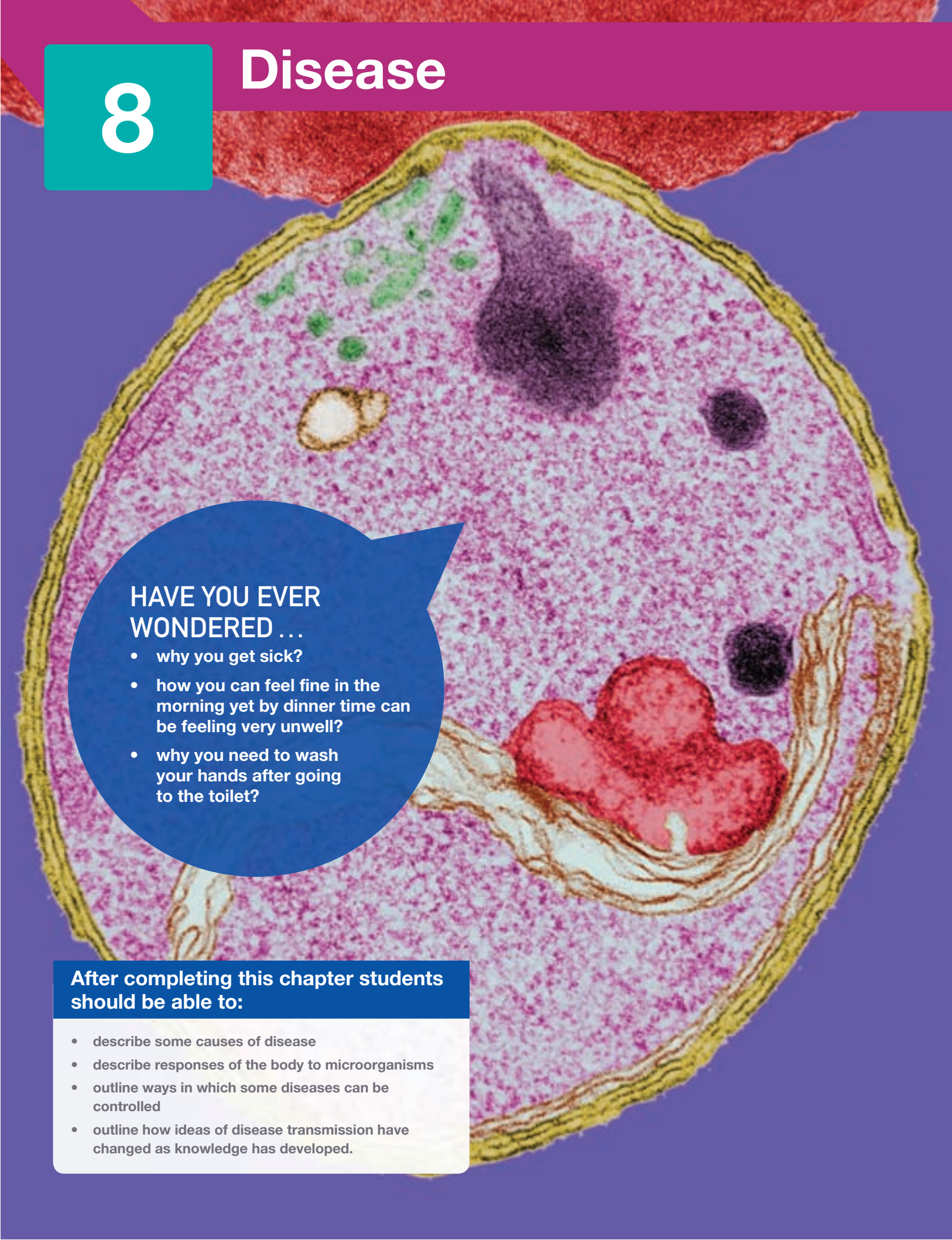
8 Disease



HAVE YOU EVER WONDERED . . .

- why you get sick?
- how you can feel fine in the morning yet by dinner time can be feeling very unwell?
- why you need to wash your hands after going to the toilet?

After completing this chapter students should be able to:

- describe some causes of disease
- describe responses of the body to microorganisms
- outline ways in which some diseases can be controlled
- outline how ideas of disease transmission have changed as knowledge has developed.

8.1 They make us sick!

Everyone gets sick at some time or another. When you get sick, you expect to get better quickly. Colds and upset stomachs are not usually called *diseases*. That term is normally used for more serious and long-term illnesses.

Bacteria

A **disease** is anything that causes your body to stop working properly. One cause of disease is bacterial infection.

Bacteria are microscopic, unicellular (one cell) organisms. Thousands of different species of bacteria have been discovered. However, scientists are finding so many new species that they believe that most have not yet been discovered. Bacteria are an important part of the natural environment. They are decomposers, converting dead plant and animal matter and wastes into nutrients that plants use to grow. Bacteria living in the intestines of herbivores such as cows and kangaroos help with digestion. Bacteria help control insects. Humans use bacteria to make medicines and to break down pollutants such as oil and plastics. A small percentage of known bacteria cause disease. These bacteria are known as **pathogenic bacteria** or **pathogens**.

Figure 8.1.1
Bacteria in the soil are decomposers, helping to break down dead plants and animals, thus returning nutrients to the soil.

SciFile

On me?

There are more living organisms on the skin of a single human being (even a clean one) than there are human beings on the surface of the Earth!

1 p266

8.1

INQUIRY science 4 fun

Is it clean?

Where in the house would you find harmful bacteria?

Yes

Collect this ...

- magnifying glass

Do this ...

1. Think about the places in the kitchen where harmful bacteria could lurk.
2. Wipe the bench surfaces over so that you think they are clean.
3. Use the magnifying glass to look at the surfaces, in corners and on ledges. You will not be able to see bacteria, but you may be able to see dust or grime that could harbour bacteria.

Record this ...

Describe what you could see.

Explain why the surfaces may not have been as clean as you thought.

Bacterial diseases

Pathogenic bacteria cause hundreds of diseases, such as whooping cough, tetanus, diphtheria, impetigo (school sores), pneumococcal and meningococcal disease, and typhoid fever. These are all **infectious diseases**—they are diseases that can be spread.

Some infectious diseases are easier to spread than others. Those that are easiest to spread are described as **contagious**. Impetigo, shown in Figure 8.1.2, is a contagious disease that is more common in children than in adults. Touching someone with impetigo could result in you becoming infected, and for this reason infected children are put into **quarantine**. They are isolated from healthy people to prevent the spread of the disease. They are not allowed to attend school or day care centres until they have started treatment for the disease. Even then they can only return to school if the sores are covered with watertight dressings. Quarantine is used to prevent the spread of disease within a community, between communities and between countries.

Figure 8.1.2 If they are not treated, the oozing sores of impetigo remain infectious until they are healed. Once treatment starts, the sores should begin to heal in about three days.

Bacterial infections are treated with **antibiotics**—substances that kill or prevent the growth of bacteria. The first successful antibiotic was **penicillin**. Penicillin was not in common use until the late 1940s. Before the development of antibiotics, you would have had to depend on your own body's **immune system** to fight off infections. Even today, antibiotics don't always work.

Some people are allergic to penicillin, and not all types of bacterial infections can be treated with it. For these reasons, antibiotics other than penicillin have been developed. Penicillin and these other antibiotics have saved the lives of millions of people since they were discovered.

2 p267

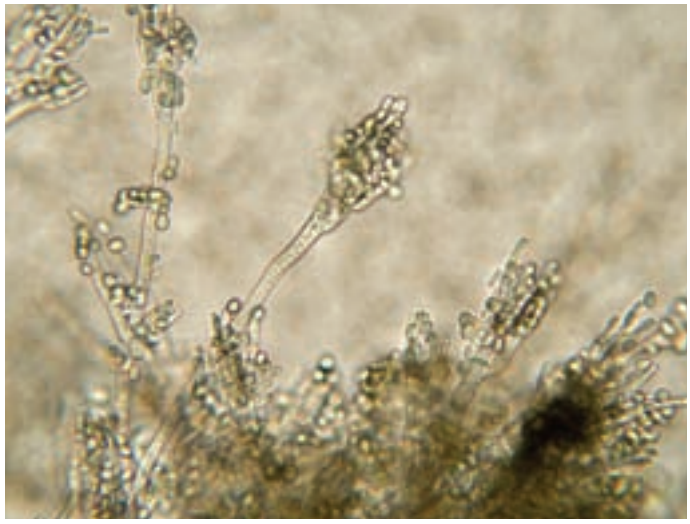


Figure 8.1.3 It was from this mould (*Penicillium*) that the first antibiotics were made.

Figure 8.1.4 People with a severe allergy to penicillin and other substances will quickly become dangerously ill if they take them. For this reason, they often wear a bracelet or medallion and carry a card with them to let emergency workers such as paramedics know of the allergy.

SciFile

Accidents that work

Penicillin was discovered by accident. The Scottish scientist Alexander Fleming left some culture plates on which he was growing bacteria on a bench while he went on holiday. Mould grew among the plates. Where one particular mould grew, the bacteria didn't. Later, Howard Florey and Ernst Chain developed penicillin into a useful medicine.

The immune system

Pathogens can enter your body in a number of ways, as shown in Table 8.1.1.

Table 8.1.1 Methods of entry of pathogens

Method of entry	Examples of disease
Food and water	Food poisoning, cholera
Breathing in	Flu, pneumonia, tuberculosis
Cuts and wounds	Tetanus, blood poisoning
Sexual contact	Gonorrhoea, syphilis
Other contact	Anthrax, leprosy

Your body has three lines of defence against disease. The first line of defence is to prevent the pathogens from entering the body.

- Skin is an effective barrier against pathogens and protects the internal organs from harmful chemicals in the environment and from sunlight.
- Fluids such as tears and saliva have mild antiseptic properties and help to wash away dust and harmful substances from openings to the body.
- Air entering through the nose is filtered by hairs in the nostrils. Other unwanted particles in the air are then trapped in the mucous lining of the trachea (windpipe). Coughing and sneezing help to get rid of these foreign particles.
- Pathogens entering the digestive system are usually killed by the acid in the stomach. Vomiting is a quick way of getting rid of something undesirable in the stomach. Diarrhoea is a rapid way of ridding the body of pathogens that have got past the stomach.

Once a pathogen enters the body tissues, the second line of defence gets started. The affected area becomes red, hot and swollen—it is inflamed. Inflammation is a response of the body to infection. Damaged cells release a chemical that causes an increased amount of blood to flow to the infected area. Within the blood are special white blood cells called **neutrophils**. You can see these in Figure 8.1.5. Neutrophils consume bacteria.

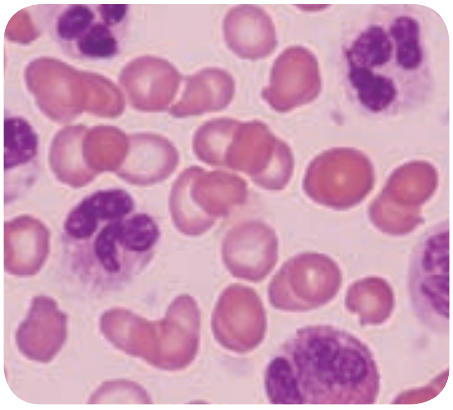


Figure 8.1.5 Neutrophils are white blood cells that have many nuclei, which you can see stained purple in some cells here. They can change shape as they hunt for and consume bacteria.

Many neutrophils are killed as a result of consuming large numbers of bacteria. Dead neutrophils form the yellow pus that collects around infected wounds, like the wound shown in Figure 8.1.6.

Figure 8.1.6 Once the skin is broken, the first line of defence is breached. The second line of defence can be seen at work here. The skin is inflamed and the yellow pus indicates that neutrophils have been at work.

If the pathogens are still active, the third and last line of defence is activated. The last line of defence is the lymphatic system. The lymphatic system is a series of vessels and capillaries that carry fluid from around your cells back to your heart. In areas of the lymphatic system there are swellings or nodes (lymph nodes).

Lymph nodes contain a large number of different types of white blood cells, called lymphocytes and macrophages. The function of these white blood cells is to destroy pathogens and to help protect the body in the future.

Macrophages are similar to neutrophils in that they consume and destroy the pathogens. A macrophage is shown in Figure 8.1.7. **Lymphocytes** respond by making a chemical called an **antibody**. Antibodies cause pathogens to clump together, making the work of the macrophages easier, as they can destroy more of the pathogens at any one time.

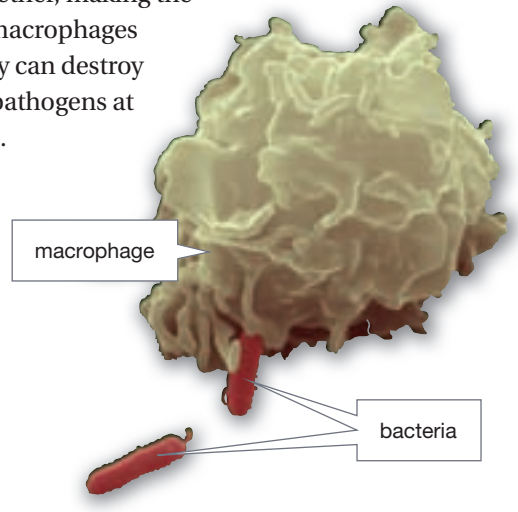


Figure 8.1.7 Macrophages are large white blood cells found in the lymph glands. This macrophage is consuming bacteria.

Each pathogen has a specific antibody that acts on it. The first time the lymphocytes meet a particular pathogen, they make antibodies that work on that pathogen. This takes some time, and meanwhile you may get sick. The next time your immune system meets the same pathogen, it is able to make the antibodies quickly and the pathogen is destroyed before it can make you unwell. You are now **immune** to that pathogen and should stay healthy if you meet it again.

When the lymphocytes and macrophages are working hard, the lymph nodes closest to the site of infection become enlarged. You can feel swollen and tender glands in places like your neck, armpits and groin.

To help you fight an infection, your body's thermostat is set higher than normal and you develop a fever. Pathogens that enter your body function best at normal body temperature. When your body temperature is higher, the pathogens are not able to function as efficiently and your immune system can fight them more easily.

The body's three lines of defence are summarised in Figure 8.1.8.

Vaccination

Some diseases are so serious that you don't want to rely on your body developing immunity by itself. To help it out, vaccines are used. **Vaccines** are chemicals that cause your body to react as if it had met a pathogen.

A vaccine is created by taking a small amount of the poison produced by the bacterium and making it inactive, or by using dead bacteria. The inactive poison and the dead bacteria are harmless, but your immune system responds to the vaccine by making antibodies and you become immune to the pathogen.

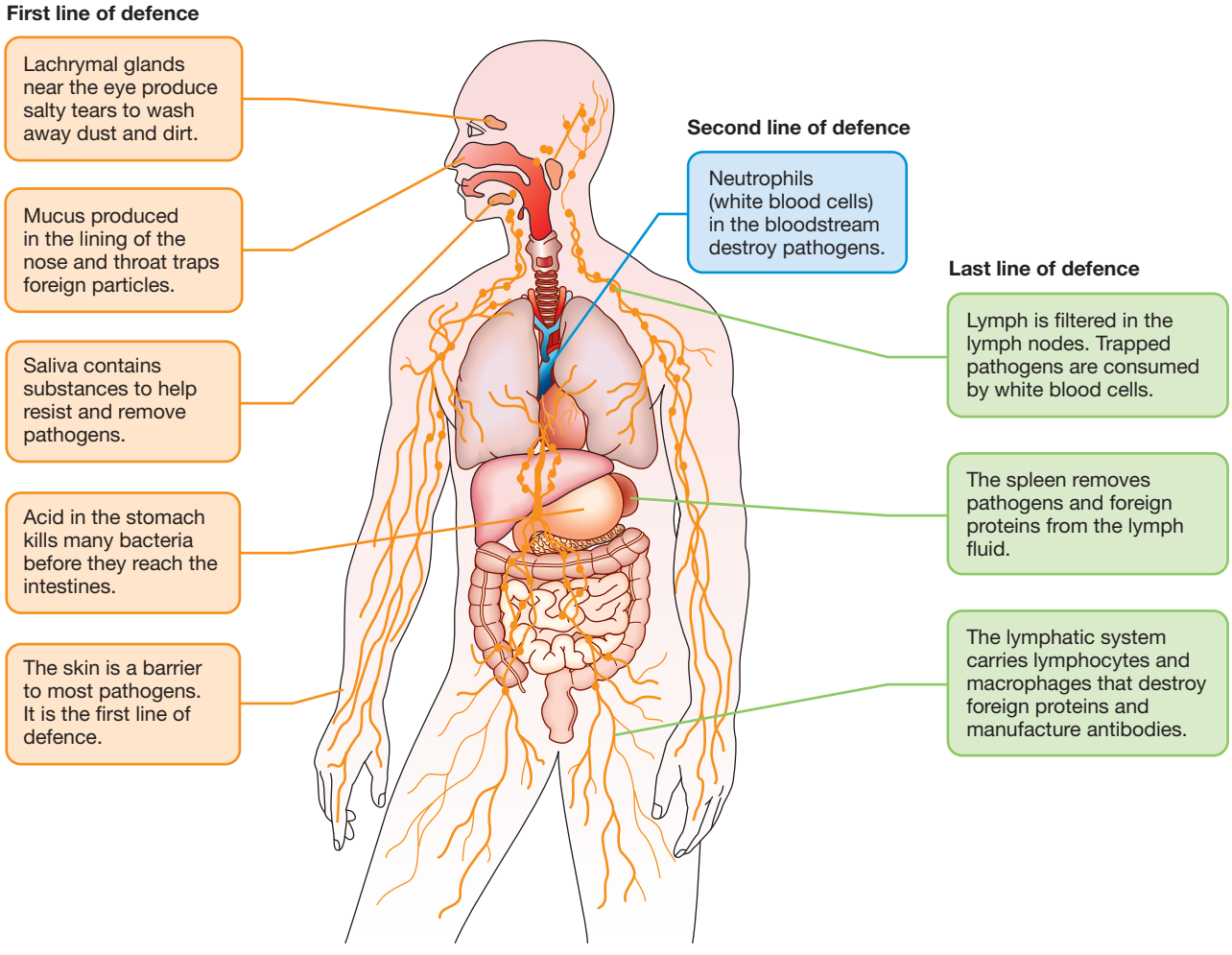


Figure 8.1.8 The function of the three lines of defence is to protect the body from pathogens.

In Australia, young children are routinely injected with vaccines against tetanus, diphtheria and whooping cough (pertussis). This process is known as being vaccinated or immunised. Other bacterial diseases for which vaccines are available include meningococcal and pneumococcal disease and typhoid fever.

8.2

Tetanus

Tetanus is a bacterial infection caused by a bacterium called *Clostridium tetani*. These bacteria, shown in Figure 8.1.9, live where there is very little air—deep in the soil, or deep in the body. They can enter your body through puncture wounds, the sort you would get from standing on barbed wire or a rusty nail. As the bacteria multiply within your body, they produce a poison that causes the muscles to become stiff and to tighten suddenly (spasm). The spasms begin in the jaw, causing the jaw to lock shut. This symptom gives the disease its common name, 'lockjaw'.

The vaccine against tetanus gives you immunity for up to 10 years. After that you need a booster.

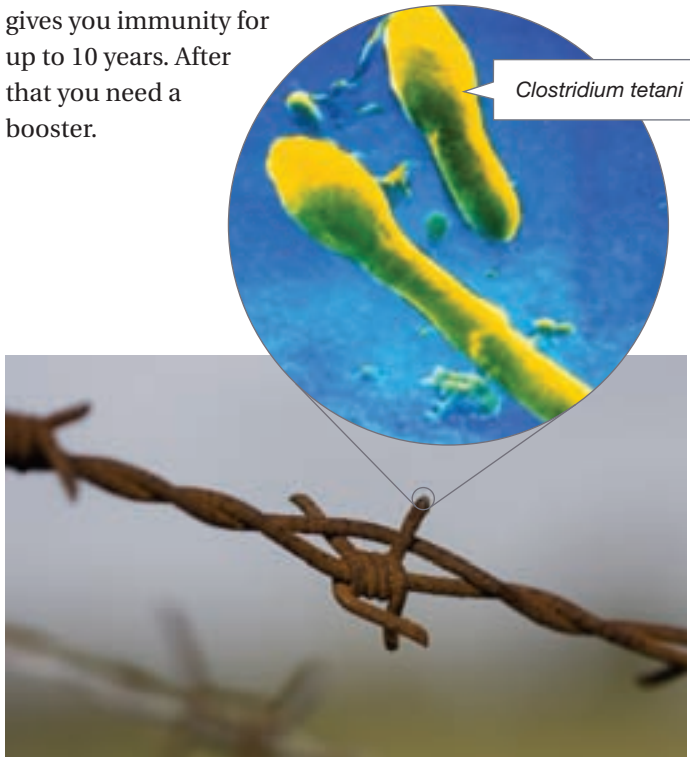
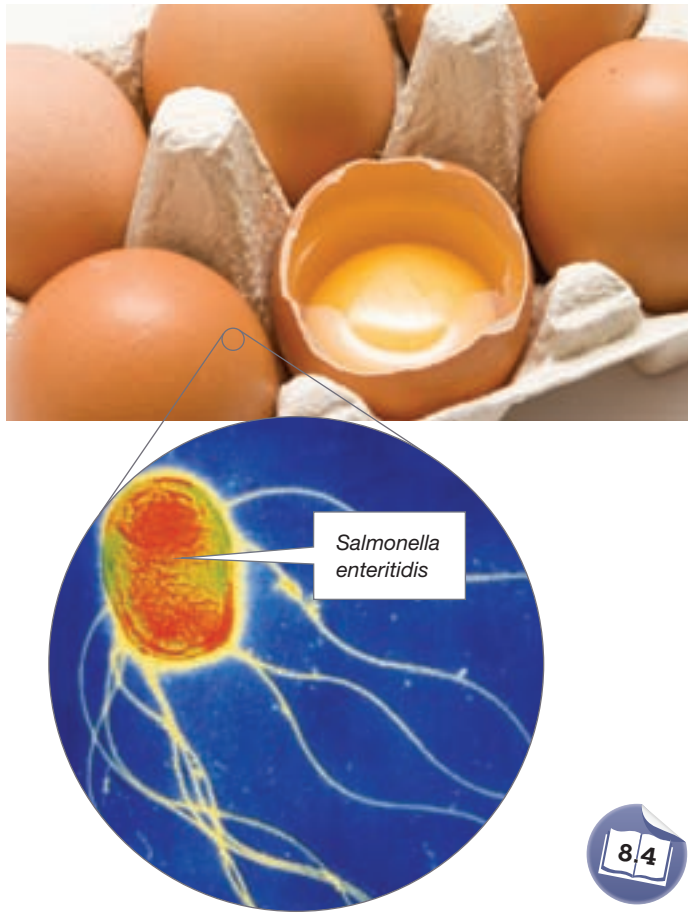


Figure 8.1.9 Barbed wire can cause deep puncture wounds that allow *Clostridium tetani*, the bacterium that causes tetanus, to enter the body.

Hygiene

Some diseases can be prevented by practising good hygiene. If you wake up one morning feeling sick in the stomach and then start vomiting, it is likely that you are infected with *Salmonella enteritidis*—a bacterium that causes **gastroenteritis**. This bacterium is shown in Figure 8.1.10.



8.4

Figure 8.1.10 *Salmonella enteritidis* is found naturally in faeces. The bacteria can be picked up when playing with animals (especially birds), or through touching dirty surfaces such as egg shells and then touching your mouth or food. *Salmonella* bacteria are responsible for over 9000 cases of gastroenteritis per year in Australia.

Salmonella enteritidis bacteria live naturally in the bowel of humans and other animals, especially birds. If the bacteria get into food you eat, they will multiply in your stomach, producing poisonous wastes as they do so. The poisons cause fever, headache and stomach pains. Your body tries to get rid of the poisons as quickly as possible. Vomiting gets rid of the poisons in your stomach contents, and diarrhoea gets rid of toxins produced lower down the gut. Vomiting and diarrhoea cause you to lose a lot of water, and dehydration (a lack of water in the body) may become an additional problem. So no matter how ill you feel, you must drink plenty of water.

Gastroenteritis is a disease that can be avoided if you:

- wash your hands thoroughly and frequently, after handling animals, after going to the toilet, and before handling food
- thoroughly wash all surfaces on which food is prepared
- keep foods like meat, fish and dairy products separate from one another and refrigerated.

SCIENCE AS A HUMAN ENDEAVOUR

Nature and development of science

Stomach pains

Figure 8.1.11 This stomach ulcer has eaten away the lining of the stomach, leaving the tissue underneath exposed to the strong acid of the stomach. This will cause intense pain and can lead to life-threatening bleeding.

Stomach ulcers occur when the lining of the stomach has been damaged. The stomach normally produces strong acid, and when this comes in contact with the damaged area, the result is pain.

Ulcers in the stomach and lower in the intestines, such as the one shown in Figure 8.1.11, have been a major medical problem throughout the world. Doctors thought that stress, poor diet, alcohol, smoking or too much caffeine could all be part of the cause.

In 1979, Dr Robin Warren was working as a pathologist at the Royal Perth Hospital. Pathologists study the causes and effects of disease. Dr Warren found that an unusual bacterium was common in the stomachs of patients suffering from ulcers. Up until then, people in the medical profession were so sure that stress and diet caused ulcers that they were very sceptical about the link between a bacterium and stomach ulcers that Dr Warren had suggested. They did not believe that a bacterium could survive in the acidic environment of the stomach.

Dr Barry Marshall is a gastroenterologist—a doctor who studies diseases of the stomach and intestine. In 1981 he was looking for a research project, and decided to work with Dr Warren. They isolated this strange bacterium from the stomach and cultured (grew) it in the laboratory. It was a new species of bacterium, which they called *Helicobacter pylori* (*H. pylori*) (shown in Figure 8.1.13). The two doctors were convinced that *H. pylori* was causing ulcers, and they continued their research. The rest of the medical profession were still sceptical, and so Dr Marshall decided to test his hypothesis by infecting himself with the bacterium to see what happened.

Dr Marshall swallowed a culture of the bacterium, and a week later he began to suffer the symptoms of gastritis, the infection that comes before an ulcer develops. He then treated himself with antibiotics to destroy the bacterium, and he recovered.

The discovery of the link between *H. pylori* and ulcers has been described as possibly the most significant event in medicine in Australia in the past 20 to 30 years.

Figure 8.1.12 Dr Barry Marshall and Dr Robin Warren are two Australians who worked together to discover the cause of stomach ulcers.

8.5

Figure 8.1.13 *Helicobacter pylori* was identified as a new species of bacterium and the cause of stomach ulcers.

It was now possible to cure a disease that doctors had previously considered incurable.

Dr Robin Warren and Dr Barry Marshall have all the characteristics of outstanding scientific researchers: ability, determination when faced with scepticism and hurdles, salesmanship, and team spirit. In 2005 they were awarded a Nobel Prize for their contribution to medicine.

8.1 Unit review

Remembering

1 **State** the general name for organisms that cause disease.

2 **Name** the system of the body that fights disease.

3 **Name** two common diseases caused by bacteria.

4 **State** the function of antibiotics.

5 **List** diseases that health authorities advise that all Australian children be immunised against.

6 **State** the cause of stomach ulcers.

Understanding

7 **Define** the term *disease*.

8 **Explain** why severe cases of gastroenteritis can cause dehydration.

9 **Outline** the process used to make a vaccine.

10 **Explain** how vaccines work.

11 **Explain** what it means to be *immune* to a disease such as tetanus.

12 **Explain** why it is important that you wash your hands after playing with pets or going to the toilet.

13 **Explain** why the medical profession did not believe that the bacteria seen in the stomach could cause ulcers.

Analysing

14 **Compare**:
- **a** a contagious disease and an infectious disease
- **b** antibiotics and vaccines.

15 **Compare** the way you become immune through natural reactions of your body and through administering a vaccine.

Evaluating

16 Some parents think that immunisation is not necessary because the diseases it is used against are so rare in Australia.
- **a** **Evaluate** whether this attitude is reasonable or not.
- **b** What would you **recommend** if someone asked you whether or not they should be immunised against a disease?

17 Three friends went for a meal at a restaurant. Next day all were feeling very ill and were diagnosed as having gastroenteritis. **Propose** the possible causes of the illness.

Creating

18 **Construct** series of diagrams to demonstrate how a tetanus vaccine protects you against the disease.

19 **Construct** a poster to inform people about tetanus and how it can be prevented.

Inquiring

1 Find out more about the discovery of penicillin. Information to look for includes:
- where the research was carried out and by whom
- the timeline for the discovery
- the contribution each person made to the discovery
- other scientific research they were involved in.

2 Investigate the work of Australian scientists Fiona Wood and Marie Stoner on artificial skin.

3 In your workbook, construct a table like the one below.
- **a** In the table, list the diseases that you have been vaccinated or immunised against. (You may have to ask your parents to come up with this list.)
- **b** Research the information needed to complete the rest of the table.

Disease	Symptoms of the disease	Prevalence in Australia	When the immunisation was developed	Age at which immunisation is given	Frequency of immunisation

8.1 Practical activities

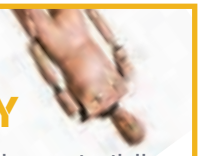
1 Growing bacteria

Purpose

To show that bacteria are common in our environment.

Materials

- prepared agar plates
- marker pen
- zip-lock bag
- access to an incubator



SAFETY

Treat all bacteria as potentially dangerous.

All plates must be completely sealed with tape.

Do not open the lids of the agar plates once you have grown the bacteria. Your teacher will dispose of the plates correctly. As an added precaution, the agar plates could be sealed within a zip-lock plastic bag, as shown in Figure 8.1.14.

Procedure

1. Take one agar plate for each group of three or four students.
2. As a group, decide where in the school you are going to expose the plates. Do not touch the plate or expose it where dangerous pathogenic organisms may exist (for example, do not expose it in toilets). Do not cough or sneeze on the plate.
3. Each group should go to a different part of the school, such as the canteen, sports oval and classrooms.
4. Go to your chosen site and open the agar plate. Wave it gently through the air for about one minute.
5. Replace the lid on the plate and seal it with tape. Mark the bottom of the plate with the name of your group and the place where the plate was exposed.
6. Place the plate top down in an incubator at 20 to 25°C and leave it overnight. If no bacterial colonies are visible, leave the plate for another 3 to 4 days.

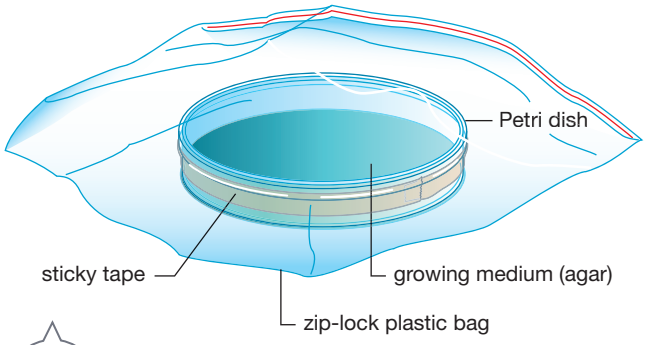


Figure 8.1.14

Results

1. Count the number of different colonies on the plate using the following characteristics as a guide.
   - Bacterial colonies tend to be smooth and round.
   - Different bacteria may have different colours.
   - Fluffy areas like cotton wool are colonies of fungi.
2. Gather results for other groups in the class and construct a table that compares the number and variety of colonies from different parts of the school.

Discussion

1. **Describe** the appearance of the colonies on your group's plate.
2. **Compare** the number of colonies found in the different parts of the school.
3. **Compare** the variety of colonies found in different parts of the school.
4. **Explain** the differences you identified.
5. **Discuss** the idea that one area of the school is more of a health hazard than another area.

2 The milk's off!

Bottled milk in the supermarket has been pasteurised. This means that most of the bacteria present in the milk have been killed. Some remain, however, and in the right conditions for growth they will multiply rapidly and cause the milk to spoil and clot. Acid produced by bacteria causes the clotting.

Purpose

To see how quickly milk spoils in different conditions.

Materials

- full-cream milk
- access to a refrigerator
- 3 tall heat-resistant beakers
- plastic wrap
- 3 rubber bands
- saucepan
- spoon
- electric hotplate or stove
- measuring cup
- universal indicator paper
- masking tape
- access to a marking pen

SAFETY

When conducting experiments with micro-organisms, treat them all as if they could cause disease.

Do not touch the milk. If you do, wash your hands thoroughly.

Do not taste or drink any of the milk.

Procedure

1. Use the masking tape to label each beaker with one of the labels 'Cold', 'Room Temp/Control' or 'Boiled'.
2. Pour one cup of milk into the beaker labelled 'Cold'. Cover it in plastic wrap secured with a rubber band. Place this in the refrigerator.
3. Pour one cup of milk into the beaker labelled 'Room Temp/Control'. Cover it in plastic wrap secured with a rubber band. Place this in an area at room temperature where it will not be disturbed.
4. Pour one cup of milk into the saucepan and bring the milk to a simmer.
5. Stir continuously while letting the milk simmer for one minute.
6. Pour the hot milk into the beaker labelled 'Boiled'. Cover it in plastic wrap secured with a rubber band. Place this in an area at room temperature where it will not be disturbed.

Results

1. Record the appearance of the milk each day for 4 to 5 days. Do not remove the plastic wrap or shake the glass.
2. At the end of the experiment, when at least one of the samples of milk has separated, place an indicator strip in each beaker and note the results—acid, base or neutral—by comparing the colour of the wet strips with the chart provided with the indicator strips.

Discussion

1. **Describe** what happened in each beaker of milk.
2. **Explain** why you think this happened.
3. **Use** your results to **explain** why milk needs to be kept refrigerated.
4. **Use** your results to **explain** why foods 'go off' faster in warm weather than in cool weather.
5. **Propose** what would have happened to unrefrigerated milk if you lived in a cooler climate.
6. From these results, **propose** recommendations on how other food products such as meat and cream should be stored.

8.2 Other sources of infection

You wake up in the morning with every part of your body aching and your head feeling as if it is about to explode. It is most probably something even smaller than a bacterium causing your pain. Symptoms like these are usually caused by viruses.

Viruses

Viruses cause many common illnesses, such as colds and flu. They also cause measles, mumps, rubella, warts (like the one shown in Figure 8.2.1), polio, cold sores (herpes) and chickenpox.

Viruses are pathogens and are about one hundred times smaller than bacteria. They are so small that they were not seen until the invention of the electron microscope in 1931. Since then, more than 5000 types of viruses have been described in detail.

Scientists debate whether viruses are living things or not. This is because viruses can only grow and reproduce inside cells they have invaded—**host cells**. A virus uses the host cell to make thousands of copies of itself. The host cell is destroyed when it bursts open and releases new viruses that spread throughout the body, infecting and then destroying other cells.

Figure 8.2.1

Warts are abnormal growths caused by a virus that infects skin cells.

Colds and flu

Over 200 different viruses cause colds. There can be thousands of microscopic virus particles in a droplet that is sneezed or coughed out by an infected person. If you breathe in an infected droplet, the virus has entered your body. Catching a cold is as easy as that.

Although colds are difficult to avoid, you can reduce your chances of catching one or spreading it to others.

- Cover your mouth when you cough or sneeze.
- Wash your hands frequently.
- Don't share personal items if you or the other person are ill.
- Avoid close contact with people who are coughing or sneezing or have a runny nose.
- If you are sick, stay at home so that you do not infect other people.

Figure 8.2.2

Coughing and sneezing pass viruses onto others nearby, quickly spreading the cold through a class, school and eventually your classmates' families.

Atishoo!

The droplets in a sneeze travel out of your mouth at over 160 kilometres per hour!

SciFile

8|3

The cold virus attacks the lining of the nose and throat. Extra mucus is produced, so your nose keeps running or becomes so blocked up that you feel as though you cannot breathe. Your throat gets sore and red, and you feel unwell.

You can catch flu (**influenza**) in the same way as catching a cold, by breathing in air containing virus particles, such as those in Figure 8.2.3, or by putting your hands near your mouth after touching contaminated surfaces. Flu is not the same as a cold. Both are caused by viruses, but flu develops more quickly and can be more severe. Infection with the flu virus causes a high temperature, and your whole body aches. However, your nose will not run as much as it would with a cold.

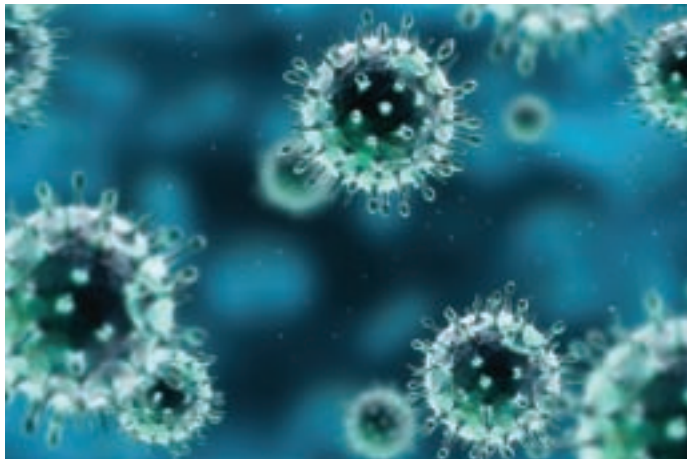


Figure 8.2.3 Viruses like these cause flu. The symptoms or indicators that you have the disease are a high temperature and aching muscles.

Antibiotics do not work against viruses. However, sometimes when you have a viral infection, bacteria invade the body and cause secondary infections. These can be treated with antibiotics. Coughing up green phlegm indicates a bacterial infection. Bronchitis and pneumonia are common secondary bacterial infections of a body weakened by fighting a virus.

Your body develops immunity to flu viruses, but you can get flu more than once because viruses are able to change quickly and new strains can appear. For each new strain of flu virus, the body has to make new antibodies, and the medical researchers have to make different vaccines. Vaccines can only be made for strains of a virus that are known.

Flu infections are usually treated as a nuisance, but they can be fatal for people with low immunity (for example, the elderly or the very young) or with other illnesses. Flu causes more than 4000 deaths in Australia each year.

Childhood diseases

When you are born, your body has not yet had the chance to build up the antibodies you need to keep you healthy. This is why children tend to come down with lots of colds and diseases that rarely affect adults.

Measles

Measles is a viral disease spread by infected people coughing and sneezing. It starts with a runny nose and sore eyes. A couple of days later a rash like the one in Figure 8.2.4 appears. In the past doctors did not worry about this common childhood illness, but now they are aware of serious side-effects. Severe cases of measles can result in permanent hearing problems or brain damage.

Figure 8.2.4 Measles rash

When European settlers first came to Australia, they brought measles with them. The Aboriginal population had no natural immunity, and measles killed a large number of them, especially children.

Measles is one of the most contagious of diseases. Since 1966, children have been routinely immunised, resulting in the disease becoming very rare in Australia.

Chickenpox

The **chickenpox** virus causes a runny nose and a slight fever, followed by a rash of small, very itchy blisters. Scratching the blisters can lead to permanent scarring or to secondary bacterial infections of the blister.

After a person has been infected, the chickenpox virus can remain inactive in the nerve cells of their body for many years. Twenty, thirty or even forty or more years later, the virus can become active again, causing shingles—a very painful rash that can last for weeks. Figure 8.2.5 shows what the blisters of chickenpox and the rash from shingles look like.

Figure 8.2.5 Immunisation against chickenpox protects you from getting chickenpox. It also protects you from developing shingles later in life.

Routine immunisation against chickenpox did not start until 2006, so infections still occur. However, the number of infections should decline as more and more children are immunised.

Parasitic disease

A **parasite** is an organism that lives on or in the body of another organism (the **host**) and takes nutrients from it. The host gets nothing in return and may be harmed. Some parasites can cause serious disease in humans.

Malaria

Malaria is an infection caused by a unicellular parasitic organism called *Plasmodium*. Mosquitoes, such as the one shown in Figure 8.2.6, carry the *Plasmodium* from one host to another. As the mosquito pierces the skin it injects a chemical (an anticoagulant) into the hosts body to prevent the blood from clotting. The *Plasmodium* is injected along with the anticoagulant.

Malaria is one of the most widespread human diseases caused by a parasite. In the 1950s there were 250 million cases of malaria each year, with 2.5 million deaths.

Figure 8.2.6 Mosquitoes carry the *Plasmodium* (a member of the protist kingdom) from one host to another, infecting a new host as it bites them and sucks their blood.

Then the World Health Organization (WHO) coordinated efforts to control the disease. It was eradicated from many areas, including Europe, North America and Australia. In Australia, complete eradication was declared in 1981. In 1988 'only' 110 million new cases were reported worldwide, but this trend has changed and now there are up to 220 million new cases of malaria each year.

Malaria has not returned to Australia, but mosquitoes capable of transmitting the disease live in northern Australia above the latitude of 19°S. About 700–800 people are hospitalised with malaria in Australia each year. These people were all infected elsewhere, mostly in Papua New Guinea.

Figure 8.2.7 Travellers to Papua New Guinea sometimes bring malaria into Australia.

Preventing infection means preventing mosquito bites in areas where the disease could return. If you live in northern Australia:

- wear protective clothing
- use insect repellent
- use a mosquito net when sleeping, if your windows are not screened
- clean up any standing water where mosquitoes could breed.

Insecticides can be used to control mosquito numbers, but they may also kill useful insects such as bees, so they are used with caution.

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SciFile

Target blue

Mosquitoes are attracted to the colour blue more than twice as much as any other colour!

Amoebic dysentery

Most of Australia is supplied with fresh, clean water, and sewage is treated effectively. This protects you from many diseases found in other parts of the world. You only come into contact with these diseases if you travel overseas, or if some disaster at home damages the sewage system or contaminates the drinking water. One disease spread through contaminated water is amoebic dysentery. This disease causes 50 000 to 100 000 deaths per year worldwide.

Amoebic dysentery is caused by a single-celled organism that is most common in tropical areas. People become infected by swallowing a cyst containing the parasite in contaminated food or water. The cyst is one stage in the life cycle of the parasite.

Figure 8.2.8 There is a greater chance of contracting amoebic dysentery when there is poor (or no) sewage treatment and the water supply is contaminated.

People who contract the disease can remain infectious for years, so it is best to prevent infection in areas where amoebic dysentery occurs. When travelling in these areas, only drink boiled water or sealed, bottled water, don't have ice in your drinks and don't eat fruit or vegetables that may have been rinsed in tap water and not cooked.

INQUIRY science 4 fun

Where do spores come from?

Yes

Collect this ...

- mushroom that is open, with dark brown gills under the cap
- sheet of white paper

SAFETY

Dispose of the mushroom and the paper in the bin when you are finished.

Wash your hands well after handling the mushroom.

Do this ...

1. Place the mushroom on the sheet of paper with the gills facing down.
2. Leave it in an area where it will not be disturbed for two days.
3. Without moving the paper, lift the mushroom carefully off the sheet of paper. There should be a deposit of black spores on the paper.

Record this ...

Describe the pattern on the paper. You could draw a picture or take a photograph.

Explain where the spores came from and what would normally happen to them.

Fungi

Fungi such as mushrooms are useful as a source of food. Others are decomposer organisms in the environment. Some fungi cause disease. Very few of the diseases they cause are life-threatening. Most are simply a nuisance.

Fungi disperse using **spores**, which are made of a single cell with a tough skin. Fungal spores are everywhere.

A cloud of spores can be seen leaving the puffball fungus in Figure 8.2.9. The spores just need to find a warm, moist environment and they will start to grow. The warmest, most sweat-prone parts of the human body are the feet and the groin. It is there that pathogenic fungi such as tinea and thrush are most likely to grow.

Figure 8.2.9 This large puffball fungus does not cause disease. However, like all fungi, it releases spores that are light and easily blown about in the wind.

Fungal infections are contagious. They can be passed from one person to another through skin-to-skin contact, the sharing of towels, or walking on floors that an infected person has walked on.

2 p276

Tinea

Tinea is a fungus that can grow on the skin, hair or nails. It grows out from a centre, producing a red, inflamed ring of skin, as shown in Figure 8.2.10. Tinea infection is often called ringworm, but no worms are involved. The tinea fungus feeds on dead skin cells. When it runs out of dead cells it will attack the living cells, causing the skin to become red and itchy. If not treated, the skin will crack and bleed. Figure 8.2.11 shows an example. The infection can be treated with a **fungicide**—a chemical that kills fungi.

Figure 8.2.10 Tinea infection is often called ringworm because of the shape of the inflamed area.

Figure 8.2.11 Tinea infection between the toes

Thrush

Thrush infection is caused by fungus that is normally found in your body. Sometimes it grows out of control, causing problems. Thrush is not serious, but is very itchy and uncomfortable. It can be found as white patches on the tongue (as you can see in Figure 8.2.12) or inside the cheek, causes nappy rash in babies, and may infect the vagina.

Thrush sometimes develops when you are taking antibiotics because the bacteria that naturally control fungi have been destroyed by the antibiotics.

Figure 8.2.12 An oral thrush infection causes the tongue to be white.

Figure 8.2.13 The ideas of Galen, Avicena and Hippocrates influenced ideas about medicine in the Middle Ages.

SCIENCE AS A HUMAN ENDEAVOUR

Nature and development of science

Medieval medicine

Hippocrates (460–377 BCE) and Galen (129–199 or 217 CE) are two very ancient and influential scientists. Galen defined disease as 'impairment of bodily activities'. Hippocrates believed that characteristics of the environment such as weather and drinking water caused disease. Although these ideas reflect some of what is believed today, ideas about disease have changed many times between then and now.

The Middle Ages (also known as medieval times) were the time from 500 to 1350 CE. The first 500 years was a time when the Roman Catholic Church dominated medicine and promoted the idea that illness was the result of sinful behaviour. The Black Death, which killed between one-third and half of the population of Europe in the mid-fourteenth century, was commonly believed to be a punishment from God.

By the eleventh century, Europe had become more settled. The ideas of Galen, Hippocrates and others were revisited. The Church established many centres of learning.

Hippocrates put forward an idea that four humours controlled the health of individuals. This idea was reinstated in the thirteenth century. The humours phlegm, blood, yellow bile and black bile were balanced in a healthy person and unbalanced where there was disease. Diagrams such as Figure 8.2.14 depicted the humours and their associations with the seasons, universal elements and certain qualities. These associations are listed in Table 8.2.1.

Table 8.2.1 The humours

Humour	Season	Universal element	Qualities
Yellow bile (coleric)	Summer	Fire	Hot and dry
Black bile (melanc)	Autumn	Earth	Cold and dry
Phlegm (flegmat)	Winter	Water	Cold and moist
Blood (sangvin)	Spring	Air	Hot and moist

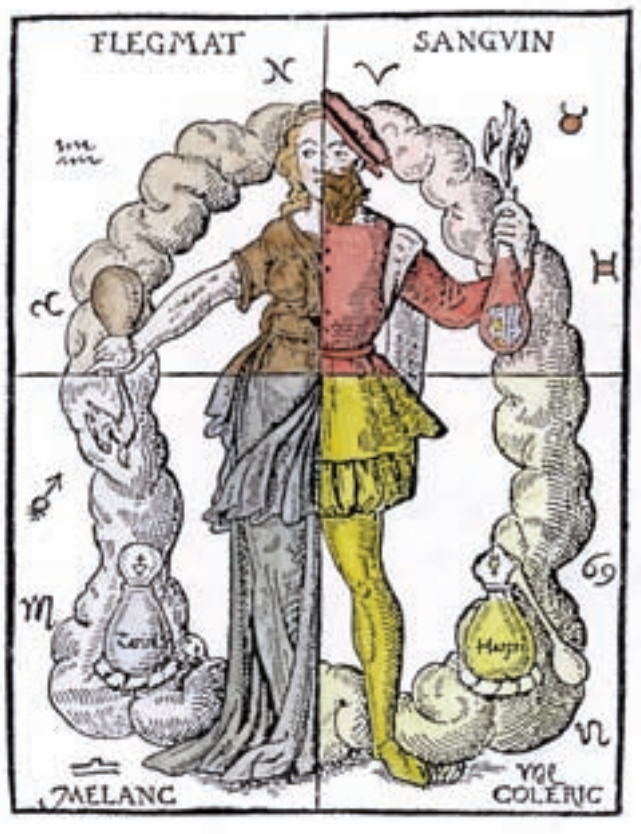


Figure 8.2.14 Each humour was associated with a particular temperament. Blood was connected with fun, yellow bile with ambition, phlegm with a calm disposition, and black bile with melancholia.

Fever was described as a hot, dry disease caused by too much yellow bile. More of the opposite humour (phlegm) was required, to cure the problem. The patient was ordered to take cold baths.

Herbal drugs were used if the treatment failed. The vomiting and diarrhoea the herbs often caused were a sign that the imbalance of the humours had passed out of the body.

Medieval doctors believed that bad smells caused disease. Getting rid of the smell would reduce the threat of disease (Figure 8.2.15). Some town authorities tried to clear the streets of rubbish and sewage even though the link between waste and disease wasn't fully understood. However, industries that produced foul smells, such as butchery, dyeing and tanning, were located side by side with homes.

Figure 8.2.15 During the plague, doctors wore a beaked mask. The beak was filled with aromatic herbs and spices to overpower foul smells that were thought to cause disease.

Aristotle (384–322 BCE) believed that living things could generate spontaneously from non-living things. Snakes and crocodiles were thought to form from the mud of the river Nile in Egypt. Rats and mice 'appeared' from old rags, and maggots spontaneously generated from rotting meat (Figure 8.2.16). This idea was not disproved until Louis Pasteur completed his experiments in 1859.

Building on the work of earlier scientists such as Francesco Redi (1626–1697), Louis Pasteur provided enough evidence to convince scientists in Europe that there was a link between germs (bacteria) and disease.

Figure 8.2.16 Until the nineteenth century, scientists believed that some animals arose spontaneously. They even wrote recipe books for making animals! The theory was finally discredited in 1859, when Louis Pasteur proved it wrong.

8.6 8.7

8.2 Unit review

Remembering

1 **Name** two diseases caused by viruses.

2 **Name** the type of organism that causes malaria.

Understanding

3 **Describe** the relationship between spores and fungi.

4 **Explain** the role (function) of the host cell in a viral infection.

5 **Outline** how malaria is spread.

6 **Explain** how the virus that causes colds is spread.

7 a **Explain** why taking antibiotics for a viral infection is usually a waste of time.

b **Describe** a situation where it is appropriate for a doctor to prescribe antibiotics for someone with a viral infection.

8 **Explain** why measles caused so many deaths when it was first introduced to the Australian Aboriginal population.

Applying

9 **Use** diagrams to **demonstrate** how walking barefoot can spread tinea.

Analysing

10 **Compare** bacteria and viruses.

11 **Contrast** colds and flu.

Evaluating

12 The mosquito is rated by many as the most dangerous animal on Earth. **Justify** why the mosquito is often considered more dangerous than crocodiles, sharks or lions.

13 Jan and Kai were arguing. Jan said that mosquitoes cause malaria. Kai said that was not a true statement.

a **Evaluate** the statement and decide who is more accurate.

b **Justify** your answer.

14 **Propose** reasons why someone got the flu even though they were vaccinated against it.

15 A family in northern Queensland know that dengue fever is carried by mosquitoes and that there are cases of it their area. **Propose** ways they could protect themselves from the disease.

Creating

16 **Construct** the scenario (story) for a 30-second television advertisement that makes people aware of how viral or fungal infections are spread, and ways they can prevent the spread.

Inquiring

1 Investigate the effect of electromagnetic radiation (EMR) on humans and how EMR is used in medicine.

2 Professor Ian Frazer was named Australian of the Year in 2006. Research the reason why he received this award and the benefit to society of his medical research.

3 Gather information about viral diseases such as dengue fever, ebola, Murray Valley encephalitis, Ross River fever, rubella, poliomyelitis and AIDS.

4 A flooring company has developed a new flooring material. They have advertised that it is ideal to use in gyms and in areas surrounding swimming pools because it cannot spread tinea. Design an investigation to test their claim.

5 When people cannot easily wash their hands before eating, they are encouraged to use alcohol-based hand washes. Design an investigation that tests the effectiveness of these products as a means of controlling disease.




8.2 Practical activities

1 Carried by mosquitoes

This could be a group activity.

Purpose

To gather information about diseases carried by mosquitoes.

Materials

- access to the internet and other research materials

Procedure

Use the internet to find the names of diseases carried by mosquitoes. For these diseases, gather information about:

- symptoms of the disease
- possible treatments and expected outcomes
- number of cases each year
- distribution throughout the world
- any control or eradication programs.

Results

Create a presentation of your research. This can be in the form of a poster, illustrated talk or PowerPoint presentation.

Discussion

1. **Describe** the most interesting thing you learned about the disease you studied.
2. **Outline** the advice you would give to people who may be travelling to where that disease is found.
3. After seeing the presentations from other members of your class, **evaluate** your presentation.
   - a. What do you think you did well?
   - b. How could your presentation be improved?
   - c. What positive comments did you receive about your presentation?
   - d. If you worked as a group to complete this task, did you work well in the group? Explain.

2 Growing fungi

Purpose

To investigate what causes fruit to rot and to find out if all fruits rot in the same way.

Materials

- paper towel
- marker pen
- a selection of fruit including:
  - 2 apples
  - 2 pieces of soft fruit such as a strawberry
  - 2 lemons
- 2 plastic boxes such as take-away containers

SAFETY

Dispose of all the fruit used in this investigation according to your teacher's instructions.

Wash your hands thoroughly after handling the fruit.

Procedure

1. Read through all the steps of this procedure before you do anything.
2. Use the marker pen to label the two containers—one with 'Cut fruit', and the other with 'Whole fruit'.
3. Wash all the fruit carefully and pat it dry with the paper towel. Do not bruise the fruit.
4. Place one apple, one of the soft fruits and one lemon into the plastic container labelled 'whole fruit'.
5. Using a clean, sharp knife, make a cut in the skin of the other apple. Wash the knife and then make a cut in the lemon. Be sure to cut through the skin into the segments. Wash the knife and then cut the soft fruit.
6. Place the cut fruit into the container labelled 'cut fruit' cut side up.
7. Leave the fruit in a well-ventilated area for 3 to 5 days.

Results

1. Write what you predict will happen to the fruit in the two different treatments.
2. Each day, observe the fruit and record any changes in its appearance. You could use photographs to support your notes.

Discussion

1. **Compare** the changes in the 'whole fruit' with the changes in the 'cut fruit'.
2. **Suggest** what could have caused the changes.
3. **Compare** the changes in the apple and the lemon.
4. **Compare** the changes in the apple and the soft fruit.
5. **Explain** what caused the changes in the fruit.
6. **Explain** why the changes were not the same for all the fruit.

Chapter review

8

Remembering

1 **Name** two different types of pathogens.

2 **Recall** the names of two diseases caused by single-celled organisms other than bacteria.

3 **State** the cause of tinea and thrush.

Understanding

4 **Explain** how washing your hands can protect you from disease.

5 **Outline** ways a viral disease may be transmitted from an infected person to a healthy one.

6 **Explain** the term *contagious*, using one contagious and one non-contagious disease in your explanation.

7 **Explain** how vaccination is able to control the spread of contagious diseases.

8 The skin, gastric juices and mucous membranes are sometimes called the body's first line of defence. **Explain** why this is an appropriate description.

9 **Describe** the role of white blood cells in the immune system.

10 **Explain** the relationship between chickenpox and shingles.

Applying

11 **Demonstrate** how the following behaviours would protect you from disease.

- **a** Protect yourself from amoebic dysentery by eating fruit only if it can be peeled before eating.
- **b** Avoid tinea infection by not sharing towels.
- **c** Use insect repellent to avoid malaria.

Analysing

12 **Discuss** the possibility of amoebic dysentery occurring in Australia.

13 **Compare** a neutrophil and a macrophage.

14 **Classify** the following as things that cause disease, or things that are part of the immune system.

pathogens, macrophages, viruses, neutrophils, skin, nose hairs, gastric juices, *Plasmodium*

Evaluating

15 **Propose** why some vaccinations against viral diseases such as polio give you lifelong immunity, whereas it is recommended that you get a flu vaccination each year.

Creating

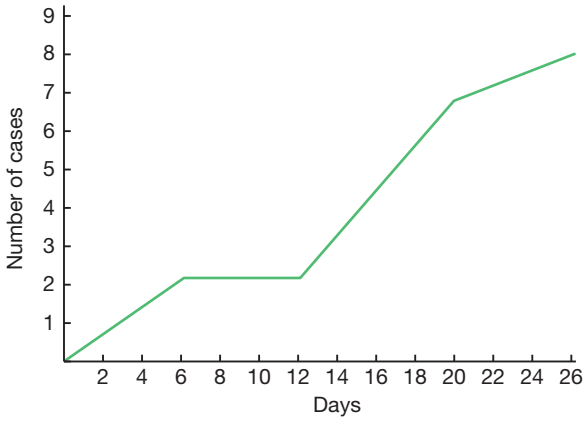
16 **Use** the following ten key words to **construct** a visual summary of the information presented in this chapter.

pathogen
infectious
immunity
virus
bacteria
vaccination
antibiotic
antibodies
lymphocytes
disease

Thinking scientifically

Questions 1 and 2 refer to the following information.

There was an outbreak of flu in the area, and the local doctor was recording the number of people diagnosed each day. Below is the graph the doctor created.



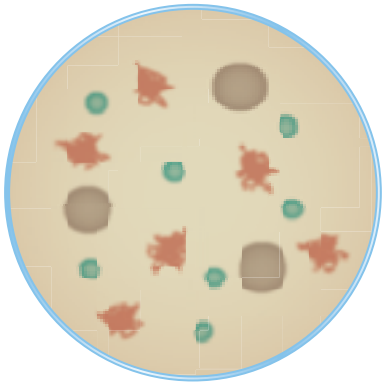
Q1 Identify the period of time when there were no more cases of flu diagnosed.

A days 0 to 6
B days 6 to 12
C days 12 to 20
D days 20 to 26

Q2 Identify the period of time when the number of cases increased most rapidly.

A days 0 to 6
B days 6 to 12
C days 12 to 20
D days 20 to 26

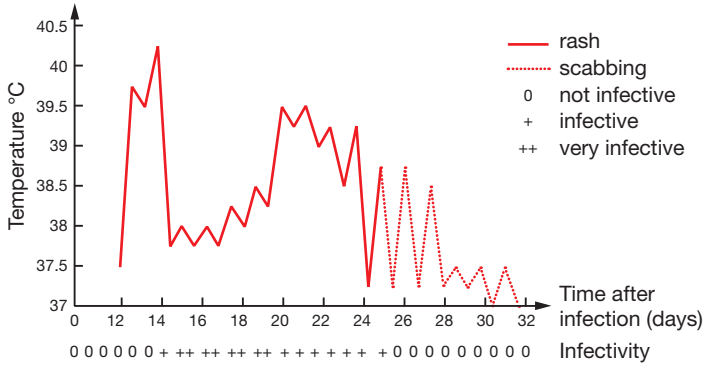
Q3 A class of students was arguing about the number of colonies of bacteria they had on the agar plate they had exposed on the windowsill of their classroom. Below is a drawing of the plate.



How many bacterial colonies can be seen on the plate?

A 3
B 6
C 7
D 10

Q4 Below is a graph of the temperature of a person suffering from smallpox.



Identify the statement that is consistent with the data presented.

A The person was most infective when their temperature was highest.
B Once the scabs started to form, the temperature was consistently lower than when the rash was present.
C The total rise in temperature from day 12 to day 14 was almost 3°C.
D Thirty days after infection, the temperature was consistently back to normal.

Q5 Bacteria in the mouth can cause bad breath. The bacteria in a mouth were counted before and after using four mouthwashes. The results are given in the table below.

Mouthwash	Bacterial count	
	Before	After
1	25	10
2	80	25
3	45	6
4	60	15

Calculate which mouthwash killed the greatest percentage of bacteria.

A 1
B 2
C 3
D 4

Glossary

Unit 8.1

Antibiotic: a substance that kills bacteria or prevents the growth of bacteria

Antibody: a chemical made by the immune system that makes it possible for white blood cells to destroy pathogens

Bacteria: microscopic, single-celled organisms

Contagious: very easy to spread; used to describe a disease

Disease: anything that causes our body to stop working properly

Immune: able to make the antibodies to a pathogen before it can make you unwell

Immune system: the system in your body that fights infections

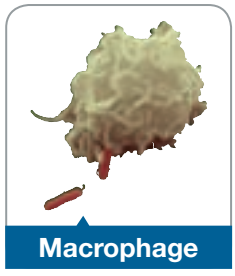
Infectious disease: a disease that can be spread


Infectious disease

Gastroenteritis: a stomach infection caused by the bacterium *Salmonella enteritidis*

Lymphocyte: a white blood cell that makes antibodies and is found in the lymph nodes

Macrophage: a white blood cell that consumes pathogens and is found in the lymph nodes


Macrophage

Neutrophil: a type of white blood cell that consumes pathogens

Pathogen: an organism that causes disease

Pathogenic bacteria: bacteria that cause disease

Penicillin: an early antibiotic

Quarantine: isolation to prevent the spread of a disease

Tetanus: a bacterial infection caused by *Clostridium tetani*

Vaccine: a chemical that causes your body to react as if it had encountered a pathogen

Unit 8.2

Amoebic dysentery: an infectious disease spread through contaminated water

Chickenpox: a viral disease; symptoms include a rash of small, itchy blisters

Fungicide: a chemical that kills fungi

Host: the organism a parasite lives in

Host cell: a cell that viruses have invaded

Influenza: a viral illness; symptoms include high temperature and body aches

Malaria: an infectious disease caused by *Plasmodium*; mosquitoes carry the *Plasmodium* parasite

Measles: a viral disease that causes a rash

Parasite: an organism that lives on or in the body of another organism (the host) and takes nutrients from it; the host gets nothing in return and may be harmed

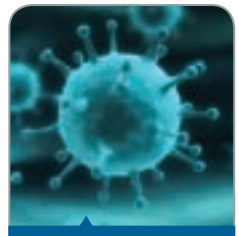

Parasite

Spore: a single cell with a tough skin that fungi use to spread

Thrush: a common fungal infection inside the mouth or the vagina, or causing nappy rash in babies

Tinea: a fungal infection in the skin, hair or nails; often called ringworm

Virus: a pathogen about one hundred times smaller than a bacterium


Virus