, thin projection that carries nerve impulses away from a neuron's cell body.



THE BRAIN



Brainstem

The part at the base of the brain that links it to the spinal cord and helps control the ANS.

Cerebellum The region at the back of the brain that deals with muscle control to make movements coordinated.

Cerebral cortex The thin outer layer of the cerebrum that consists of grey matter. It is divided into different areas, each with a particular function.

Cerebral hemispheres The two halves of the cerebrum. The right hemisphere controls the left side of the body and deals with artistic skills and imagination. The left hemisphere controls the right side of the body and deals with language, numbers and logic.

Cerebrum The largest part of the brain. It deals with sensing, movement, thought, reasoning, memory, problem solving and other conscious actions.

Cranial nerves Nerves that extend directly from the brain.

Dendrite One of several thin projections that extends from a neuron's cell body and collects nerve impulses from other neurons.



Connections between neurons inside the brain

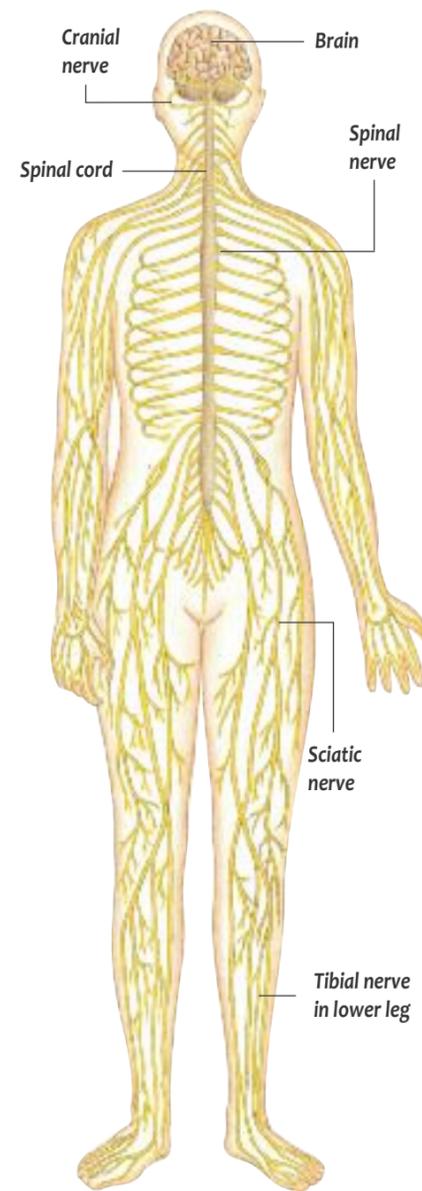
Endocrine gland A type of gland that produces and releases hormones.

Gland An organ that produces a substance needed by the body, such as tears or saliva.

Grey matter Darker tissue in the CNS that is packed with neurons and is where information processing happens.

Hormones Chemical messengers carried in the bloodstream. They alter the activities of certain cells and tissues, controlling body activities such as growth and reproduction.

Hypothalamus A small but important brain area that monitors and controls thirst, hunger, body temperature and many other activities. It sends signals to the rest of the body via the ANS and hormones produced in the pituitary gland.



THE NERVOUS SYSTEM

Motor neuron A neuron that carries nerve impulses from the brain and spinal cord to the body's muscles.

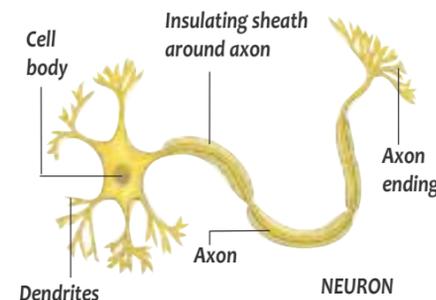
Nerve A bundle of neurons that relays nerve impulses between the central nervous system and the body.

Nerve impulse A tiny electrical signal that travels along a neuron at high speed. It can only travel in one direction along a neuron.

Nervous system The network made up of the brain, spinal cord and nerves. The brain and spinal cord form the **central nervous system (CNS)**. The nerves comprise the **peripheral nervous system (PNS)**.

Neuron An individual nerve cell. It has a cell body from which shorter dendrites and a single, long axon project.

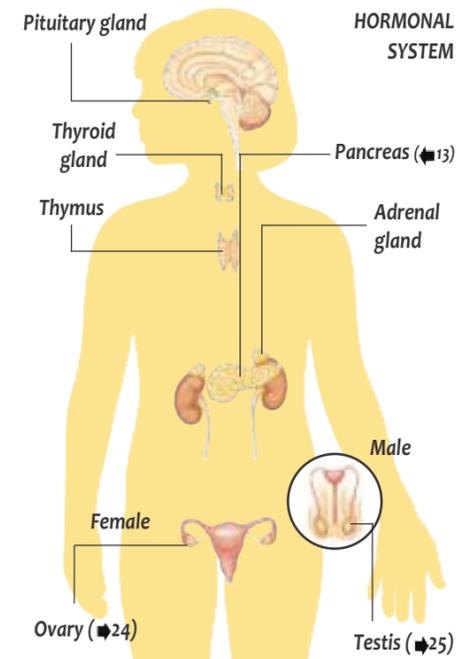
Pituitary gland A tiny endocrine organ at the base of the brain. It releases several hormones, some of which control other endocrine glands.



Reflex An automatic, unconscious response made by the body, often without involving the brain. If you touch something sharp, pain sensors in the skin send nerve signals along the arm to the spinal cord. Signals go straight back to the arm to make it move.

Sensory neuron A type of neuron that carries signals to the brain and spinal cord from sense organs: the eyes, ears, tongue, nose and skin.

Spinal cord A column of nervous tissue, no wider than a pencil at its thickest, that runs from the brain down the back, protected by the backbone (22).



Synapse A gap between neurons. Signals cannot cross a synapse in their electrical form, so one neuron releases a chemical that passes across the gap and triggers an electrical impulse in the next neuron.

Thalamus Part of the brain that relays incoming information to the cerebrum.

Thymus A gland that helps develop the body's immune system (28) in early life.

Thyroid A gland in the neck that controls the rate at which the body's cells "burn" food to release energy.

FACTFILE

- ★ The brain contains approximately 100 billion neurons.
- ★ Nerve signals travel at different speeds along different types of neuron. They can be as slow as 0.5 metres per second, or as fast as 120 metres per second.
- ★ During early pregnancy, about 250,000 neurons develop per minute inside the foetus (26).
- ★ The brain uses one-fifth of all energy consumed by the body.

EYES & EARS

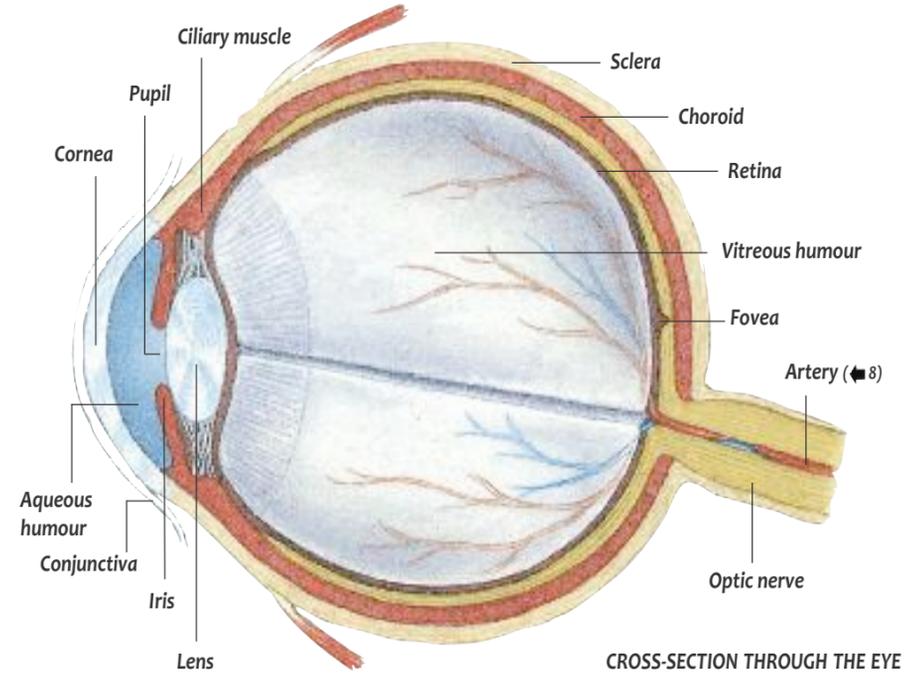
Five main senses tell the body what is happening in the outside world: sight, hearing, taste, smell and touch. Of these, sight is the most important—around three-quarters of all information processed in the brain comes from the eyes. The eyes are two round organs at the front of the head. They detect light rays and convert them to nerve signals (14) which are sent to the brain. On either side of the head are the ears, the organs that detect sound. They collect sound vibrations from the air, and change them into nerve signals which are sent to the brain. They also help the body to balance.

Aqueous humour A watery fluid in the eye between the cornea and the lens.

16 **Choroid** A layer of the eye between the retina and sclera, containing blood vessels.

Ciliary muscle The muscle that controls the shape of the lens so that it can focus on objects at varying distances.

Cochlea A tiny, coiled tube in the inner ear. It contains a fluid that ripples as sound vibrations pass through it. Hairs detect the movement and convert it to electrical signals, which are passed to the brain.



CROSS-SECTION THROUGH THE EYE

Cones Cells in the retina that convert light into nerve signals. Cones detect colour and detail but do not work well in low light levels.

Conjunctiva The membrane that covers the sclera at the front of the eye. It produces mucus, which lubricates the eye.

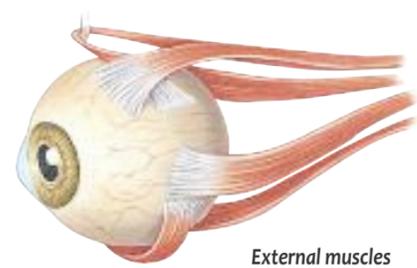
Cornea The transparent dome at the very front of the eye. The cornea does most of the work of focusing images on the retina.

Ear bones Three tiny bones in the middle ear. They are: the **malleus** (hammer), attached to the eardrum, the **stapes** (stirrup), attached to the inner ear and the **incus** (anvil), which connects the two. They amplify vibrations from the eardrum.

Ear canal A tube that runs from the pinna to the eardrum, and carries sound waves into the ear.

Ear wax A yellow, waxy substance produced in the ear. It protects the ear by trapping dirt and fighting off infections.

Eardrum A thin piece of skin stretched tight between the middle and outer ear. When sounds hit the eardrum it vibrates, transmitting sound waves to the ear bones.



External muscles

External muscles Six strap-like muscles that control the movement of each eyeball.

Fovea A small region of the retina, densely packed with cones. It is responsible for sharp, central vision, as used when reading.

Inner ear The innermost part of the ear, containing the cochlea, which deals with hearing, and the vestibular system, which deals with balance.

Iris The coloured part of the eye, a ring of muscle that controls the amount of light entering the eye.

Lens The clear, elastic part of the eye behind the iris. Ciliary muscles pull the lens into shape to adjust the sharpness of the image projected onto the retina.

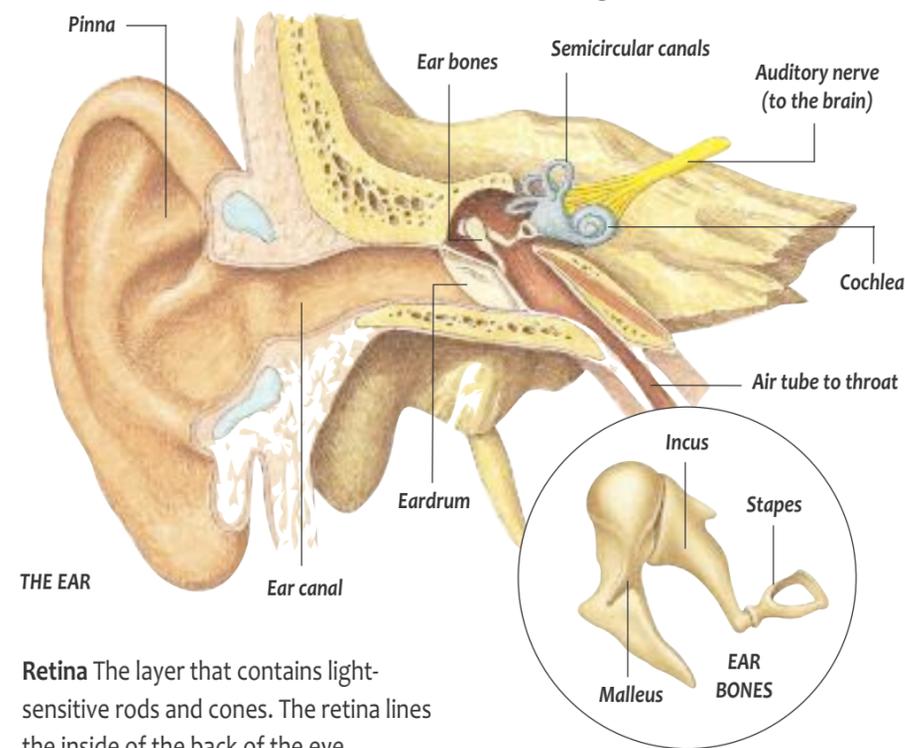
Middle ear The part of the ear between the eardrum and cochlea. This is where sounds are converted to vibrations.

Outer ear The fleshy external part of the ear, including the pinna and ear canal. It funnels sounds into the middle ear.

Optic nerve The nerve at the back of the eye that carries messages to the brain.

Pinna The visible part of the ear, made of skin and cartilage (22). It acts as a funnel to direct sound waves into the ear.

Pupil A hole in the iris, through which light enters the eye. It varies in size to control the amount of light reaching the retina, shrinking in bright light and growing larger in dim light.



THE EAR

Retina The layer that contains light-sensitive rods and cones. The retina lines the inside of the back of the eye.

Rods Cells in the retina that change light into nerve signals. Rods work in low light levels but cannot see colours or detail.

Sclera The tough, white part of the eye.



Microscopic "hairs" inside the cochlea

Semicircular canals Three tiny tubes in the inner ear that detect head movements so the body can balance. They are filled with liquid that moves as the body moves. Microscopic hairs sense this movement and send signals to the brain.

Vestibular system The part of the inner ear that controls balance. It includes the semicircular canals and two tiny sacs, the **sacculle** and **utricle**. These contain tiny grains of chalk that shift as the head moves, passing over nerve endings, which send messages to the brain.

Vitreous humour A clear, jelly-like substance that fills the space in the middle of the eyeball.

FACTFILE

★ Muscles move the eye about 100,000 times a day.

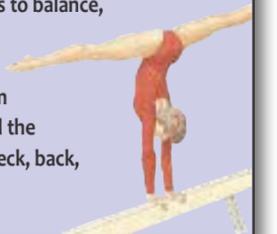
★ Pupils can vary in size from one to eight mm across.

★ Eyebrows, eyelids and eyelashes all protect the eyes from sweat and dirt.

★ If you spin around for very long, the liquid in your cochlea keeps moving even after you stop. This makes you feel dizzy.

★ The ear bones are the smallest bones in the body.

★ In order for us to balance, the brain must process nerve signals both from the inner ear and the muscles of the neck, back, legs and feet.



Images are focused upside down on to the retina. The brain turns them the right way up again.



MOUTH & NOSE

The mouth is a large opening in the face through which food and air enter the body. Inside the mouth, teeth chew food so it can be swallowed, while the tongue tastes food to check it is safe. The tongue and teeth are also important to speech. Above the mouth is the nose, the organ that detects smell. Like the mouth, the nose links to the trachea (11) via the throat. Fine hairs in the nose catch dust and germs carried on the air. The air is also warmed and moistened in the mouth and nose before it enters the lungs (10).

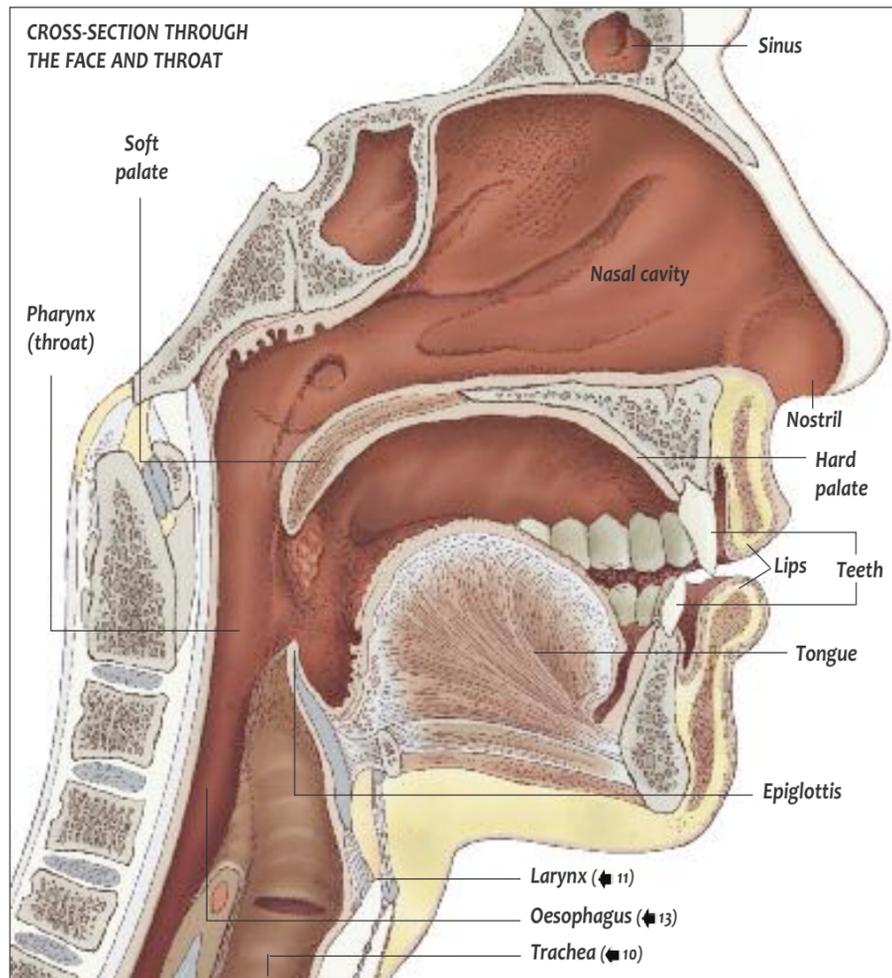
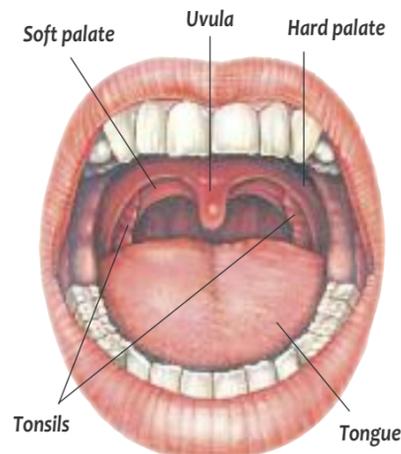
Canines The four pointed teeth near the front of the mouth, used to rip food.

Crown The part of a tooth that is visible above the gum.

Dentine A hard, yellowish, bone-like material inside teeth.

Enamel The hard white coating on the outside of teeth. Enamel is the hardest substance in the body.

Epiglottis A flap at the top of the trachea. It stops food from entering the trachea.



Gum The pink tissue that forms a tight seal around the teeth.

Incisors The thin, sharp teeth at the front of the mouth. During chewing, they come together like scissors to cut up food.

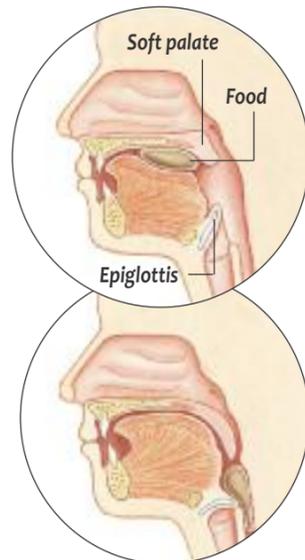
Jaws The part of the skull enclosing the mouth. The upper jaw cannot move. The lower jaw is moved by muscles in the head.

Lips The two fleshy, flexible folds of skin that surround the mouth. The lips close during chewing to keep food in the mouth. They also help to form words.

Molars The wide teeth at the back of the mouth, used to crush and chew food.

Nasal cavity The large space behind the nose. The lower, respiratory region warms and moistens air before it enters the lungs. The upper, olfactory region is lined with receptors that detect smells.

Nostrils The two openings in the nose, separated by a thin wall of cartilage (22) called the **septum**.

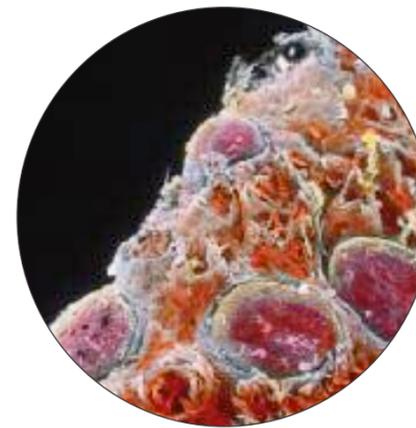


When swallowing, the soft palate moves up to block off the nose and the epiglottis closes the trachea.

Palate The roof of the mouth. The front **hard palate**, is a surface that the tongue can push food against when chewing. The back part, the **soft palate**, prevents food going into the back of the nasal cavity.

Papillae Tiny bumps on the top of the tongue. They help grip food, and some contain the tongue's taste buds.

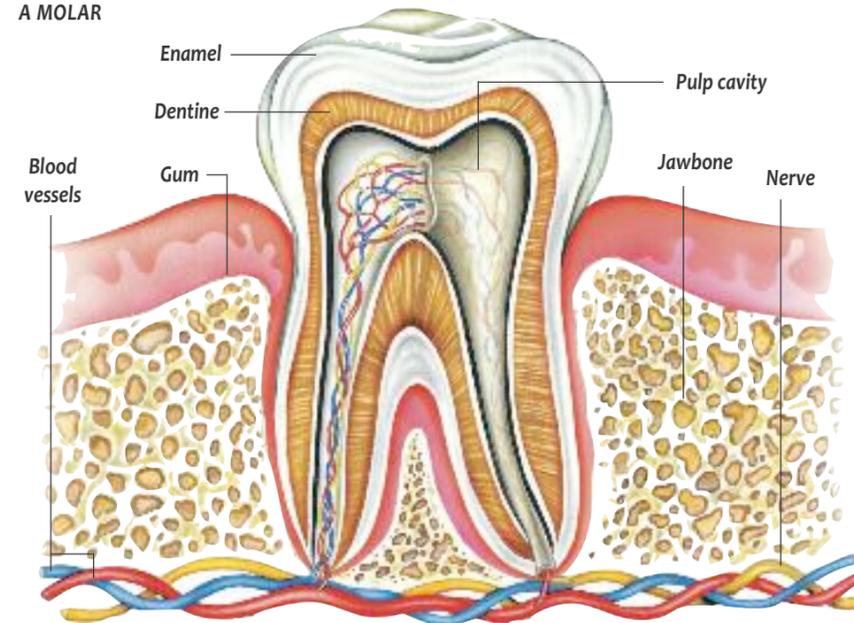
Pharynx The throat, extending from the mouth and nose to the point where the trachea and oesophagus (13) divide.



A micrograph of tongue papillae. The mushroom-shaped papillae contain taste buds.

Premolars The flat, broad teeth between the canines and the larger molars. Premolars are used for grinding food.

CROSS-SECTION THROUGH A MOLAR



Pulp The soft tissue at the centre of teeth, containing nerves and blood vessels.

Root The part of a tooth under the gum that fixes the tooth firmly to the jaw bone. It is attached to the bone by a hard substance called **cementum**.

Saliva A slippery liquid that makes food moist and easy to swallow. It contains enzymes (12) that start digestion and moistens food, enabling the taste buds to respond to it. Saliva is produced by six glands (14) located around the mouth.

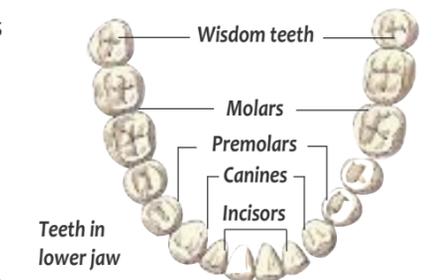
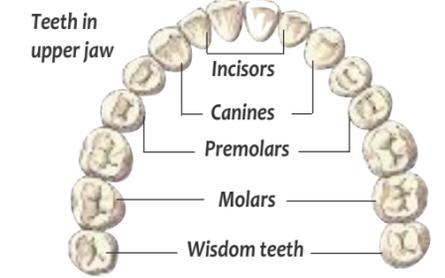
Sinuses Small air pockets in the skull bones around the nasal cavity. They make the skull lighter and help moisten inhaled air.

Taste buds Clusters of taste detecting cells housed in certain papillae on top of the tongue. Taste buds detect tastes that have dissolved in saliva as food is being chewed. Five tastes—sweet, sour, salty, bitter and unami (savoury)—can be detected.

Tongue A muscular organ attached in part to skull bones. The tongue tastes food, and helps to move it around the mouth. It also helps us to form words during speech.

Tonsils Patches of tissue that surround the back of the mouth. The tonsils help to kill bacteria (28).

Uvula A small strip of tissue that hangs down at the back of the mouth. The uvula helps to make certain noises in speech.



Wisdom teeth Four molar teeth at the very back of the mouth that usually appear between the ages of 18 and 21. Some people's wisdom teeth never come through.

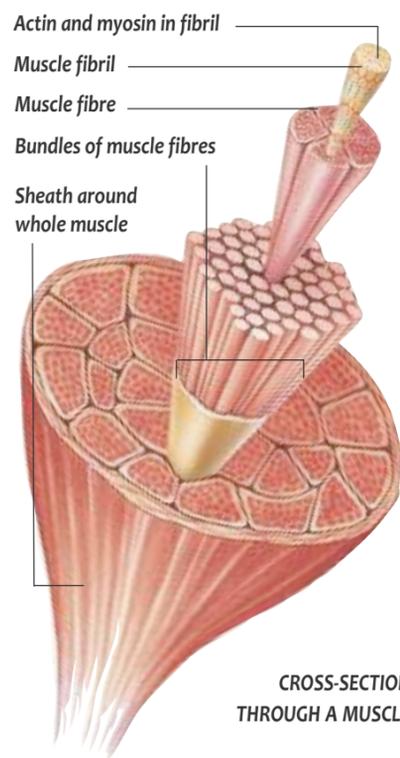
FACTFILE

- ★ Children have twenty small teeth, called milk teeth or baby teeth. Throughout childhood they gradually fall out and are replaced by larger, permanent teeth.
- ★ The average person can recognize about 10,000 different smells.
- ★ The nose is crucial to taste as well as smell. If you hold your nose, it is much harder to tell different foods apart.
- ★ The human body produces nearly two litres of saliva a day.
- ★ Inhaled air passes both the respiratory and olfactory regions of the nasal cavity. Exhaled air only passes the respiratory region. This is why we cannot smell our own breath.

MUSCLES & SKIN

Muscles are made of long cells called fibres that are able to contract (shorten) in order to move body parts. Skeletal muscles are attached to bones and work in opposing teams to move parts in different directions. The walls of the body's organs, such as the intestines, bladder (12) and heart (8) also contain muscle. Covering the entire body is its largest organ, the skin. Tough, waterproof and germ-proof, it protects the body's insides from wear and tear, and from the sun's harmful rays. It also gives the body its sense of touch.

Cardiac muscle A specialized muscle found only in the wall of the heart. It contracts automatically and without tiring for a whole lifetime, to pump blood around the body.



CROSS-SECTION THROUGH A MUSCLE

Dermis The lower layer of skin, containing blood vessels, nerve endings and hair roots.

Epidermis The protective upper layer of the skin. It constantly renews itself as dead cells are worn away.

Fibril A fine bundle of long, chain-like muscle proteins called actin and myosin. Bundles of fibrils make up fibres, and bundles of fibres form a muscle. When a muscle contracts, actin and myosin slide past each other. These tiny movements inside every fibril make the muscle shorter.

Hair A thread-like strand growing from the skin. Hair consists mainly of dead cells packed with tough, waterproof keratin, the substance also found in nails. The visible part of the hair is called the **shaft**. Living cells at the base of a hair follicle divide to make the hair grow.

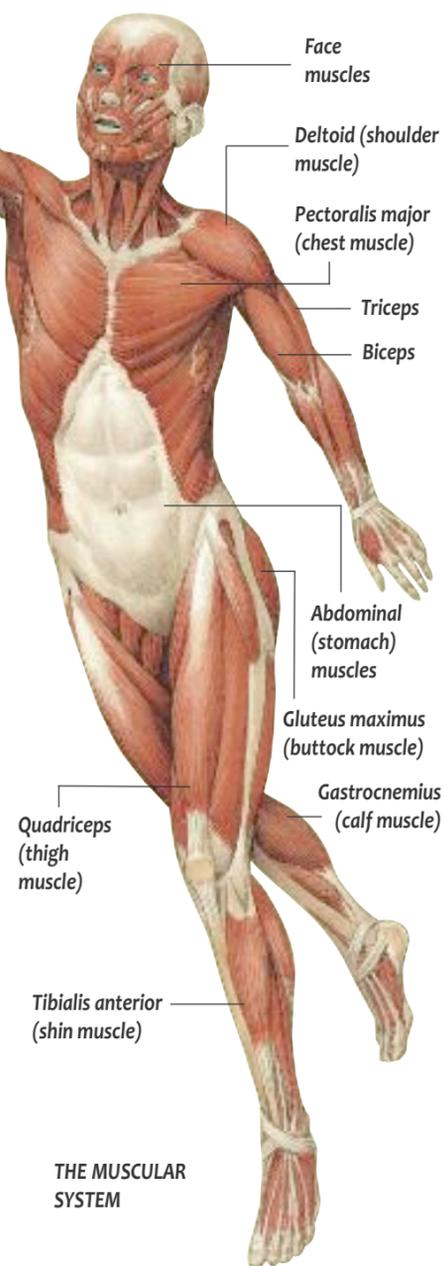
Hair erector muscle A muscle attached to each hair follicle. In cold conditions, it contracts to pull the hair upright, producing goosebumps.

Hair follicle A tiny pit in the skin, from which a hair grows. The shape of hair follicles determines whether hair is curly, wavy or straight.

Melanin The dark pigment that gives skin its colour and protects it from sunlight. It is made in cells in the epidermis called **melanocytes**. If the skin is exposed to the sun for long periods, it may make more melanin for protection, resulting in a tan.

Musculoskeletal system The skeletal system (22) and muscular system combined. It consists of: bones, muscles and joints. Bones and muscles work together to make the body move.

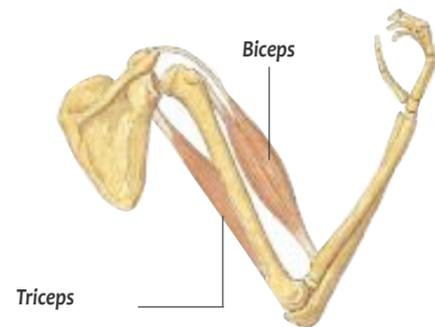
Nail A hard, flat surface at the end of a toe or finger. Nails grow from roots tucked into folds in the skin. The visible part of the nail is dead.



THE MUSCULAR SYSTEM

Nail cuticle A skin fold at the base of a nail.

Pore An opening in the skin, through which cooling sweat seep out on to the skin.



The biceps shortens and pulls the lower arm to bend the elbow. The triceps shortens and pulls to straighten the elbow, as the biceps relaxes.

Sebum The natural oil that keeps skin moisturized and waterproof.

Sebaceous glands Glands (14) attached to hair follicles that produce sebum.

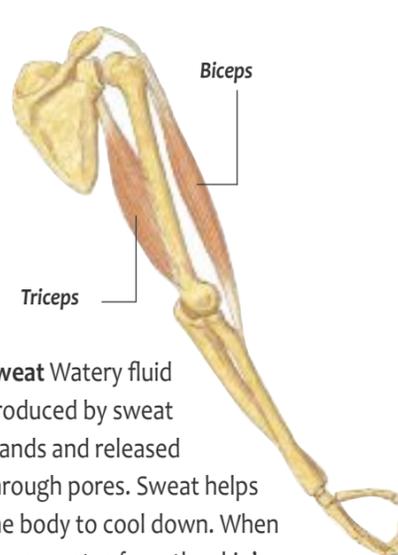


A close-up view of a hair shaft

Skeletal muscle Muscle connected to two bones across a joint, and responsible for moving part of the skeleton. Skeletal muscle is also known as **voluntary muscle** because it can be moved at will, or **striped muscle** because its long fibres have a striped appearance under a microscope.

Smooth muscle A type of muscle found in the walls of hollow internal organs, such as the bladder, blood vessels and stomach. It is also known as **involuntary muscle** because it works automatically.

Subcutaneous fat A layer of fat just beneath the skin. It keeps the body warm and cushions it from knocks.

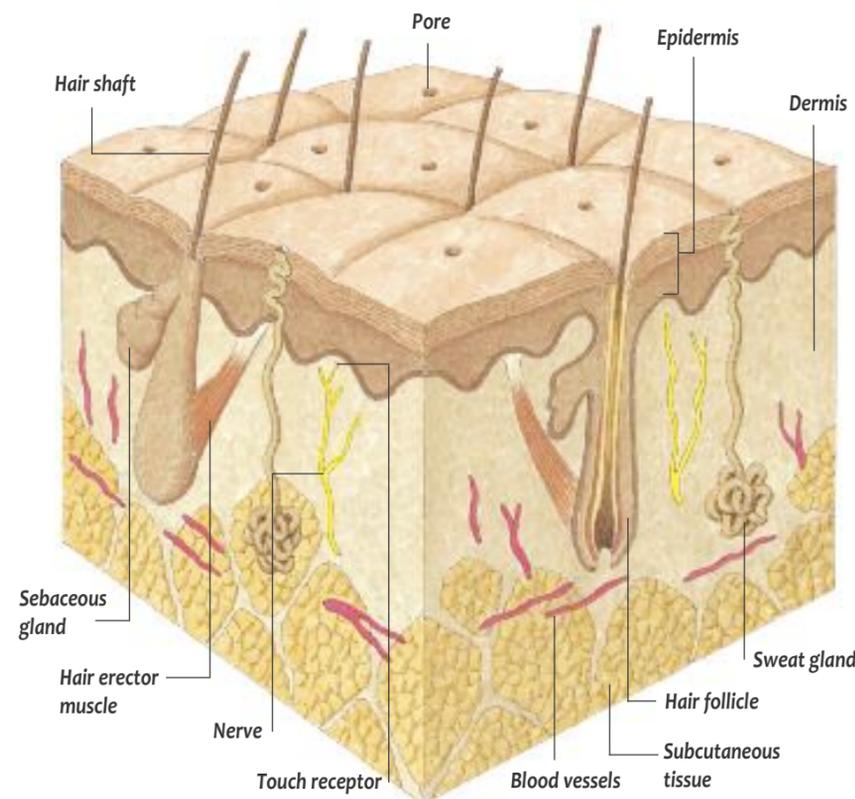


Sweat Watery fluid produced by sweat glands and released through pores. Sweat helps the body to cool down. When it evaporates from the skin's surface (turns from a liquid into a gas), it takes some of the body's heat with it.

Sweat glands Glands (14) in the dermis that produce sweat.

Tendon A strong, tough cord that attaches a muscle to a bone. Bones are moved when muscles pull on tendons. Tendons contain fibres of tough collagen (22).

CROSS-SECTION THROUGH THE SKIN



FACTFILE

- ★ The bulkiest muscle is the gluteus maximus in the buttock.
- ★ The smallest muscle is the stapedius, inside the ear. It is just a few millimetres long and thinner than a piece of thread.
- ★ The strongest muscle is the masseter in the jaw.
- ★ Skeletal muscle forms up to 45% of an average adult's weight.
- ★ There are about two square metres of skin covering the average body.
- ★ The thickest skin in the body grows on the soles of the feet and the palms of the hands, where it is up to 5 mm thick. The thinnest skin is on the eyelids, where it is only 0.5 mm thick.
- ★ An average person has about 120,000 hairs on his or her head.
- ★ Fingerprints are the patterns made by ridges of skin on the fingertips. Even though skin is constantly replaced, this pattern will never change. No one person has the same fingerprints—not even identical twins.

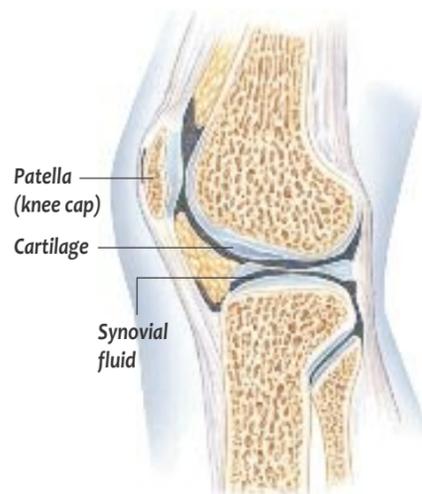
BONES & JOINTS

Bones are hard, strong structures that fit together to make the body's basic framework—the skeleton. Bone is made of living cells, surrounded by hard minerals, such as calcium phosphate, and tough, flexible collagen fibres. Bones support the body's weight and give it shape, protect its internal organs, and work together with the muscles to make the body move. The places where bones meet are called joints. They allow the skeleton to move into different positions.

Backbone The column of irregular bones (vertebrae) that run the length of the back, supporting the body and protecting the spinal cord (15). The backbone is also known as the **spine** or **vertebral column**.

Ball-and-socket joint A type of joint that allows bones to move in any direction. The round end of the bone sits in the joint like a ball in a cup. The hips and shoulders are both examples of ball-and-socket joints.

CROSS-SECTION THROUGH THE KNEE JOINT



Bone marrow The jelly-like substance in the middle of bones. **Red bone marrow** makes new blood cells (9). **Yellow bone marrow** stores fat and minerals (28). Most of the bones in a baby's body contain red marrow. With age, this changes mostly into yellow.

Cancellous bone Spongy bone tissue with a honeycomb structure that makes it both strong and light. It is found in flat bones and at the end of long bones.

Cartilage A strong, flexible tissue that covers and cushions the ends of bones in synovial joints. Some body parts, such as the outer ear, are shaped by cartilage.

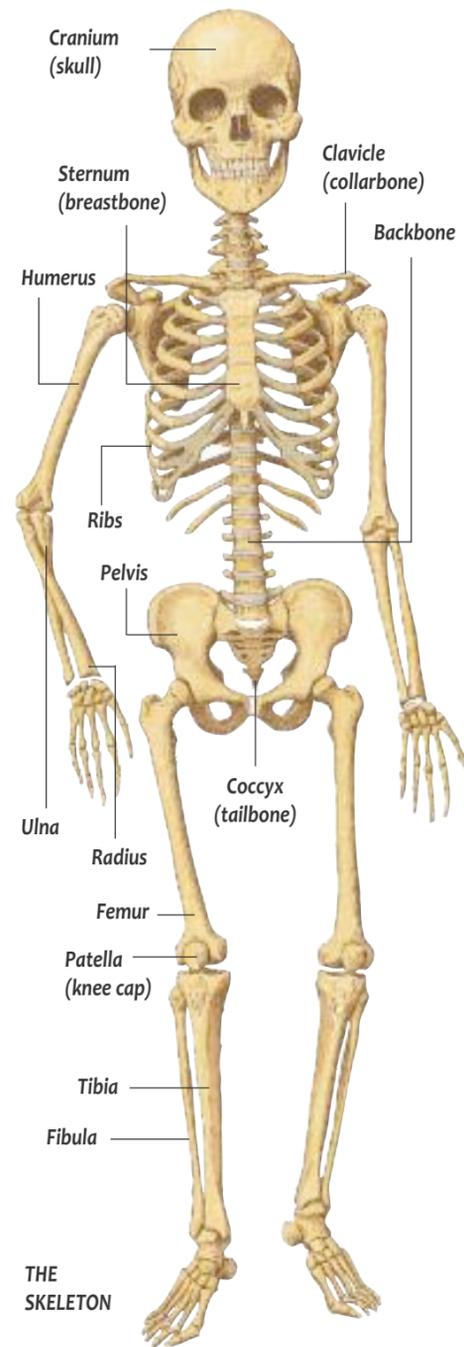
Cartilaginous joint A slightly flexible joint connected solely by cartilage, for example, the joints between ribs and the breastbone.

Collagen The tough protein found inside bone. It makes bones slightly flexible.

Compact bone Hard, strong bone tissue that forms the outer shell of most bones. It is the strongest type of bone in the body.

Fibrous joint A fixed, immovable joint connected by fibrous tissue.

Flat bone A broad, flat bone, consisting of cancellous bone between compact bone. Flat bones either protect internal organs, as in the pelvis, or form a surface for muscles to attach to, as in the shoulder blades.



THE SKELETON

Hinge joints A type of joint that allows bones to move in one plane, like an opening and closing door. The elbow is a type of hinge joint.

Irregular bone A bone that cannot be grouped as flat, long or short but is shaped for the particular task it serves. Irregular bones include vertebrae and facial bones.

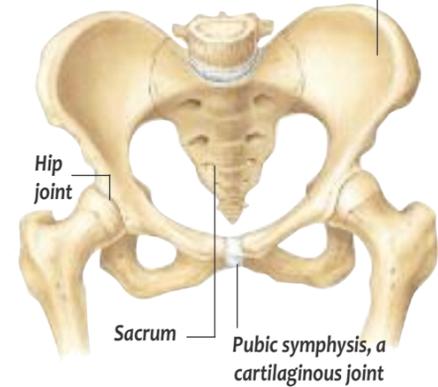
Ligament A strong, flexible strap that holds two bones together at a joint. Ligaments are made of collagen fibres.

Long bone A long, thin bone with a knob at each end. The shaft is reinforced by compact bone, while cancellous bone is at the ends. Long bones are found in the arms and legs.

Ossification The process of bone growth. Babies have about 300 bones, made mostly from cartilage. Over time, this hardens into bone, and the bones fuse together. Bones stop growing at around the age of 20.

Osteoblasts Cells that grow new bone and repair damaged bone.

BONES OF THE PELVIS



Osteoclasts Cells that break down bone tissue by dissolving calcium phosphate and other minerals in the bone.

Pelvis A bowl-shaped ring of bones consisting of two hip bones joined to the sacrum of the backbone. It protects the bladder, intestines and reproductive organs.

Periosteum A membrane that covers the outside of bones. Periosteum contains blood vessels that nourish the bones.

Ribcage The curved, flat bones that surround the chest and protect the lungs, heart, liver and stomach. The ribcage is formed of 12 pairs of ribs, attached to the backbone and, in most cases, to the sternum at the front.

Sesamoid bone A small, flat bone that is embedded in a tendon (21). For example the patella (knee cap), is a sesamoid bone.

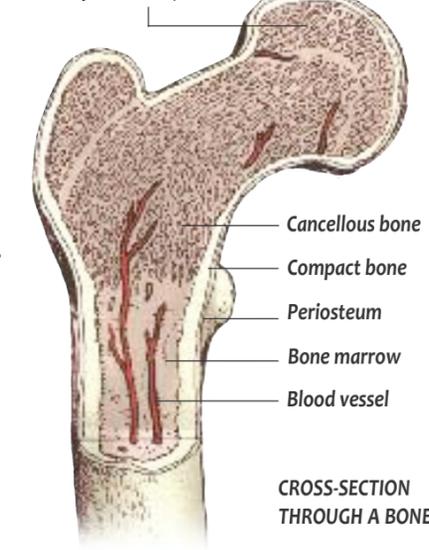


Close up photograph of cancellous bone

Short bone A bone that is as wide as it is long. Short bones are located in the ankles, wrists, hands and feet, and are very strong.

Skull A domed case that protects the brain and shapes the face. The skull is made up of 22 bones, all fused together at suture joints, except for the lower jaw.

Ball-shaped head of bone



CROSS-SECTION THROUGH A BONE

Socket A hole into which another body part fits, for example where a bone fits into a joint. Another example of a socket is the eye socket in the skull, which protects the eyes.

Suture A type of fibrous joint only found in the skull.

Synovial joint A mobile joint surrounded by bags called **synovial capsules**. These produce and contain an oily liquid known as **synovial fluid**, which lubricates the joint and enables bones to move against each other without rubbing.

Vertebrae The 26 separate bones that fit together to make the backbone. Discs of cartilage between each bone cushion the vertebrae so that they can twist and tilt against each other as the back moves.

FACTFILE

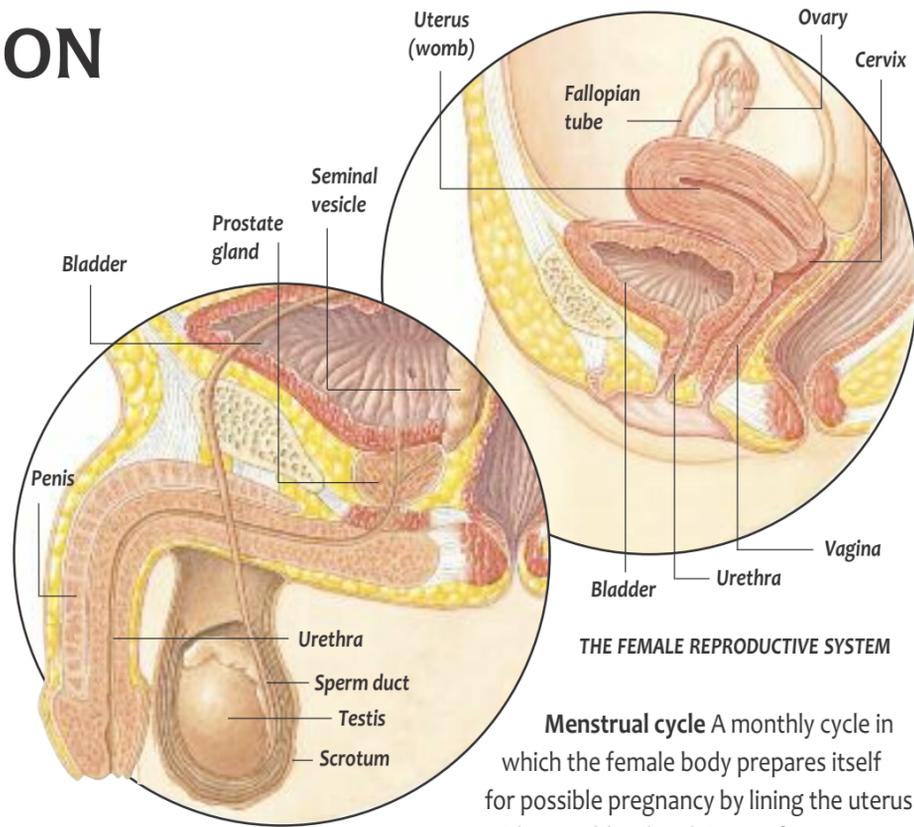
- ★ There are 206 bones in the human skeleton. Half of these are found in the hands, feet, wrists and ankles.
- ★ About one-fifth of all bone is water.
- ★ Heavy compact bone makes up about 80% of the weight of an adult human body.
- ★ Bones are strong but sometimes they cannot withstand the stress put on them, especially in an accident. Sometimes a bone may crack or snap. This is known as a fracture. Bones heal themselves naturally, but often a doctor will put a hard plaster cast around a broken bone to hold it in place and make sure that it mends straight.

REPRODUCTION

A key feature of all living things is that they make more of their kind. This is called reproduction. The main parts of the female reproductive system are the uterus and the two ovaries, which produce eggs. The main parts of the male reproductive system are the two testes, which produce sperm. When a male and female come together in sexual intercourse, a sperm fuses with, or fertilizes, an egg. The fertilized egg divides and develops in the uterus of the female. It takes about 38 weeks to grow into a baby ready to be born.

Amniotic fluid The fluid that surrounds and protects a baby when it is inside the uterus.

Embryo An unborn baby in the first eight weeks of gestation. During this period, all of the main body parts and organs, such as the brain, heart, eyes, ears and toes form.



THE MALE REPRODUCTIVE SYSTEM

THE FEMALE REPRODUCTIVE SYSTEM

Menstrual cycle A monthly cycle in which the female body prepares itself for possible pregnancy by lining the uterus with extra blood and tissue. If an egg is fertilized it will bury itself in the tissue to develop. If not, the tissue will break down and leave the body through the vagina. This is called **menstruation**.

Oestrogen The main hormone (♣15) in the female reproductive system. It is made in the ovaries and controls many of the changes in a girl's body during puberty.

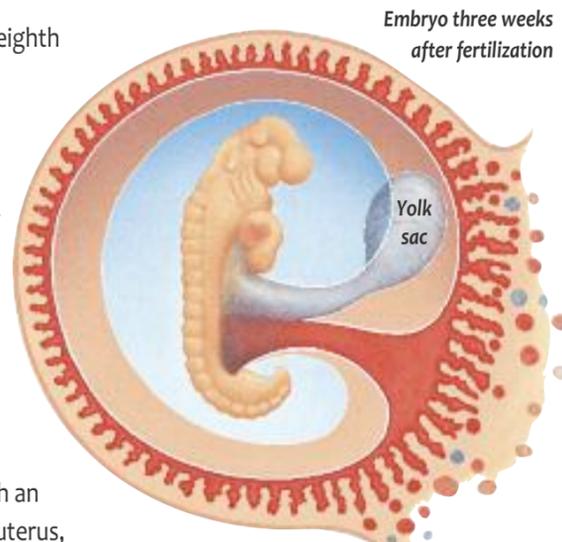
Fallopian tubes Two tubes, also known as oviducts, that connect each ovary to the uterus. Eggs made in the ovaries pass down the fallopian tubes into the uterus.

Fertilization The coming together of a sperm and an egg. A fertilized egg is ready to grow into a baby.

Foetus An unborn baby after the eighth week of gestation until it is born. The baby spends most of this period simply growing bigger.

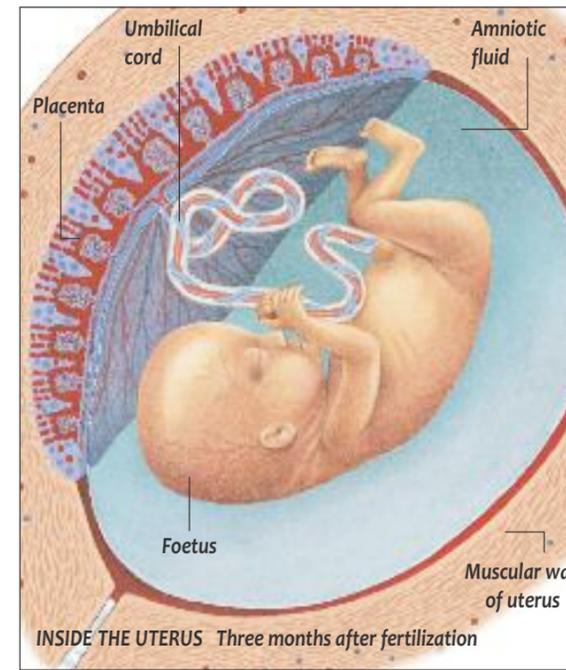
Gamete A sex cell (egg or sperm). Sex cells contain half as much genetic material (♣28) as other cells. During fertilization, a male and female sex cell come together to make one cell with a complete set of genetic material.

Gestation The period during which an unborn baby develops inside the uterus, also called pregnancy. The gestation period for humans is about 38 weeks.



A yolk sac nourishes the embryo until the placenta takes over 10-12 weeks into gestation.

Fingers and toes appear in the seventh week after fertilization.



An ultrasound scan allows doctors to see how a foetus is developing inside its mother's uterus.



Ovaries Two female reproductive organs that produce eggs, or ova. Every 28 days an egg is released from one ovary and travels down the fallopian tube into the uterus. This is called **ovulation**.

Ovum A female sex cell, or egg.

Penis The male sex organ. During sexual intercourse the penis is inserted into the female's vagina where it releases sperm.

Placenta A plate-shaped organ in the uterus lining. It provides a baby with nourishment and oxygen via the **umbilical cord**.

Progesterone A female hormone (♣15) that helps to control the menstrual cycle and prepare the body for pregnancy.

Puberty The period when a child's body develops so that it is able to reproduce. This usually takes place between the ages of 11-14 in girls and 13-16 in boys. Girls develop a more rounded body shape and grow breasts. Boys grow facial hair and their voices deepen.

Sperm Tiny, tadpole-shaped male sex cells. During sexual intercourse, sperm pass along the sperm duct and out of the penis, into the female's body.

Testes The main parts of the male reproductive system, where sperm cells are made. They hang below the body in a sac of skin called the **scrotum**.

Testosterone The hormone (♣15) made by the testes. It controls all of the changes in a boy's body during puberty.

Umbilical cord A cord containing blood vessels and connecting a foetus to the placenta during gestation.

Uterus An organ in a woman's lower body, where a baby develops during pregnancy. It is also known as the **womb**. The uterus is lined with powerful muscles. When birth starts, these contract to squeeze the baby out of the mother's body.

FACTFILE

★ An egg is the largest type of cell (♣26) in the body. It is just big enough to be seen without a microscope.

★ After three months, a foetus has ears and can hear sounds such as its mother's heartbeat. It can also hear loud noises from outside which may make it jump.

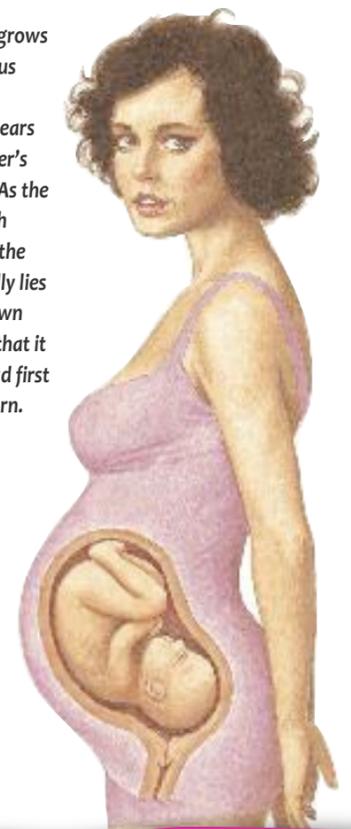
★ During the final seven months of pregnancy, a baby will grow at a faster rate than at any other point in its life.

★ Newborn babies can sleep for up to 20 hours a day. Most new growth takes place when a baby is asleep.

★ During puberty, some people grow more than 10 cm a year. By the end of puberty, most people have reached their final height and will not grow any more.

Vagina The tube-shaped part of the female reproductive system, through which a baby leaves the mother's body. During sexual intercourse, the male's penis is inserted into the female's vagina.

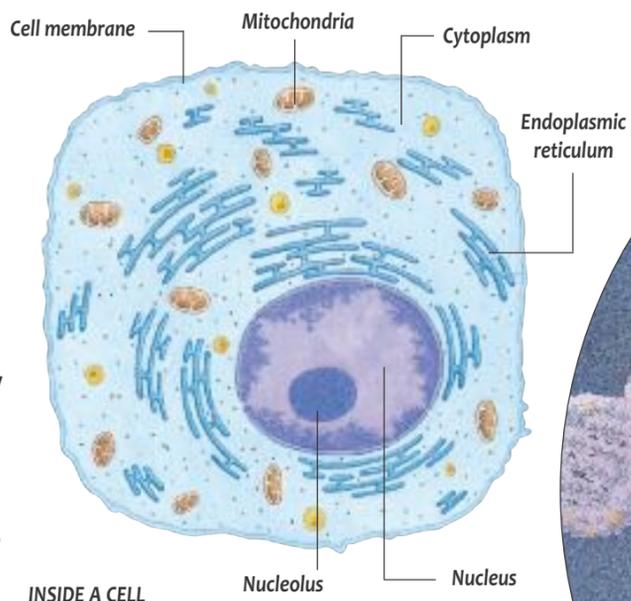
As the baby grows and the uterus stretches, a "bump" appears on the mother's lower body. As the time for birth comes near, the baby normally lies in a head-down position, so that it emerges head first when it is born.



CELLS & GENES

Cells are the basic “building blocks” of the body. There are over 200 kinds, such as blood cells (8), nerve cells (15) and muscle cells (20). They vary in size and shape, depending on their function, but nearly all are far too small to see without a powerful microscope. A typical cell is a bag of jelly, or cytoplasm, containing tiny organelles. At the heart of the cell is the nucleus, which controls the rest of the cell. Coiled up inside the nucleus are strands of a substance called DNA, which contains genes, a kind of “instruction manual” for the body.

Bases Chemicals that make up the “rungs” on a double helix of DNA. There are four different types: adenine (A), thymine (T), guanine (G) and cytosine (C). Each “rung” is a combination of two bases. A always links to T, and G always links up to C. The order in which the bases appear forms the coded instructions in genes.



INSIDE A CELL

Cell division The process by which a cell divides to make two new cells. There are two types of division: mitosis and meiosis. **Mitosis** makes two new cells which are each identical to the original cell. **Meiosis** makes two new cells which each have only half of the original cell’s DNA. This produces the sex cells, eggs and sperm (24).

Cell membrane The lining around the outside of a cell. It allows only certain substances to pass in and out of the cell.

Chromosome A long, thread-like structure inside the nucleus of a cell. A chromosome is made of tightly-wound coils of DNA. Most cells in the human body contain two sets of 23 chromosomes.

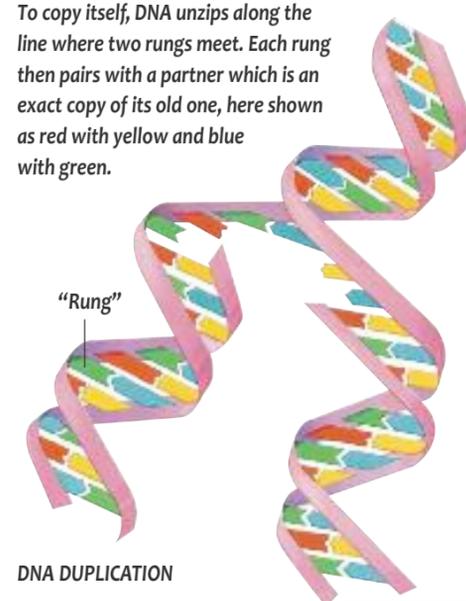
Cytoplasm The jelly-like liquid inside a cell in which organelles float.

DNA (Deoxyribonucleic acid) A chemical in the nucleus of each cell that can copy itself, and carries the instructions (genes) needed to build and run a cell. DNA’s structure resembles a twisted ladder, with two strands linked by “rungs” made of bases. The sequence of bases in DNA forms the “letters” of the coded instructions within genes.

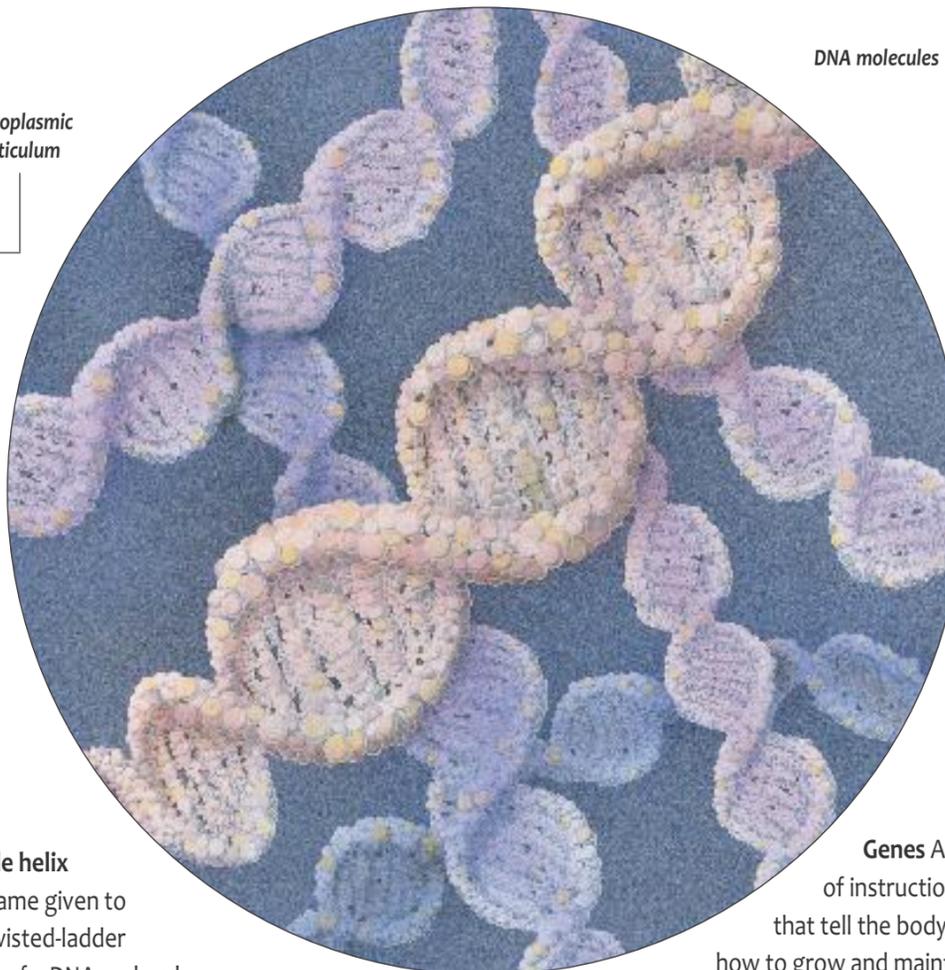
Double helix The name given to the twisted-ladder shape of a DNA molecule.

Endoplasmic reticulum A network of membranes inside a cell’s cytoplasm. The membranes make and transport proteins and other substances, including fats.

To copy itself, DNA unzips along the line where two rungs meet. Each rung then pairs with a partner which is an exact copy of its old one, here shown as red with yellow and blue with green.



DNA DUPLICATION



DNA molecules

Genes A set of instructions that tell the body how to grow and maintain itself. Because genes control the way a body’s cells are built, they help determine a person’s characteristics and appearance. Genes are contained within DNA.

Identical twins look the same because they both developed from one fertilized cell that split in two. This means they share the same genes.



Genetics The branch of science that deals with **heredity**—how features are passed on, or **inherited**, from parent to child via genes.

Genotype The combination of all a person’s genes, inherited from both parents.

Lysosome An organelle filled with enzymes (12) that break down and recycle worn-out organelles.

Mitochondrion An organelle that takes in glucose (12) and other “fuels” and breaks them down using oxygen to release energy for use inside the cell.

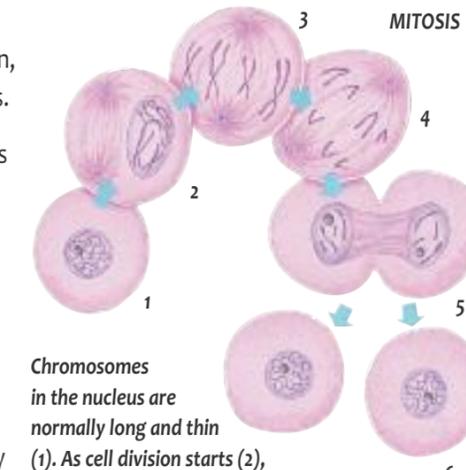
Nucleus A large structure inside a cell. It contains the gene-carrying chromosomes and therefore controls all cell activities.

Nucleolus A small structure inside a nucleus, where RNA is produced.

Organelle A tiny structure inside a cell, such as a mitochondrion. Each type of organelle has its own specific function. Organelle means “little organ”.

Phenotype A person’s appearance as a result of both genotype and environmental factors, such as diet.

RNA (Ribonucleic acid) A chemical related to, but smaller than, DNA. It copies sections of DNA (genes) in the nucleus and uses the instructions to make cell-building proteins.



Chromosomes in the nucleus are normally long and thin (1). As cell division starts (2), they shorten, thicken and duplicate (3). They then line up, split and are pulled to opposite ends of the cell (4). A new nucleus forms around each set (5) and the original cell pinches into two new cells (6).

Ribosome An organelle often attached to the endoplasmic reticulum. Ribosomes are the site of protein production.

Sex chromosomes Two chromosomes that determine sex. Females have two X chromosomes and males have one X and one Y. Sex cells, sperm and eggs, have only one sex chromosome each. When a sperm and egg fuse during fertilization, the sex of the fertilized egg depends on whether the sperm carried an X chromosome or a Y.

Trait A characteristic that is inherited, for example eye colour or hair type.

FACTFILE

- ★ There are more than 100 million million cells in the whole body.
- ★ All the DNA in one cell joined together would stretch nearly two metres. All of the DNA in the whole body could stretch to the Sun and back around 400 times.
- ★ The DNA in any two people is 99.9% the same. It is the remaining 0.1% that makes each of us unique.
- ★ Cell division happens as cells wear away or die and need replacing. The body makes about 3000 million new cells every minute.

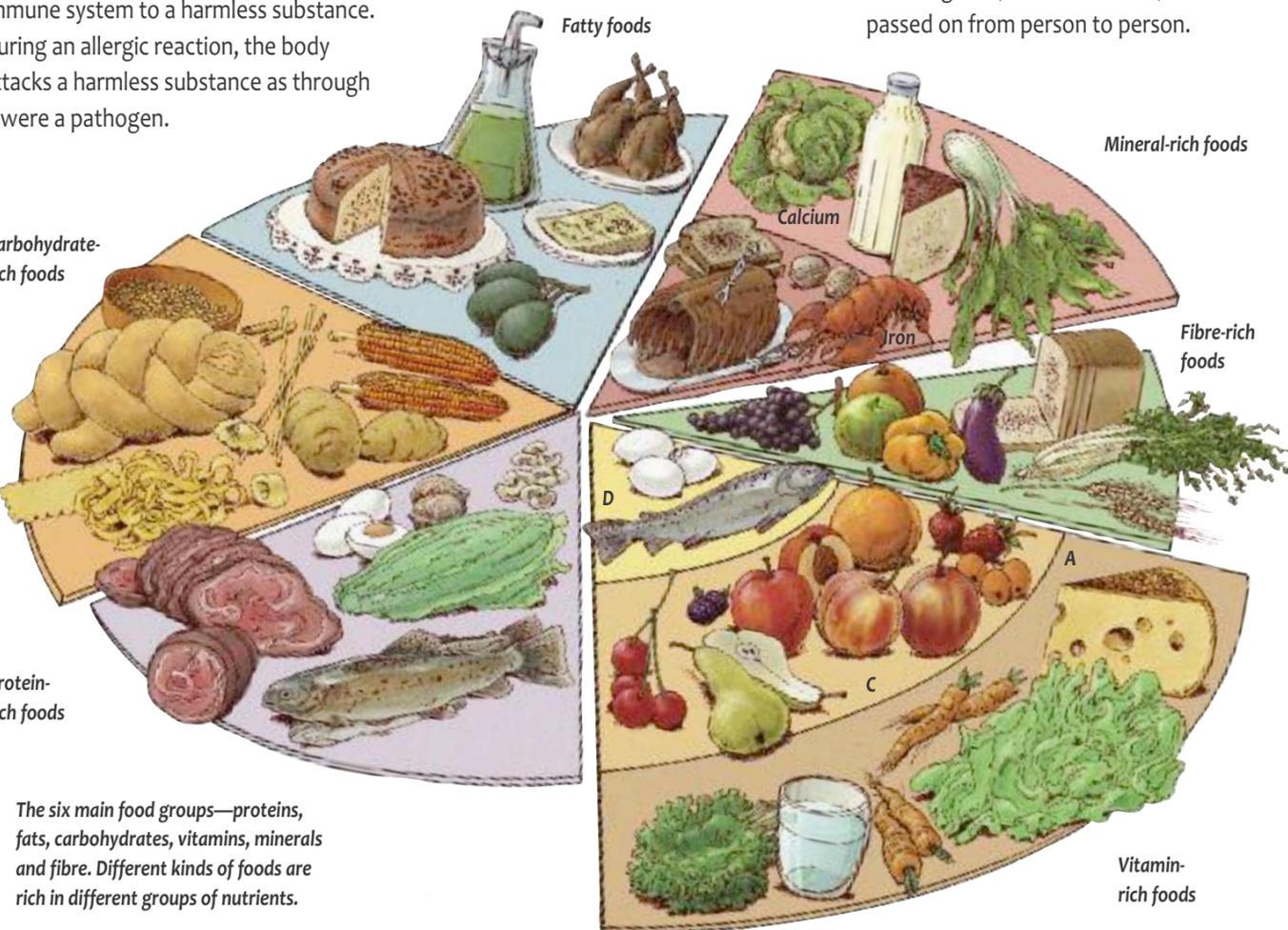
HEALTH

The body is constantly under attack from tiny pathogens (germs) called bacteria and viruses. They enter through cuts in the skin, or in food, water or the air. As a first defence, the body is covered in skin, and the airways are lined with mucus (11) to trap germs. If rotten or poisonous food is swallowed, the stomach pushes it up and out of the mouth. Should germs enter body tissues, the immune system destroys them. But not all diseases are caused by germs. Some are inherited or caused by other factors. To stay healthy, the body also needs a balanced diet to obtain the right amounts of nutrients.

Allergy An abnormal reaction of the immune system to a harmless substance. During an allergic reaction, the body attacks a harmless substance as though it were a pathogen.

Carbohydrate-rich foods

Protein-rich foods



The six main food groups—proteins, fats, carbohydrates, vitamins, minerals and fibre. Different kinds of foods are rich in different groups of nutrients.

Bacterium (plural bacteria) A tiny organism made of just one cell (14). Some bacteria invade living things and cause diseases, but most types are harmless.

Carbohydrate A type of nutrient found in bread, pasta, potatoes and cereals. It is an important source of energy.

Disease A disorder that affects how the body functions. It may affect a certain body part and may have symptoms, such as a cough or high temperature.

Fat A type of nutrient found in meat, dairy products and some fruit and vegetables. Fats, also known as lipids, are needed to build cell membranes and maintain nerves.

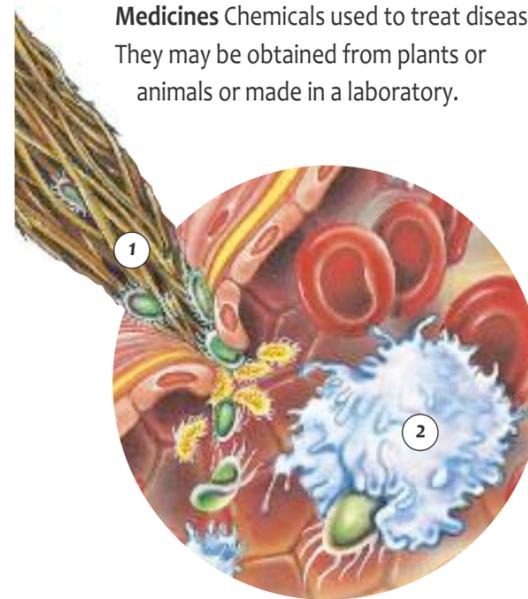
Fibre The part of fruit and vegetables that the body cannot digest. Fibre adds bulk to food. This improves the pushing power of the intestines as they squeeze food along.

Immune system The body system that protects it from invasion by pathogens. It consists mainly of the defensive white blood cells (9) that are found in the circulatory and lymphatic systems, and in body tissues.



A doctor using a stethoscope to listen to a patient's heartbeat and breathing.

Infectious disease A disease caused by pathogens entering and multiplying inside the body. Some infectious diseases, including cold, flu and measles, can be passed on from person to person.



Bacteria may enter the body through a cut (1). White blood cells (2) gather to attack them.

Mental illness An illness that affects a person's emotions, behaviour or learning.

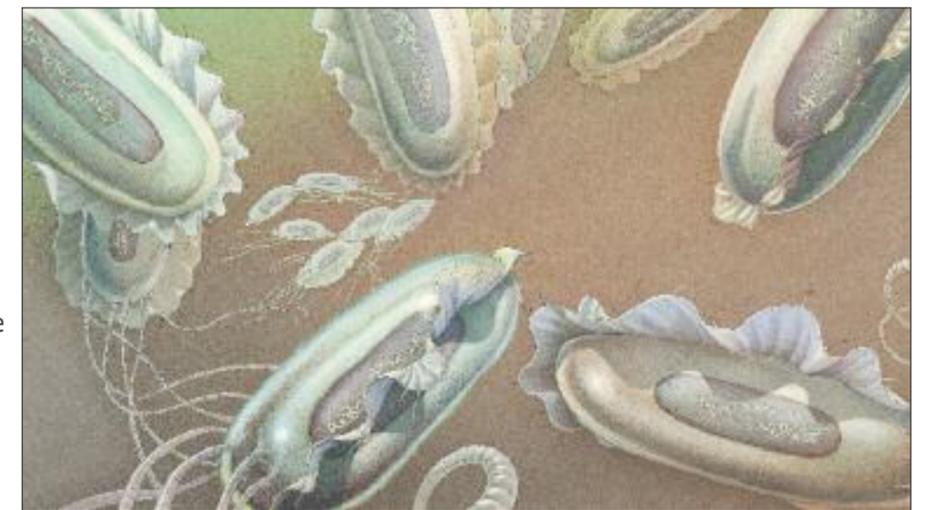
Minerals Chemicals that are needed by the body in order to function properly. For example, calcium, needed for healthy teeth and bones, is found in milk, cheese and vegetables. Meat, bread and nuts contain iron, used to make red blood cells.

Non-infectious disease A disease that is not caused by a pathogen. Non-infectious diseases may be inherited via genes (27), caused by environmental factors such as pollution or brought on by an unhealthy lifestyle. Unlike infectious diseases, they cannot be passed on through contact.

Lymph Fluid that is drained from the body's tissues by lymph vessels, which return it to the bloodstream. Fluid in the bloodstream passes through capillary walls (8) to carry nutrients to tissue cells and pick up wastes. Most of it passes back into the blood but some remains in the tissue until removed, as lymph, by lymph vessels. Along the way, it passes through lymph nodes, where white blood cells kill pathogens in the lymph.

Lymphatic system The network of vessels that carries lymph around the body.

Medicines Chemicals used to treat diseases. They may be obtained from plants or animals or made in a laboratory.



Bacteria as seen under a powerful microscope

Nutrients Substances in food, including carbohydrates, proteins, fats, vitamins and minerals, that humans and other living things need in order to build and run their bodies and maintain good health.

Pathogen A bacterium, virus or other micro-organism that causes disease. Pathogens multiply inside the body.

Protein A type of nutrient that helps to build muscles and other body parts. Proteins are found in meat, poultry, fish, milk, beans and green vegetables.

Vaccination A treatment that prevents disease by injecting the body with a harmless version of a pathogen, which the immune system learns to identify. If the body encounters the harmful version of the pathogen, it will destroy it rapidly.



An x-ray of a chest, showing the lungs and ribs

Virus A microscopic, disease-carrying organism that can reproduce itself only inside the cell of a living organism.

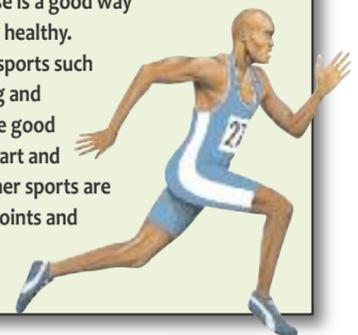
Vitamins Chemicals that the body needs to stay healthy. Vitamin A, found in green vegetables and dairy products is important to eyesight and skin. Vitamin C, which helps to heal wounds, is found in citrus fruits. Eggs and fish are rich in vitamin D, needed for strong bones.

X-ray An image showing the inside of a body. X-rays can reveal a broken bone, or show if the lungs are infected.

FACTFILE

★ Before the invention of the microscope, people had no knowledge of pathogens, so no one understood the importance of keeping wounds clean. Surgeons rarely washed their hands or instruments. Many more people died following operations than recovered.

★ Exercise is a good way of staying healthy. Vigorous sports such as running and cycling are good for the heart and lungs. Other sports are good for joints and muscles.



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