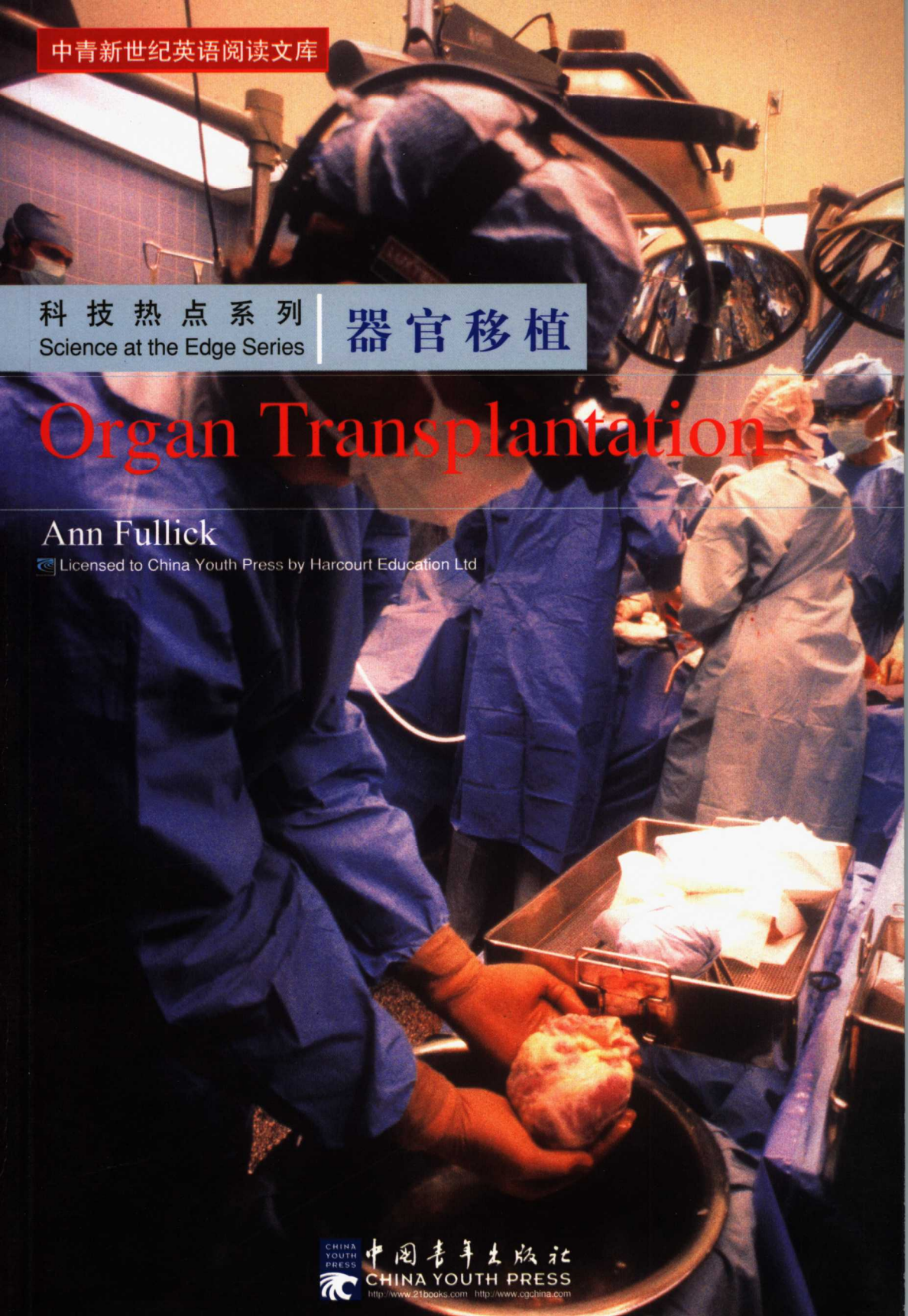

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# 器官移植

# Organ Transplantation

Ann Fullick

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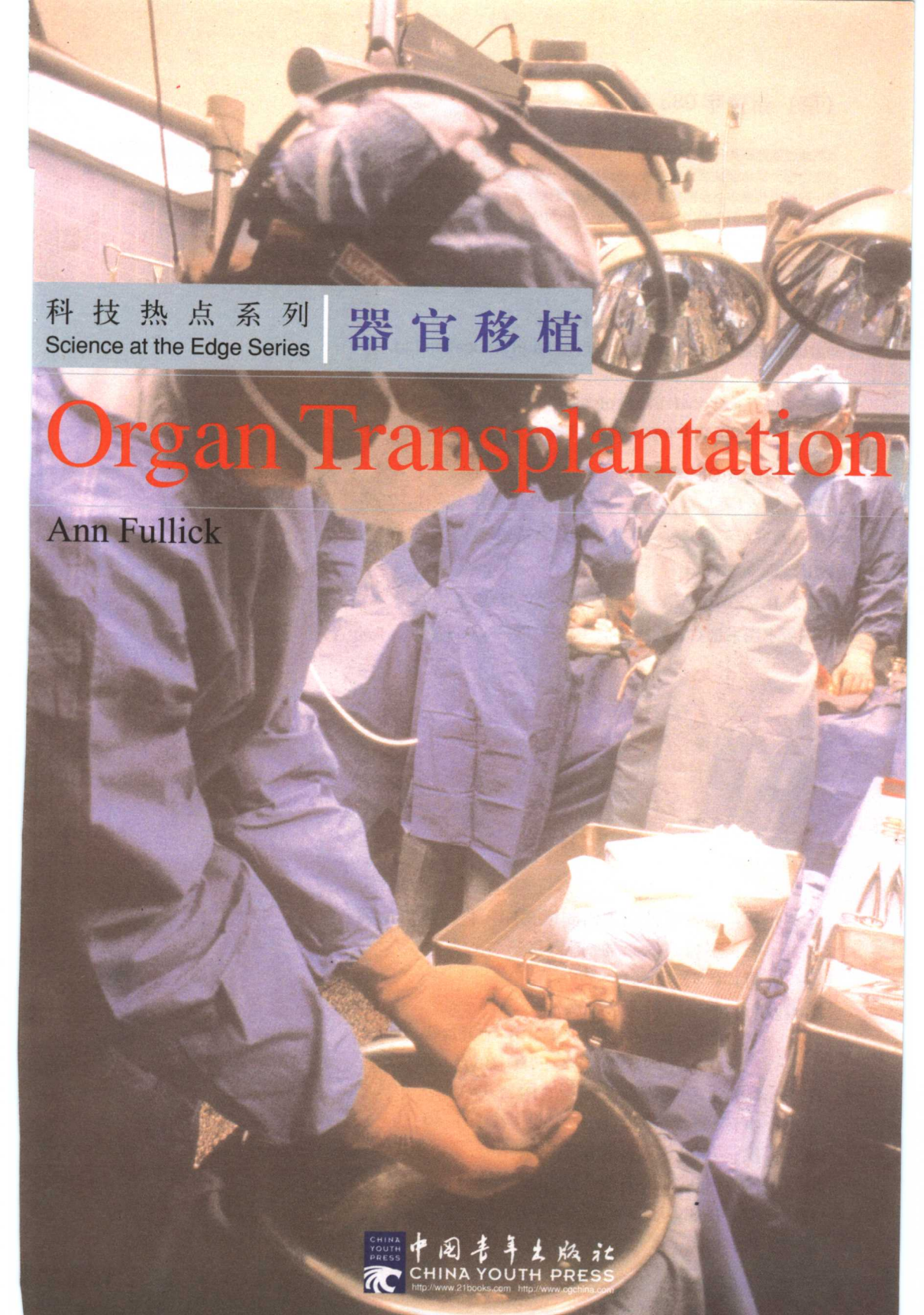

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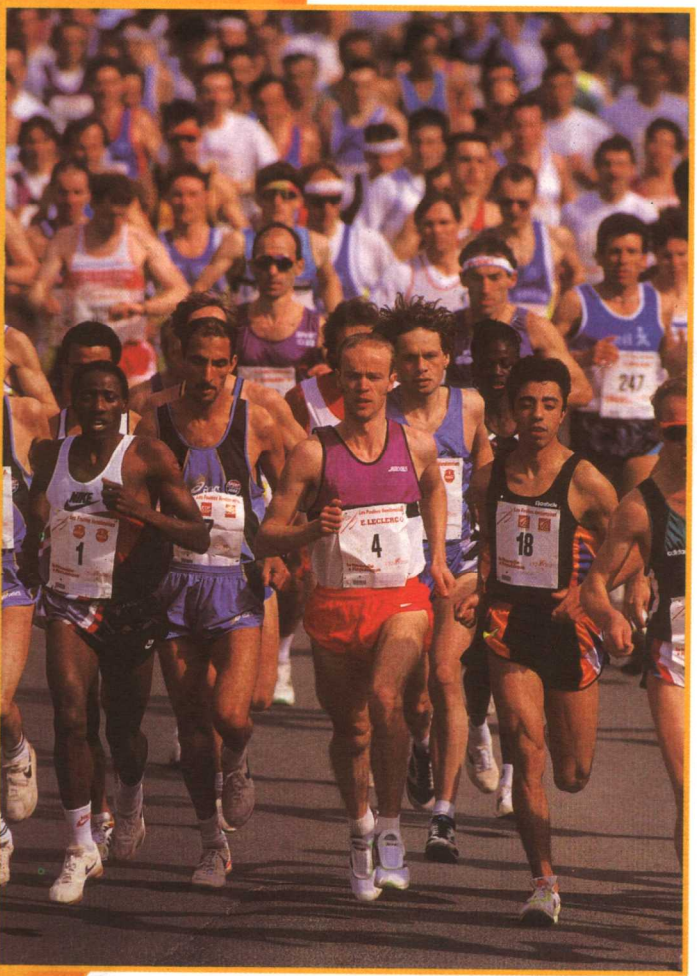
# Contents

# The organs of the body

The human body is a masterpiece of biology. It enables us to move around to get food, escape danger, get to school on time, play football, baseball, cricket... More than that, the human body uses the food that we eat and turns it into more body or even new human beings. The body can get rid of poisons that may be taken in or produced by the body itself. It can survive in an enormous range of conditions, use tools, write books – and all these things are possible because of the complex biology going on inside it.

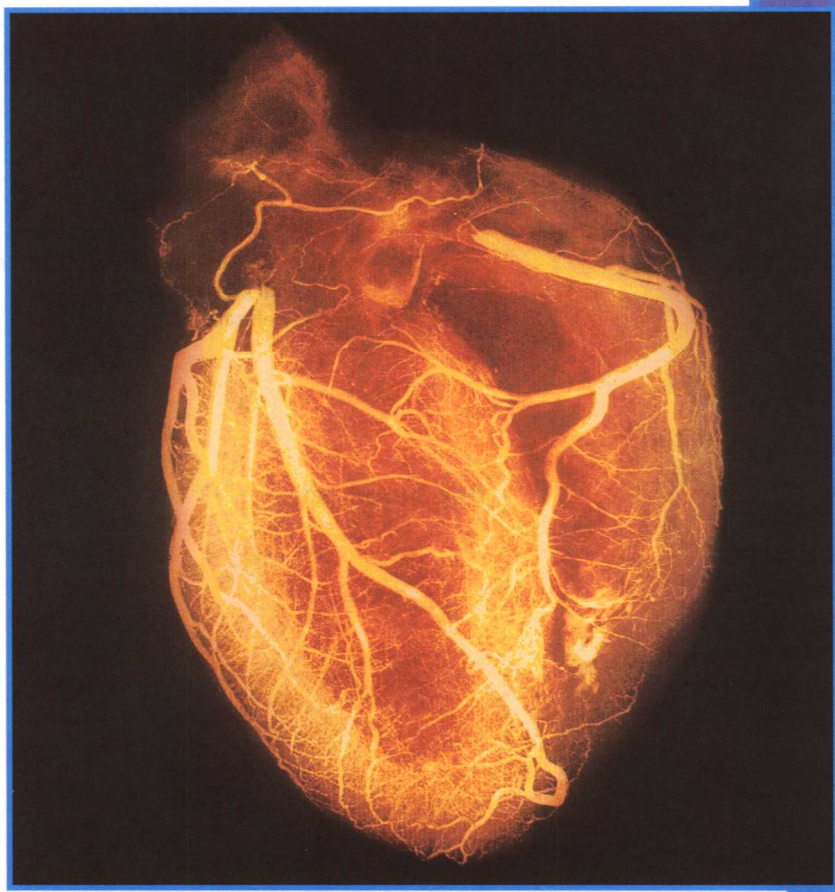


All of the activities of the body are made possible by major organs (collections of cells and **tissues** that carry out a major function in the body) working together to produce a co-ordinated whole. Each organ carries out a very specific job within the body. These major organs include the heart, which pumps the blood around the body, the kidneys, which balance the water levels in the body and get rid of waste, the eyes, which enable us to see, and the liver, which cleans and purifies the blood. The organs work together to maintain steady conditions inside the body, regardless of how it is being used or where it is.

The average human being contains billions of cells, miles of **tubing**, square metres of skin, litres of fluid and pounds of muscle. Somehow all of this body-stuff has to be organized to work, and work properly, whatever demands are put on the body.

## What if things go wrong?

Almost everyone takes their body completely for granted – until something goes wrong. And if anything does go wrong with any of a person's major organs, they are in deep trouble – in fact the failure of a major organ can mean death. However, in the last 50 years, there has been an enormous increase in the number of people who survive the total failure of one of their body organs, thanks to the development of transplant surgery or organ transplantation. This involves giving a very sick person the healthy organs they need from someone else, often someone who has died very suddenly. There are many thousands of people around the world who are only alive and well today because they have someone else's heart, kidney, liver, lungs or small **intestine** working away inside their body, carrying out the important job that their own organ was no longer able to do.

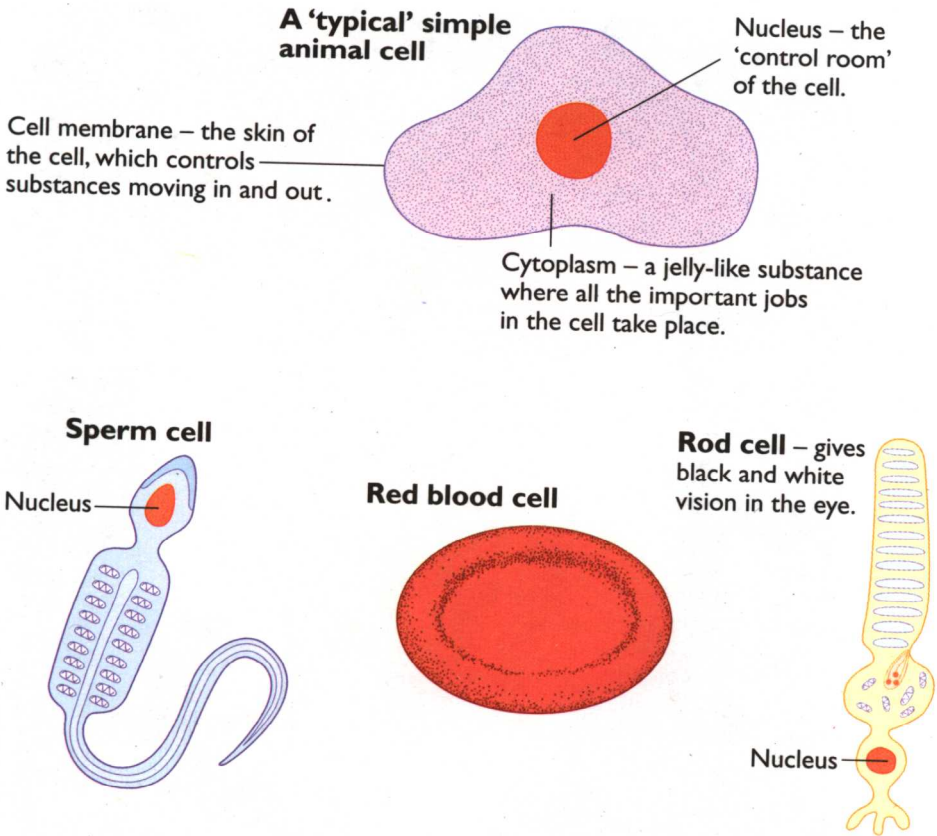


The idea that a complex organ like the heart can be removed and replaced with another one would have seemed completely unbelievable 100 years ago – yet now, every 27 minutes, someone somewhere in the world receives a transplanted organ!

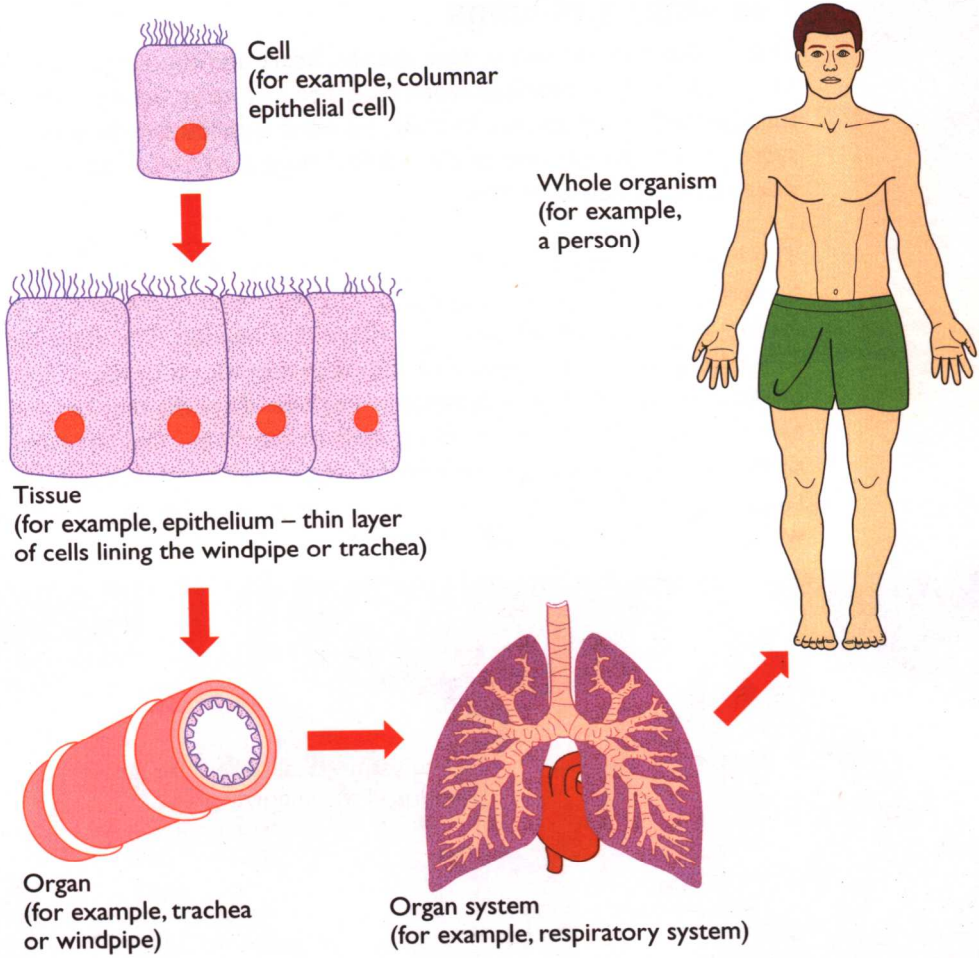
## How does the organization work?

The basic unit of a human being is a single cell – a jelly-like blob contained in a **membrane**. A cell carries out lots ands lots of chemical reactions at the same time. In large organisms, such as human beings, cells are often very specialized. This means they carry out one particular job. The structure of these cells is different from the 'basic model' in order to suit the very specialized jobs that they do.

The specialized cells are often grouped together to form a tissue. In human beings, connective tissue joins bits of the body together, while nervous tissue carries information around the body, and muscles move the body about.




Sometimes cells become so specialized that they only have one function within the body. Good examples of this include sperm, red blood cells and the specialized cells involved in colour vision in the human eye (rod cells).




Human body organs are made up of groups of specialized cells and the organ systems are designed to carry out very specific jobs – for example getting oxygen into the blood, pumping blood around the body or hearing what is going on in the environment.

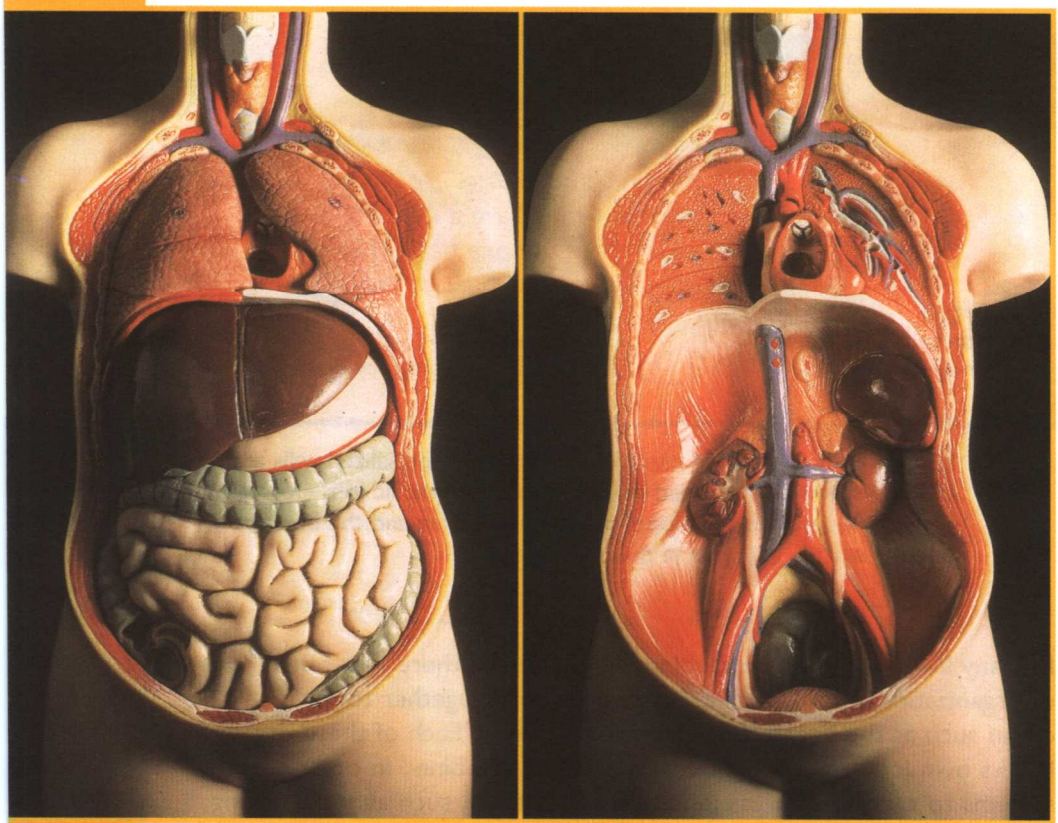
In many living organisms, including human beings, there is another level of organization – several different tissues work together to form an organ such as the heart, the kidneys or the liver. Each of these organs has its own job. In turn, different organs are combined in organ systems to carry out major functions in the body, such as transporting the blood or reproduction.

A look at the work of some of the human organs and organ systems makes it all too clear why it is such a disaster if they go wrong.

## The heart and lungs

The best-known human organs are the heart and the lungs. They are both vital for life, and they work together as a team, along with miles of tubing called blood vessels, to make up what is called the **cardiovascular** system. The heart is one of the earliest organs to be formed in the developing human **embryo**.

The heart is basically a bag of muscle that beats from a few weeks after a person is formed in the **uterus** until their death. It fills and empties, forcing blood out of the heart to where it is needed. The right-hand side of the heart sends blood to the lungs to pick up oxygen. The blood also gets rid of the poisonous **carbon dioxide** that has built up as a waste-product in the working cells of the body. The left-hand side of the heart sends oxygen-rich blood, which has been through the lungs, around the whole of the rest of the body, supplying all the cells with the oxygen they need for life.



Inside everyone there are lots of different organs, all doing important jobs that help to keep us alive.

The heart is made up of muscle tissue that has its own rich blood supply. It also contains special tissue that makes up the **valves** of the heart – flaps that stop blood flowing in the wrong direction – and big blood vessels that allow blood to flow into and out of the heart.

The lungs take the blood from the body and pass it through specially adapted tiny **air sacs**. These make it possible for as much oxygen as possible to be picked up by the blood, and as much carbon dioxide as possible to be removed from the blood. The process is known as gaseous exchange, and it must take place efficiently if someone is to lead a healthy, active life.

## A pair of kidneys

The kidneys remove **urea** from the system, a poisonous waste product that results from the breakdown of **protein** in the diet. They also remove excess salt and control the water balance of the body. This is enormously important – if the water balance goes wrong, all the cells in the body are in danger of either **swelling** or shrivelling up. Either way, they wouldn't work properly and death would not be far away!

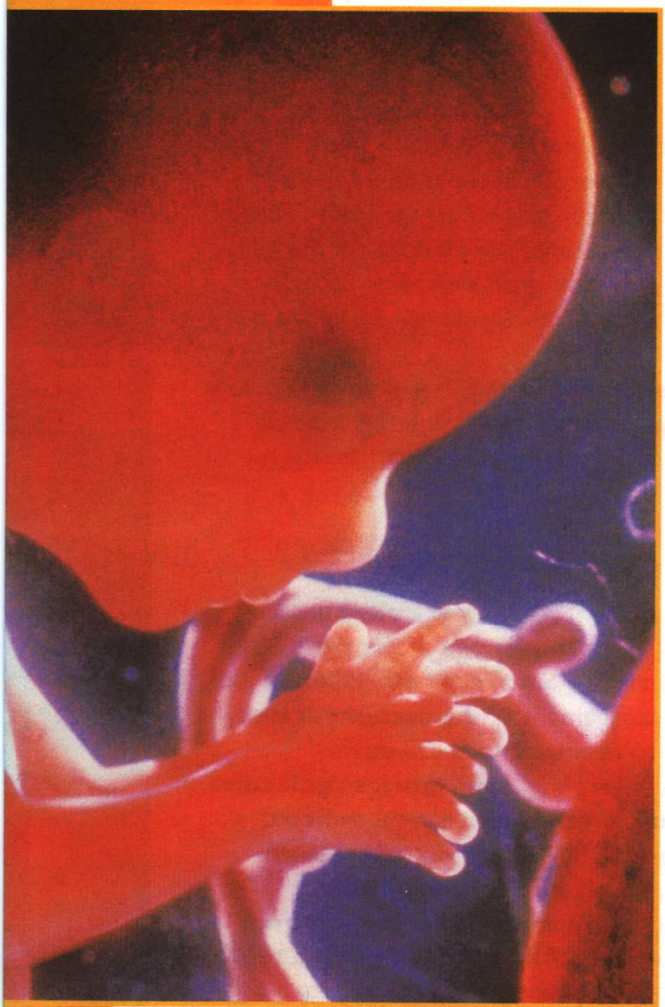
Some organs, like lungs and kidneys, come in pairs – but why? Probably because these organs are so important they have a kind of 'built-in spare'. But if that is so, why do we only have one heart? No one is quite sure.

## What does a liver do?

Most people know that they have a liver, but they are often unsure about where it is and what it does. The liver is one of the most important organs in the body – it carries out around 500 different jobs! It is involved in the control and management of the **carbohydrates**, proteins and fats we eat. It helps to remove and break down **cholesterol** and other fats and convert them into storage **molecules**. It breaks down excess proteins into urea – which can be excreted – and useful **amino acids** (the chemical building blocks of proteins). It stores a number of substances, makes **bile** (a liquid that helps in digestion), helps control the body temperature and breaks down some of the **toxins** taken into the body. And this happens on a regular basis, because substances such as alcohol and painkillers are toxins. In fact, the liver acts like a personal detoxification (poison-removal) plant, getting rid of harmful chemicals. So a liver is a very useful organ to have, and when the liver fails, the body is affected in a wide number of ways, several of which can lead to death.

# Organ failure!

Most people are born with a set of perfectly healthy organs which then go on to work throughout their life. After 70, 80, 90 or even 100 years, their heart, kidneys, lungs and liver may all still be carrying out the tasks for which they developed so many years earlier. However, not everyone is so lucky. Organ systems can be damaged in a number of ways, or may stop functioning altogether, for a number of reasons. The effect this has on the person concerned ranges from distressing – when, for example, the sight or the hearing is lost because of damage to the eyes or ears – through to completely life-threatening – for example when an organ such as the heart, liver or kidneys fail.



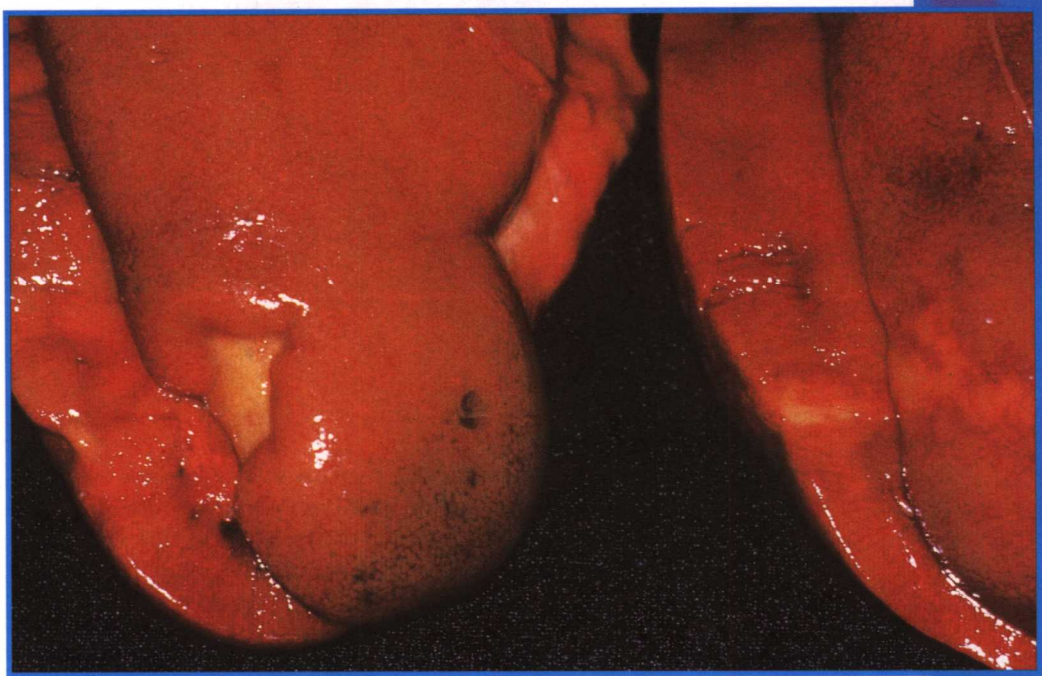
Problems can start even before a person is born. Sometimes organs do not form properly as the embryo develops. If the problem shows up on an **ultrasound scan** – a technique using very high frequency sound to see inside the body during pregnancy – then doctors and the parents are prepared. If surgery is possible, it is done shortly after the birth. Sometimes it can even take place while the baby is still developing in the uterus. Babies born after this type of surgery heal so well, they are born without a scar! But even with all the modern technology available

While a baby is developing in the uterus, many of its main body functions are dealt with by the mother's body, through the **placenta**. If its heart or lungs do not work properly it is not greatly affected. But after birth, the baby can be in real trouble – indeed babies die on a regular basis because of faulty organs that have failed to develop in the uterus.

today, babies are still born with unexpected organ problems. When this happens, the worst case is that the baby will die before surgery can correct the problem. However, in many cases, the child can be kept alive for at least a few weeks or months, by which time a solution – corrective surgery or a transplant – may be found.

## Kidney infections

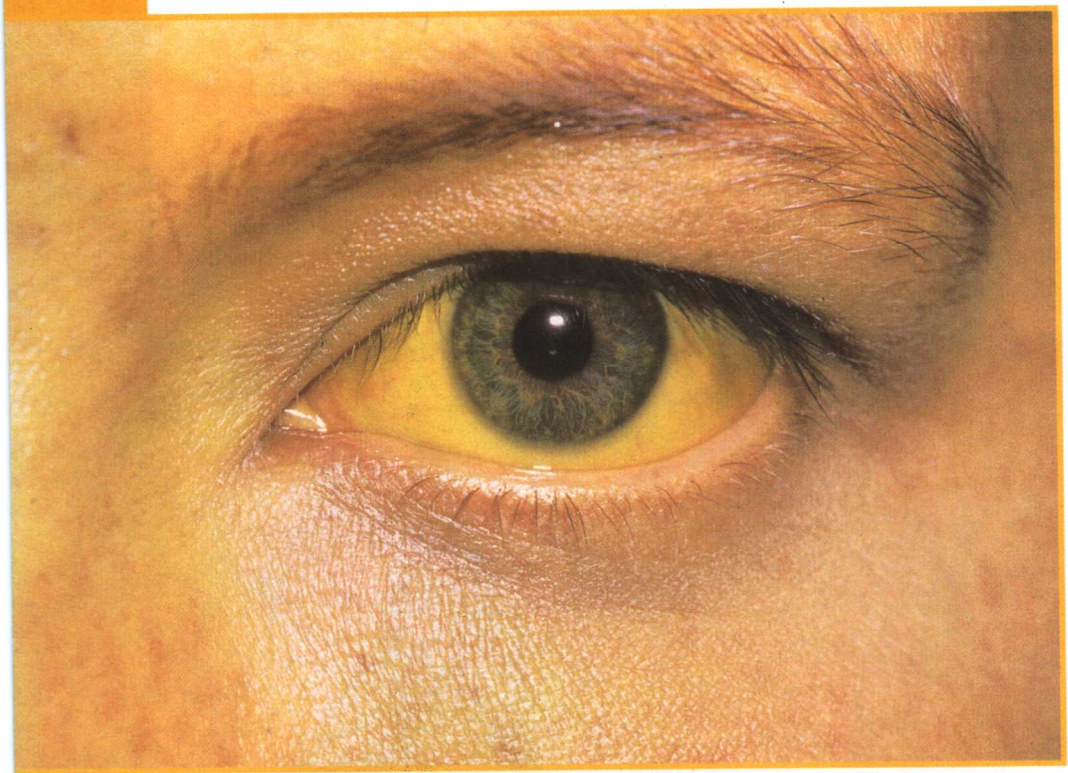
Sometimes people are born with a set of perfectly healthy organs, but develop an **infection** at some stage of their life that attacks and damages an organ beyond repair. For example, if an infection in the urethra (the tube which carries **urine** from the **bladder** out of the body) is neglected, the infection can spread up into the bladder and on into the kidneys, causing kidney damage and even kidney failure. Although many kidney infections are easily treated with **antibiotics**, repeated infections over the years or sudden very severe infections can both result in kidney failure. Without the kidneys, urea quickly builds up to **toxic** levels and the water balance of the body is lost. Death will occur a few days after the kidneys fail.



When an infection takes hold it can destroy an organ with terrifying speed. Within days, healthy kidney tissue can be damaged forever. This kidney has been damaged by a rapid bacterial infection.

## Other infections

The kidneys are not the only organs that can be affected by the invasion of micro-organisms. Infections of the heart can damage the heart muscle so severely that it can no longer pump the blood effectively – and a badly damaged heart can cause death even more rapidly than failing kidneys. Similarly, hepatitis, a disease that is becoming increasingly common in the developed world, causes massive destruction of the liver cells. The same thing happens if the liver is attacked by liver cancer, another reason why liver function is sometimes lost.



Typical **symptoms** of liver disease include a yellow skin and yellow 'whites' of the eyes. Bile, produced from the breakdown of the red blood cells, is not removed by the liver and builds up in the blood, colouring the skin and other tissues. In contrast to the skin, the **faeces** lack the colour of the bile **pigments**, and so appear very pale. This is known as **jaundice**, and the level of jaundice can give an immediate indication of how well the liver is working.

The gut too can be attacked by severe infections which damage the lining so badly that it can no longer absorb food, and it needs to be replaced. In the most severe infections, there is multiple organ failure. Even transplant surgery cannot help in these circumstances.

## Gradual damage

Organ failure that results from severe infection does not always happen rapidly. Sometimes the destruction progresses relatively slowly, with the functioning of the organ getting weaker over a number of years. This can be caused by progressive illnesses or by damage caused by drugs. Drinking too much alcohol over a period of time can cause permanent liver damage – and brain damage as well. Smoking cigarettes causes damage to the lungs, damaging the structure of the delicate air sacs and making it harder and harder to get enough oxygen into the blood. It also affects the heart, making heart attacks more likely. If unsuitable drugs are given to a patient, kidney and liver damage can result. High blood pressure is another common cause of damage to organs such as the kidneys. Once the filtering mechanism is damaged the organs never work properly again.

*'My kidneys started to fail when I was given a drug to treat another problem. For the first nine and a half years I coped by managing my diet very carefully – I could only eat small amounts of protein and the levels of liquid and salt I took in mattered, too. But eventually I became more and more tired and began to feel really unwell.'*

Bernard Everard, a kidney patient, describing the gradual failing of his kidneys when he was in his fifties, after a prescribed drug for another illness caused irreversible kidney damage

Another common cause of organ damage occurs when the **coronary** arteries, the blood vessels that supply blood to the heart, become narrowed due to a build-up of fatty deposits on the walls. If a clot then forms in the blood and blocks the blood vessel, the muscle walls of the heart are starved of oxygen and may die. This is what is commonly known as a heart attack or coronary thrombosis. Even if the patient survives the attack, if the heart is severely damaged it may never work as effectively again.

So the organs of the body can fail for a number of reasons. Problems can arise at any time from **conception** onwards, although the risk of organ failure gets higher with age. But many babies and young children also face the prospect of a much shortened life if some of their vital organs begin to fail. The challenge is to find ways to repair or replace those failing organs and give the patients back their quality of life.

*'One day Christopher was playing happily with the other children – and a few days later, his life was hanging in the balance and his kidneys had failed completely. The infection struck so quickly, we were all completely stunned.'*

Ann Fullick, describing the speed at which a neighbour's child was affected by a kidney infection

# New parts for old

For centuries, doctors have struggled to deal with the life-threatening situation of organ failure, and for most of that time there has been little or nothing they could do. Today, however, there are a number of ways of helping such patients not only to survive, but to live very healthy, active lives. One of the ways of restoring quality of life to a patient with failing organs is to give them an organ transplant.

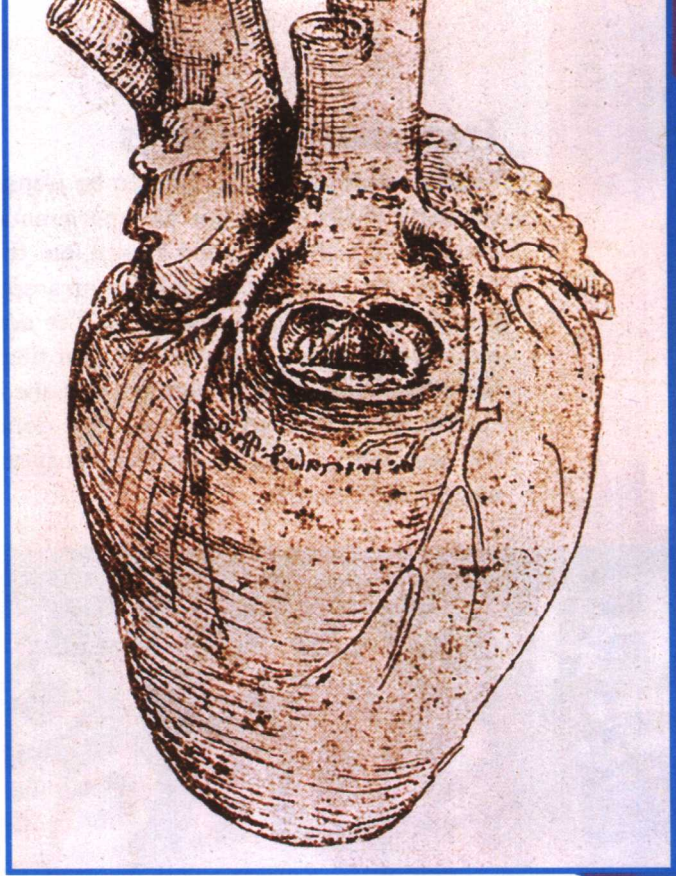
The history of organ transplantation goes back a very long way. People recognized that if they could replace damaged or broken body parts, many other people would be healed. But progress was very slow because extremely sophisticated science needed to be **unravelled** before successful transplants could really become possible. In spite of this, some early attempts were made.

In 800 BC, there was a report in India that a surgeon called Susrata **grafted** new noses on to people using flaps of skin. From around AD 200 in China, there were reports of Hua-To replacing diseased organs with healthy ones. This seems unlikely because of what we now know about rejection, but if family members were used as donors, or a lucky tissue match came up, he could have had enough success to make an impression. Nobody says how long the patients lived!

But genuine transplants, where a new organ is placed in the body of the **recipient** and restores them to a healthy way of life, have been a long time in coming.

## The compatibility question

Before transplants could help people overcome the problems of failing organs, scientists needed a better understanding of the human body. An important step was developing their knowledge of the human **immune system**. The basis of this system is the recognitive ability of cells. It can tell the difference between the cells of the person's body and all other cells. It therefore rejects and destroys transplanted organs because it recognizes them as different. This means that not only have scientists and doctors needed to develop surgical techniques for successful transplants, but they have also had to find ways



From very early times people tried to understand what was going on inside their bodies. However their knowledge was limited to what they could find out from examining dead bodies. Over the centuries many careful drawings of human organs were made, and understanding of the way organs worked grew, too. This drawing of the heart by Leonardo da Vinci dates from the fifteenth century.

(for example using special drugs) of preventing rejection of the new organ. Throughout the first 50 years of the last century, doctors and scientists were gaining in knowledge and understanding of how the organs of the body worked. They were also learning to recognize some of the signals used by the immune system. Sir Peter Medawar, often known as the father of modern immunology (the study of the immune system), did a great deal of pioneering work with skin grafts during World War II, leading to a far deeper understanding of the problems of rejection (for more on the immune system and the problems of rejection, see pages 28–29). Scientists and doctors were working towards the point where they would be able to transplant organs from one person to another, but this was always going to be an enormous leap in the dark. The patients would be very sick, indeed dying people – yet if the organ transplant failed to save them the technique would be seen as a failure.

## Transplanting kidneys

Kidneys were the first organs to be transplanted successfully. During the early 1950s, a number of experimental kidney transplants were carried out in America and France, but they were largely unsuccessful. In 1954, the first successful kidney transplant was carried out by Dr Joseph E. Murray in Boston, USA. The donor was the living **identical** twin of the patient, which meant that there were no problems with rejection. The cells of identical twins are identical, so the immune system of the twin who received the donor kidney did not recognize the new kidney as different. The transplanted kidney worked for a further eight years.


Dr Joseph E. Murray won the Nobel Prize for Medicine in 1990, for his pioneering work on kidney transplantation. Of English and Irish origins, he began his surgical career in the USA, working on soldiers burned during WWII. This is where his interest in the problems of avoiding rejection began. His work on kidney transplantation helped make successful life after transplantation a reality for many thousands of people.