Chapter 22
Expanding knowledge of ourselves

Unit
1A

Unit content

The relevance of human biology to everyday life
Human biological science knowledge is evolving at a rapid rate due to technological advances, increasing the amount and type of information available about ourselves. This impacts on areas such as human survival rates, and risks, ethical concerns and benefits of medical interventions and also helps to explain variations.

Support and diagnosis:
- medical systems to support organs *e.g. dialysis*
- imaging techniques and resulting information *e.g. X-rays, CAT scans, MRI procedures*.

Survival:
- changes in survival rates *e.g. over generations, in different countries*
- changing life span of humans
- historical development of knowledge of the causes of disease and treatments
- risks, ethical concerns and benefits of common medical procedures *e.g. appendectomy and pharmaceuticals such as taking antibiotics*.

Figure 22.1 CT scanners are just one of the technological advances that have helped us to increase our knowledge of the human body

We are very fortunate to be alive in the 21st century and to be living in a country like Australia. Babies born in Australia today can expect to live longer than babies born in just about any other country in the world. We are able to choose from a wide range of healthy foods that have been prepared under hygienic conditions. If we become ill the standard of medical care available is world class. Our doctors, dentists and nurses are well trained and highly skilled and the latest medical technology is available in hospitals and surgeries. In addition there are para-medical experts such as physiotherapists, podiatrists, occupational therapists and ambulance officers available to help when required.

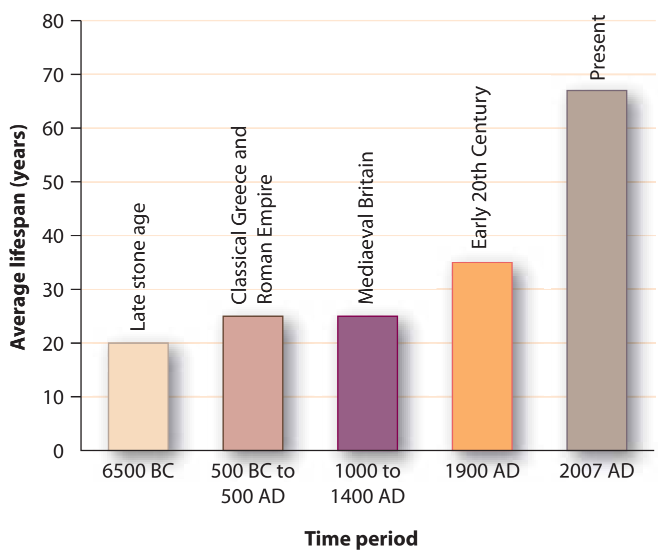

Figure 22.2 Increasing life expectancy

How long do humans live?

If you had been born in the Stone Age, about 8500 years ago, you could have expected to live for about 20 years. During the period of classical Greece and the Roman Empire, from about 500 BC to 500 AD life expectancy was 20 to 30 years. By the time of mediaeval Britain from 1000 to 1400 AD things had not changed much; life expectancy was still only 20 to 30 years. Early in the 20th century it had increased to 30 to 40 years and today, early in the 21st century, the world average life expectancy is 67 years (see Fig. 22.2).

Australian life expectancy

Statistics on the ages of Australians were first collected in 1885. At that time life expectancy for males was 48.7 years and for females 51.5 years. Since that time there has been a big increase in the number of years an Australian can expect to live. A boy born in 2006 would have been expected to live for 78.7 years and a girl 83.5 years. Figure 22.3 shows the changes in life expectancy in Australia from 1885 to 2006.

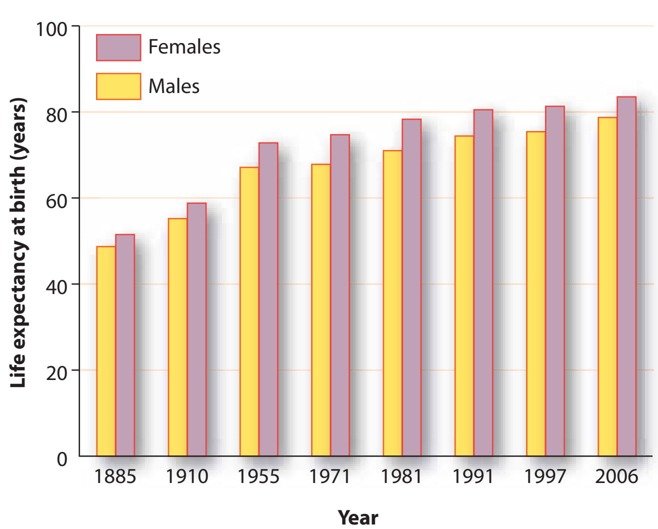

Figure 22.3 Life expectancy for Australian males and females, 1885 to 2006

Some of the factors that have brought about the huge increase in life expectancy over the past 100 years are improved standards of hygiene, mass immunisation and use of antibiotics. In more recent times the increase has been due to improved diet, reduction in smoking and advanced medical technology leading to fewer deaths from heart disease.

Unfortunately life expectancy is not the same for all Australians. Australian Aboriginal people born in 2008 have a life expectancy that is 17 years less than that for other Australians. There are many reasons for this. Poor housing, poor access to education, inadequate diet and limited access to medical facilities are just a few.

Life expectancy in other countries

People living in Japan have the longest life expectancy in the world. Australia is not far behind in fifth place. At the other end of the scale, Swaziland has the shortest, 40% below the world average. In many countries where the life expectancy is low it is due to a high infant mortality rate—many babies do not survive beyond their first year of life. Deaths of babies are usually due to dehydration, lack of food or disease.

Table 22.1 shows the life expectancy of some countries.

Find out a person's average life expectancy for any country at http://en.wikipedia.org/wiki/List_of_countries_by_life_expectancy

Table 22.1 Life expectancy of selected countries, 2006 figures

Rank	Country/territory	Life expectancy at birth (years)		
		Overall	Male	Female
	World average	**67.2**	**65.0**	**69.5**
1	Japan	82.6	79.0	86.1
2	Hong Kong	82.2	79.4	85.1
3	Iceland	81.8	80.2	83.3
4	Switzerland	81.7	79.0	84.2
5	Australia	81.2	78.9	83.6
13	New Zealand	80.2	78.2	82.2
22	United Kingdom	79.4	77.2	81.6
66	Malaysia	74.2	72.0	76.7
82	People's Republic of China	73.0	71.3	74.8
110	Indonesia	70.7	68.7	72.7
139	India	64.7	63.2	66.4
159	Papua New Guinea	57.2	54.6	60.4
178	South Africa	49.3	48.8	49.7
188	Afghanistan	43.8	43.9	43.8
189	Zimbabwe	43.5	44.1	42.6
195	Swaziland	39.6	39.8	39.4

Source: United Nations World Population Prospects 2006 Revision

Changing ideas about disease and treatments

In Australia, we take it for granted that if we become ill doctors will be able to treat us with medicines, operate on organs that are not working properly or, at least, help to reduce pain and suffering. It has not always been so. In prehistoric times disease was blamed on the gods or on evil spirits. Ancient skulls have been found with a hole cut in the brain case, probably to allow an evil spirit to escape (see Fig. 22.4). People also tried to help the diseased person by performing religious ceremonies that were meant to please the gods or drive out the evil spirits.

Figure 22.4 A 2500-year-old skull found in a bog in Denmark: the skull has a 3 cm diameter hole that has been deliberately made, probably to let evil spirits escape; the smooth edges to the hole show that the patient survived and the wound healed

Herbs and other plants were often used to treat people who were ill and some of those remedies are still in use today. The use of plants for healing is shown in cave paintings in France that are at least 13 000 years old. This was the beginning of the modern science of pharmacology.

The ancient Egyptians, Indians and Persians all had medical beliefs about the cause of diseases and the best ways to treat them. However the 'father of modern medicine' is considered to be Hippocrates, a Greek who lived from 460 to 377 BC. Hippocrates believed that diseases had natural causes and were not due to witchcraft, evil spirits or angry gods. If diseases were caused naturally then it would be possible for people to cure diseased patients. Hippocrates described the symptoms of many diseases and suggested treatments for them.

It was not until the Renaissance in Europe (about 1350 to 1600 AD) that a major step forward in the study of disease occurred. Laws against dissecting dead bodies were relaxed so that detailed study of the structure of the human body became possible. A much better understanding of human anatomy (the structure of the body) then developed.

During the 1600s important discoveries were made in **physiology**, the study of the way the body functions. William Harvey (1578–1657), for example, demonstrated that the blood circulates (see Fig. 22.5). Until the time of Harvey it was widely believed that blood was made in the liver and the lungs. It was then thought that the heart pumped the blood to the various parts of the body where it was consumed. Harvey was able to show that it was the same blood that was pumped around and around the body—the circulation. Other important advances around this time were the invention of the microscope, leading to the discovery of micro-organisms; vaccination against smallpox; and the discovery that scurvy could be prevented by eating fresh fruits and vegetables.

Figure 22.5 William Harvey giving a lecture on the circulation of the blood

Modern medicine

During the 19th century (the 1800s) the treatment of disease made great progress due to advances in chemistry and in laboratory equipment used for investigation. Due to the work of Pasteur, Koch and others the germ theory of disease became established. The germ theory stated that many diseases were caused by micro-organisms. Although rejected by many when it was first proposed, acceptance of the germ theory led to improvements in hygiene and eventually to the development of antibiotics. The germ theory also led the way for Joseph Lister, around 1865, to demonstrate the importance of using antiseptics in operations.

Use of the scientific method (see Fig. 1.3, page 4) to solve problems in medicine was pioneered by people like Pasteur, Koch and Lister. However it was not until the 20th century that the use of the scientific method in medical research led to huge advances in the diagnosis and treatment of illness. Discoveries like penicillin and other antibiotics, the development of vaccines for a wide range of transmissible diseases and the use of diagnostic tools like X-rays and CT scans have all come about through rigorous scientific investigation.

Today this scientific approach is known as **evidence-based medicine**. Scientific investigation is used to assess the risks and benefits of new drugs, tools for diagnosis, surgical procedures and other treatments for illness. Evidence-based medicine is also used by individual doctors. They collect as much evidence as possible about a patient using X-rays, scans, blood test results, physical examination and other techniques. Based on the evidence they then decide on the most appropriate course of treatment.

In the next section of this chapter we will look at some of the methods used to gather evidence about patients.

Technological advancements in the collection of data

People visit a doctor when they are ill. They may have pain somewhere in the body; they may have diarrhoea or be vomiting; they may have a cough or they may be aware of some change in the body that indicates illness. These are **symptoms**. Symptoms are the sensations or feelings that tell people something is wrong. From the patient's description of the symptoms the doctor has to work out what the problem is. The doctor's decision is called a **diagnosis**.

In the past doctors had to make a diagnosis by asking questions and by making observations of the outside of the patient's body. With advances in technology doctors are now able to find out what is going on inside the patient's body. Machines and probes allow doctors and technicians to see inside the body. Tests can be done to check for changes in the blood and other body fluids. Samples of cells can be looked at under a microscope, or cultured in a laboratory. DNA profiles can be examined to find out whether a person is likely to develop a disease.

In this section we look at a few of the ways in which technology has made it possible for doctors to collect information about the body.

X-rays

X-rays were discovered in 1895 by Wilhelm Roentgen, a German physicist. He was experimenting with electric currents passing through a vacuum tube when he noticed that a nearby fluorescent screen glowed when the current was switched on. Roentgen did not know what the radiation was that caused the effect. In mathematics x is used as the symbol for an unknown number. As Roentgen did not know what the rays were he called them X-rays. He found that when he put his hand in front of the fluorescent screen the bones could be seen. Within two months of the discovery of X-rays they were being used in Europe and North America to diagnose bone injuries.

X-rays, like light, are a form of electromagnetic radiation. They have more energy than light, which allows them to pass through some body tissues. For medical use X-rays are recorded on photographic film. Soft body tissues like blood, skin, fat and muscle allow most of the radiation to pass through. They appear on the film as dark grey or black. Denser tissues, like bone or a tumour, allow fewer X-rays to pass through and appear on the film as white. If a bone is broken the radiation passes through the break and a dark line is seen in the white bone (see Fig. 22.6)

Some soft tissues can be observed with X-rays if contrast media are used. **Contrast media** are liquids that absorb X-rays. To observe blood vessels contrast media can be injected into the bloodstream. For X-rays of the alimentary canal, contrast media, usually barium compounds, are swallowed. The soft tissue containing the contrast media will absorb the X-rays and will show as white areas on the film (see Fig. 22.7).

Fluoroscopic X-rays are used to obtain an image of the patient on a screen. Using the 'live' image a surgeon can guide instruments through blood vessels or other parts of the body. A good example of the use of fluoroscopic X-rays is in guiding instruments that clear blockages in the arteries.

The amount of radiation a person absorbs from an X-ray is very low. However radiation does cause cancer and precautions are taken to limit exposure. For example when dental X-rays are taken the patient's body is covered with a shield containing lead. Barium contrast media and fluoroscopic X-rays involve more radiation than a normal X-ray but the benefits are far greater than the risks. X-rays can harm a developing embryo so pregnant women need to discuss the risks with their doctor before having an X-ray.

Figure 22.6 An X-ray of a broken bone in the hand: notice how the bones show up as white because they absorb the radiation; the outline of the soft tissue can just be seen because it absorbs a little radiation

Figure 22.7 An X-ray of the large intestine: contrast media containing barium has been used so that the intestine absorbs the X-rays leaving a whiter image on the film

CT scans

CT (computerised or computed tomography) scans are used to diagnose and treat certain medical problems. The **CT scan** is produced using X-ray equipment that gives a series of pictures of the inside of the body. A computer joins the pictures together to produce a cross-section of the area being studied. The image produced is then examined on a computer monitor or it can be printed (see Fig. 22.8). They are sometimes called CAT scans (computerised axial tomography).

The CT scanner (see Fig. 22.1) directs numerous X-ray beams at the body while X-ray detectors rotate around the body. At the same time the examination table on which the patient is lying moves through the scanner. The detectors measure the amount of radiation absorbed and because the patient is moving a series of slices of the body can be displayed on a monitor.

CT scans provide much clearer pictures than ordinary X-rays. They have many uses including examination of the chest and abdomen, diagnosis of many types of cancer and detection and treatment of cardiovascular diseases.

Radiation absorbed by the body from a CT scan is much higher than that for an ordinary X-ray. The risk of a scan causing a cancer later in life is therefore much greater. CT scanning is not recommended for pregnant mothers because of the risk of harm to the baby. Doctors and patients must weigh up the risks and benefits of having a CT scan.

Figure 22.8 A coloured CT scan of the human brain: bleeding (the red area) has occurred in part of the brain

The first commercial CT scanner was produced in 1972. It was developed and made by EMI, the well-known music recording company. It has been said that the pop group, the Beatles, made a significant contribution to the development of the first CT scanners. From the huge profits made by selling Beatles records, EMI was able to fund research into CT scanning.

PET scans

PET (positron emission tomography) scans are used to find out the level of chemical activity in parts of the body. They do not produce clear pictures of structures. A **PET scan** is done by giving the patient a radioactive chemical that collects in the part of the body being examined. The radioactive chemical gives off energy in the form of positrons (atomic particles). These are detected by the scanner and converted into pictures by a computer. The pictures show the structure and functioning of organs.

PET scans are often used for detecting cancer. To locate cancerous growths the patient is given glucose that has a radioactive atom added to the glucose molecules. Inside the body the glucose is absorbed by cells that are very active and using a lot of glucose for respiration. Cancerous cells need more energy than normal cells because they are growing and dividing faster than normal. The tagged glucose accumulates in the cancerous tissue and is detected by the PET scanner. Besides detecting cancers PET scans are used to assess cardiovascular diseases and brain diseases (see Fig. 22.9).

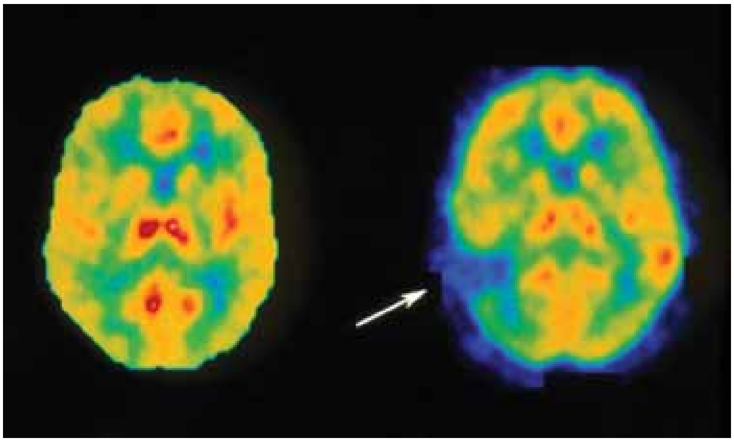

Figure 22.9 PET scan of a healthy brain (left) and the brain of a stroke patient (right): the stroke patient has suffered brain damage in the area shown by the arrow; areas of low brain activity show up as blue and green, areas of high activity as yellow and red

PET scans are generally considered to be safe. The exposure to radiation is about the same as a person would absorb from their surroundings over three years. Radiation from the injected chemicals does not last long and is removed from the body fairly quickly. At present PET scans are only available at a few medical centres in Australia.

MRI scans

MRI (magnetic resonance imaging) is another type of scan for diagnosis that has been in use since the 1980s. **MRI scans** use a magnetic field and radio waves to make images of body structures. They are particularly useful for seeing soft tissues that do not show up on X-rays. The scanning machine produces a powerful magnetic field that lines up the magnetisation of hydrogen atoms in the body. Magnetised hydrogen atoms echo radio waves from the MRI machine and a computer arranges the echoes into images (see Fig. 22.10).

MRI scans do not use any harmful radiation and so do not have the risks associated with CT, PET scans and X-rays. They are also better for detecting cancers. However CT is more widely available, much less expensive and faster than MRI.

Ultrasound

Find out more about the various types of medical imaging at http://en.wikipedia.org/wiki/Medical_imaging

Ultrasound is high frequency sound waves that are beyond the range of human hearing. In **ultrasound imaging** the sound waves are produced by a small hand-held device. Sound waves are reflected from objects. By measuring the echoes the ultrasound machine determines how far away the object is, its size, shape and other details. This information is displayed as a picture on a monitor.

Ultrasound has been used in medicine for over fifty years. It is now one of the most widely used tools for diagnosis of disease. It uses no harmful radiation and has no known harmful effect on humans. Ultrasound is used to examine the heart and blood vessels, spleen, liver, gallbladder, kidneys, bladder, pancreas, scrotum and other parts of the body. It is also used to guide needles when samples of cells are taken for examination.

Ultrasound has been particularly useful in examining the developing baby during pregnancy (see Fig. 22.11). It can identify many problems that could be harmful to the baby and the mother. If carried out early in pregnancy the parents may decide to have an abortion if abnormalities are detected.

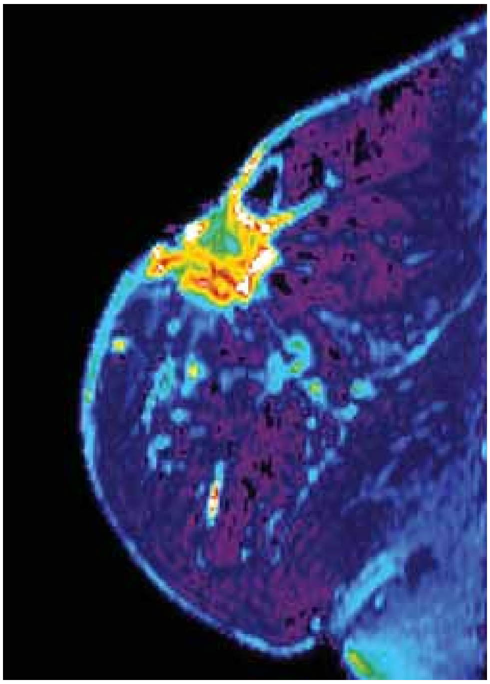

Figure 22.10 MRI scan of the breast: a malignant cancer can be seen at the top left

Figure 22.11 Ultrasound being used to examine a developing baby

Table 22.2 summarises and compares the technologies that we have discussed for producing images of the body.

Table 22.2 Comparison of imaging technology

Imaging technique	Used for	Advantages	Disadvantages and risks
X-rays	Observing dense tissues like bones and tumours; with contrast media some soft tissues can be seen	Fairly low radiation dose; little risk of harm to baby if used during pregnancy; relatively cheap and easy to administer	Some exposure to radiation
CT scans	Producing cross-sectional images, especially of chest and abdomen	Much clearer images than X-rays	Higher radiation dose than X-rays; not recommended during pregnancy
PET scans	Checking functioning of body organs by checking chemical activity	Very useful for accurate diagnosis of cancers and cardiovascular disease	Equipment is very expensive to set up and to run; tests are time consuming; relatively high radiation dose
MRI scans	Observation of soft tissues	No radiation; better for detecting cancers than CT or PET scans	Slower and more expensive than CT scans
Ultrasound	Examination of a wide range of internal organs; guiding probes and needles	No radiation; no known harmful effects; equipment is relatively inexpensive and portable; can be used without risk during pregnancy	Images not as clear as scans and X-rays

Medical technology can provide support for organs

Kidney dialysis

Our kidneys excrete waste and regulate the amount of water in the body (see Chapter 10). Sometimes the kidneys lose the ability to work in this way. This is called **kidney failure**. Kidney failure may happen suddenly but is more likely to develop over a period of years. Factors such as diabetes, high blood pressure or kidney disease slowly damage the kidneys. Eventually, the only way to keep a person alive is by dialysis or a kidney transplant.

Dialysis removes wastes from the blood when kidney failure occurs. There are two types of dialysis: peritoneal dialysis and haemodialysis.

The **peritoneum** is a membrane that lines the inside of the abdomen and also covers organs in the abdomen like the stomach, liver and intestines. It has a very rich blood supply. In adults, 2–3 L of fluid are passed through a tube into the abdomen. The fluid contains glucose and other substances at concentrations similar to those found in the blood. However, there are no wastes in the fluid. This means that, because of the concentration difference, wastes will diffuse out of the blood into the fluid in the abdomen. After several hours the fluid that was placed in the abdomen is drained out

Figure 22.12 A person attached to a dialysis machine: the patient's blood is going through a tube from a blood vessel in the arm to the machine where wastes are removed; another tube takes the blood back to the patient's arm

through the tube, along with any wastes and extra water that have diffused from the blood. This is called **peritoneal dialysis** and it is usually done every day.

Haemodialysis involves passing the blood through an artificial kidney or dialysis machine. The blood passes through thousands of fine tubes made of a membrane. The tubes are surrounded by a bath of fluid. The concentrations of substances in the fluid are similar to those in the blood except that the fluid has no waste. Due to the differences in concentration, wastes diffuse from the blood into the fluid. Patients spend about four to five hours attached to the machine and haemodialysis is normally done three times per week.

Artificial heart pacemakers

The heart has a little clump of nerve tissue that sends out a nerve impulse to make the heart muscle contract. This is the heart's natural pacemaker. Every time the heart beats it is because it has been stimulated by a nerve impulse from the pacemaker.

Sometimes the heart's own pacemaker fails to work properly. The impulses may be irregular so that the heart does not beat with a steady rhythm. In other cases, the impulses may not be produced often enough so that the heart beats too slowly. In situations like these an artificial pacemaker can be used.

The first artificial pacemakers were developed in the 1950s. They were placed inside the chest near the heart and had wires passing through the skin to an outside battery. Short battery life was a major problem.

Today pacemakers are very small (see Fig. 22.13) and they contain a tiny battery that is long lasting and very reliable. Modern pacemakers are implanted under the skin of the chest with wires connected to the heart. They have a micro-processor and are able to respond to the physical activity of the patient. As the patient becomes more active the device speeds up the basic heart rate.

Patients with an artificial pacemaker can live a normal life and can engage in moderate to strenuous exercise. The pacemaker is checked every six months and can be reprogrammed from outside the chest if necessary. Battery life is about five years and the battery is able to send a signal when it is running low.

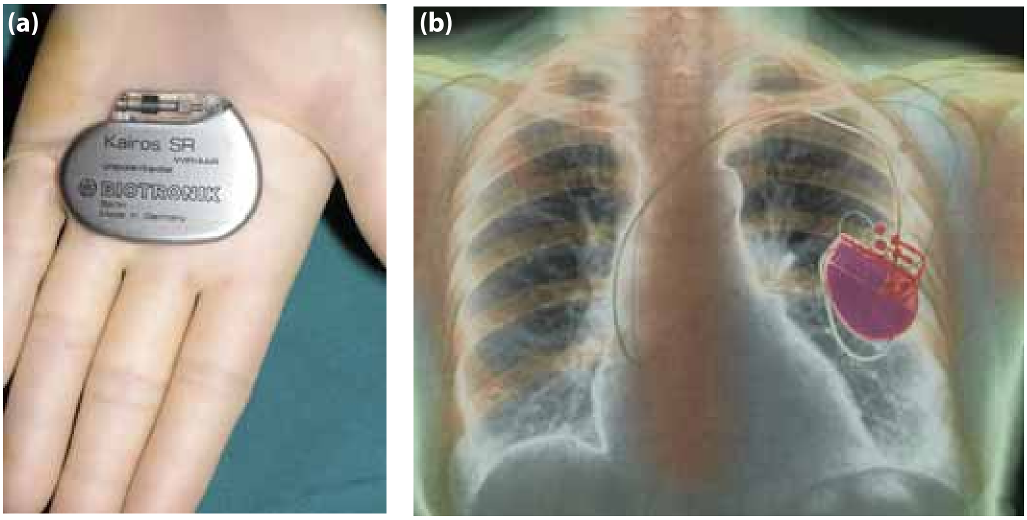

Figure 22.13 **(a)** A pacemaker; **(b)** an X-ray of a pacemaker in place in a person's chest

Heart–lung machines

A **heart–lung machine** is used during operations on the heart. The heart is stopped and the machine takes over the job of pumping the blood. It also adds oxygen to the blood. While the heart is stopped the surgeon can carry out delicate operations like repairing damaged valves or inserting blood vessels that bypass blockages. When the surgery is complete the patient's heart is re-started and the heart–lung machine is disconnected.

The first successful use of a heart–lung machine was in 1953. Today they are used for thousands of operations every year. Problems can occur due to blood clotting, leakage of blood, entry of air into the bloodstream or other causes. Despite these problems the rate of complications from use of heart-lung machines is very low.

Since about 2000, techniques have been developed that allow some operations to occur while the heart is still beating. Bypass surgery, where a blood vessel is inserted to bypass a blocked vessel in the heart muscle, is now often carried out without the use of a heart-lung machine.

Artificial heart valves

The heart has four valves. There is a valve between each of the atria and ventricles, and there is a valve where the artery to the lungs and the artery to the body leave the heart (see Fig. 6.4 on page 68). The purpose of the valves is to stop blood flowing backwards and at the same time allow the blood to flow freely.

Sometimes the heart valves become diseased and blood begins to leak past the valve in the wrong direction or the flow of blood is slowed down. It is sometimes possible to replace faulty valves with an artificial valve. Artificial valves are of two types. One type is mechanical, the other type is biological—from another animal.

Figure 22.14 A heart–lung machine in use during an operation

Figure 22.15 An artificial heart valve: this is a biological valve made with membrane from a pig

Mechanical valves, made of metal or carbon, are long lasting but the patient must take blood thinning drugs all the time. The blood thinners are to reduce the risk of blood clots forming at the mechanical valve. Most mechanical valves last about twenty to thirty years.

Biological valves may come from a pig heart because pigs have hearts that are most similar to humans. The human body rejects any foreign tissue, so with a pig valve the patient must take anti-rejection drugs all the time. Another type of biological valve is made from heart membrane of pigs, cows or horses that is sewn onto a metal frame. The animal tissue is sterilised so that the patient does not reject the foreign tissue. Blood thinning drugs are not required with biological valves but the valves do not last as long as the mechanical type.

Although artificial valves are fairly reliable, problems do occur. Sometimes the valve does not work properly or there may be leakage of blood from around the valve. In such cases a valve may have to be replaced only a few months after being put in place.

Joint replacement

Joint replacement is used to treat diseased joints especially those affected by arthritis. The first operation to replace a joint (a hip joint) took place in 1936. In Australia today more than 50 000 joint replacement operations are done each year.

Figure 22.16 Knee joint replacement

The operation involves removing the diseased or damaged joint surface and part of the bone. New joint surfaces are then implanted. In some cases the bone grows into the implant to hold it in place; in others an adhesive is used to glue the implant to the bone. Implants are made of metal, high density plastic or sometimes ceramics.

Hips and knees are the most common joints to be replaced but replacement of ankle, shoulder, elbow and finger joints is also possible. Joint replacement is major surgery and there are risks both during and after the operation. As with all surgery there is the risk of blood clots, reaction to the anaesthetic and infection. There is also the possibility of damage to nerves and blood vessels. In the longer term artificial joints can dislocate or become worn and loose.

Intensive care/life support

'After the shooting the injured woman was air lifted to hospital and immediately placed on life support.'

We often hear of situations like this where critically ill patients are on life support.

Life support is a set of procedures that keep a person alive when their body systems are not working well enough to maintain life. Life support is used to stabilise the patient but is often not enough to allow full recovery. **Intensive care** uses the same procedures and is aimed at restoring the patient to health. It usually involves constant checking of the patient's progress. Intensive care is often used during a patient's initial recovery from major surgery. In practice the terms life support and intensive care tend to be used interchangeably.

Life support, or intensive care, involves a combination of procedures that may include feeding tubes, drips to add fluid to the blood, mechanical breathing devices, heart-lung machines and kidney dialysis. Usually the patient requiring such treatment is unconscious.

There are ethical issues associated with life support because it may be used to prolong the life of a patient who will never recover. Some of these issues will be discussed in the next section.

Organ and tissue transplants

It is 3.45 am when Silvana Marasco pushes her gloved hands into the young man's chest and gently eases his heart and lungs out of his body. The man died more than 14 hours ago but it is just 13 minutes since his heart stopped beating. The heart will remain still, resting on ice inside a blue picnic Esky for just a few hours. The person chosen for this heart is only a short trolley ride away, in an operating theatre down the corridor and whose chest is already open and waiting. Within hours, this heart will beat again.

The Age, 11 February 2002

Organ transplants save the lives of people with an organ that has lost the ability to do its proper job. In Australia the organs that can be transplanted are the heart, liver, lungs, kidneys and pancreas. Some tissues can also be transplanted. These include bone marrow, heart valves, skin and the cornea (the transparent tissue across the front of the eye).

You will find links to many websites dealing with transplantation of tissues and organs at http://www.accessexcellence.org/HHQ/HRC/HF/transplant.php

The first transplants in Australia were corneal transplants to save a patient's eyesight. These began in the early 1940s. The first successful Australian transplant of a whole organ was a kidney in 1965. By the end of 2007 more than 30 000 Australians had received transplants.

Organs and tissues for transplant are taken from people who have died, except for kidney transplants where a living person can donate one of their kidneys. Up to ten people can benefit from the donation of organs and tissues of one dead person. Usually the donations come from someone who has had a stroke or been involved in an accident. The patient suffers brain death while on a ventilator (breathing machine). The blood will then continue to supply oxygen to the organs, keeping the organs alive until the ventilator is turned off. Less than 1% of deaths occur in such a way.

Australia has one of the highest success rates in the world for tissue and organ transplants. Unfortunately the number of donations of organs and tissues is one of the lowest in the developed world. In late 2007, 1855 Australians were waiting for an organ transplant but fewer than 200 organs were donated that year. The donation rate in Australia in 2006 was 9.8 donors per million people in the population. In Spain,

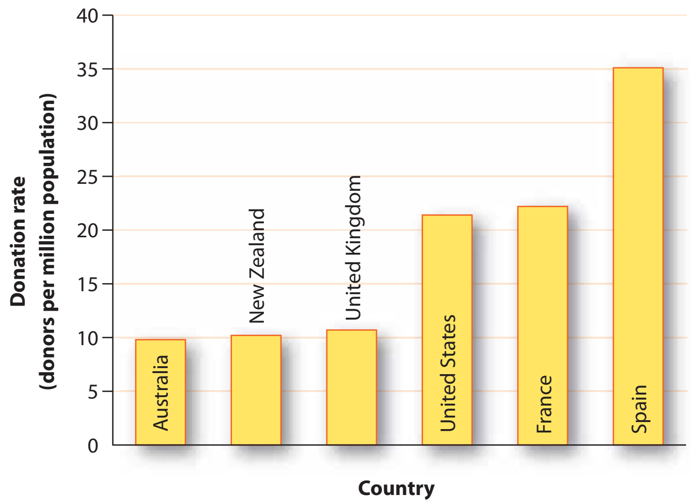

Figure 22.17 Graph showing organ donation rates for selected countries (2006)

the world leader, the rate was 35.1. Figure 22.17 shows the donation rates for a number of countries.

The Australian Organ Donor Register was set up in 2000 to list people who wanted their organs and tissues to be available for transplant when they died. People on the register are given a card that identifies them as organ donors. At the end of 2007, more than 982 000 Australians had registered as organ donors. This is not a very high proportion from a population of over 21 million.

Australia's system for organ donation is currently an 'opt in' system. Potential donors have to offer their organs for transplant. In Spain, and some other countries, there is an 'opt out' system. All people are considered to be donors and if they do not want their organs taken after death they have to make their wishes known. One of the problems in Australia is that the dead person's relatives often do not know whether that person wished to be an organ donor or not. Being a *registered* organ donor makes your wishes known.

Any person aged 18 or over can register as an organ donor. If you are aged between 16 and 17 years you can register an intent to donate. People less than 18 years of age can be organ donors if their family agrees to the donation at the time of death.

Risks, ethical concerns and benefits of medical procedures

Risks and benefits

Some of the methods that are used to collect information about the structure and workings of the body have been discussed in this chapter. We have also discussed some of the ways of helping organs that are not working properly. In our discussions we have described some of the risks and benefits of those procedures. No medical procedure is without risk. Some have more risks than others but even simple procedures have an element of risk.

Before any procedure is carried out the provider (doctor, physiotherapist, dentist, etc.) should discuss with the patient what is involved in the procedure, the benefits and the risks. The patient can then make a decision on whether to go ahead. This is called **informed consent**. The patient has been made aware of all the factors involved and can then make a decision about whether the benefits are going to be worth the risk.

Medicines, or **pharmaceuticals**, also have risks. Many of them have side effects in some people and some cause problems if taken in high doses or for long periods. Again, it is the responsibility of the doctor to explain the risks to the patient who can then decide whether to take the drug or not. The package of any medicine that is supplied on a doctor's prescription usually contains an information sheet. This gives details about what the drug is used for and lists any side effects that may occur. Patients should read the information sheet before using the medicine so that they know what symptoms to watch out for should side effects occur.

Information on medicines is also available from a number of websites, for example: http://www.mydr.com.au/drugs/drugs.asp or http://www.drugs.com

Figure 22.18 Medicine package and information sheet

Ethical concerns

Ethics are a set of moral principles or values. They are standards that are observed by most people in our society. **Ethical behaviour** is behaviour that follows those principles or values. In the use of diagnostic tools and in the treatment of people who are ill many ethical concerns arise. Just a few of those concerns are listed here.

- Some medical procedures have a very high risk of causing death or permanent disability. Sometimes there has to be a choice between saving or extending the life of the patient, or not continuing with a procedure that is very uncomfortable or has a high risk of causing further damage.
- Patients on life support may suffer brain death. In such cases the patient is legally dead but will continue to breathe, will have a heart beat and will be warm to touch. The life support machines give the person the appearance of still being alive. Medical staff have the difficult task of explaining to relatives that the person is actually dead and there is no hope of any recovery.
- Patients in a coma may be kept alive on life support for weeks or months while being in a vegetative state. This is not the same as brain death. Higher brain functions are lost but the patient can still breathe and the heart still beats. The agonising decision then has to be made on whether to withdraw the life support or to continue to hope for some sort of recovery.
- Some patients may be in severe and prolonged pain and discomfort with no hope of improvement. In cases where the quality of the patient's life is very poor, should life-prolonging treatment be continued?
- Organ donation can cause ethical dilemmas. When a person dies suddenly in circumstances where their organs could be donated the relatives may have to make a decision about organ donation. If the wishes of the dead person are not known the relatives must try to decide what the person would have wanted.
- Euthanasia is the deliberate ending of a person's life when there is no hope of recovery. At present in Australia euthanasia is illegal but there is a growing demand for it to be legalised. Should a person be able to arrange to end their life when terminally ill?
- An ethical question for governments and health administrators is how best to spend the money available for health. With a budget of $4 million would it be better to buy a PET scanner, employ more nurses so that patients could be better cared for in hospital or run an advertising campaign to educate people on the health risks of obesity?

There are no right or wrong answers to ethical questions. That is why these problems are so difficult to solve. Opinions will vary and it is unlikely that a solution to an ethical problem will satisfy everyone involved. The important thing is to carefully consider all of the factors involved and to respect the opinions of others even if you disagree with them.

Working scientifically

Activity 22.1 Help for diseased hearts and blood vessels

A number of medical procedures are available to diagnose and treat people suffering from cardiovascular disease. Some, such as pacemakers and artificial valves, have been described in this chapter. Other procedures include balloon angioplasty, bypass surgery, ultrasound, coronary arteriography and the use of clot dissolving drugs.

Your teacher may want you to work in groups and may assign a particular procedure to each group for investigation. Find out what you can about your assigned procedure and how it works. With your group write a summarising statement about the procedure. Your teacher may ask your group to present a report to the other members of your class.

Activity 22.2 Is it worth it?

Hold a debate or a class discussion on the topic: 'Heart transplants are a waste of money'. Make a summary of the important points for and against heart transplants.

What did the class conclude? Are heart transplants a waste of money?

Activity 22.3 Historical perspectives

The following is a list of medical techniques or instruments. Select one item from the list and write an account of the history of that item. Your teacher may wish you to present a talk on your instrument/procedure to the rest of the class.

- Anaesthesia
- Stethoscope
- Obstetric forceps (for delivering babies)
- Sphygmomanometer (for measuring blood pressure)
- Hypodermic syringe
- Endoscope
- Saline drips
- Blood transfusion
- Defibrillator

REVIEW QUESTIONS

1. The average life span in Australia has increased from around 50 years in 1900 to about 80 years in 2000. What has brought about this big increase in life expectancy?
2. Why is life expectancy in Australia much higher than in Papua New Guinea?
3. What is evidence-based medicine? Give an example of how it is used.
4. Explain the difference between a symptom and a diagnosis.
5. Dentists place an apron that contains lead over the patient's body when taking X-rays of the teeth. What is the purpose of the apron?
6. PET scans do not produce a clear image of structures. What are PET scans used for?
7. Ultrasound examination has a big advantage over an X-ray, especially for pregnant women. What is the advantage?
8. **(a)** What is dialysis? Why would a person have to undergo dialysis?
   (b) List the two different types of dialysis.

9. Why do some people need to have an artificial heart pacemaker?
10. Explain the difference between an organ and a tissue transplant.
11. What could be done to improve the rate of organ donation in Australia?
12. What is meant by informed consent?

APPLY YOUR KNOWLEDGE

1. Make a list of all the factors you can think of that would have contributed to life expectancy in Australia increasing from about 50 years in 1885 to about 80 years in 2008.
2. There are many websites that deal with the history of particular diseases. Choose a disease and see what you can find out about the history of that disease. Write a short article describing the history of the disease.
3. Over the course of history many people have made great contributions to our understanding of disease. Choose a name from the following list and find out what that person's main contribution was to the understanding and treatment of disease.

Claudius Galen	Hippocrates	Joseph Lister
Florence Nightingale	John Snow	Robert Koch
Edward Jenner	William Harvey	Claude Bernard
Andreas Vesalius	Howard Florey	Louis Pasteur
Anton van Leeuwenhoek	Francesco Redi	Rudolf Virchow
James Lind	Wilhelm Röntgen	Karl Landsteiner
Frederick Banting and Charles Best		Jonas Salk

4. Panadol is a drug that is widely used as a pain killer, Amoxil is a commonly used antibiotic and Ventolin is inhaled by people with asthma. Choose one of these drugs; go to http://www.mydr.com.au/drugs/drugs.asp and make a list of the side effects that a person should be aware of if using the medicine.
5. A doctor was examining a scan of a patient's gallbladder. Which scanning technique/s could have been used to make the scan? Give reasons for your answer.
6. Use the data in Table 22.1 to construct a column graph showing life expectancy for the following: world average, Australia, United Kingdom, Indonesia, Papua New Guinea and Zimbabwe. Use one colour for females and another for males. Does presenting the data in this form make it easier to compare life expectancy in different countries?
7. A doctor was about to perform a routine operation to remove the appendix of a teenage boy, an operation known as an appendectomy. Do you think this doctor should warn the patient and his parents of the risks involved? What would be the risks associated with such a routine procedure? (You may use references if necessary.)