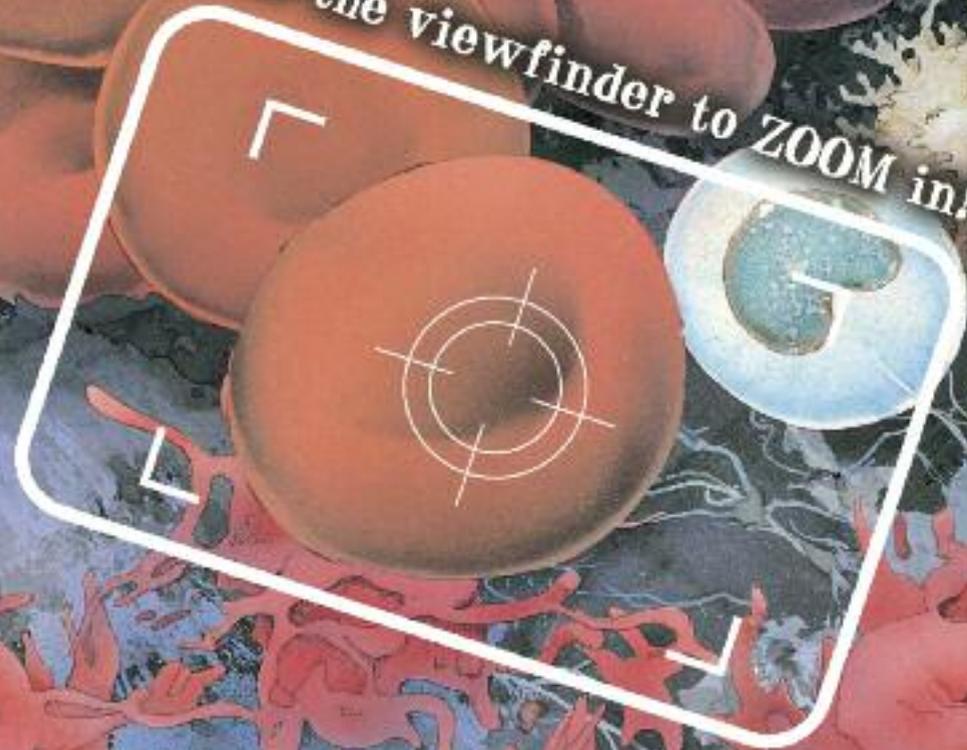


# ZOOM!

through the  
Human Body

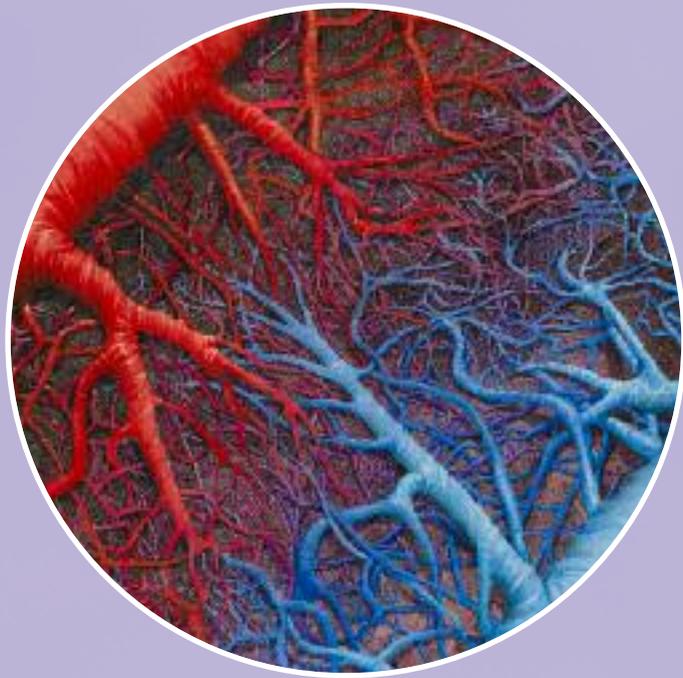
Use the viewfinder to ZOOM in!



# ZOOM!

through the

# Human Body



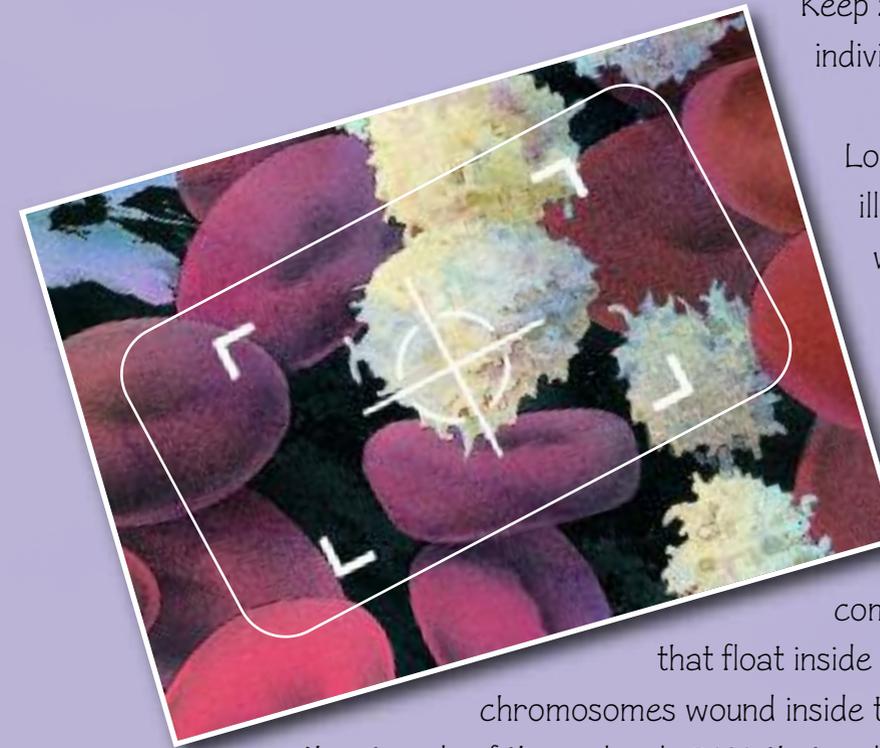
 Orpheus



# Let's zoom!

IMAGINE you could go on a journey inside the human body, getting smaller and smaller all the time until you were actually inside a cell, only millionths of a millimetre in size. That is exactly where this book takes you to. With your viewfinder trained on the skin of a sleeping child, you can see the hairs on his skin appearing like mighty tree trunks. Zooming in beneath his skin you see the blood vessels looking like a tangle of tree roots.

Keep zooming, and you'll start to see the individual cells that make up the blood itself.



Look for the viewfinder on each illustration. Then turn the page to see what you've zoomed in on next. As the magnification gets bigger and bigger, you'll enter some incredible

new worlds at every scale.

You'll visit the cells, the

complex structures

that float inside them, the

chromosomes wound inside the cell nucleus,

the strands of the molecule DNA that makes up the

chromosomes, and finally the mysterious interior of just one atom that makes up that molecule.



First published in 2012 by Orpheus Books Ltd.,  
6 Church Green, Witney, Oxfordshire, OX28 4AW England  
[www.orpheusbooks.com](http://www.orpheusbooks.com)

Copyright © 2012 Orpheus Books Ltd.

Created and produced by Orpheus Books Ltd.

Text Nicholas Harris

Consultant Steve Parker, Scientific Fellow of the Zoological Society

Illustrated by Studio Inklink, Firenze

Other illustrators Giuliano Fornari, Debra Woodward

All rights reserved. No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the copyright owner.

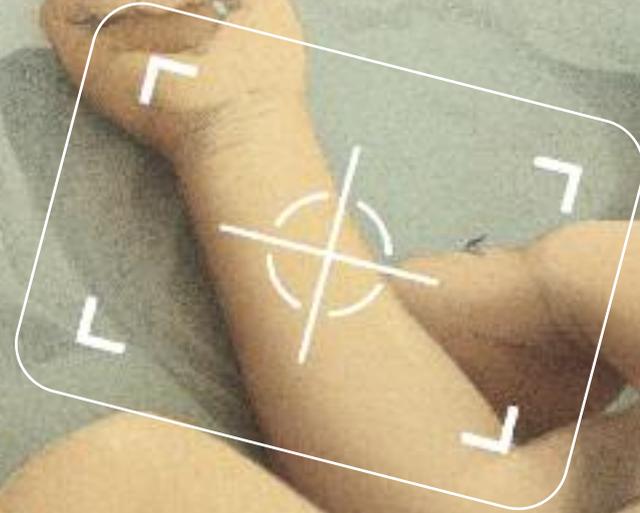
ISBN 978 1 7418 3795 2

A CIP record for this book is available from the British Library.

Printed and bound in Singapore.

# A sleeping child

**A** young child sleeps. While he does so, all his body's working parts continue to function. His digestive organs, including the stomach, intestines and liver, sort out the nutrients, the substances useful to the body, from the food he has eaten. His body has a constant need for oxygen, so he breathes air, his lungs alternately sucking in oxygen and expelling carbon dioxide. His heart still beats, pumping blood, which carries nutrients and oxygen to all parts of his body. Even his brain is active, controlling his digestion, breathing and heart beat, and many other things besides.



**T**he human body is an amazing natural machine. If you give it food, water, air and warmth, it can walk, talk, think and produce more of its own kind. Flesh and bones, blood and organs are all superbly designed to act together and make it a moving, feeling and clever being!

The human body is made of tiny building blocks called cells. There are more than 100 million million of them. In this book, we will zoom down into the very heart of one of these cells ...

# Skin

The human skin is a vital outer layer for the body. Tough, waterproof and germ-proof, it protects the insides from wear and tear, and from the sun's most harmful rays.

The skin helps keep the body at a constant temperature (37°C) by flushing with blood and sweating when it gets too hot. The skin is also very sensitive, containing millions of tiny nerve endings that provide the body's sense of touch. But one thing skin, sadly, cannot do is protect you from the bite of a hungry mosquito, seen here helping itself to a tasty meal of human blood!



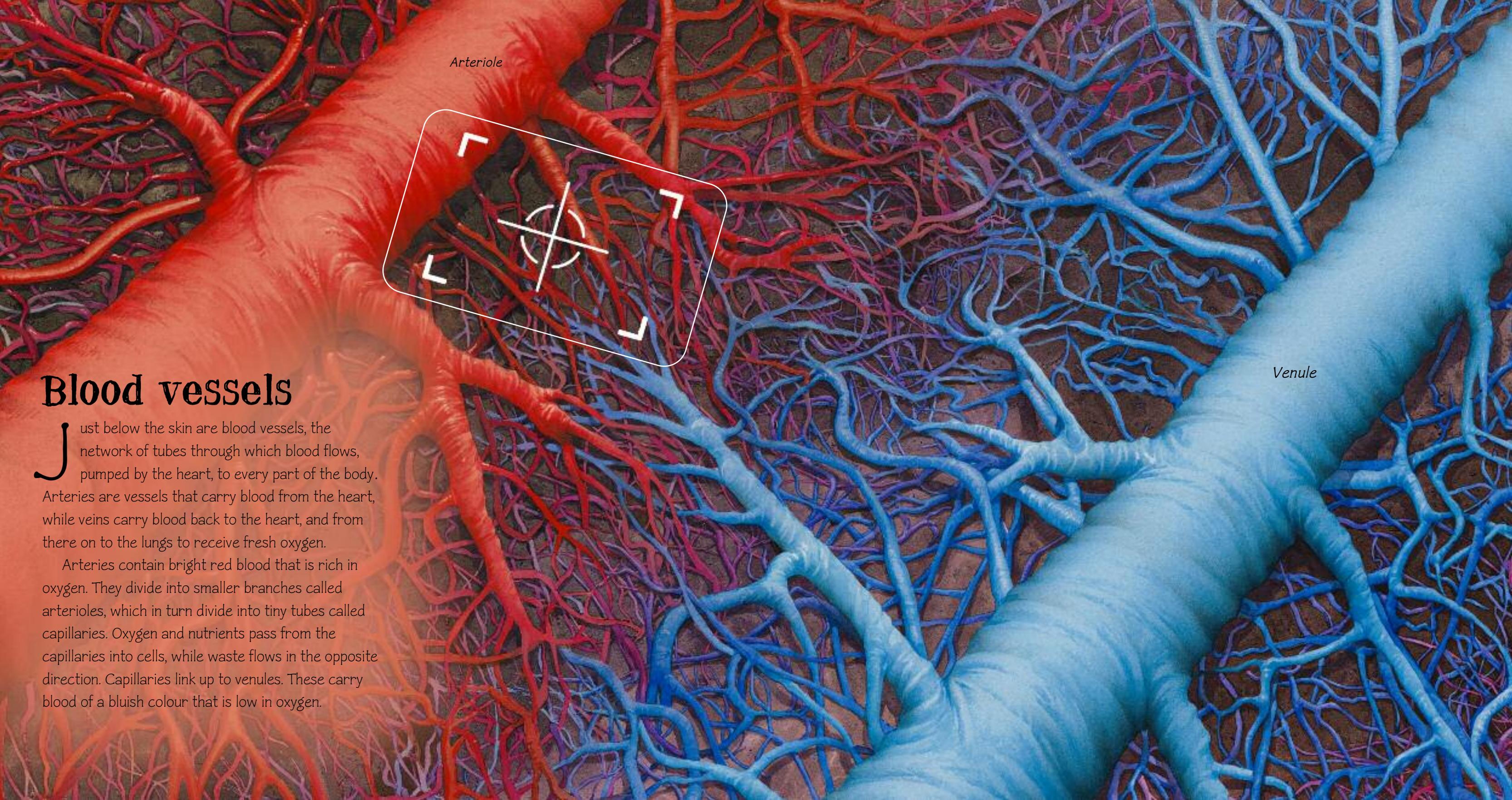
# Hair

Skin may feel quite smooth, but when we zoom in close it looks like an amazing, craggy landscape of hills and valleys. There are huge pits, each sprouting a gigantic column of hair (seen here about 750 times their actual size). At this magnification you can see that those shiny, thin strands have, in fact, a rough, scaly surface.



Hair is made from keratin, the same substance that forms fingernails, toenails and the tough outer surface of the skin. The visible part, called the shaft, is actually dead tissue. The live part is at the base of the hair, rooted deep inside a pit in the skin, called a follicle. Each follicle contains a tiny muscle. In cold weather, these muscles pull the hairs upright to try to trap the body's heat. The skin is bunched up around the hairs to form goose pimples.

Hair grows thickest on the head, but fine, downy hair is found all over of the body, except on the palms of the hands and the soles of the feet.



*Arteriole*

*Venule*

## Blood vessels

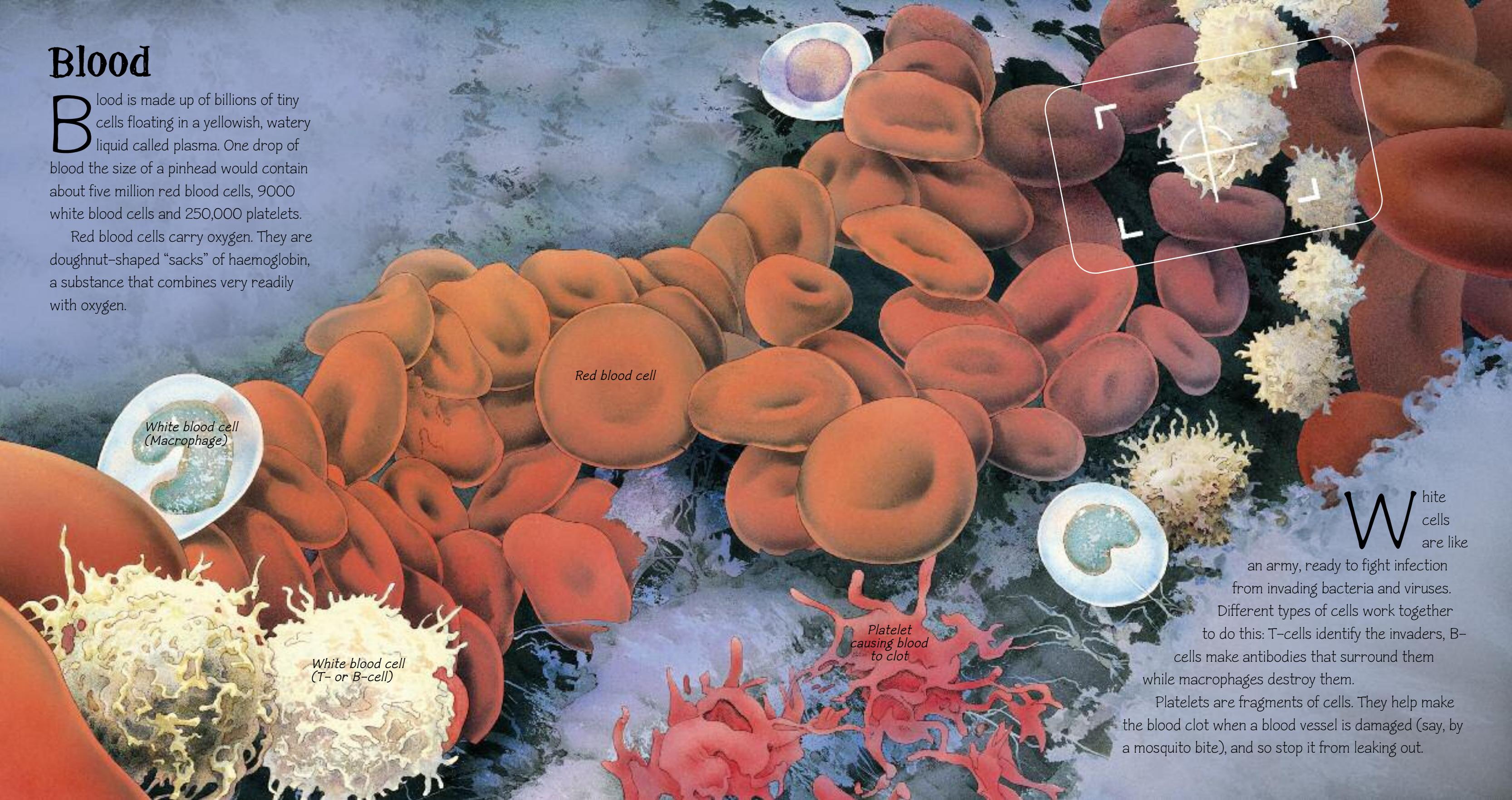
Just below the skin are blood vessels, the network of tubes through which blood flows, pumped by the heart, to every part of the body. Arteries are vessels that carry blood from the heart, while veins carry blood back to the heart, and from there on to the lungs to receive fresh oxygen.

Arteries contain bright red blood that is rich in oxygen. They divide into smaller branches called arterioles, which in turn divide into tiny tubes called capillaries. Oxygen and nutrients pass from the capillaries into cells, while waste flows in the opposite direction. Capillaries link up to venules. These carry blood of a bluish colour that is low in oxygen.

# Blood

**B**lood is made up of billions of tiny cells floating in a yellowish, watery liquid called plasma. One drop of blood the size of a pinhead would contain about five million red blood cells, 9000 white blood cells and 250,000 platelets.

Red blood cells carry oxygen. They are doughnut-shaped “sacks” of haemoglobin, a substance that combines very readily with oxygen.



*Red blood cell*

*White blood cell  
(Macrophage)*

*White blood cell  
(T- or B-cell)*

*Platelet  
causing blood  
to clot*

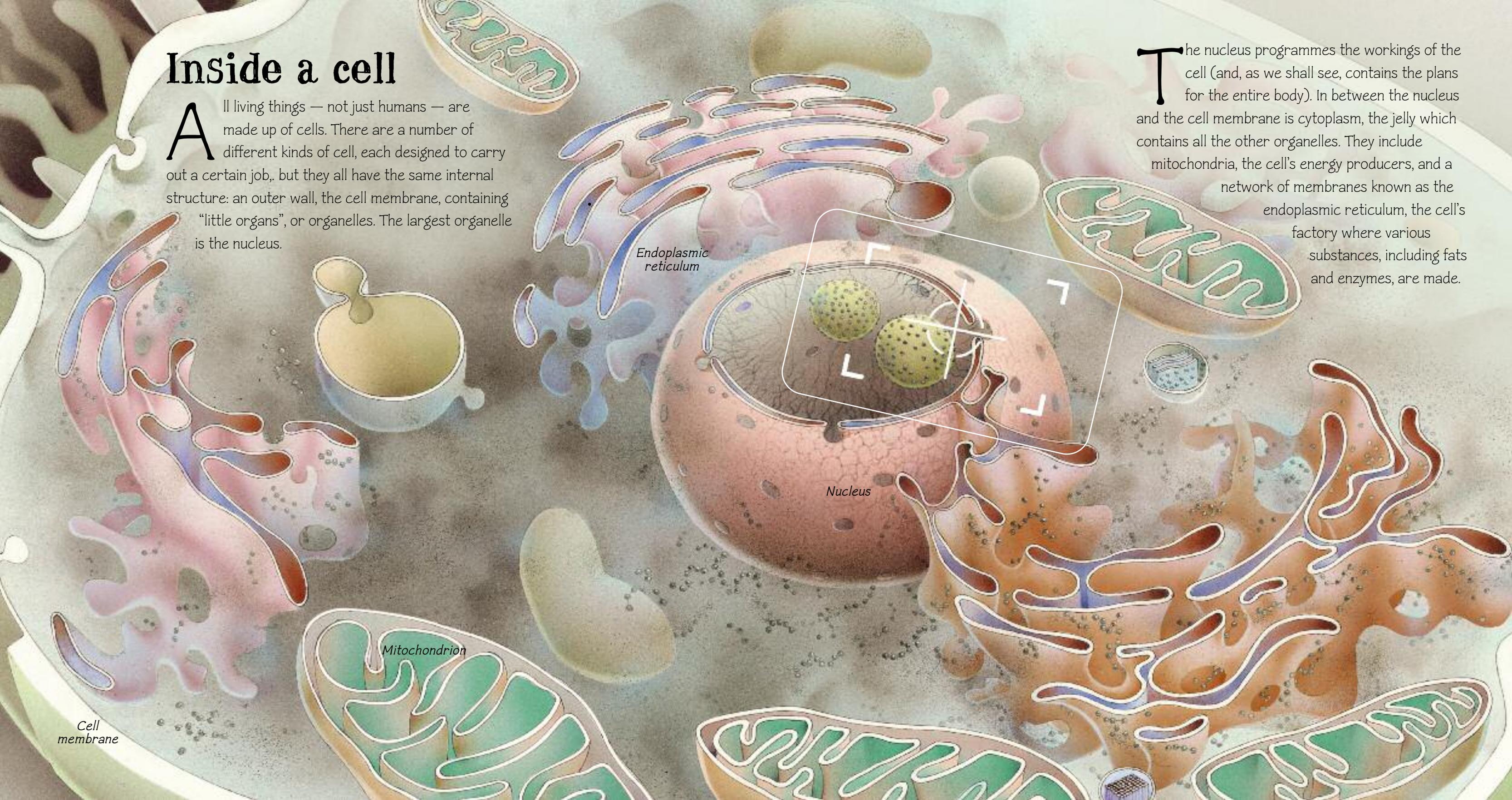
**W**hite cells are like an army, ready to fight infection from invading bacteria and viruses. Different types of cells work together to do this: T-cells identify the invaders, B-cells make antibodies that surround them while macrophages destroy them.

Platelets are fragments of cells. They help make the blood clot when a blood vessel is damaged (say, by a mosquito bite), and so stop it from leaking out.

# Inside a cell

All living things — not just humans — are made up of cells. There are a number of different kinds of cell, each designed to carry out a certain job, but they all have the same internal structure: an outer wall, the cell membrane, containing “little organs”, or organelles. The largest organelle is the nucleus.

The nucleus programmes the workings of the cell (and, as we shall see, contains the plans for the entire body). In between the nucleus and the cell membrane is cytoplasm, the jelly which contains all the other organelles. They include mitochondria, the cell’s energy producers, and a network of membranes known as the endoplasmic reticulum, the cell’s factory where various substances, including fats and enzymes, are made.



Endoplasmic reticulum

Nucleus

Mitochondrion

Cell membrane

# Chromosomes

The cell nucleus is packed with chromosomes, tightly-wound strands of a substance called DNA (deoxyribonucleic acid). This is an extremely long, thin molecule which contains your genes.

Genes are like tiny instruction manuals containing all the information necessary to create your body in a certain way— blue eyes or brown eyes, curly or straight hair, tall or short, and so on.

DNA

Protein

There are 46 chromosomes inside the nucleus of every cell in the human body (other animals have different numbers of chromosomes). Usually each piece of DNA is spread out like an unwound length of rope. But when the cell is about to divide and form two cells, each length twists itself into a tight coil. In turn, this coil twists itself into a super-coil and combines with protein cores. As a result each length of DNA forms a short, super-coiled bundle, a chromosome.

# DNA molecule

The twisted-ladder shape of the DNA molecule is called a double helix. Like all molecules, it is made up of atoms bonded together. The two “uprights” of the ladder are linked together by “rungs”. These are made up from links between two of four chemicals: adenine (A), thymine (T), guanine (G) and cytosine (C). A always forms a link with T, G with C. The exact order in which the rungs appear on the ladder forms a code.

A gene consists of a length of DNA with thousands of rungs. The code is detailed enough to provide instructions for making proteins, which provide the material for building cells. The human body has more than 100,000 genes.

Every minute, the body makes about three billion new cells as old ones die. When a cell divides to make two new cells, its DNA unzips itself along the line where the rungs are linked together. Each single strand then makes a new “partner” which is an exact copy of its old one.

“Upright”

“Rung”



# Inside an atom

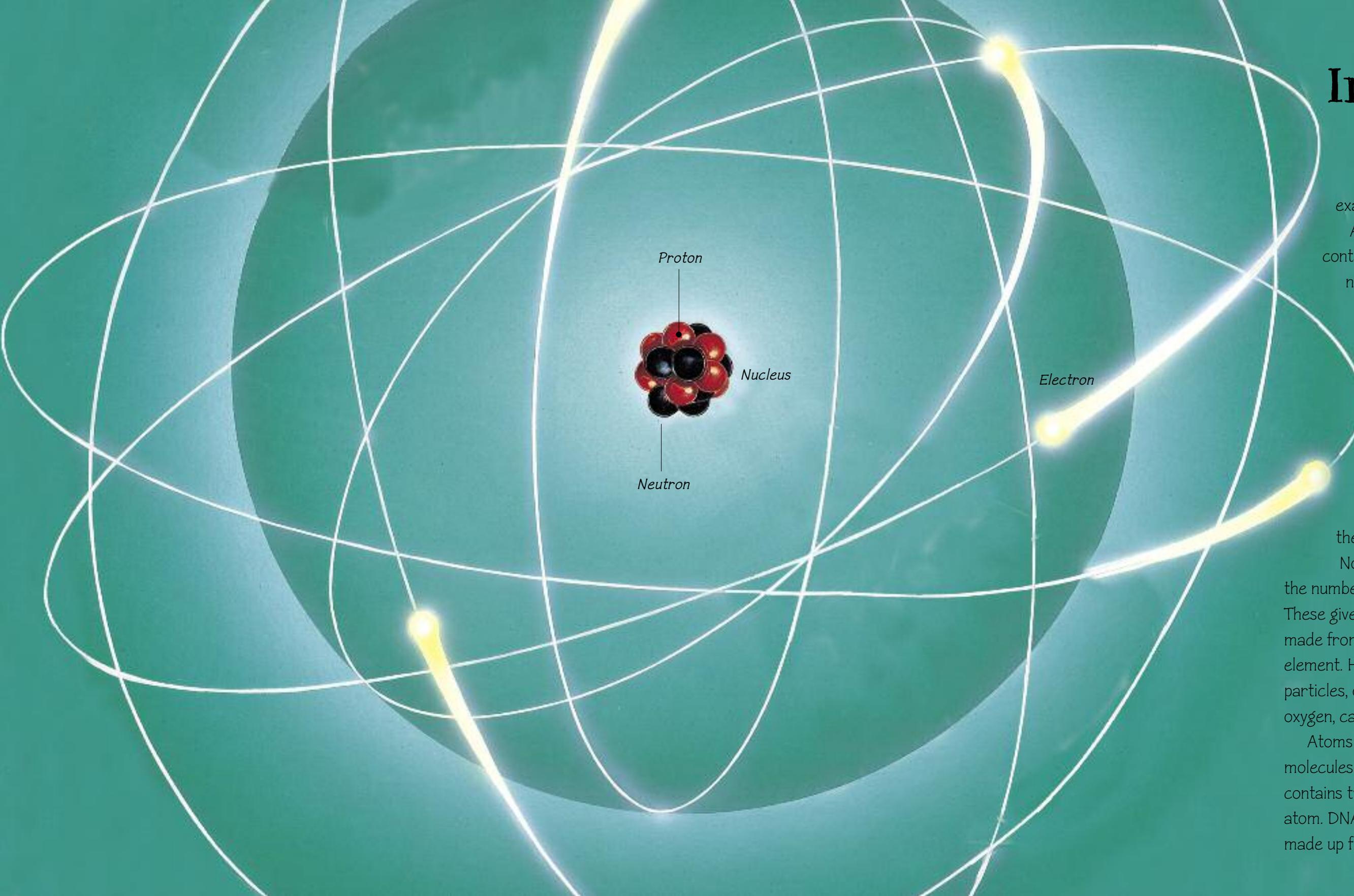
All substances, including DNA, are made up from atoms. They are so small that a pinhead, for example, contains one billion *billion* of them.

An atom is mostly empty space, containing even tinier particles. Protons and neutrons are found clustered together in a minute, dense nucleus at the centre of the atom. Little bundles of energy called electrons whizz around this atomic nucleus.

In an atom there are the same number of electrons as there are protons. Both have electrical charges: electrons negative, protons positive. Unlike charges attract, and so the atom is held together and is stable.

Not all atoms are the same. They differ by the numbers of electrons and protons they have. These give them different properties. A substance made from one kind of atom is known as an element. Hydrogen, for example, has just two particles, one proton and one electron. Others, like oxygen, carbon, silver or lead, have more.

Atoms bond with each other to make molecules. A molecule of water, for instance, contains two hydrogen atoms and one oxygen atom. DNA is a very large and complex molecule made up from many different atoms.



# Glossary

**Antibody** A substance carried in the blood which helps destroy unwanted bacteria and viruses.

**Artery** A tube which carries blood away from the heart. Most carry oxygen-filled blood to the body's organs and tissues but the pulmonary artery, which runs from the heart to the lungs, carries blood with very little oxygen in it.

**Atom** A basic building block of matter.

**Bacteria** Tiny living things made up of only one cell. They can only be seen through a powerful microscope. Some bacteria live inside other cells. Some types cause disease.

**Capillaries** The smallest type of blood vessels, whose walls are only one cell thick.

**Cell** A tiny "building block" which makes up all the tissues in all living things. The blood provides it with nutrients and oxygen and removes waste from it. A cell is like a miniature factory, producing proteins and many other vital substances.

**Chromosome** A tiny, thread-shaped body inside the nucleus of a cell. Chromosomes are made of tightly-wound strands of DNA and proteins.

**DNA** (short for deoxyribonucleic acid) A molecule found in chromosomes, whose structure encodes a living thing's genes.

**Element** A substance made up of atoms of the same type. Different elements have different characteristics, which are determined by the number of particles (protons, neutrons and electrons) they have.

**Enzyme** A substance, usually a kind of protein, that speeds up chemical reactions. Enzymes help the body to digest food and obtain energy from it.

**Genes** The instructions contained in the chromosomes and which are passed from parent to offspring. Because they control the way in which all the cells are built, they determine a living thing's characteristics.

**Haemoglobin** The red protein found in red blood cells. It combines with oxygen to carry it to the body's tissues.

**Hair follicle** A tiny pit in the skin, from which a hair grows.

**Heart** A large muscular organ in the chest that pumps blood around the body.

**Intestines** The continuous tube linking the stomach to the anus.

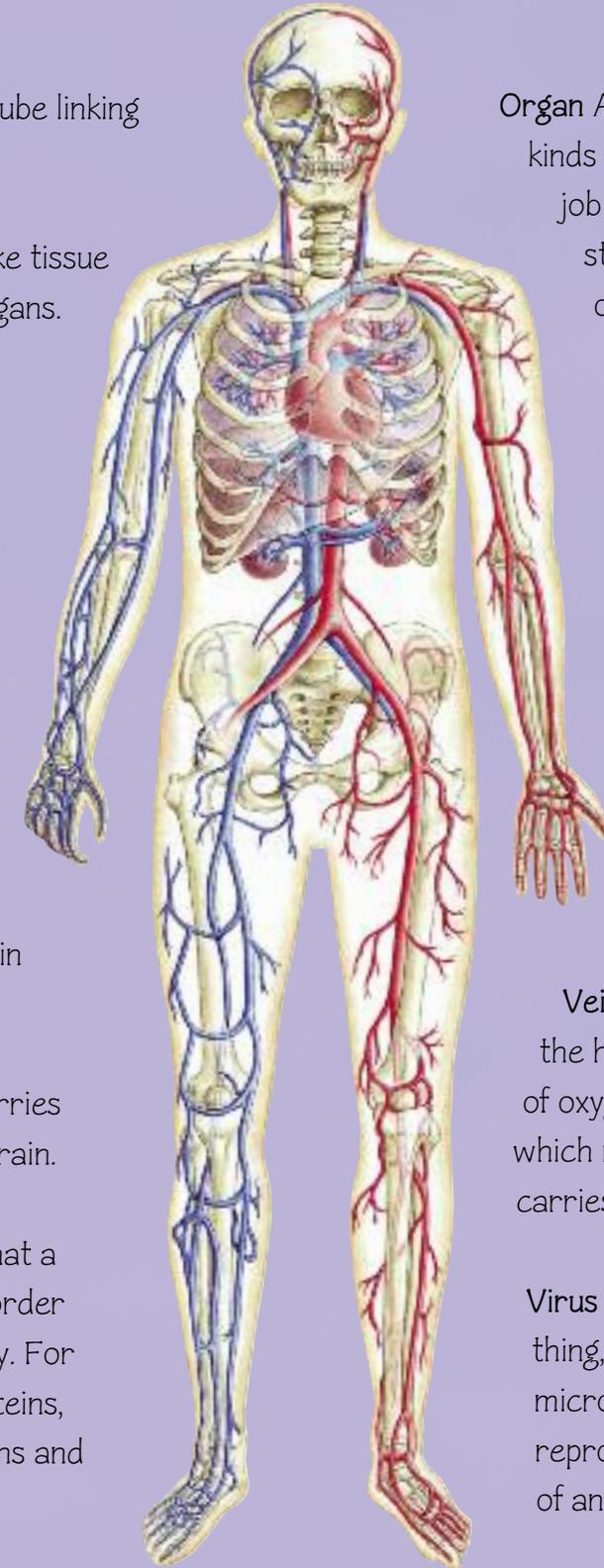
**Membrane** A thin, sheet-like tissue that lines body parts or organs.

**Molecule** A combination of atoms of different types bonded together. A molecule is the smallest part of a substance that can exist by itself and still possess its chemical properties.

**Nerve** A group of long, thin cells that carry messages between the brain and the rest of the body.

**Neurone** A nerve cell. It carries messages to or from the brain.

**Nutrients** Raw materials that a living thing must obtain in order to make and repair its body. For humans, nutrients are: proteins, carbohydrates, fats, vitamins and minerals.



**Organ** A structure made of different kinds of cells which does a particular job in the body. The brain, lungs, stomach and skin are all examples of organs.

**Proteins** Chemical substances found in all living things that carry out many essential tasks. For example, in humans, they form enzymes, which allow chemical processes to take place; they make up other substances that protect against diseases; they are found in muscles, skin and cartilage.

**Vein** A tube which carries blood to the heart. Most carry blood drained of oxygen but the pulmonary vein, which runs from the lungs to the heart, carries blood with fresh oxygen in it.

**Virus** A tiny, disease-carrying living thing, visible only under a powerful microscope. Viruses can only reproduce themselves inside the cell of another living thing.

