

# 10 Diseases and immunity

## 10.1

## Disease

### LEARNING OUTCOMES

- Define the terms *pathogen* and *transmissible disease*
- Describe how pathogens can be spread from person to person
- Outline the body's defences against disease



Even though she is using a handkerchief, droplets of water containing pathogens from her nose and mouth are entering the air and may be inhaled by others.



These houseflies may have picked up bacteria on their bodies while feeding on rubbish and human wastes and are now transferring them to uncooked meat.

**Pathogens** are organisms that cause disease. Most of the organisms that cause disease in humans are bacteria and viruses. Other pathogens are fungi, protists and worms. The diseases that they cause are **transmissible diseases** because the pathogens are passed, or transmitted, from one person to another. They are also called infectious diseases.

The table shows different ways in which diseases are transmitted.

method of transmission	description	examples of diseases
through the air	pathogens are in tiny droplets of liquid from the airways and lungs of infected people (see photo opposite)	influenza, tuberculosis, common cold
contaminated food and drink	people preparing food do not wash their hands; foods are not cooked properly; human faeces contaminate water supplies; flies transfer pathogens on their bodies	cholera, typhoid
direct contact	uninfected people touch infected people, or items, that infected people have used	athlete's foot
insect vectors	insects, e.g. mosquitoes, feed on the blood of an infected person and then feed on an uninfected person	malaria, dengue fever
body fluids	blood from an infected person enters the blood of an uninfected person, e.g. in an unsterilised needle shared between drug addicts	HIV/AIDS, hepatitis
sexual activity	pathogens pass from infected person to sexual partner in blood, semen or vaginal fluid	HIV/AIDS, non-specific urethritis (NSU), chlamydia

### Defences against disease

We have three different lines of defence against disease. The first line prevents pathogens entering the body; the second line destroys any pathogens that break through the first line and enters the blood. The third line produces antibodies that defend us against specific pathogens.

## Barriers to infection

The defences we have against entry of pathogens are mechanical and chemical barriers.

### Mechanical barriers:

- The dead outer layers of the skin form a barrier to entry (see Topic 14.8)
- The hairs in the nose trap larger particles that you breathe in.

### Chemical barriers:

- The stomach makes hydrochloric acid that kills pathogens in food (see Topic 7.7).
- Cells that line the airways (trachea and bronchi) make mucus that traps small dust particles and microorganisms. The mucus is moved away from the lungs and up to the throat by cilia (see Topic 11.3). The mucus is swallowed and any pathogens are destroyed by stomach acid.

If any pathogens get through these barriers to enter the blood, then there is a second line of defence.

## Blood defences

White blood cells form a line of defence against any pathogens that enter the body's tissues or the blood. **Phagocytes** engulf bacteria and viruses into vacuoles where they are digested and destroyed. The process of **phagocytosis** is described in Topic 9.7. **Lymphocytes** are white blood cells which produce **antibodies**. When activated during an infection by pathogens they produce antibodies which are proteins that have a variety of effects, such as stopping pathogens moving through the body and making it easier for phagocytes to engulf them. Vaccination is a way to make lymphocytes produce antibodies and give long-term protection against certain diseases.

### SUMMARY QUESTIONS

1 Copy and complete the following:

Pathogens are \_\_\_\_\_ that cause disease. Human diseases are caused by bacteria, \_\_\_\_\_ and \_\_\_\_\_. The airways have cells that make \_\_\_\_\_ to trap any pathogens that enter the body when people \_\_\_\_\_. The stomach lining makes \_\_\_\_\_ which kills pathogens in the \_\_\_\_\_. Dead cells on the surface of the \_\_\_\_\_ form a \_\_\_\_\_ barrier to pathogens.

2 Explain why you should:

- always wash your hands before handling food
- never share a towel with someone
- always wash your hands after going to the toilet
- use a handkerchief when sneezing
- never let a dog lick your face

3 Explain how the climber in the photograph is at risk of infection.

### STUDY TIP

You do not have to know examples of the diseases that are transmitted in the ways shown in the table. However, you may find it easier to learn the methods of transmission if you learn an example for each one.



All outdoor activities involve some risk of infection.

### KEY POINTS

- 1 A pathogen is a disease-causing organism.
- 2 Pathogens can be transmitted from one host to another through the air in droplets, by direct contact, in food and water and by animal vectors (e.g. mosquitoes).
- 3 The skin and hairs in the nose are mechanical barriers to entry of pathogens.
- 4 Mucus in the airways and acid in the stomach are chemical barriers.
- 5 Phagocytes are white blood cells that engulf pathogens and digest them; lymphocytes make antibodies to attack pathogens that enter the blood.

## LEARNING OUTCOMES

- Explain the importance of hygienic food preparation, good personal hygiene, proper waste disposal and sewage treatment in preventing the spread of disease
- Explain the role of vaccination in controlling the spread of disease

Supplement



It is important that everyone learns to wash their hands with soap and water to prevent the spread of disease.



Chicken meat is often found to be contaminated by bacteria, such as *Salmonella*. It is safe to eat if it is cooked thoroughly.

## Preventing infection

**Personal hygiene** is important in preventing the spread of some infectious diseases.

- People of all ages should wash their hands after going to the toilet to urinate or defecate and also before handling or eating food.
- Hair should be washed with shampoos to prevent dandruff and headlice.
- Everyone should wash themselves frequently, especially in hot weather.
- Dental hygiene is most important in fighting dental caries (see Topic 7.6).
- Cuts and bruises should be washed with an antiseptic and plasters applied to open wounds.

## Hygienic food preparation

- Food should be covered to keep flies away.
- Kitchen surfaces should be cleaned with disinfectants to kill bacteria.
- Food should be cooked thoroughly to make sure any bacteria, such as *Salmonella*, are killed.
- Cooked food that is going to be eaten cold should be kept separate from raw food, especially meat.
- Water used for cooking and/or drinking should be boiled or sterilised by adding water purification tablets if it comes from sources that might be contaminated.

## Proper waste disposal

- Household waste should be put into covered bins and collected at regular intervals, e.g. weekly.
- Garbage collected from houses and businesses should be disposed correctly so it is not a health hazard. It should be recycled, incinerated or buried in properly regulated landfill sites. Putting garbage onto rubbish tips where it is not buried carefully means it will attract rats and flies which spread disease. The effluent from rubbish tips may also contain harmful chemicals that cause pollution.

## Sewage treatment

- Toilet waste is a serious health hazard if it is not disposed properly through drainage pipes to a sewage treatment works.
- Human wastes are broken down by microorganisms in sewage treatment works (see Topic 21.8).
- The pathogens that cause typhoid and cholera are transmitted through faeces and transmitted to people who drink food or water contaminated with raw sewage.

- Thorough sewage treatment breaks the transmission of typhoid and cholera so these diseases are unknown in countries with proper sanitation.

Supplement

### The role of vaccination

Vaccination programmes are an important part of the health protection offered by governments to their citizens. Infants and children are vaccinated against diseases that used to be very common and were responsible for much ill health and many deaths.

Many of these diseases are now very rare in many parts of the world, e.g. the last case of polio in the Americas was in 1991, and in 1994 it was declared that transmission of polio had been successfully interrupted. But the disease still exists in other regions of the world and could be introduced into the Americas by travellers. In 2013, there were 93 cases of polio in Pakistan with more in neighbouring countries and in Syria, parts of West Africa, Somalia and Kenya. You can follow the progress of the campaign to eradicate polio from the whole world by searching online for 'polioeradication'.

During eradication programmes vaccination is used in two ways. Mass vaccination schemes attempt to give active immunity to everyone. Some people do not respond to vaccines, but they can be protected because the chances of them coming into contact with the disease are small as most people around them have immunity and will not transmit the disease. Careful surveillance by health workers identifies people who have infectious diseases and their spread can be limited or stopped by vaccinating all people in the neighbourhood who may have come into contact with infected people. For some diseases there are no vaccines (as of 2015); examples are HIV, Ebola and dengue fever.

#### DID YOU KNOW?

There may be as many as 100 million different lymphocytes that have the ability to become antibody secreting cells. Whatever foreign substance enters the body, there will be a lymphocyte with the right specificity to destroy it.

#### SUMMARY QUESTIONS

- 1 Suggest why it is important to:
  - a teach children to wash their hands
  - b put food waste into covered bins
  - c connect toilets to the main drainage system
  - d cook chicken thoroughly
- 2 The Americas were declared free of polio in 1994. Why do children throughout the Americas receive polio vaccinations?
- 3 Why is it important that everyone receives the vaccinations offered by their country's health service?

Supplement



Household garbage should be kept in covered bins and collected before overflowing and becoming a health hazard.



Vaccination against polio in Quetta, Pakistan in 2014.

#### KEY POINTS

- 1 The spread of transmissible diseases is prevented by good personal hygiene, hygienic food preparation, proper waste disposal and sewage treatment.
- 2 Vaccination programmes are used to prevent the spread of transmissible diseases.
- 3 Many diseases are controlled effectively by mass vaccination of children.

Supplement