

# Unit 2A

## Chapter 9

# Protection against invaders



**Figure 9.1** Bacteria that have invaded the body can be cultured and identified by testing procedures

### Unit content

#### Cells, metabolism and regulation

Efficient functioning of the body requires non-specific protection. Non-specific protection includes internal and external methods.

#### Body systems

Circulatory system

Structure and function related to:

- clotting of blood at a wound including fibrinogen and platelets
- inflammatory response
- lymphatics and white blood cells

Assisted protection of the body:

- external e.g. hygiene, topical preparations and barriers

#### The relevance of human biology to everyday life

Lifestyle choices can compromise body functioning in the short term and affect future health.

Lifestyle choices that compromise health:

- personal hygiene

#### Approaches to investigating and communicating human biology

Plan and conduct a safe investigation on a question of choice developed from a given contextual problem.

The human body has a number of mechanisms to protect it from invading organisms. If the body's defences are overcome, the invaders may cause disease. **Communicable or infectious diseases** (also called transmissible diseases) are diseases that are caused by foreign organisms invading the body and multiplying there. Such disease-causing organisms are called **pathogens**. Some communicable diseases are said to be **contagious**; this means that they are passed by direct contact with a person suffering from the disease, or by contact with something touched by the person. Other communicable diseases may be spread from person to person by **vectors**, intermediate hosts of the pathogen, such as mosquitoes or fleas.

The body has defences against pathogens. External defences stop pathogens from entering the body. Internal defences are also available should the invaders get past the external barriers.

## Pathogens

The most common pathogens that affect the human body are bacteria and viruses, although fungi and animal parasites can also be involved.

### Bacteria

The great majority of bacteria are harmless to humans; they are non-pathogenic. Indeed, many bacteria are essential to life on earth through their role in the decomposition of organic material and the cycling of the elements. Some bacteria are used in industrial processes. For example, *Lactobacilli* are used to make yoghurt and sauerkraut, and the flavour of cheeses depends on the type of bacteria used in their production.

Huge numbers of bacteria live on our skin, in our alimentary canal and in other parts of the body. In the armpit of an adult male there are more than two million bacteria per square centimetre of skin surface, and in the intestines bacteria are so numerous that the major part of the digesting food contents consists of bacteria. These bacteria have no ill effect on our health, yet there are others that may cause illness or death when present in relatively small numbers.

Bacteria all consist of a single cell (Fig. 9.2a) and can be seen only with a microscope. Under the light microscope, about all that can be seen of bacteria is the shape of their cells. Cell shape is used to classify bacteria (Fig. 9.2b).

Some of the better known diseases that are caused by bacteria are shown in Table 9.1.

### Viruses

The discovery, by scientists such as Pasteur and Koch in the late nineteenth century, that some diseases were caused by bacteria, was a great step forward for medical science. There were, however, certain diseases for which no bacterial cause could be found. For example, Pasteur tried in vain to find a bacterium that caused the disease rabies. The causes of these diseases are **viruses**, structures too small to be seen with the ordinary light microscope.

It was not until 1938 that scientists, using an electron microscope, first saw viruses. Subsequent studies showed that they had distinctive structures and differing sizes. All viruses were found to contain genetic material in the form of a molecule of either DNA (deoxyribonucleic acid) or RNA (ribonucleic acid), but they never contained both. The molecule of DNA or RNA is surrounded by a coat of protein (Fig. 9.2c).

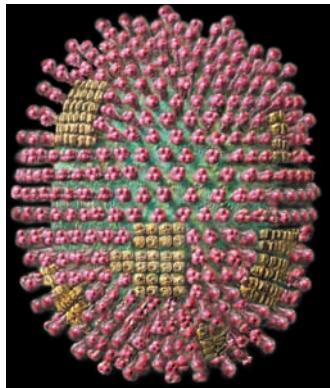
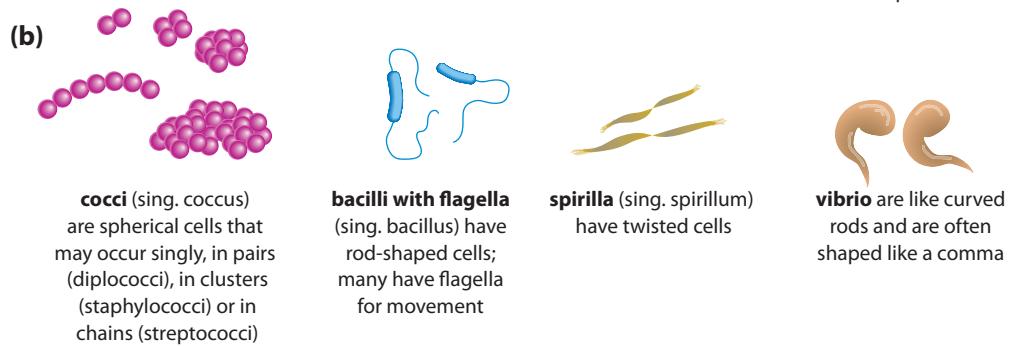
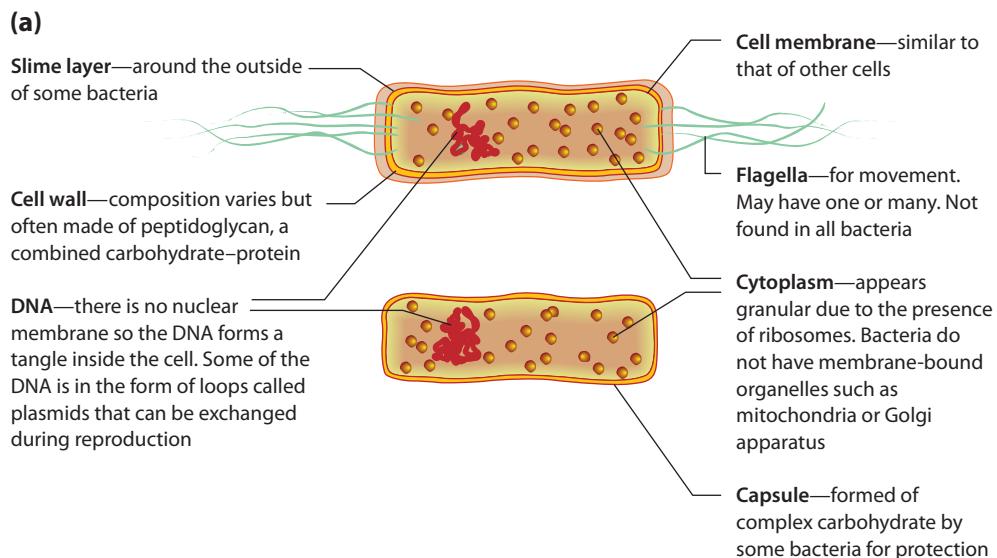
When the virus infects a living cell its DNA or RNA induces the cell to manufacture more virus particles. The new virus particles are then able to leave the host cell to

**Figure 9.2** The structure of micro-organisms.

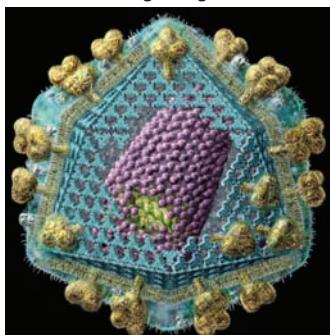
(a) The structure of a bacterial cell.

(b) Types of bacteria.

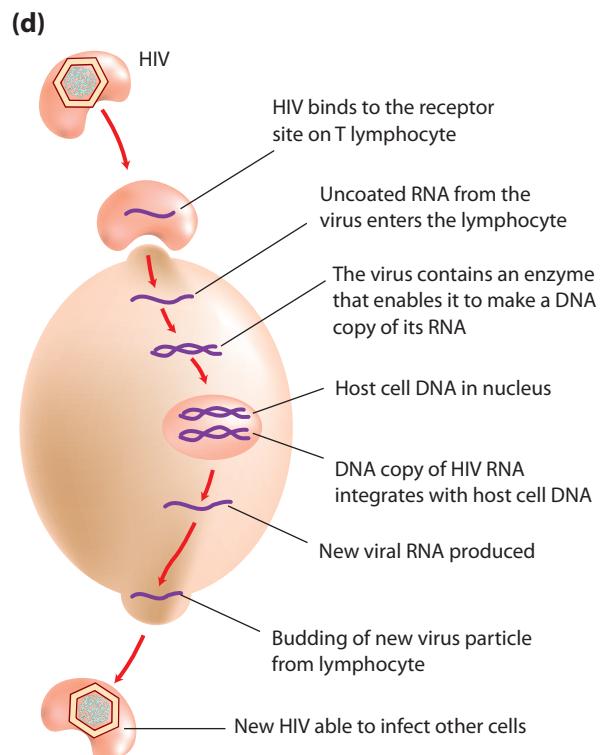
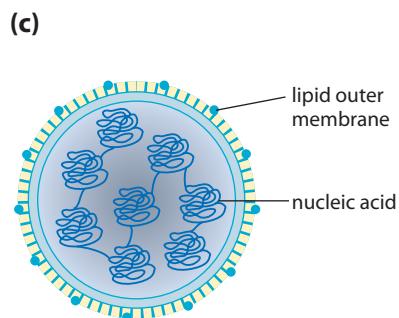
(c) Viruses. (d) The process of viral replication illustrated by HIV



Influenza virus has a lipid outer membrane. The RNA is in eight segments



Human immunodeficiency virus (HIV) has a lipoprotein envelope with an internal protein coat



Viruses cannot reproduce themselves. They attach to the outside of a host cell and the nucleic acid enters the cell. New viral genes are produced by the host cell so that hundreds of new virus particles are formed.

Viruses all contain either DNA or RNA but not both. Around the nucleic acid is a protein coat and some viruses have an additional envelope of lipid and protein molecules.

infect others (Fig. 9.2d). Some viruses multiply in bacterial cells, causing the death of the bacterium. Such viruses are known as **bacteriophages**.

Some diseases caused by viral infections are shown in Table 9.1. However, not all viruses are harmful. Viruses are now used to insert new genes into other organisms. Bacteria that have been genetically modified in this way are used to produce insulin for the treatment of diabetes.

## Fungi

Compared with bacteria and viruses, fungi are relatively unimportant in humans. Most pathogenic fungi cause diseases of the skin, some of which are mentioned in Table 9.1.

Like bacteria and viruses there are many useful fungi, such as mushrooms and the yeasts used in baking.

## Animal parasites

**Parasites** are organisms that live on or in another living thing—the **host**—and gain food and shelter from it. They may cause the host little or much harm, depending on the nature of the relationship. Humans are potential hosts for many parasites. Some, such as fleas and lice, are **ectoparasites**: they live on the surface of the body. Others, such as worms or protozoans (single-celled animals), are **endoparasites**, living inside the body. Table 9.1 lists some of the animal parasites of humans.

**Table 9.1** Pathogenic organisms and some of the better known diseases that they cause

Bacteria	Viruses	Fungi	Animal parasites
Anthrax	HIV/AIDS	Ringworm	<i>Protozoans</i>
Botulism	Bird flu	Thrush	Amoebic dysentery
Chlamydia	Chickenpox	Tinea	Amoebic meningitis
Cholera	Cold sores (herpes)		Malaria
Dental caries (tooth decay)	Colds		Sleeping sickness
Diphtheria	Encephalitis (viral)		Toxoplasmosis
Gastroenteritis	Genital herpes		<i>Platyhelminthes (flatworms)</i>
Gonorrhoea	Glandular fever		Blood flukes
Impetigo (school sores)	Hepatitis A, B, C, D, E and G		Hydatids
Legionnaire's disease	Influenza		Liver flukes
Leprosy	Measles		Tapeworms
Meningitis (bacterial)	Meningitis (viral)		<i>Nematodes (round worms)</i>
Peptic ulcers	Mumps		Hookworms
Plague	Poliomyelitis		Roundworms
Pneumonia	Rabies		Threadworms
Scarlet fever	Ross River virus		<i>Arthropods</i>
Syphilis	Rubella		Lice
Tetanus	SARS (severe acute respiratory syndrome)		Scabies (mites)
Trachoma	Shingles		Ticks
Tuberculosis	Smallpox		
Typhoid	Warts		
Whooping cough	Yellow fever		



## EXTENSION

Infections that pass from animals to humans are called zoonotic infections (or zoonoses). New pathogens affecting humans by 'jumping' from other species are being reported at an increasing rate. SARS and bird flu (avian influenza) are recent examples.

Find out:

- some diseases that originated in other animals but now occur in humans
- possible reasons why zoonotic infections are increasing
- the dangers of zoonotic infections
- what can be done to decrease the risk of zoonotic infections.

## Defences against disease

Our bodies have a number of defences that protect us against invasion by pathogenic micro-organisms. Very often we are exposed to pathogens without realising it. Many pathogens are prevented from entering the body or, if they do enter, they are dealt with before they can cause symptoms of disease. Even if we do become ill, the defence system often enables recovery to occur without any medical intervention.

**Non-specific defences** are defences that work against all pathogens. They are the body's first line of defence. In the remainder of this chapter we will discuss some non-specific defences.

**Specific defences** are directed at a particular pathogen. For example, if you get infected (or vaccinated) with chickenpox virus the body will make antibodies to combat the virus. Those antibodies are only effective against the chickenpox virus; they will not work against any other virus or bacterium.

### Non-specific defences

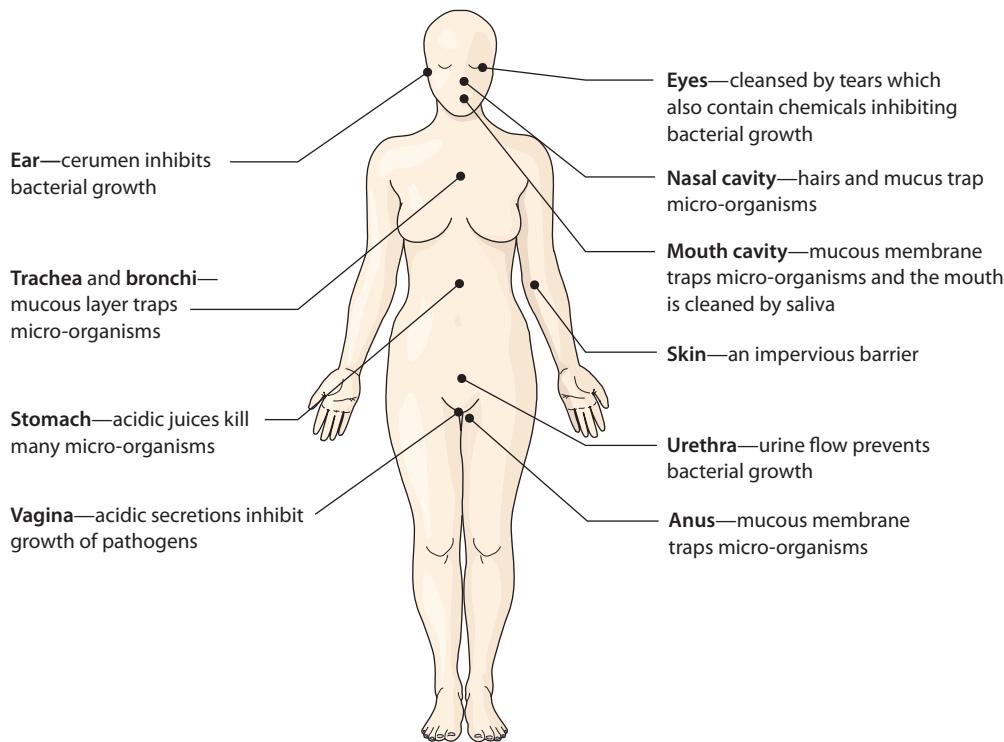
#### External defences

The body has many external defences to try to stop pathogens from entering. The skin, for example, is an effective barrier covering the outside of the body. At openings in the skin, such as the mouth, eyes and anus, special protection is provided by other defences. The skin is relatively impervious to the entry of micro-organisms provided it is not broken by cuts or abrasions. Other external defence mechanisms are detailed in Figure 9.3.

#### Protective reflexes

A reflex is an automatic, involuntary response to a stimulus. Protective reflexes help to protect the body from injury, such as the blink reflex, or from infection, such as vomiting. There are four reflexes that help to protect against infection.

1. **Sneezing.** The stimulus for sneezing is irritation of the walls of the nasal cavity. The irritation may be caused by noxious fumes or dust particles, which are likely to be carrying micro-organisms. Forceful expulsion of air from the lungs carries mucus, foreign particles and irritating gases out through the nose and mouth.



**Figure 9.3** The body's external defences against entry of pathogenic micro-organisms

2. **Coughing.** For coughing, the stimulus is irritation in the lower respiratory tract—the bronchi and bronchioles. In a manner similar to sneezing air is forced from the lungs to try to remove the irritant. The air drives mucus and foreign matter up the trachea towards the throat and mouth.
3. **Vomiting.** Psychological stimuli, excessive stretching of the stomach and bacterial toxins can all induce vomiting. It is not contraction of the stomach but contraction of the muscles of the abdomen and the diaphragm that expel the stomach contents.
4. **Diarrhoea.** Irritation of the small and large intestines by bacteria, viruses or protozoa can cause diarrhoea. The irritation causes increased contractions of the muscles of the wall of the intestines so that the irritant is removed as quickly as possible. Material does not stay in the large intestine long enough for water to be absorbed so the faeces are very watery.

## Blood clotting

When an injury occurs that involves damage to blood vessels, the events that follow help to minimise blood loss from the broken vessels and prevent the entry of infecting micro-organisms. The muscles in the walls of the small blood vessels that have been injured or broken constrict immediately to reduce blood flow. The internal walls of blood vessels are normally very smooth, but any damage creates a rough surface to which the platelets stick. Sticking platelets attract others, so that a plug is built up at the site of the injury. This plug also helps to reduce blood loss. The platelets release substances that act as vasoconstrictors, which enhance and prolong the constriction of the damaged vessels. For many of the small tears that occur in capillaries each day, this plugging action of the platelets and constriction of the blood vessels is sufficient to stop any bleeding. For more serious injuries **blood clotting**, or **coagulation**, is necessary.

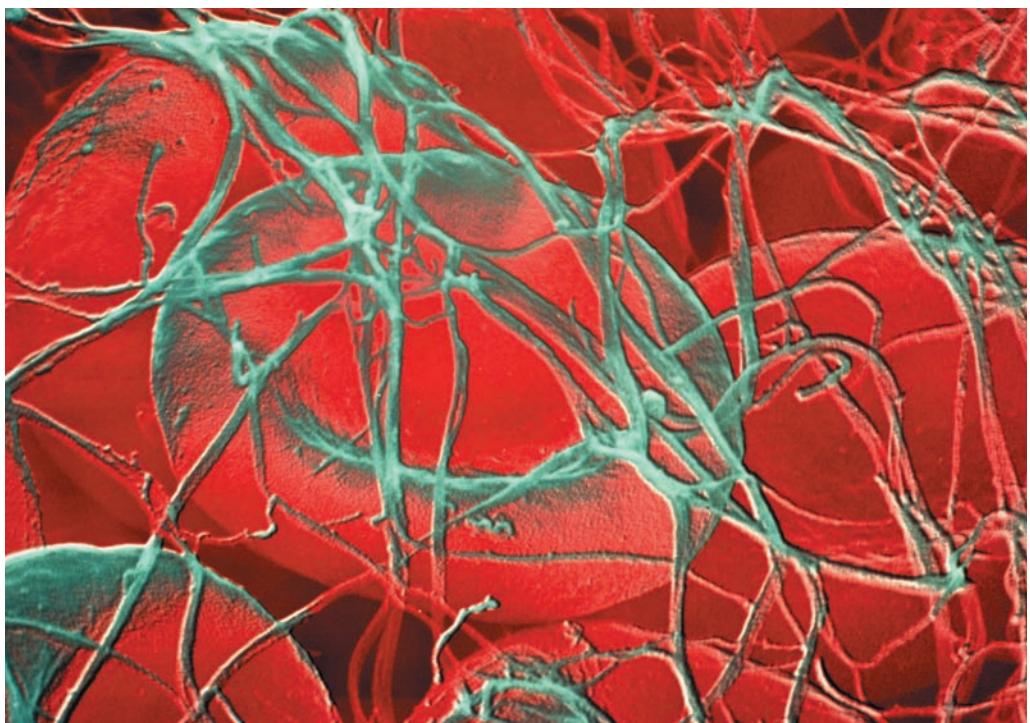
You can find out more on how the blood clots at <http://library.thinkquest.org/C0115080/?c=clotting>

The formation of a blood clot is a complex process, involving a large number of chemical substances, or **clotting factors**, that are present in the blood plasma.

The complex series of reactions results in the formation of threads of insoluble protein. The threads form a meshwork that traps blood cells, platelets and plasma. This mesh with its trapped material is the **clot**. The threads stick to the damaged blood vessels and hold the clot in position (Fig. 9.4).

After the formation of the clot, a slower process known as **clot retraction** occurs. The network of threads contracts, becoming denser and stronger and pulling the edges of damaged blood vessels together. As clot retraction occurs, a fluid known as **serum** is squeezed out. The clot then dries, forming a scab over the wound that prevents entry of infecting micro-organisms.

**Figure 9.4** A blood clot showing red blood cells in a fibrin mesh



### Internal non-specific defences

If pathogens get past our external defences there are internal non-specific defences that can help deal with the invaders.

#### Phagocytes

Organisms that penetrate our external defences are attacked by phagocytes. **Phagocytes** are cells that can engulf and digest micro-organisms and cell debris (Fig. 9.5). They are very important in defence against disease.

**Figure 9.5** The process of phagocytosis



**Leucocytes** are white blood cells. There are a number of different types of leucocytes but they all play a part in phagocytosis. Leucocytes are able to leave the blood capillaries and migrate through the tissues to places of infection or injury. Some secrete substances that destroy bacteria before they are engulfed, whereas others engulf live bacteria and digest them.

**Macrophages** are large phagocytic cells that develop from some leucocytes. Some of them are wandering cells that move through the tissues looking for pathogens and destroying them. Others are fixed in one place and only deal with the pathogens that come to them. Like the leucocytes, the macrophages either engulf and digest the micro-organisms or release substances that destroy them. By these processes many pathogens are eliminated before an infection has a chance to take hold. Figure 9.6 shows macrophages actively ingesting a large particle that is foreign to the body.

### The inflammatory response

**Inflammation** is a response to any damage to the tissues. The purposes of inflammation are:

- to reduce the spread of any pathogens, to destroy them and to prevent the entry of additional pathogens
- to remove damaged tissue and cell debris
- to begin the repair of the damaged tissue.

Words ending in *-itis* indicate inflammation of specific organs or tissues: for example, tonsillitis—*inflammation of the tonsils*; meningitis—*inflammation of the meninges, the membranes around the brain*; laryngitis—*inflammation of the larynx*. Inflammation of the skin is a readily observable inflammatory response to, say, a mosquito bite, a scratch or bacterial infection in a pimple.



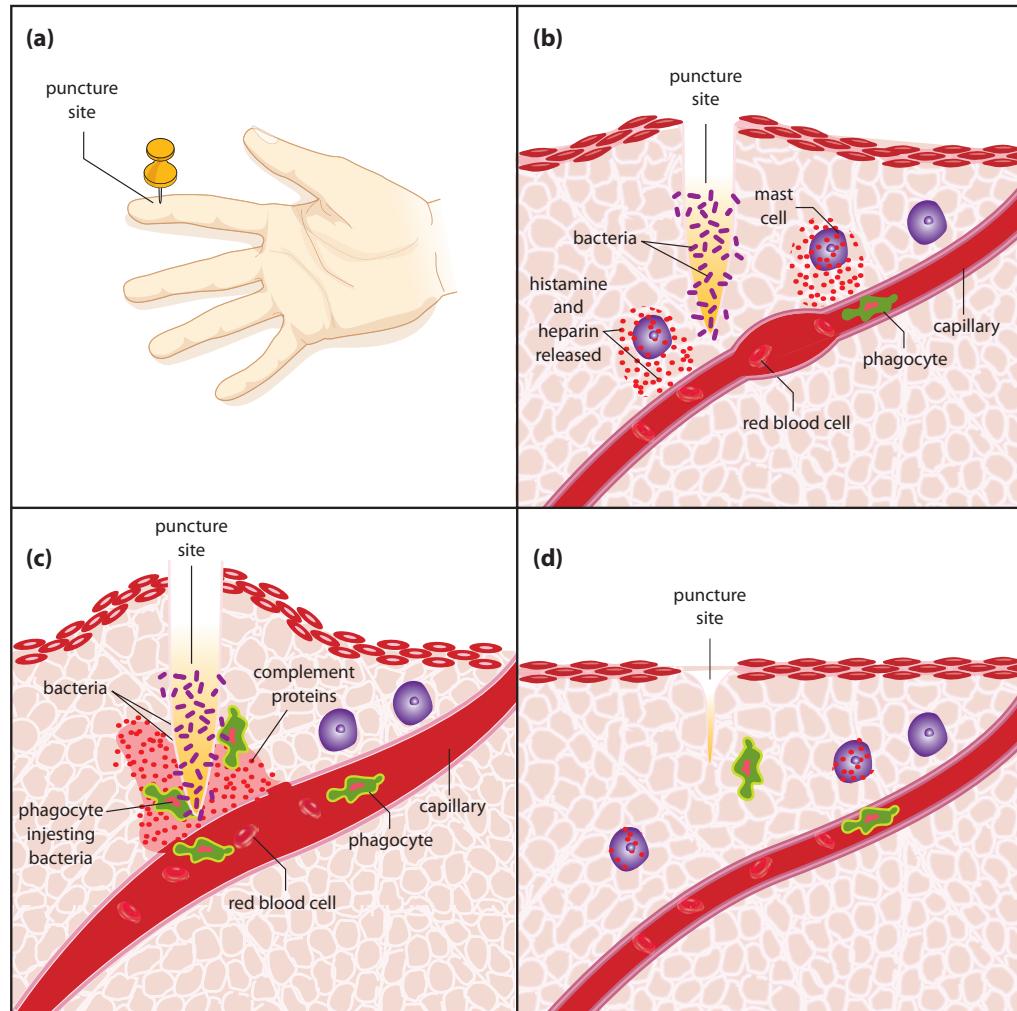
**Figure 9.6** A group of macrophages attacking a large foreign particle

There are four signs of inflammation, and if you think of an infected cut, a pimple or a mosquito bite you will be able to relate to each of the four signs. These are redness, swelling, heat and pain.

Damage to tissues stimulates an integrated series of steps in the inflammatory response, which is shown diagrammatically in Figure 9.7.

- When stimulated by mechanical damage or by local chemical changes mast cells release histamine, heparin and other substances into the tissue fluid. **Mast cells** are special cells that are present in most tissues. They stimulate and coordinate inflammation by releasing chemicals.
- Histamine** increases blood flow through the area and causes the walls of the blood capillaries to become more permeable so that fluid is filtered from the blood. It is the increased blood flow that causes the heat and redness associated with inflammation and the escape of fluid from the blood causes the swelling.
- Heparin** prevents clotting so the release of heparin from the mast cells prevents clotting in the immediate area of the injury. A clot of the fluid around the damaged area does form and this slows the spread of the pathogen into healthy tissues.
- The chemicals released by the mast cells attract **phagocytes**. Macrophages and leucocytes actively consume micro-organisms and debris by phagocytosis.
- The abnormal conditions in the tissue stimulate pain receptors so that the person feels **pain** in the inflamed area.

**Figure 9.7** The inflammatory response. **(a)** When the skin is broken, a non-specific inflammatory response is triggered. **(b)** Mast cells release histamine and heparin. Histamine diffuses into capillaries, causing them to dilate and become leaky. The area becomes red and swells. Heparin prevents clotting in the immediate area. **(c)** Complement proteins are activated and attract phagocytes to the area, which engulf and digest dead cells and bacteria. **(d)** The tissue heals when histamine and complement protein signalling finish and phagocytes are no longer attracted to the area



6. The phagocytes, filled with bacteria, debris and dead cells begin to die. The dead phagocytes and tissue fluid form a yellow liquid called **pus**.
7. New cells are produced by mitosis and **repair** of the damaged tissue takes place.

## The lymphatic system and non-specific defence

The lymphatic system consists of:

- a network of lymph capillaries joined to larger lymph vessels
- lymph nodes, which are located along the length of some lymph vessels.

The main function of the lymphatic system is to collect some of the fluid that escapes from the blood capillaries and return it to the circulatory system. In addition to this main function the lymphatic system is an important part of the body's internal defence against pathogenic organisms.

### Lymph vessels

At the arterial end of a blood capillary, fluid tends to leak out due to the high pressure in the blood. Some, but not all, of this fluid returns to the capillary at the venous end. The excess fluid in the tissues is returned to the blood by the lymphatic system. Fluid returned to the blood in this way is known as **lymph**. Unlike the blood in the circulatory system, lymph does not circulate—the lymphatic system is a one-way system carrying fluid away from the tissues. The lymph vessels originate as blind-ended tubes in the spaces between the cells of most tissues (Fig. 9.8d on p. 122). These **lymph capillaries** are usually slightly larger than blood capillaries. They are also more permeable than most capillaries. Proteins and disease-causing organisms in the intercellular fluid can easily pass through the walls of the lymph capillaries into the lymph.

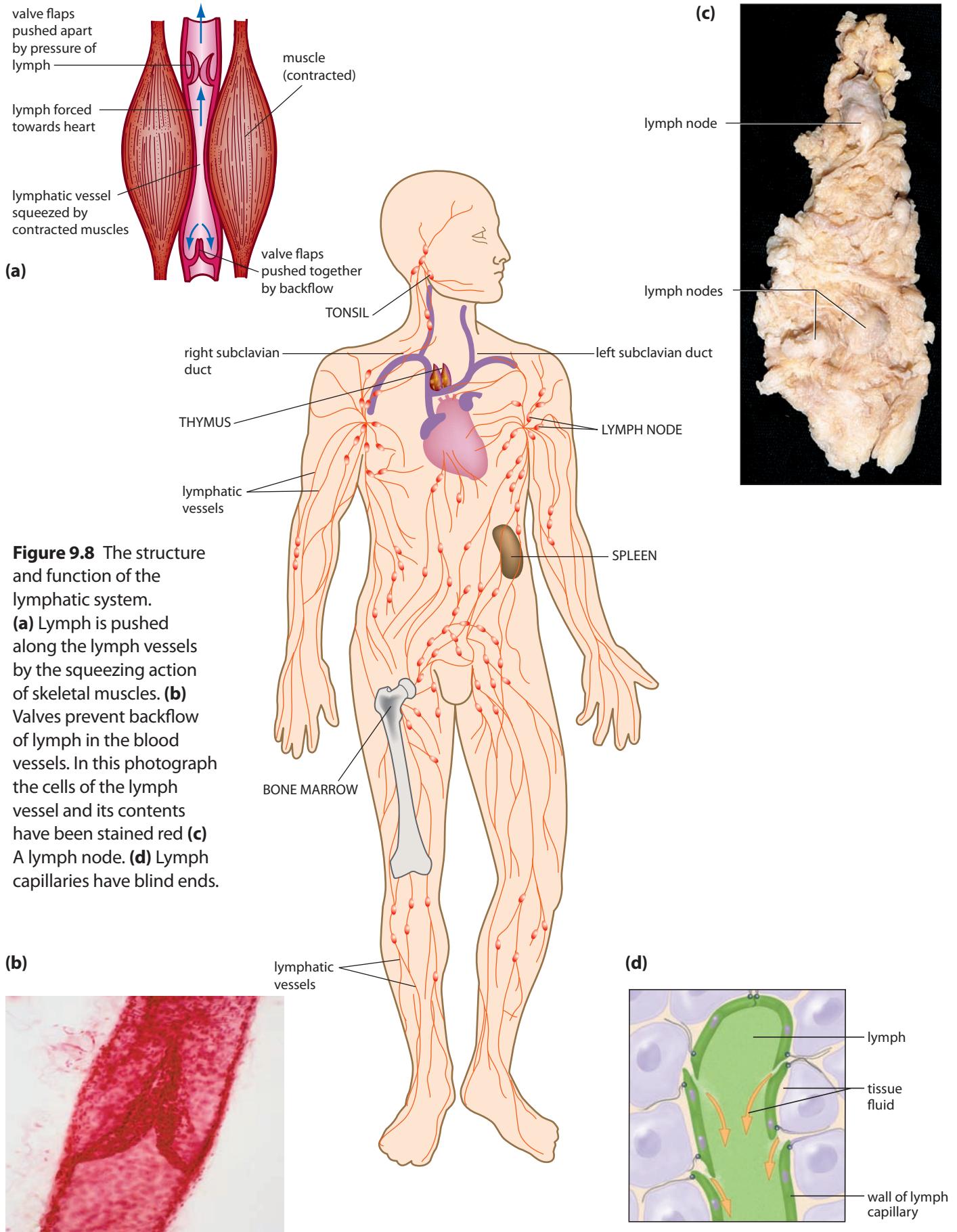
### Lymph nodes

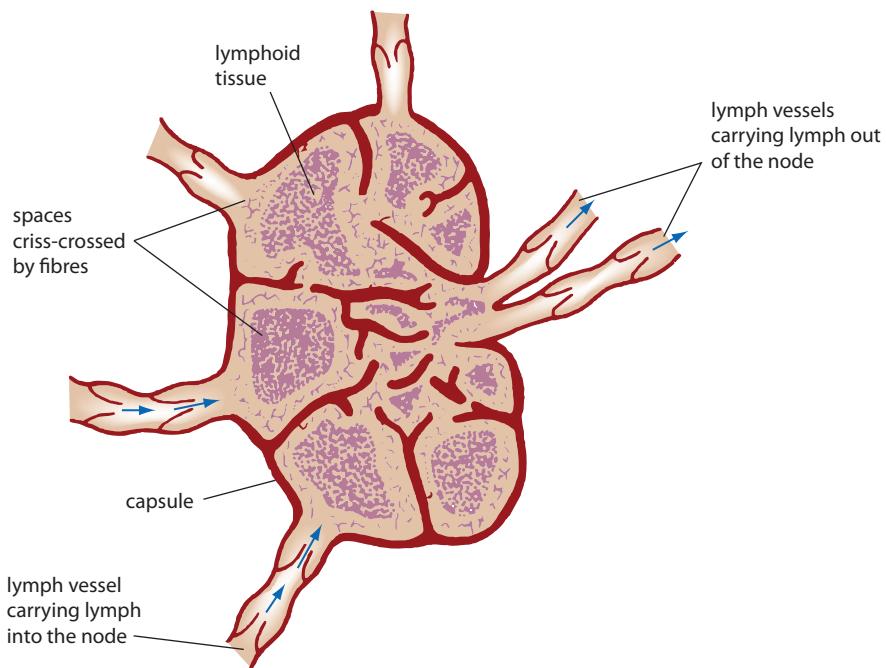
**Lymph nodes**, also called **lymph glands**, occur at intervals along the lymphatic vessels. They are most numerous in the neck, armpits, groin and around the alimentary canal (Fig. 9.8). Nodes are bean-shaped and range in length from 1 to 25 mm. Each is surrounded by a capsule of connective tissue that extends into the node, forming a framework. Within the framework are masses of **lymphoid tissue**, containing cells known as **lymphocytes**, **macrophages** and **plasma cells**. Spaces between the cells of the lymphoid tissue are criss-crossed by a network of fibres. Lymph enters through vessels on the convex side of the node, filters through the spaces and passes out through vessels on the opposite side (Fig. 9.9 on p. 123). The lymph passes through several nodes before entering the circulatory system.

### Role of the lymphatic system in non-specific defence

Lymph entering the lymph nodes contains cell debris, foreign particles and micro-organisms that have penetrated the body's external defences. Some of these micro-organisms may be pathogenic and, if not destroyed, could cause disease.

Larger particles, such as bacteria, are trapped in the meshwork of fibres as the lymph flows through the spaces in the nodes. Macrophages (Fig. 9.6) destroy these particles. The macrophages ingest the particles by **phagocytosis**. Projections from the macrophage surround the particle and take it into the cell, where it is destroyed by enzymes (Fig. 9.5). Most bacteria ingested in this way are killed within 10–30 minutes.





**Figure 9.9** Section through a lymph node. The arrows indicate the direction of lymph flow

When infections occur, the formation of lymphocytes increases and the lymph nodes become swollen and sore. For example, an infected finger may result in swelling and tenderness in the armpit, where there are a large number of lymph nodes. Most lymphocytes are important in the *specific* immune response to a particular pathogen.

## EXTENSION

Two groups of proteins, interferon and complement protein, provide short-term, non-specific resistance to infection by bacteria and viruses.

Find out:

- the source of each of these proteins
- the role of each in non-specific defence.



## Helping the body's non-specific defences

### Good hygiene

There are a lot of positive things that can be done to reduce the risk of infection with pathogens. If we do happen to be infected, such as with a cold or the flu, these same practices will reduce the possibility of passing the infection on to others.

**Wash your hands**, especially:

- before preparing or eating food
- after using the toilet
- before and after providing first aid
- after handling blood or body fluids
- before and after caring for an ill person
- after coughing and sneezing
- before breastfeeding.

Thorough hand washing with soap and water is the most effective way of reducing the spread of micro-organisms from person to person. Listed below are some other habits that you should develop.

- **Cover your mouth** when you cough or sneeze so that you reduce the spread of infection to others.
- **Wear gloves** when cleaning up blood or other body fluids. If there is a risk of splashing, safety glasses should be worn.
- **Wipe surfaces with disinfectant** if they have been contaminated with blood or other body fluids, or if they are just plain dirty.
- **Use tongs, pliers or tweezers** or wear heavy gloves when picking up discarded syringes or condoms. Use a puncture-proof container, such as a tin with a lid, to dispose of syringes and needles.
- **Never share** personal articles such as toothbrushes, razors, towels or syringes.

### Mechanical barriers

Mechanical barriers provide an obstacle to invading pathogens and therefore reduce the risk of getting a disease. One of the most common mechanical barriers is a surgical mask and it is now frequently worn by people when there is a high risk of inhaling disease-causing pathogens. During the SARS epidemic many people wore surgical masks when in public places (Fig. 9.10). Surgical masks also diminish the chance that the wearer will breathe out pathogenic organisms and therefore reduces the spread of disease.

Surgeons wear masks because most operations involve cutting through the skin. The body's first line of defence has therefore been breached and pathogens can easily enter the tissues. For the same reason surgeons 'scrub up' before an operation and wear sterile gloves (see Fig. 9.11).

Other mechanical barriers include protective clothing, gloves and safety glasses when there is a chance that the eyes may be affected. Protective clothing is important

**Figure 9.10** People wearing surgical masks in Hong Kong during the SARS outbreak





**Figure 9.11** To avoid spreading disease, surgeons and nurses wear gloves, gowns and masks in the operating theatre

in areas where an individual may be subjected to insect bites or bites by ticks and mites. For example, mosquitoes spread malaria, Ross River virus and other pathogens, so people visiting an area where mosquitoes occur should ensure that their bodies are well covered by clothing to reduce the chance of being bitten.

## Pain relief

An inevitable consequence of many infections is pain. Drugs that relieve pain are called **analgesics**. Examples include aspirin, codeine, paracetamol, morphine, heroin, methadone and pethidine. The medical use of some of these drugs is very restricted, and the use of heroin in Australia, for any reason, is prohibited. Pain killers that are readily available from supermarkets and pharmacies are effective in reducing low-level pain.

Pain killers should be used with caution and always in accordance with the instructions on the packet. It is possible to overdose even on 'over the counter' analgesics. Like all drugs, analgesics have side effects. They may cause stomach and kidney disorders, high blood pressure, joint deterioration or other problems. While very useful for short-term pain relief, analgesics should not be used long term without medical supervision.

## Topical preparations

Topical preparations are used on the skin. They include ointments, creams, gels, lotions and solutions. Not all are for the prevention or treatment of infection.

Types of topical preparations include:

- protective preparations, such as sunscreens for protection against sunburn and skin cancer
- antiseptics to prevent infection when the skin is broken
- antibiotic solutions, such as eye drops used to clear up conjunctivitis
- analgesics to reduce pain, often from muscles and joints
- insecticides, miticides and fungicides for the treatment of conditions such as lice, scabies and tinea
- cosmetics, many of which keep the skin moist, thus reducing the chance of mechanical damage.

## Antimicrobials

Sometimes the body's immune system is unable to deal with an invading micro-organism quickly enough. The micro-organism multiplies in the body and symptoms of disease can occur. A large number of chemicals that can be used to kill infecting micro-organisms, **antimicrobials**, are now available. **Antibiotics** are used against bacterial infections and **antifungals** are used against fungal infections. Effective antimicrobials must be toxic only to the infecting micro-organism and not to the patient's own cells. Each antimicrobial attacks a specific target in the micro-organism's cells. For example, penicillin prevents the synthesis of bacterial cell walls; tetracyclines, erythromycin and streptomycin affect bacterial ribosomes and so prevent protein synthesis; and nystatin affects the cell membrane of fungal cells.

The development of antimicrobials has had a dramatic impact on human health. Many infections that in the past had devastating effects on a community suddenly became easy to treat. However, a problem with antibiotics is that the bacterium, through natural selection, gradually develops a resistance to the drug. For example, penicillin

**Figure 9.12** Topical preparations are used on the skin



was used very successfully to treat the sexually transmitted infection gonorrhoea. In 1975, cases of gonorrhoea that could not be cured by penicillin were first reported. The bacterium that causes the disease had developed a resistant strain. By the 1990s multiple-drug-resistant strains of a number of disease-causing bacteria were appearing in hospitals worldwide. These strains are resistant to all or most antibiotics.

The evolution of multiple-drug resistance has been hastened by the overuse of antibiotics in medicine and in agriculture. Doctors have prescribed antibiotics for the prevention of infection rather than the treatment of an existing infection. Farmers are using antibiotics as 'growth promoters' in poultry, pigs and cattle. International efforts are now being made to reduce the use of antibiotics so that the development of further strains of multiple drug-resistant bacteria will be delayed. Researchers are also continually looking for new antibiotics to replace those to which pathogens have become resistant.

Although effective drugs are available for most bacterial and fungal diseases, there are only a few drugs available for the treatment of viral diseases. Viruses take over a host cell and utilise some of the enzymes in that cell. This makes it difficult to find a drug that will prevent viral reproduction without also interfering with the metabolism of the host cell. Some antiviral drugs have now been developed. For example, zidovudine, or AZT, is widely used for the treatment of HIV/AIDS; topical antiviral preparations are available for herpes; and antiviral drugs are available for influenza.

## EXTENSION



Research has been taking place for many years now to try and find effective drugs to fight viral infections.

Use references to find out:

- the antiviral treatments available for influenza
- how these treatments work
- current lines of research to combat viral infections.

## Working scientifically



### Activity 9.1 Fever

**Fever** is when a person's body temperature is higher than the normal 37 °C. It can result from injury, infection, toxins, reaction to a drug or a number of other causes. At one time it was thought that fever was harmful to the body and everything possible should be done to reduce a high temperature. It is now known that, provided a person's temperature is not too high (over 40 °C), fever can actually speed recovery.

Table 9.2 shows the temperature recorded for a person who suffered a viral infection and recovered after about 10 days.

**Table 9.2** Temperature recorded for a patient during a viral infection

<b>Day</b>	<b>Time</b>	<b>Body temperature (°C)</b>	<b>Day</b>	<b>Time</b>	<b>Body temperature (°C)</b>
1	8.00 am	37.1	7	8.00 am	39.1
	8.00 pm	37.4		8.00 pm	38.7
2	8.00 am	37.2	8	8.00 am	38.3
	8.00 pm	38.1		8.00 pm	38.1
3	8.00 am	38.6	9	8.00 am	37.7
	8.00 pm	39.2		8.00 pm	37.4
4	8.00 am	39.1	10	8.00 am	37.2
	8.00 pm	38.9		8.00 pm	36.9
5	8.00 am	39.2	11	8.00 am	37.1
	8.00 pm	39.3		8.00 pm	37.2
6	8.00 am	38.8			
	8.00 pm	39.0			

### What to do

1. Plot these data on a graph. Make sure your graph conforms to all the conventions for drawing scientific graphs (see Chapter 2, page 20).
2. Describe in words what happened to the patient's temperature over the 11-day period covered by the data.
3. Calculate the patient's average temperature from 8.00 am on day 3 to 8.00 pm on day 8.
4. During a fever the body's 'thermostat' is set to a higher level. Explain how your graph illustrates this characteristic of a fever.

### Activity 9.2 Reye's syndrome

Reye's syndrome (pronounced ryes) is a serious disorder that sometimes occurs in children after a viral infection such as chickenpox or the flu. It was first recognised as a distinct disorder in 1963 by R. Douglas Reye, an Australian pathologist. Reye's syndrome mainly affects children between the ages of 4 and 16 and statistics show that it can be triggered by the use of drugs that reduce fever, such as aspirin.

Use the Internet to research Reye's syndrome. See if you can find out:

1. the signs and symptoms
2. the long-term consequences
3. how often Reye's syndrome occurs in Australia
4. the causes
5. prevention
6. expert opinions on whether Reye's syndrome really is associated with aspirin use, or whether Reye's syndrome really is a distinct disorder.

## Activity 9.3 Skin bacteria

Washing hands is recommended as a way of reducing the spread of bacteria. Antiseptics are used to further reduce the risk of infection.

The purpose of this activity is to determine the effect of hand washing or antiseptic solution on the bacterial population of the skin. The presence of bacteria on the skin of the fingers can be demonstrated by pressing the fingers onto the surface of the medium in a sterile culture plate. A culture plate is a Petri dish with a thin layer of agar jelly in the bottom. The agar contains nutrients for any micro-organisms that may grow on its surface.

After pressing fingers onto the agar, the plate is incubated (kept in a warm place) for several days. Bacteria that were transferred from the fingers to the agar will reproduce and form colonies that can be seen with the naked eye. The more colonies, the more bacteria there were on the skin.

### You will need

For each pair or group: 6 or more sterile nutrient agar plates; 2 large beakers; soap, or soap solution; antiseptic solution such as Dettol, Solyptol or Cetavlon; marking pen; adhesive tape; an incubator (if available).

### What to do

When handling the culture plates you should take the following precautions.

1. Do not open the lid of the sterile culture plate until you are ready to press your skin onto the surface. It is most important that exposure of the plates to the atmosphere be kept to an absolute minimum.
2. Press gently on the surface; do not push your fingers into the agar.
3. Replace the lid on the culture plate as quickly as possible.
4. Label the plate.
5. Tape the lid onto the plate with two pieces of adhesive tape so that it cannot be accidentally removed.
6. **Never remove the lid after the plate has been exposed.** The plate should be destroyed with the lid still in place.
7. Incubate the plates upside down so that any moisture condensing on the lid of the plate cannot drip onto the nutrient medium.
8. After washing your hands, or using antiseptic, rinse them and shake off the excess water. Do not dry your hands or touch the tap or any other objects.

At the end of the incubation period you can count the number of bacterial colonies that have grown on the agar. If there are a large number you may have to estimate by counting just one-quarter or one-eighth of the plate. You could also count the number of different species of bacteria—the colonies will have a different colour or texture.

Using this method you could:

- test for the presence of bacteria on the fingers before and after hand washing
- test the effect of different periods of hand washing
- compare hand washing and the use of antiseptic solution
- test the effectiveness of different brands of antiseptic
- compare bacterial populations on the fingers and toes
- compare bacterial populations on the fingers and lips
- compare the effectiveness of bacterial wipes and antiseptic solution

- compare the effectiveness of natural antiseptics, such as tea tree oil, lavender oil and thyme oil, with manufactured antiseptics
- try any other comparisons that you may wish to make.

Propose a hypothesis and then design your experiment.

1. What will be your independent variable—what variable are you investigating?
2. What will be your dependent variable—what variable will change because of the changes you make to the independent variable?
3. What variables will you need to control—what variables will have to be the same for all trials?

Draw up a suitable table in which to record your results (see Chapter 2, page 20 for the correct format for a results table). You may be able to combine results with other groups that have tested the same hypothesis.

### Studying your results

Discuss the results of your investigation. Your discussion should include answers to the following questions:

1. Was your hypothesis supported or disproved?
2. What were some of the sources of error in your investigation?
3. How confident are you of your results?
4. What further investigations need to be made?
5. What improvement could be made to your experimental procedure?



## REVIEW QUESTIONS

1. What is a communicable disease? Give five examples of such diseases.
2. Explain the difference between:
  - (a) a pathogen and a vector
  - (b) ectoparasites and endoparasites
  - (c) RNA viruses and DNA viruses
  - (d) bacteria and bacteriophages
3. (a) Bacteria were first seen in 1683 but viruses were not seen until 1938. Why?  
(b) List four differences between bacteria and viruses.
4. List the external defences that prevent the entry of pathogenic organisms into the body.
5. (a) What is a phagocyte?  
(b) Describe the process of phagocytosis.  
(c) Explain the importance of phagocytes in defence against disease.
6. (a) Describe the sequence of events that occurs in blood clotting.  
(b) How can blood clotting be considered as a protective device against invading micro-organisms?
7. (a) What are the four signs of inflammation?  
(b) How does the inflammatory response cause the four signs?
8. Describe the role, in the inflammatory response, of:
  - (a) mast cells
  - (b) histamine
  - (c) heparin
  - (d) phagocytes

9. List behavioural practices that can be adopted to help reduce the spread of disease.
10. What are mechanical barriers and how do they reduce the spread of infectious diseases?
11. List the various ways topical preparations may be used.
12. (a) What is an antibiotic?  
(b) Distinguish between antibiotic and antifungal drugs.  
(c) There are a large number of antibiotics now available. Why is it necessary for researchers to continually look for new antibiotics?

## APPLY YOUR KNOWLEDGE

1. Leprosy (Hansen's disease) is endemic to the Northern Territory of Australia, where it is found mainly among Australian Aboriginal people. It is not very contagious but it is found in unhygienic, overcrowded conditions. What could be done to reduce the incidence of leprosy in Australia?
2. An economist claimed that, economically, the virus causing the common cold was the most important of the viruses that cause disease in humans. What do you think would be the economic importance of the cold virus?
3. The Russian composer Tchaikovsky died of cholera during an epidemic in Moscow in 1893. It is believed that Tchaikovsky drank unboiled water during the epidemic, some think in a deliberate attempt to commit suicide. Why would drinking unboiled water increase the risk of cholera infection?
4. Hepatitis B is a disease that is causing concern in Australia. Why are medical authorities so concerned about the disease? What precautions can you take to avoid the disease?
5. Draw a flow chart that shows the events that occur in an inflammatory response.
6. Explain why someone with an infected toe may experience a lump in his or her groin.
7. Outbreaks of virulent forms of influenza and other diseases such as SARS create major problems for health agencies around the world that are seeking ways to control the spread of the disease. What action could these agencies take to protect the citizens of their country?
8. Medical practitioners are now urged not to over-prescribe antibiotics. What problems have occurred in the past with the over-prescription of these drugs?
9. When medical practitioners do prescribe antibiotics, the patient is told to complete the entire course and not to stop taking the drug when the symptoms of the infection are no longer evident. Why is it necessary to ensure all the prescribed medication is taken?
10. It has been possible to keep Australia relatively free of infectious diseases such as typhoid, cholera and yellow fever. Why has AIDS, however, been able to spread so rapidly throughout Australia?

