The Human Body
by Alex Raynham
(Adapted book. Pre-Intermediate level)

Chapter 1 You are amazing

It's a burning hot summer afternoon. As you run up the field, your heart and lungs arc working twice as hard as usual, and your blood is moving five times as fast. Your legs hurt, and you feel very, very tired, but you can't stop now. Suddenly, the ball is coming towards you, turning in the air. Your eyes follow it while your brain does the thinking: Where will it be a moment later? How can I reach it? Where arc all the other players?

You jump: nerve signals shoot through your body, and hundreds of muscles in your legs, arms, back, and stomach move together to push you into the air. Ar just the right moment you push your neck forwards, and your head hits the ball. It flies into the goal at 60 kilometres per hour! As you run back down the field, six pairs of muscles move in your face, and you smile. You don't feel tired any more. Your body wants you to forget the pain and feel good - so you can go on and win the game.

In the evening, you will be asleep, but your body will be hard at work. It will mend the damage that you did to your muscles in today's match, and do a thousand other things to keep you alive. Your body will make new skin and new blood, your muscles and your hair will grow, and in the eight hours before you wake up, your heart will beat 33,000 times. In the morning, you may hurt all over, but you will be ready to start a new day.

Under your skin there is an extraordinary world full of tiny living things called cells - the smallest parts of any animal or plant. There are hundreds of different types of human cell, and everything in your body is made of them: from your eyes and your heart to your skin and your teeth. Your body is like an amazing machine, with 100 trillion living, working parts. But unlike machines, you can think and feel. So how docs your body work? How does it make you who you are? And what happens when things go wrong?

Chapter 2. Quick thinking

A few years ago, Stephen Wiltshire flew over New York City and looked down at the streets below. He didn't take any photos, and he was in the air for only twenty minutes. But amazingly, Stephen remembered everything. For the next few days, he sat on a chair, listened to music, and drew for hours and hours. Stephen was making a 5.5-metre picture of Manhattan from the air - with hundreds of streets and thousands of buildings. Central Park, the Empire State Building, Brooklyn Bridge, the boats in the Hudson River - it's all there in his picture, and everything is in the right place.

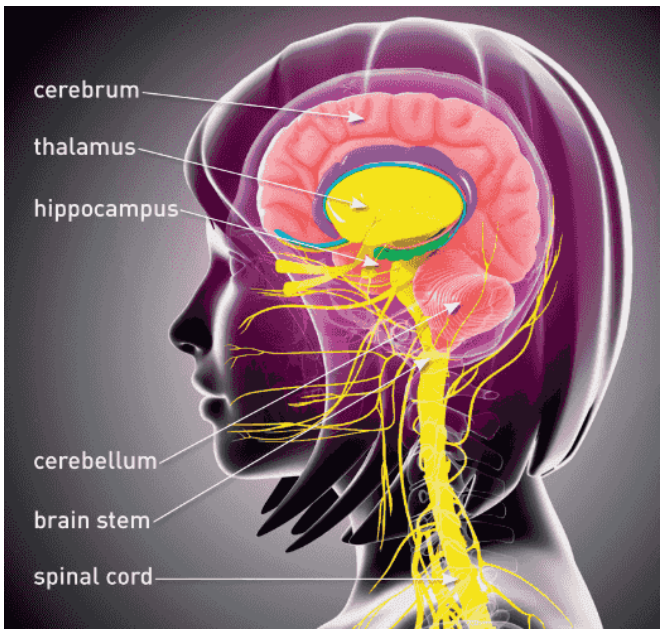
Stephen Wiltshire has got an amazing brain, but your brain isn't very different. It is a 1.3-kilogram living computer, and it processes 100 trillion pieces of information every second. To do this, it uses 20 per cent of your blood and produces

as much heat as a small light. Right now, your brain is working very hard - just to help you to stay alive, think, and understand these words.

Your brain is made of cells called neurons. They look a lot like trees, with ‘branches’. Short branches get chemical signals from other neurons, and one long branch carries signals to other places in your brain or body. There arc about 100 billion neurons in your brain, and each one is connected to thousands of other neurons. These connections make you who you are. Nobody understands how this works, but when signals travel between millions of neurons, you feel, think, and remember things.

The brain has many parts, and they each do different jobs. For example, the hippocampus helps you to remember things, and the cerebellum moves your muscles in the right way - so you don’t fall over when you walk! The brainstem sits below’ the cerebellum, and it controls automatic things like the working of your heart and lungs. It also connects the brain to the spinal cord. The outside of your brain - about 85 per cent of it - is called the cerebrum. You use your cerebrum to think and feel, and also when you decide to move your body. The cerebrum has two halves, and each half controls the opposite side of your body. For example, the left half of your cerebrum feels and moves your right hand. Both sides are connected, so you always know what all of your body is doing!

Signals travel to and from the brain along the spinal cord, and nerves (groups of neurons) connect the spinal cord with every part of your hotly. When you move your legs, signals from your brain travel down the spinal cord and then along nerves to your leg muscles. When you touch something, signals travel up the nerves to your spinal cord, and then go up to your brain. Nerves are made of lots of neurons, but each neuron is only one cell. They arc too thin for the human eye to see, but they can be very long. Some neurons start in your foot and end in your spinal cord — about a metre away! Every time you do something, the neurons in your brain make new connections. This is how you learn to do things. These new connections can break easily, but the good news is that thinking about or doing the same things again makes them stronger. This is why it helps to play the guitar every day if you want to be good at it.



The brain doesn't stop working when you are asleep - and your senses don't stop either. Your ears can still hear sounds, but a part of the brain called the thalamus processes this information before it gets to the cerebrum. How important is it? Should you wake up? You don't need to hear the traffic outside the window when you arc sleeping, so you don't wake up. But you wake up immediately when the telephone rings - it could be important.

In the same way, everything that you taste, smell, see, or touch is processed by the brain before you know about it. Your brain takes information from both eyes and turns them into one picture. Because the brain does this many times every second, you see movement. It takes the brain time to process signals from the eyes, but when you are in danger, your brain can do this faster than normal. Because of this, everything around you seems to slow down. It can give you time to think, and even save your life!

In February 2012, Canadian firefighters were inside a burning hotel when big pieces of the roof began to fall around them. The heat was terrible and they couldn't see much through the thick smoke, but they needed to think clearly. Where were the stairs? What was the best way out? Which way was the fire moving? As the men fought their way through the burning building, everything a round them seemed to happen very, very slowly. Seconds seemed like minutes. Their brains were giving them time to think - and all of the firefighters got out alive!

Chapter 3. The 'five' senses

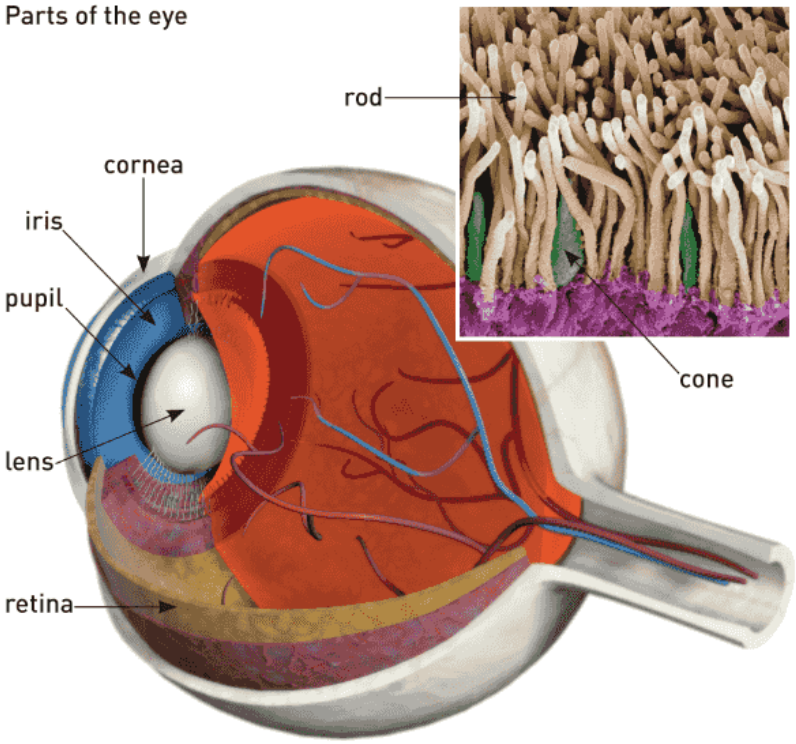
You arc walking on a beach, and the bright silver light hurts your eves. You can feel the stones under your feet, and hear the children shouting as they play in the water. You breathe in deeply and smell the air, then run and jump into the sea. A big wave hits you as you come up for air, and the cool, salty water goes into your mouth. Your senses tell you everything that you know about this beautiful world. But how many senses have you got, and how do you use them?

Sight

Look at your eyes in a mirror. The circle in the centre of each eye is your pupil, and the ring of colour around it is your iris. Surprisingly, the shapes and colours in your iris arc different to everyone in the world! Light comes into the eye through the cornea and then passes through the pupil. On a sunny day, your pupils arc very small, but at night, your irises let your pupils open and they become much bigger. This lets more light into your eyes, so you can see in the dark.

Behind the pupil, a lens focuses the light onto the retina, at the back of your eye. The lens can change shape very quickly: Muscles make it thicker to see things close to you, or thinner to focus on things that are far away.

On your retina, special cells called rods sense light, dark, and moving things. Other cells called cones sense colours. Together, about 140 million of these cells turn light into nerve signals and send them to your brain.



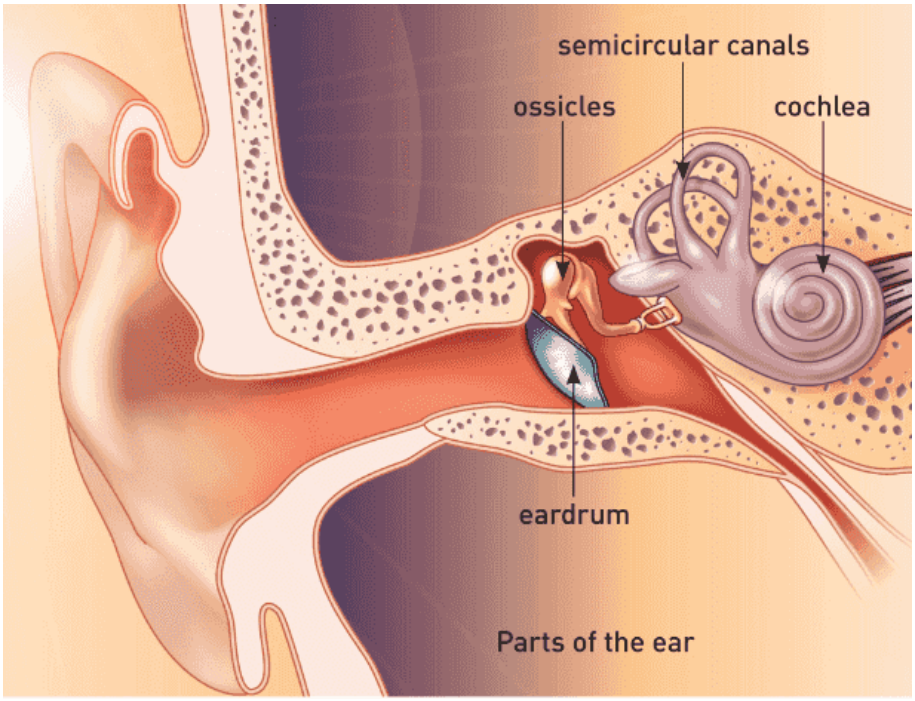
Most of the rods and cones in your eyes are in the centre of your retina. This part of the retina is only about 0.6 centimetres across, so you can only see clearly when you look straight at something. You never notice this because your eyes are moving all the time. Muscles move them up and down, left and right very fast - focussing about four times a second. This lets your brain make a clear picture of everything around you.

Your eyes work very hard, so your body needs to look after them. Eyelids stop things from getting into the eyes. Your eyes also make a fluid called tears - and you don't just do this when you cry. About once every ten seconds, you blink - your eyes open and close very quickly - and tears wash them.

Your eyes tell you more about the world than any other sense, and they are truly amazing! They can sense 10 million different colours and change their shape in a fifth of a second. And on a very dark night, they can see the light of a burning match 48 kilometres away!

Hearing and balance

In the dance school across the street, the music begins to play. It's a winter night, and my windows are closed, but the shape of my ears helps me to catch the sound. Inside each ear, my eardrum begins to move in and out, or vibrate. Behind the eardrum, the three smallest bones in my body - the ossicles - begin to vibrate too. Each of them is about as big as a piece of rice, but they make the vibration thirty-five times bigger before it gets to the cochlea, deep inside my head. Inside the cochlea, fluid moves past tiny receptors, and nerve signals go to my brain. The dance teacher is playing music by Tchaikovsky. Every time you hear a sound, your brain processes it. Have you heard this sound before? What is it? Amazingly, your brain can recognize about 400,000 different sounds, and it can even put them together to 'play" a favourite piece of music in your head.



Across the road, the dancers are moving to the music. It isn't easy to balance when you're dancing, but they can do it because of three tiny tubes called the semicircular canals. These are next to the cochlea, and as the dancers move, fluid inside the tubes moves up and down, left and right, or forwards and backwards. Receptors inside the semicircular canals tell the dancer's brains how their heads are moving, so they don't fall over.

This helps you to balance, but it's not enough. All over your body, more receptors tell your brain what your bones and muscles arc doing. In this way, dancers know where their arms and legs are without looking at them. Information from your

eyes also helps you to balance. Stand on one leg, then close your eyes, and you will see what I mean!

Taste and smell

You buy a hot coffee and a sweet cake. Why does it taste - and smell - so good? Small groups of cells on your tongue called taste buds sense everything that you eat. Babies have taste buds all over their mouths, but people lose most of these when they grow older. That's why young children don't like some types of food. They still have extra taste buds, so the food tastes too strong for them.

Taste and smell are different senses, but when you eat, your brain uses information from both to decide if the food is nice. Find a vegetable with a strong smell, then hold your nose and put a piece on your tongue. You probably can't taste it very much. That's because about 75 per cent of the taste of food actually comes from its smell.

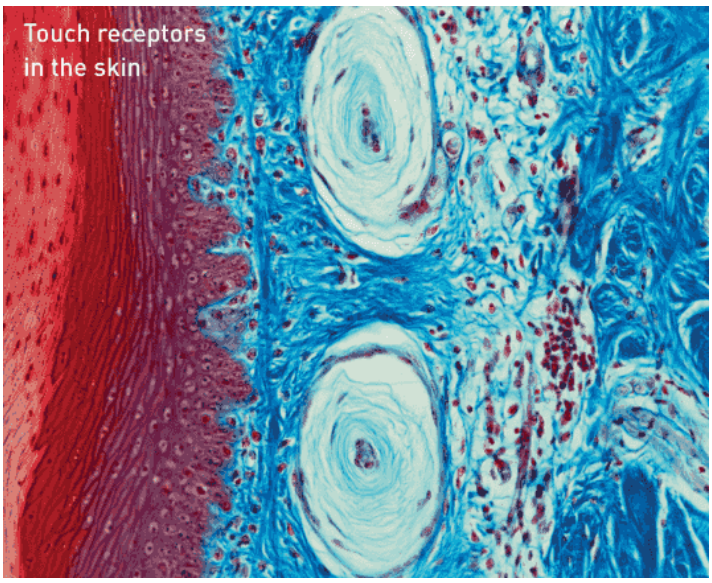
Every time you eat or breathe in, chemicals go into your nose. Receptors in your nose send information about these chemicals to a place in the brain called the olfactory bulb. The olfactory bulb can recognize about 10,000 different chemicals, and the brain uses this information to decide what you are smelling. Smells are made of lots of different chemicals - there are thirty-five different chemicals in the smell of coffee, and about twenty in the smell of a flower.

The olfactory bulb is very close to the hippocampus - the part of your brain which helps you to remember. That's why when people smell something unusual, they often remember things in the past.

Touch, pain ... and more

There is an unusual family in the hills of Tuscany, Italy Many of the women in the family - from the children to the grandmother - can't feel pain. It may sound great, but it's a kind of disease. They arc a healthy family except for this problem, but they have to be very careful. Pain stops you from hurting yourself and from touching very hot things. Without it, the world can be a very dangerous place!

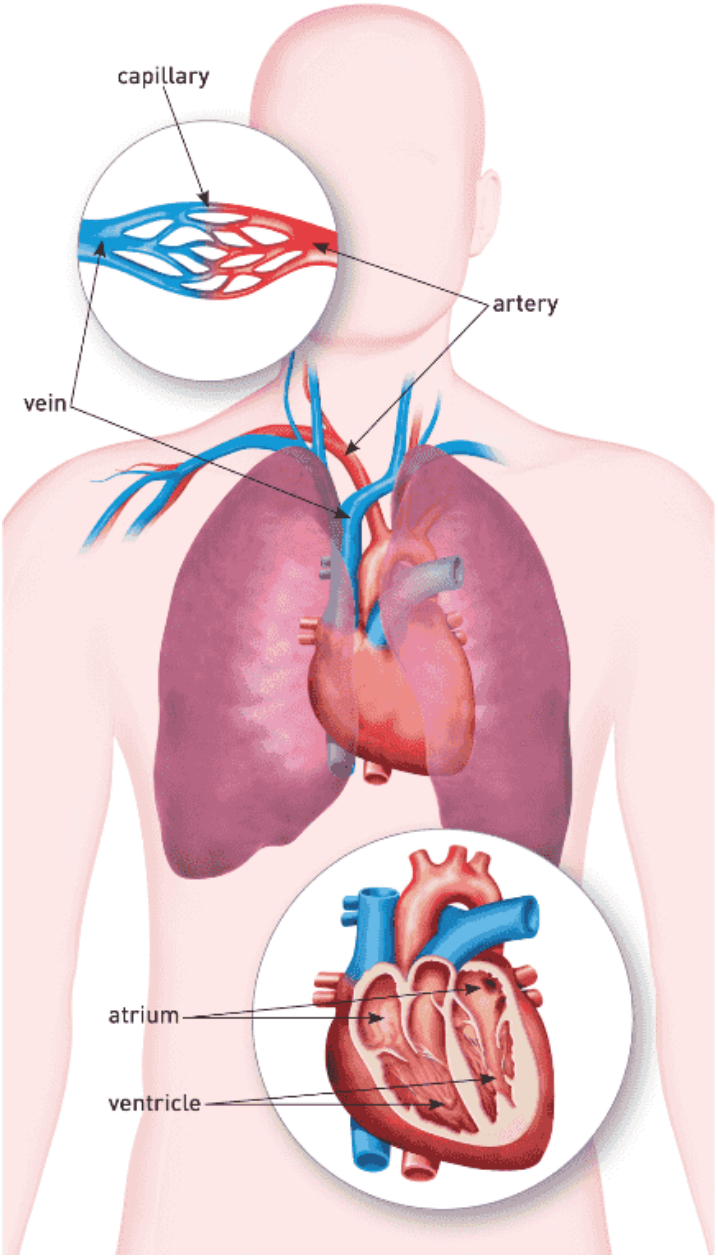
The nerves in your skin end in receptors for hot and cold things, for pain, touch and vibration. There are millions of these receptors all over your skin, but places like your fingers and your lips have got more of them. There are also touch receptors in your mouth and other places, and there arc pain receptors all over the inside of your body Pain keeps you safe. It tells you when your stomach hurts or when you've hurt your muscles and bones - so you can get help or rest.



At school, children learn about the ‘five senses’: sight, hearing, taste, smell, and touch. But you can sense a lot of things inside your body too. You feel hungry and thirsty, and you know where your arms and legs are without looking at them. You know when your stomach is full, and when you need to go to the toilet. And there are senses that you don’t know about too. Parts of your brain sense things like your body heat and how much sugar there is in your blood. We never think about these other senses, but we couldn’t live without them.

Chapter 4. Every beat and every breath

A few years ago in South Carolina, USA, an 11-year-old hoy was standing on a sports field when a ball hit him hard in the chest. His heart stopped, and he fell to the ground. A doctor reached him quickly, and started to push and push on his chest. Suddenly, the boy’s heart started again, and he opened his eyes. He was very, very lucky! You have about 5.6 litres of blood, and your heart pushes it all around your body about once a minute. If this stops - even for a short time - you can die.



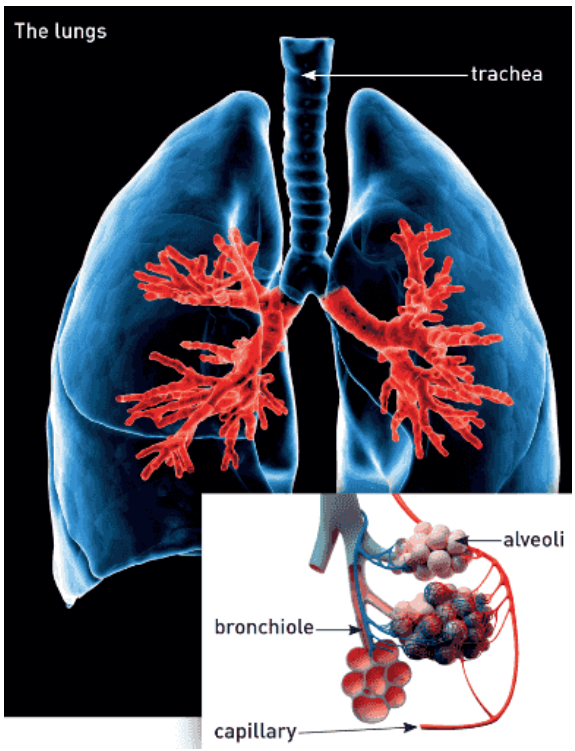
Blood is full of nutrients and oxygen. Your cells work like tiny engines and use these things to live. They also produce waste, like carbon dioxide (CO_2). Trillions of round red blood cells carry oxygen to every other cell in your body, and they also take away carbon dioxide. Blood contains other chemicals that your body needs too, and other cells. White blood cells fight dangerous germs - foreign cells from outside your body: And when you cut yourself, special blood cells called platelets join together and close the cut. This stops you from bleeding.

The blood that leaves your heart goes into arteries. All over your body, these arteries divide and get smaller and smaller until they become tiny capillaries. They become so narrow that only one red blood cell can pass through them at a time! Oxygen passes from your blood through the capillary walls, and then into your cells, while carbon dioxide goes the other way. From your cells, the capillaries join again and become veins. These take the blood back to your heart.

Your heart is an extraordinary muscle. Special cells inside the heart produce signals to make the walls of the heart contract, or beat. This sends blood to your lungs and the rest of your body. Even when you are resting, your heart muscles are contracting about 70 times a minute.

Your heart has two sides, bur the left side is bigger because it has to move blood further. Blood from your lungs enters the left atrium, which sends it to the left ventricle. The left ventricle pushes this blood all around your body. When blood comes back to your heart it enters the right atrium, then the right ventricle, which sends the blood back to your lungs.

Your lungs take oxygen from the air around you. When you breathe in, muscles make the ribs move up, and a wall of muscle called the diaphragm contracts. This makes the chest bigger, so air is pulled down an air pipe called the trachea and into your lungs. Air pipes called bronchioles in your left and right lungs divide into smaller and smaller branches. When they are as thin as the hairs on your head, they end in tiny balls called alveoli. Together, your lungs are about as big as a shopping bag, bur they have about 500 million alveoli!



There are capillaries around the alveoli, and oxygen passes through the walls of the alveoli into the blood. Carbon dioxide moves the other way. When you breathe out, your chest becomes smaller, pushing air - with carbon dioxide in it - out of the lungs. As the air travels up the trachea, it moves past the vocal cords. By opening and closing these, you can make sounds. You speak and sing by using the vocal cords, mouth, and tongue. When the world's top singers perform, their vocal cords crash together and vibrate about 170 times a second!

You usually breathe in and out about fourteen times a minute, but what happens to your body when you can't? In the sport of freediving people go deep

under the water - and stay there for minutes - with only the air in their lungs. It's one of the most dangerous sports in the world.

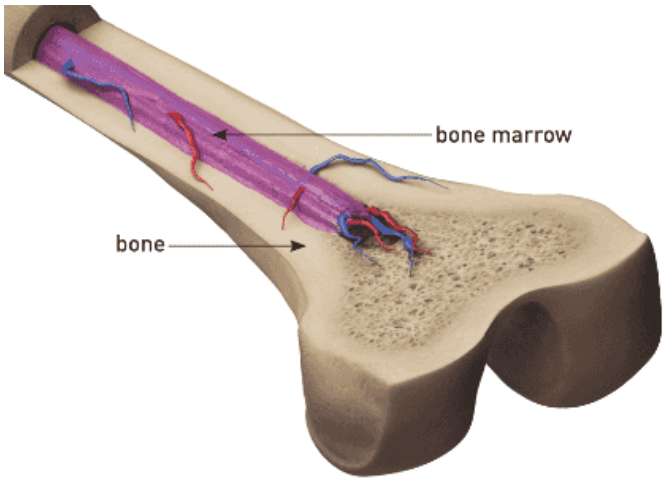
In August 2002, Tanya Streeter climbed over the side of a boat in the Caribbean. She breathed very, very deeply and stood on a machine. When she was ready, the machine pulled her down through the water like a stone. At 100 metres below the sea, everything was dark, and Tanya's heart was heating very, very slowly. Her lungs had become as small as apples. When she reached 160 metres, she stopped and began to swim back up. But it's very hard to swim when your muscles don't have enough oxygen.

Tanya's lungs hurt terribly, and her eyes couldn't focus very well. Slowly she went up towards the light. Finally, Tanya's head came out of the water, she opened her mouth and her lungs filled with air. Tanya Streeter had just gone deeper than anyone in the world at that time. And she had lived.

Muscles and bones

At the 2012 London Olympic Games, American runner Mantco Mitchell heard the start gun and jumped to his feet. A few seconds later, he was moving at more than 30 kilometres per hour. Suddenly, after two hundred metres, a bone in his lower leg broke. Mantco cried in pain, but amazingly, he finished the race. How could he run on a broken leg?

There are two bones in the lower leg. The other bone, and the muscles around it, supported Manteo long enough for him to finish the race. The bones and muscles work together. They support, protect, and move the body And sometimes they can help you to do extraordinary things.



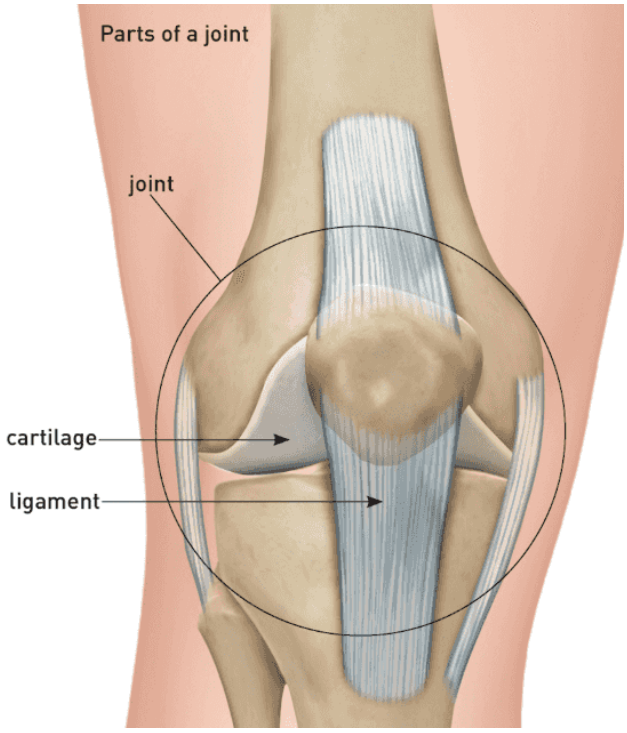
Adults have 206 bones in their bodies, and together they make your skeleton. Some bones in the skeleton protect the body. For example, your skull protects your brain, and your ribs protect your lungs and heart. Other bones support you and help you to move, like the bones in your arms and legs.

Your bones are very light, but they are stronger than the metal in a car - and they are alive, too. Bones look dry and hard on the outside, but the centre of many bones is full of tiny holes. Veins, arteries, and nerves run through them, and thick

bones have got a tissue called bone marrow in the centre. Bone marrow is important because it produces white and red blood cells. The bone marrow in your body makes about 2.4 million red blood cells every second of your life!

Special cells inside your bones are destroying old bone all of the time, while others are making new bone. In this way, bones can grow and change, and broken bones are fixed. This happens so fast that children actually get a 'new skeleton' about every two years. And even when you are eighty, no bone in your body will be more than about ten years old. Everyone's bones look the same, but inside they are different. This is because the things that you do make your bones grow and change over time. A runner has got stronger, thicker leg bones than a swimmer - and a right-handed tennis player has got bigger bones in the right arm.

Joints are places where bones meet. Some joints, like the ones in your skull, can't move. Other joints can move in different ways. For example, your knee joint moves your leg forwards or backwards, but you can move your hand up and down, left and right, or in a circle. Inside moving joints, a soft tissue called cartilage protects the bones and stops them from touching. In some joints, fluid also helps the bones to move easily.



In many joints, long pieces of tissue called ligaments join the bones on both sides of the joint, and this makes it stronger. Just think of your knees: every time you jump, run, or even stand up, you push very hard on your knees. In your life, you will walk about 150,000 kilometres - that's nearly four times around the world. That's why you need good strong knees.

Muscles are made of long cells called muscle fibres. Nerve signals make the fibres contract, and this moves the muscle. Some muscles work automatically. Your heart beats all the time and muscles in your stomach break up your food, and you never think about them. Other muscles called skeletal muscles only contract when

you want to move. These muscles are joined to your skeleton by long tissues called tendons, or sometimes they join your bones to your skin - like the muscles in your face.

You have over 650 skeletal muscles. They can pull on bones, but they can't push on them. For this reason, pairs or groups of skeletal muscles always work opposite each other. When some muscles contract, the opposite muscles relax.

To lift your foot, muscles at the front of your lower leg contract and muscles at the back relax. Every time you move, lots and lots of skeletal muscles have to work together. Surprisingly, it takes about 200 muscles to walk and 70 muscles to lift a cup of coffee!

Every time you play sports, you damage millions of muscle fibres. When your body mends them, the muscle fibres grow - and you get stronger. By using the same muscles again and again, sportspeople can make them amazingly strong. The world's best dancers can stand and turn on the ends of their toes and jump two metres into the air. And climbers can hold onto a rock using only the muscles in one hand - hundreds of metres above the ground.

You usually use about a third of the fibres in each muscle, even when you're running fast or lifting something heavy. This is your body's way of protecting the muscles from damage. But sometimes - when someone is in terrible danger - people can use more muscle fibres and become much stronger. In 2012, Austin Smith was mending a car with his grandfather in Michigan, USA, when the car fell onto the old man's chest. Amazingly, Austin was able to lift the front of the car and save his grandfather's life. Austin still doesn't know how he did it. It should be impossible for a 15-year-old boy - or anyone - to lift a 900 kilogram car!

Chapter 6. You are what you eat

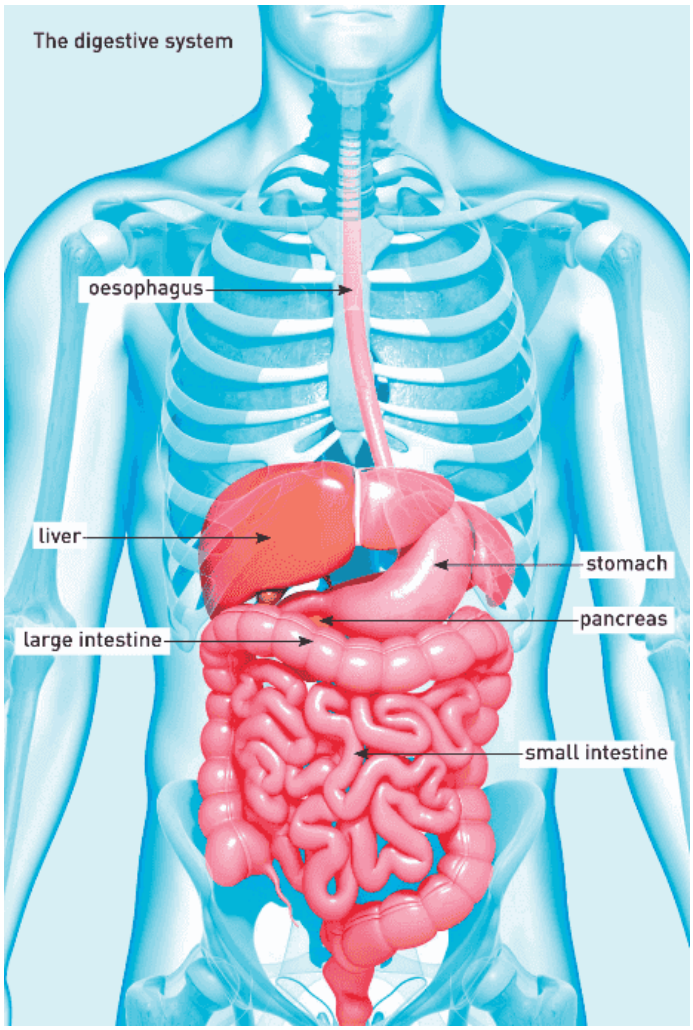
People in many countries ear more food than they did fifty years ago. In fact, Americans now eat nearly one tonne of food per person every year! More than 300 kilos of fruit and vegetables, 84 kilos of meat, and over 10 kilos of pizza goes into each mouth! So what happens to all that food, and how does the body use it?

Food gives you the nutrients that you need to live and grow. You get different nutrients from different types of food. The protein that you use to build muscles comes from things like meat, eggs, and fish. Foods like bread and rice give you carbohydrates, which you burn for energy. Fat comes from things like meat and milk. You need fat to make body tissues and produce energy, but too much of it is very bad for you. Fruit and vegetables are very important for your health. They contain carbohydrates and fibre, which helps you to move food through the intestines. They also have important chemicals called minerals, and lots of vitamins - like vitamin A, which is good for your eyes and helps you to fight disease.

The body starts to digest food as soon as you eat it. Your teeth break the food into smaller pieces, and your mouth produces a fluid called saliva. This kills germs and makes the food softer, and surprisingly your body produces a litre of saliva every day! When your food leaves your mouth, it moves down a tube called the oesophagus and goes into your stomach.

Close your fingers and make your hand really small. That's how big your empty stomach is, hut after a big meal it can be forty times bigger! Inside the stomach, muscles pull and push your food, breaking it into pieces. The acid in your stomach is strong enough to burn through metal, and it makes the food very soft - like a very thick fluid. The inside layer of your stomach changes every ten days to protect you from this acid - so it doesn't start to digest you!

After about three hours, food leaves your stomach and goes into the small intestine. The small intestine is very narrow but it's about 7 metres long, and most of your food is digested there. Organs like the liver and pancreas produce fluids that digest different types of food. They turn it into nutrients that your body can use. The nutrients pass through the walls of the small intestine and go into your blood. Your intestines are also home to trillions of bacteria. They use the nutrients in your food to live, but they're good for you too. Bacteria help to digest food, and they produce chemicals that your body can't make.



Muscles move the food along the small intestine. After about six hours, it arrives in the wide, 1.5-metre-long large intestine. Now it is mostly fibre and waste. The large intestine takes water out of it, and any nutrients that you can still use. Then, about forty hours after you had your meal, it comes to the end of the large intestine, and you go to the toilet.

Your stomach and intestines work very hard. They digest different kinds of food in different ways, and if you eat something bad, they get it out of your body very fast! They can do all of this because they have their own brain cells. In fact, your stomach and intestines have more neurons than the brain of a cat! These neurons don't just help you to digest food. They 'talk' to your brain all of the time and produce chemicals and nerve signals which change how you feel. That's why your stomach feels so strange when you're afraid.

People often say 'You are what you cat', but it's truer to say 'You arc what your mother ate'. Your mother's body digested the right nutrients at the right time - and made them into you! When mothers are going to have babies, they often hate food that they usually like, or they really, really want something that they don't usually eat. Some people think this happens because different foods contain things that are good or bad for the growing baby. Perhaps your body always knows what you need - even if you don't.

Chapter 7. The human factory

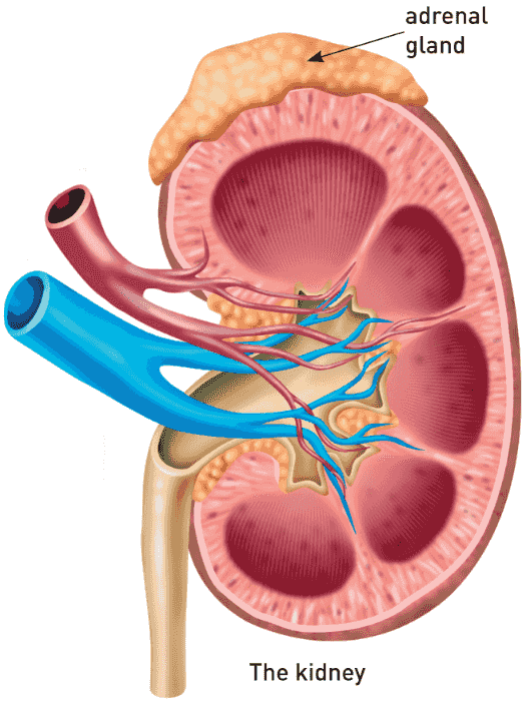
Your body is like an amazing factory. It gets nutrients from your food and uses them to make muscles, bones, and every type of tissue inside you. All over your body, cells move, clean, and process things, and produce waste. And chemicals called hormones control the factory and tell your cells what to do.

Your body is about 60 per cent water, and a lot of it is in the fluid between your cells. Special capillaries take extra fluid from your body tissues. They join together to make lymph vessels, and these pass through tiny organs called lymph nodes. Special cells inside the lymph nodes clean the fluid and destroy germs and waste. Then the clean fluid goes back into your blood.

Billions of cells in your body die every day, but the lymph nodes and organs like the liver clean them up and get their nutrients - so you can use them again.

Your liver does hundreds of different jobs, and it produces or controls a lot of the chemicals in your body. Inside the liver, nutrients pass to and from your blood, so your cells get the right nutrients when they need them. The things that you cat and drink sometimes have dangerous chemicals in them, and the liver takes many chemicals out of the blood. It takes four minutes for all of your blood to pass through your two kidneys. The kidneys clean the blood and use the waste to make a fluid called urine. This fluid goes to the bladder - and when the bladder is full, you go to the toilet.

Hormones are chemical messages that can reach every cell in your body. They are produced by glands and other organs, and they control things like how much you grow, how fast your cells work, and even what your adult body looks like. Hormones from a gland near your brain make you feel sleepy or awake. Your pancreas produces two hormones which control how much sugar there is in your blood. Hormones from other organs control things like how hungry you feel, the minerals in your blood, or how your body fights germs.



The kidney

Children also produce hormones which change their bodies into adults. For example, when boys are about ten, they start to produce a hormone which gives them wider shoulders, deeper voices, and hair on their faces. Most hormones work slowly - sometimes over many years - but one important hormone, adrenaline, is different. It is produced by glands on top of your kidneys, and it works very, very fast.

In 2009, firefighter Jason Durbin was walking down a road in Chicago when he saw smoke. It was coming from the top of a very tall building. Just seconds later Jason's body was alive with adrenaline. It made his heart beat faster, and his lungs took in much more air. More blood went to his muscles, making him feel stronger. He wasn't working that day, but he went straight into the building. As he started to run up the stairs, his body was ready for anything!

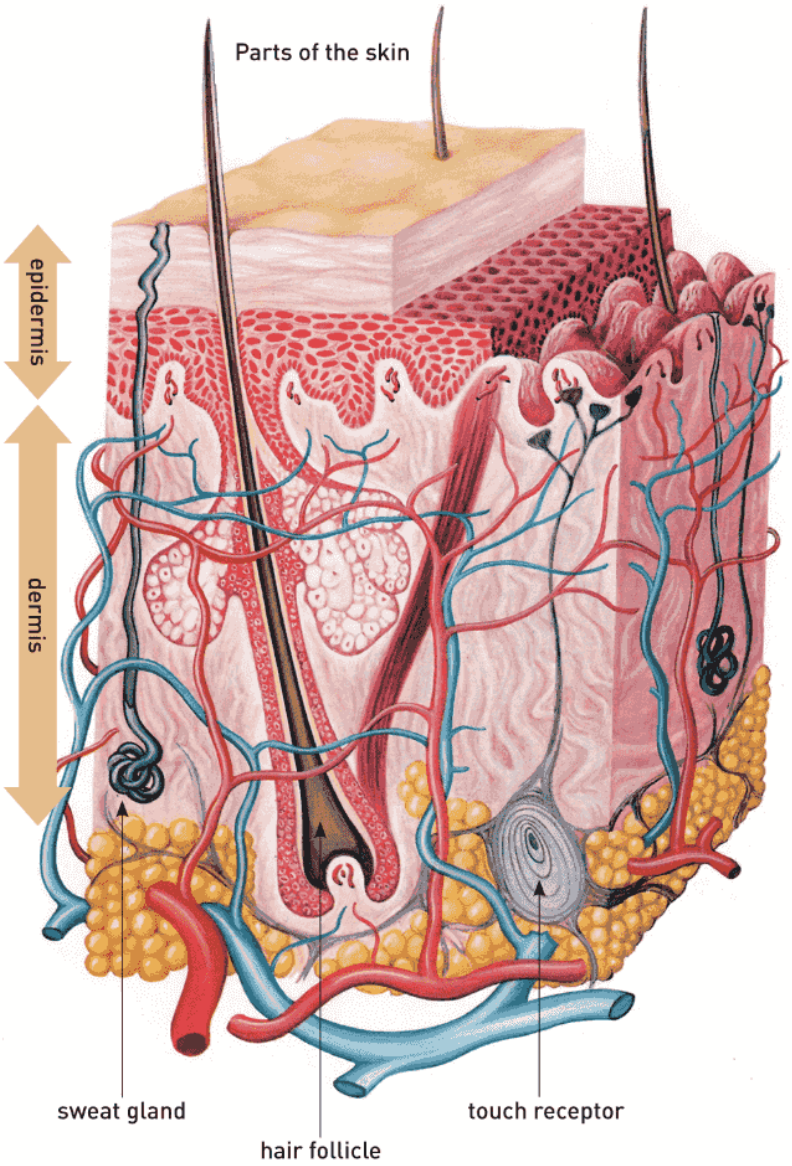
Jason ran and ran - all the way up to the fire on the twenty-eighth floor. There was smoke everywhere, but suddenly he saw a woman lying on the floor. He picked her up and carried her down all twenty-eight floors to the street outside! Jason saved the woman's life. And as he watched the ambulance driving away, taking the woman to hospital, he probably thought, 'How did I just do that?' The answer is 'Adrenaline made it possible'.

Chapter 8. Skin deep

Around the world, people spend a lot of time and money - about $250 billion a year - on their skin, hair, and nails. But these parts of your body do a lot more than help you to look good.

Your skin is the largest organ in your body. It protects you from chemicals, dirt, and too much light. It keeps nutrients inside the body and keeps out water - so you don't become bigger when you go out in the rain! Your skin helps to control your body temperature, and it also contains many kilometres of nerves. Skin may look

beautiful to the human eye, but with the help of machines we can study it much more closely.



In the forest of hairs on your body, billions and billions of germs are moving across your skin all of the time. There are about 5 million germs on every square centimetre of your body - and they are eating your skin!

The skin is made of two layers, and together they are about 0.2 centimetres thick. The outside layer of your skin is called the epidermis. New skin cells arc made at the bottom of the epidermis, but they move up as more cells are made below them. After about two weeks, the cells reach the outside of your skin and die. All of the outside of your epidermis is made of dead cells. You lose about 30,000 skin cells every minute, or 3.6 kilograms of skin every year! Germs eat this dead skin, or it falls off your body as you move around. In fact, most of the dirt in your house is actually pieces of you!

Cells in your epidermis use light from the sun to make vitamin D, which is important for your bones. But too much light can damage your skin and make you ill. Because of this, special cells in the epidermis make a chemical called melanin. This makes the skin darker, which protects you from too much light. Melanin changes

your skin colour, hair colour, and the colour of your eyes. Everyone produces melanin, but people with light skin can't produce as much as people with dark skin - so going out in the sun is more dangerous for them.

Under the epidermis lies the second layer of your skin: the dermis. The dermis contains things like capillaries, lymph vessels, nerves, and places where hairs grow called hair follicles. The dermis is very important for controlling your body temperature. When you are hot, glands inside the dermis make a watery fluid called sweat. Losing sweat keeps you cool, and it also helps your body to lose waste.

The capillaries in the dermis also become wider when you're hot. More blood goes to your skin, and it loses heat to the air around you - so you stay cool. In cold weather, the capillaries become narrower, and tiny muscles pull on your hairs, so they stand up. This keeps warm air near to your skin. Layers of fat cells under the dermis also help to keep your body warm.

You lose a lot of heat from your head, so the longest hairs on your body are on your head too. Each hair is made of cells that grow out of a hair follicle. Inside the follicle, the bottom of each hair is made of living cells. The top of each hair - the part that you can see - is made of layers of dead cells. That's why it doesn't hurt when you cut your hair. You have about 100,000 hair follicles on your head, and it takes between two and seven years for a hair to begin, grow, die, and fall out of each follicle. Old people have less hair because a lot of their hair follicles have stopped growing hairs.

Your nails grow in the same way as your hair. Cells divide deep inside your fingers and toes, and these are slowly pushed out of your body by more new cells behind them. When they reach the outside of your body, they begin to die. The hardest parts of your nails are made of layers of dead cells. They protect the ends of your fingers and toes, and they also help you to pick up small things. Do you write with your left or your right hand? Nails grow faster when you use them more, so your nails grow fastest on your writing hand.

When people grow old, the first thing that you notice is the change in their skin and hair. Old people's hair follicles produce less melanin, so their hair loses its colour and becomes grey. Light and chemicals damage the skin, and it can't move easily any more. Because of this, more and more lines appear in places where the skin moves. Look at an old person's face, and you can tell a lot about them. If they are happy and smile a lot, there will be more lines around their eyes. One thing that never changes about you is your fingerprints: the circles and lines on your fingers. They appear a few weeks after you arc born, and they stay the same for the rest of your life.

Chapter 9. It's all in your genes

Paula Bernstein and Elyse Schein are twins, but they didn't know that for thirty-five years! Different families looked after them when they were children - and neither family knew about the other child. They finally learned about each other in 2004, when Elyse was living in Paris and Paula was in New York. When the sisters finally met, they realized that they were very alike. Of course, they looked like each other, but it was more than that. They liked the same music and books, they both

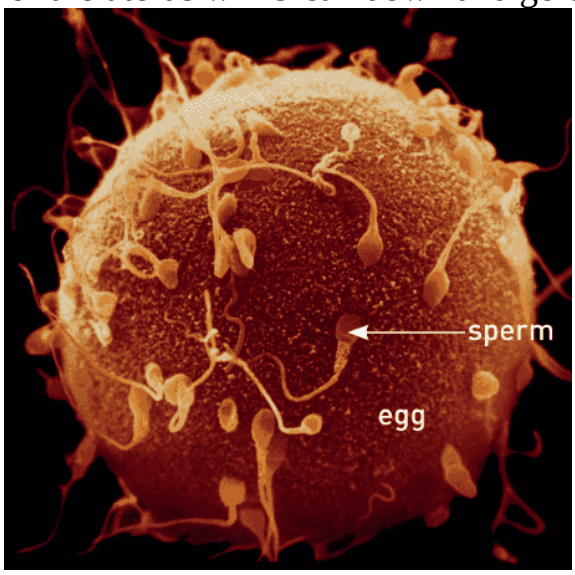
wrote for their school newspapers, they both studied film at university ... and it goes on.

Paula and Elyse look like each other because they have got the same genes. Genes arc like natural libraries of information. They are made of a chemical called DNA which ‘tells’ the cells in your body how to make different proteins. This makes the cells do different jobs in the body. Except for twins, everybody’s genes are a little different, and this changes how you grow as a baby. For example, genes decide the colour of your eyes or the shape of your nose and mouth. Genes control what you look like and how your body works - but as Paula and Elyse discovered, they may even change what kind of person you are.

Humans have got twenty-five to thirty thousand genes, and together they contain all the information that your body needs to make you! If you put this information into a computer, it takes about the same space as 750 songs or 3,000 books. That’s a lot of information, but amazingly there is a copy of all of your genes in almost every cell in your body!

Have you got your father’s hair and your mother’s smile? You look a little like both of your parents because you have got genes from both of them. Inside your cells, genes are joined together in long lines called chromosomes. Most of your cells have got twenty-three pairs of these chromosomes: half of each pair comes from your father and the other half from your mother. So if your mother has light skin and your father’s skin is dark, your skin can be light, dark or something in between.

Inside a woman’s body, special cells called eggs are kept in two organs called ovaries. When an egg in one of the ovaries grows big enough, it leaves the ovary and moves into a tube called the fallopian tube. This happens about once a month for many years in a woman’s life - from about the age of eleven to about the age of fifty-five. Deep inside the woman’s body, the egg travels down the fallopian tube towards the uterus. At the same time, the inside of the uterus grows and becomes thicker. It is getting ready to look after the egg. But the egg will only stay in the uterus if a special cell from a man - a sperm - meets it in the fallopian tube. If this doesn’t happen, the egg and the inside layer of the uterus will break down and go out of the body.



A woman’s egg cell and a man’s sperm cell have twenty-three chromosomes each. When they join, they make twenty-three pairs of chromosomes: all of the genes

that the egg needs to grow into a baby. This is called fertilization. About twenty-four hours after fertilization, the egg cell divides into two new cells. Later, it divides into four cells, then eight. After about seventy-two hours, a tiny ball of about sixteen cells moves into the uterus.

Five weeks later, there arc millions of cells, and the tiny baby's heart is beating. An organ with arteries and veins called the umbilical cord has grown between the baby and the mother's uterus. This carries oxygen and nutrients to the baby. Carbon dioxide and other waste passes the other way. After six months, the baby is moving a lot - and the mother can really feel it! Then, about nine months after fertilization, muscles in the uterus begin to contract and push the baby out of the mother's body. After many hours, and often a lot of pain, the baby is born.

On a cold winter afternoon in Hangzhou, China, Meilin Guosung breathes air for the first rime, and cries. She is one of 44,000 healthy babies born in the country every day. She can't move well, talk, cat food, or understand the world around her, but it won't take her long to learn. Children arc born with as many brain cells as

adults, but the neurons in places like the cerebrum aren't connected. This is why babies can't control their senses or their bodies very well. Kvery time a baby tries to do something, neurons in the brain make new connections, and things like moving become a little easier. This is how we all learn.

In about thirteen months, Meilin will try to walk for the first time. It won't be easy, and she will fall over a lot. But finally, she will take a few steps, then fall into her parents' arms. By the time Meilin is three years old, there will be a trillion new connections in her brain. By then, she will walk and talk easily, and even dance to C-pop music!

Chapter 10. When things go wrong

In May 1996, Beck Weathers was lost in a terrible storm near the top of Mount Everest. At 8,000 metres there wasn't much oxygen to breathe, and the temperature was -40°C. Slowly, Beck became weaker and weaker, then he fell down. Soon he couldn't move his body at all - not even to blink. When some climbers found Beck, they thought that he was dead and left him. But amazingly, after lying outside in the snow for nearly twenty-four hours, Beck Weathers stood up and walked down the highest mountain in the world.

Eight climbers died in that storm, but Beck lived. As he lay in the snow, his body moved blood to his organs, and away from his skin and muscles. Because he didn't move, he didn't use much energy or oxygen, and he didn't lose as much heat. One by one, Beck's organs began to slow down, so his heart and lungs could work slowly and keep him alive. But later, Beck's brain did something extraordinary, it sent blood back to his muscles, and he found the energy to get up and walk. It's an amazing story, and it shows how good the human body is at staying alive. And every minute of every day, your body is working hard to keep you alive too. It has to mend damage and fight germs all of the time.

An illness

Every time you eat, drink, or breathe, germs go into your body. You already have ten times more germs inside you than human cells! Most of these germs arc good for you, but sometimes a dangerous germ like a virus can make you very ill.

It's a winter evening, and Claire is sitting on the bus on her way home from work. The person behind her is ill. He coughs, and millions of viruses go into the air. Claire breathes some of them in. Most of the viruses arc caught in her nose and destroyed, but a few of them reach the back of her throat. There, they go into her cells. Chemicals inside the virus change each cell into a 'virus factory': the cell starts producing thousands of new viruses.

Special cells called white blood cells are moving through Claire's body all of the time. Like soldiers in a tiny army, they arc watching for dangerous germs. When they find one, they try to kill it! A few days after the bus ride, Claire's white blood cells are fighting the virus in her throat. They are killing damaged cells before they

can produce more viruses. But this makes Claire's throat very painful. She starts to cough.

Claire's white blood cells produce chemicals to tell the brain and other cells what's happening. But these chemicals make Claire's body hurt everywhere. At the same time, Claire's body temperature goes up. It's another way to try and kill the virus in her throat, but it makes her feel terrible. Claire's head hurts badly, and she just wants to go to bed. Her body is telling her to rest.

Claire's body has got many different types of white blood cell. Some of them kill damaged cells. Others catch germs and destroy them, and some make special proteins called antibodies. Antibodies fit into germs like a key fits into a lock. They help other cells to find and destroy the germs. There arc lots of different germs, and different antibodies to fight each one. This is how vaccination works. Doctors give you a dead or weak germ, and your body makes antibodies to fight it. In this way, you will be ready if you get the real germ.

Deep inside Claire's bone marrow, white blood cells with the right antibodies begin to divide. Soon, thousands of cells will produce antibodies to fight the virus. Claire is beginning to win the battle.

A week later, Claire feels much better. She has beaten the virus, and the new antibodies will stay in her tissues for years. If Claire catches the same virus again, her body will be ready.

An accident

Fifteen-year-old Sergio is running down the stairs at school when he falls and breaks a bone in his left arm. As it breaks, it tears muscles and damages hundreds of capillaries deep inside the arm. Sergio doesn't feel much at first because glands near his brain produce endorphins - chemicals to stop the pain. This is your body's way of helping: if you don't feel pain for a while, you can escape from danger more easily.

A few hours later, Sergio is in hospital. His arm looks much bigger because his body has sent fluid and nutrients to the broken bone. It also hurts a lot - Sergio's brain wants him to be careful now, and not use the arm. Already, his body is trying to mend the damage. Millions of blood cells called blood platelets have joined together around the broken bone. They've made a sheet of cells called a blood clot. More blood clots have also closed the holes in Sergio's capillaries.

Sergio isn't bleeding any more, and something amazing has already begun to happen. Inside his bone marrow, special cells called stem cells have begun to divide more quickly than usual. Stem cells can change into any type of cell in your body, like cells for making new bone. A few days later, millions of cells are busy mending the bone in Sergio's arm. Some of them make proteins to join the pieces together. Others cover the blood clot-and themselves - with minerals. Slowly, these minerals become new bone.

Five weeks after Sergio fell down the stairs, the broken bone has joined together. The new piece of bone is much stronger and thicker than before, but in about a year it will become thinner again. Then Sergio's bone will look the same as it did before.

Growing old

Every day, billions of cells in your body die, but you don't die because cells can copy themselves. One cell divides into two new cells, so you can grow and mend damage. But if the body is so good at mending itself, why do people grow old and die?

Over a long time, dangerous chemicals begin to damage the body. They come from the air that we breathe and the things that we eat and drink. Other dangerous chemicals are made naturally by your cells. These things damage organs like the liver and the heart, and they can destroy DNA too. Cells with damaged DNA die, and as people get older the body also produces fewer and fewer new cells. This means that it can't fix damage easily any more.

And some parts of your body don't make any new cells at all. You produce new skin cells all of your life, but a baby is born with all the heart muscle fibres and most of the brain cells that it will ever have. If you hit your head very hard, millions of brain cells die - so you really need to look after yourself!

We still don't understand all of the reasons why people get older. But the good news is that people are living longer and staying healthier than in the past. A hundred years ago, 'lucky' people lived for about sixty years. Now, many people live to eighty, ninety, or even a hundred. Every year we discover new medicines, new ways to mend - or even grow - organs, and other ways to fight damage and disease. At the same time, people all around the world arc studying how we grow old. One day, they may find a way to stop it!

Chapter 11. Amazing bodies

Daniel Kish is riding his bicycle through the streets in Long Beach, California, on a Monday morning. He stops at traffic lights, waits, then goes on. Morning traffic can be dangerous for anyone on a bicycle, but Daniel Kish is blind! He lost both eyes when he was thirteen months old, but he has taught himself to 'see' with sound.

Daniel makes a special sound with his mouth and tongue. The sound hits things like cars and people, then comes back to his ears. Different things change the sound that comes back, so Daniel knows what they are. Try closing your eyes when you're a passenger in a car. If you are driving along a quiet street, you can hear the sound change when you go past something big - like a house or car.

Of course, Daniel Kish is very, very good at doing this. His brain uses sounds to make a picture of the world. Daniel can tell where things are, how fast they are moving, if they are big or small, and even what they are made of.

Daniel has taught many blind people to use sound in this way. He enjoys swimming, he dances well and he likes to ride his bicycle in the mountains, far away from any roads. At first, many people don't think that he can possibly be blind!

Evelyn Glennie began to lose her hearing when she was twelve years old. But that hasn't stopped her from doing what she loves. Evelyn has made twenty-eight music CDs, and performed in front of big crowds in cities all over the world. Her

music is always unusual, different, and exciting. She once played an amazing piece of music using only things that you can find in a kitchen! When Evelyn talks to people, she watches their mouths and ‘reads’ their lips. But when she performs, she ‘feels’ the music with all of her body. Evelyn takes her shoes off before she plays music, so that she can feel more with her feet.

There are lots of very successful disabled people around the world. There is a cook who can’t taste his food, a dancer with one leg, writers who write with their feet ... and many, many more amazing people. People like Daniel Kish and Evelyn Glennie don’t stop doing things because they are disabled. They find ways to beat their problems and they have happy, successful lives. They don’t think that they are different from other people - and they don’t want other people to feel differently about them.

The Paralympic Games happen every four years, straight after the Olympic Games. It’s a great chance to see some of the world’s top disabled sportspeople. On the fourth day of the 2012 London Paralympic Games, thousands of people waited excitedly for the start of the men’s T44 200 metres. T44 is the name for a race between people who have lost part of one or both legs. They run with blades - special legs for disabled runners. The fastest T44 runner in the world, Arnu Fourie, was in the race, and he started very well. Fie was in front for a long time, but then Oscar Pistorius, a South African runner, caught him. Pistorius was winning the race until the last 50 metres. Then suddenly, a young runner called Alan Fonteles Cardoso Oliveira came up fast from behind.

Nobody thought that the twenty-year-old Brazilian could win the race, but he crossed the line 0.07 seconds in front! The crowd went crazy! In Brazil, 8,000 kilometres away, Oliveira’s family jumped to their feet, shouted, and cried. It was an amazing win for him - and one of the most exciting races in the Olympics or Paralympics in years.

Chapter 12. Healthy living

We all know that it’s important to look after our health, but how? There are lots of ideas in magazines and on TV and the internet, but always remember that everyone is different. Some people are healthier than others, and it can be dangerous to diet fast or exercise too hard. Here are a few ideas about how to stay healthy, but talk to people like parents, doctors, and teachers, and listen to their ideas too.

Exercise

From Monday to Friday the city of Bogota, in Colombia, is full of traffic. But on Sunday the streets are silent. You can’t drive in the city centre on Sundays, so people walk or ride their bicycles everywhere. More than a million people go for a walk in Bogota every Sunday. It’s a great way to make people exercise more.

It’s very important to exercise because many people spend hours and hours sitting down. We sit in cars, buses, and trains on the way to work or school, and then

many of us sit at a desk all day. And when we get home, we sit in front of the computer or watch TV.

When you exercise, or just move around, your muscles burn nutrients faster. When you sit and do nothing, these nutrients stay in your blood. Over time, this can make your artery walls narrow and full of fat. In the end, it can stop blood from getting to your heart!

Do you like swimming, playing basketball, or running? How about working in a garden, or walking to school or work? There are lots of ways to exercise, and not all of them are sports. The best exercise makes your heart beat fast, but even cleaning the house is much better than watching TV.

Exercise is great for your health, but it's important to exercise safely. Lifting something heavy can hurt your back, and running fast will hurt your legs if you haven't done it before. So always start slowly and exercise gently. Check with a doctor before you try anything new.

Healthy eating

Your body needs carbohydrates, proteins, and fats, but some types of these nutrients arc better for you than others. Chocolate and fruit both have carbohydrates like sugars in them, but the natural sugars in fruit are much better for you than the sugar in chocolate. It's also important to get your nutrients from healthy, not unhealthy, food. You can get protein and fat from unhealthy things like hamburgers, or from healthy foods like fish and some vegetables. Don't forget to drink lots of clean water every day too.

The plate on the right shows one example of a healthy diet: how much of each kind of food you should eat. The two biggest parts of the plate are fruit and vegetables (green) and foods like rice, bread, and spaghetti (yellow). These are great foods for vitamins, minerals, fibre, and 'good' carbohydrates.

The smallest part of the plate is for foods with a lot of fat or 'bad' carbohydrates, like sugar. A lot of these foods, like chips, also have salt in them. Over many years, eating too much fat, sugar, and salt can damage most of the organs in your body.

Eating too much food is bad for you, but many people don't realize that eating too little food is also dangerous. If you eat more food than you need, your body will change the extra nutrients into fat. This fat stays under your skin and around your organs, and it's very dangerous for your health. But if you don't eat enough food, your body won't get enough nutrients to work well. You will be tired all the time, and you will become ill.

Some people try to lose extra kilos by dieting, but it isn't easy. When people diet too quickly, their bodies make them feel tired and hungry all of the time. The body doesn't want them to lose the extra kilos, so what can they do?

If you want to lose extra kilos, it's important to diet very slowly, not fast, and to exercise at the same time. When you exercise, your muscle fibres change. Inside the muscle fibres, tiny parts divide so they can burn more nutrients. Slowly, the body becomes better at burning extra fat.

Drugs, alcohol, and cigarettes

Chemicals in drugs, alcohol, and cigarettes are very addictive: people want to have them again and again. And they can easily destroy their health.

Alcohol and drugs change the way that nerve signals move between the brain cells. When this happens, people can't do things like thinking clearly or remembering information. Drugs and alcohol are bad for many organs in the body, and they can even damage the brainstem. The brainstem controls things like the heart and lungs - if it stops working, you will die. Some drugs are very, very addictive, and they can kill someone very easily.

A chemical called nicotine in cigarettes wakes people up and makes them feel good for a short time. Later, they feel bad and want to smoke again. For this reason, it's very hard to stop smoking once you start. Dangerous chemicals in cigarette smoke damage your lungs and many other organs in your body. It becomes more difficult to breathe, and smokers cough all the time. In the end, smoking kills about 50 per cent of people who smoke cigarettes for a long time.

Don't worry - be happy!

Stress makes your body produce 'stress hormones'. In the past, these hormones made people ready to fight or run away from danger. But most of the stress in modern life comes from things like working too hard or worrying about something. Over time, too many stress hormones can make you ill. They can damage organs and arteries, make it harder to fight germs, and also stop you from sleeping.

Being happy is good for you because the body produces less stress hormones and other dangerous chemicals. Of course, nobody can be happy all the time. But people who do interesting things, go outside a lot, and spend time with friends are usually happier than people who don't do these things. So it's good to think about how you spend your free time.

People in some countries say 'The doctor goes where the light doesn't go.' And it's true. You need light to produce some vitamins, and 'good' hormones that make you feel better and sleep well. Bright, light houses make people feel happier too. So open the windows and use light colours on the walls. Studies show that pictures help people in hospital to get better, so it's also a good idea to put some nice pictures on your walls.

A few years ago, people studied groups of old men and women in Britain. They found that older people who do things in their free time and feel good about life live about six years longer! That's a long time in a person's life. So if you want to stay healthy, go out, meet people, try new things - and have some fun!

Chapter 13. No one like you

My friend Kemal was born in Erdemli, Turkey. He is seventy-three, with kind, coffee-brown eyes and a nice smile. His hair is white, his knees hurt in cold weather,

and his back isn't straight any more. But Kemal doesn't really 'feel' old. He still walks on the beach where he played as a child. He used to run there straight after school - then come home late with dirty clothes.

'You've been swimming again!' his mother used to say, trying to be angry. 'I can taste the salt on your skin.'

There are more than seven billion people in the world, but there will never be another person like Kemal - or like you.

From the trillions of connections in your brain to the colour of your iris, your fingerprints, and the shape of your muscles and bones - you are different from every other person in the world. And of course, nobody will ever feel, think, or remember the same things as you.

Hold up your hand and look at it for a moment. It has twenty-seven bones, thirty-four muscles, twenty-nine joints, and thousands of touch, heat, and pain receptors. A few thousand kilometres of nerves, lymph vessels, arteries, and veins join it to the rest of your body. And every part of you is just as amazing as your hand.

Your body is truly wonderful. Look after it - it's all that you have.

- THE END -

Hope you have enjoyed the reading!