Micro-organisms and disease

Unit 4

Contents

4.1 Micro-organisms

By the end of this section you should be able to:

- Define micro-organisms and list the main types.
- Explain the useful and harmful effects of some micro-organisms.
- Explain how vaccines are made, how they work and their importance.
- Distinguish between disinfectants, antiseptics and antibiotics.
- Describe the methods used to control micro-organisms.
- Describe how to grow a bacterial culture and show simple staining methods of micro-organisms.
- Explain how vaccination works and evaluate the impact of vaccination on diseases in Ethiopia.

KEY WORDS

bacteria *micro-organisms, members of the Monera*

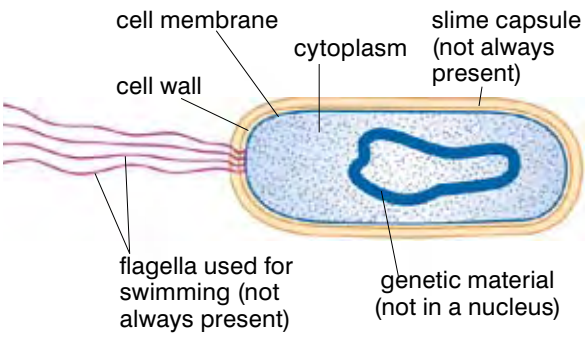
flagella *parts of a bacterium that help it to move*

Micro-organisms are tiny living organisms that are usually too small to be seen with the naked eye. To see them we need to use a microscope. In fact the definition of a micro-organism is an organism that can only be seen with the aid of a microscope.

Many of these micro-organisms are very important. Some play a major role in decay and the recycling of nutrients in the environment. Many micro-organisms are very useful to us and are used in making foods, such as injera, ergoo and ayib, and in producing alcoholic drinks, such as beer, wine and tej. With the arrival of new technologies like genetic engineering, micro-organisms are becoming more useful all the time. However, other micro-organisms cause disease in plants, animals and humans, which you will study in more detail in sections 4.2 and 4.3 of this book.

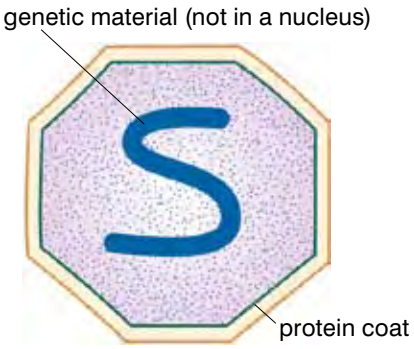
Bacteria are single-celled organisms (figure 4.1). They are much smaller than the smallest animal and plant cells. A bacterial cell has many similarities to animal and plant cells. It is made up of cytoplasm surrounded by a membrane and a cell wall. Inside the bacterial cell is the genetic material, but this is not contained in a nucleus. The bacterial cell wall differs from a plant cell wall because it is not made of cellulose. Some bacteria have additional features like **flagella** to help them move, or protective slime capsules. Bacteria also come in a variety of different shapes and sizes. Some are rod-shaped, some are round, some are comma-shaped and some

Figure 4.1 *Bacteria come in a variety of shapes and sizes, but they all have the same characteristic basic structure.*



are spirals. Whilst some bacteria cause disease, many are harmless and some are actively useful to people. In fact you contain millions of bacteria, which live both on your skin and inside your body.

Viruses are even smaller than bacteria. They usually have regular geometric shapes, and they are made up of a protein coat surrounding genetic material containing relatively few genes. They do not carry out any of the functions of normal living organisms except reproduction, and they can only reproduce by taking over another living cell. As far as we know, all naturally occurring viruses cause disease.



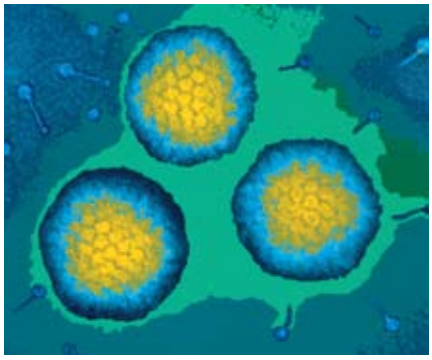


Figure 4.2 *Viruses are minute with a very simple structure. They all cause disease.*

Some of the micro-organisms that are most useful to people are **moulds** and **yeasts**. These are both **fungi** – living organisms which obtain their food from other dead or living organisms. Both moulds and yeast are extremely important as decomposers, breaking down animal and plant material and returning nutrients to the environment.

Yeasts are single-celled organisms. Each yeast cell has a nucleus, cytoplasm and a membrane surrounded by a cell wall. The main way in which yeasts reproduce is by asexual budding – splitting to form new yeast cells.

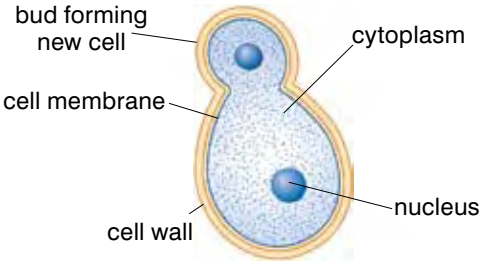


Figure 4.3 *Yeast cells – these microscopic organisms have been useful to us for centuries.*

Moulds are rather different. They are made up of minute, thread-like structures called **hyphae**. The hyphae are not made up of individual cells – they are tubes consisting of a cell wall containing cytoplasm and lots of nuclei. Moulds, like yeasts, generally reproduce asexually but they do it by producing fruiting bodies containing spores.

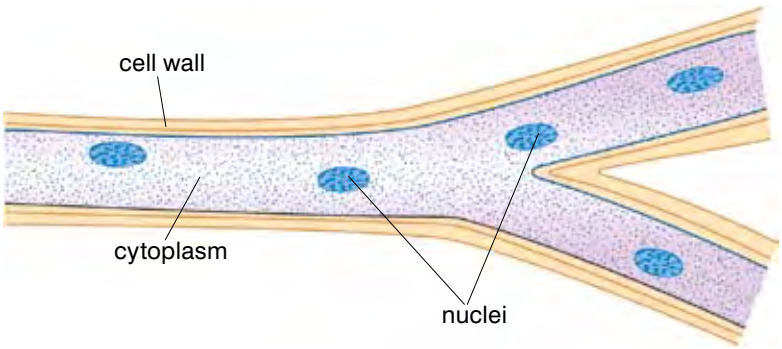


Figure 4.4 *Moulds are closely related to yeasts, but they are very different in structure.*

KEY WORDS

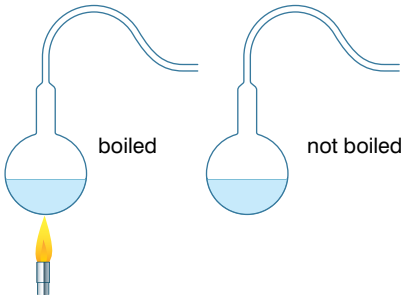
virus *microscopic particle that causes disease*

moulds *fungi that are made up of minute, thread-like structures, producing fruiting bodies containing spores*

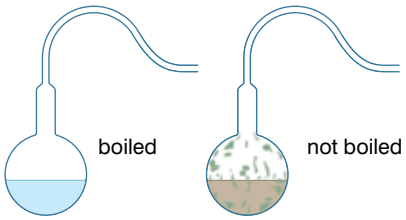
yeasts *single-celled fungi reproducing by asexual budding*

fungi *living organisms obtaining their food from dead or living organisms*

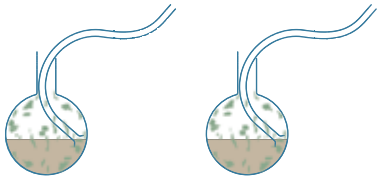
hyphae *thread-like structures of mould*



1 Pasteur prepared a series of flasks and drew the necks out into narrow curved extensions. Without sealing he boiled the broth in some of them for several minutes and left others unboiled.



2 All the flasks were left in calm air and within 36 hours the unboiled flasks were full of microbes and moulds, while the boiled flasks remain unchanged.



3 If the curved necks were snapped off and dipped into the broth of the boiled flasks, microbes immediately began to grow.

Figure 4.5 *From these experiments, Louis Pasteur concluded that the 'swan necks' of his flasks trapped germs from the air, preventing them from reaching the broth and growing.*

KEY WORDS

immune system *the system in the body which protects you against invading micro-organisms and foreign proteins*

antigens *proteins found on the outer surface of all cells*

The germ theory of disease

The idea that micro-organisms or 'germs' cause disease is widely accepted today, but it is quite a modern theory. For many thousands of years people did not understand the cause of disease and thought that illness was a sign of anger by their God, or that it was the result of a curse. A look back in time can help us understand how people began to understand the real causes of disease, and how difficult it has been to help people understand this.

In the 17th century a Dutchman, Anton van Leeuwenhoek, designed the first microscope. Robert Koch improved microscopes so much in the 19th century that people could see the tiny organisms which we now know are bacteria clearly for the first time.

It was the work of the Frenchman Louis Pasteur in the later part of the 19th century which finally resulted in the widespread acceptance of the germ theory of disease.

To begin with Pasteur showed that the fermentation reactions which are used to make beer and wine are the result of the action of micro-organisms on sugar.

At that time many people believed that living things could arise from non-living things spontaneously. This was called spontaneous generation. Pasteur was convinced that any growths that appeared – for example, mould on food as it decayed – came from microscopic organisms already present in the air. First he showed that the theory of spontaneous generation was wrong. Then he showed that if he boiled broth and sealed the container, the broth would stay clear until he introduced material which had been exposed to the air. At this point micro-organisms grew and the broth turned cloudy. Finally he designed some experiments which showed this happening (see figure 4.5).

Pasteur went on to identify the micro-organisms that caused a number of diseases in people and animals, including anthrax, rabies and diphtheria. He found ways of weakening or killing the microbes and made vaccines against the diseases. Pasteur's work showed everyone that infectious diseases are caused by micro-organisms.

The immune system

Our white blood cells help to defend us against infective micro-organisms and protect us from the worst effects of disease. They make up the **immune system**.

Like all living cells, pathogens carry unique protein molecules called **antigens** on their cell surfaces. When a pathogen gets into your body the antigens on the surface stimulate a response by your immune system, and your white blood cells (lymphocytes) produce antibodies to disable the pathogen. Other white blood cells (the phagocytes) then engulf and digest the disabled pathogens.

However, in the meantime you may well suffer from the symptoms of disease.

Once you have had a disease, your immune system 'remembers' the antigen and the right antibody to deal with it. If you meet the pathogen again, your white blood cells will produce antibodies immediately. The pathogen will be destroyed before it can cause the symptoms of disease. You are **immune** to the illness. This is known as acquired immunity because you have developed it for yourself.

However, there are some pathogens – such as the virus which causes HIV/AIDS – which your body simply cannot deal with.

As scientific understanding of the causes of disease and the way the body fights disease have grown, so have the artificial defence mechanisms we can call on to help us in our fight against micro-organisms.

KEY WORDS

immune *protected from disease by the body having fought it off successfully previously*

sterilisation *the process of killing micro-organisms on an object by making it safe to handle without fear of contamination*

autoclaving *sterilisation of items in intense heat*

Control of micro-organisms

One way of preventing the spread of diseases is to try and control and reduce the number of micro-organisms you take into your body. One way of doing so is by the process of **sterilisation**. Sterilisation is the killing of all micro-organisms in a material or on the surface of an object, making it safe to handle without fear of contamination. A surface or object is either sterile (it contains no micro-organisms) or it is not. There are no shades of grey in-between! There are a number of different ways we can sterilise things. These include the use of:

- High temperatures or heat
- Disinfectants
- Antiseptics

Using heat to control micro-organisms

Heat is a highly efficient means of sterilisation provided that the material to be sterilised is heat resistant. There are different ways of using heat to control micro-organisms – some of them give you a completely sterile environment and others simply reduce the numbers of micro-organisms substantially.

- The simplest and best known method of sterilising thing, using heat involves boiling. The objects are placed in boiling water (at 100 °C) and kept there for some time. Ten minutes will kill most cells, but some viruses and bacteria (hepatitis viruses, *Clostridium* bacteria) take several hours of boiling to kill them.
- **Autoclaving**: Normally water boils at 100 °C, but under pressure it boils at much higher temperatures. This is the principle used in autoclaving, the method most commonly used to sterilise materials that are not damaged by heat. An autoclave is very similar to a pressure cooker, which might be used in your kitchen at home to speed up the cooking of vegetables. The autoclave is used at 15 pounds per square inch of pressure, which raises the boiling point of water to 121 °C. 15–45 minutes of 'cooking' at these temperatures is enough to kill all micro-organisms and sterilise the equipment.

DID YOU KNOW?

Pasteurisation is named after the famous French scientist Louis Pasteur, who was one of the first people to realise that micro-organisms cause disease – and that they are responsible for food going bad. He also discovered that by heating food you can kill the micro-organisms and stop it going bad, particularly if you then keep it away from the air.

KEY WORDS

UHT *treating food with intense heat to kill micro-organisms*

pasteurisation *heating food to make it safe by killing most micro-organisms*

microbiology *study of micro-organisms*

chemically *using antiseptics and disinfectants to kill micro-organisms*

disinfectants *chemicals applied to an inanimate object to kill micro-organisms*

- **Ultra high temperature** (**UHT**) is a way of treating food to kill all the micro-organisms on it. The temperatures used range from around 135 °C to 150 °C. The food is only heated to these extreme temperatures for 2–6 seconds, but that is long enough to kill any micro-organisms present and completely sterilise it. Because UHT treatment sterilises food, it not only gets rid of any disease-causing micro-organisms but also destroys the organisms that cause food to go bad. As a result, UHT food or milk will last for years if no air is allowed to get to it.
- **Pasteurisation**: This is another technique widely used to treat milk, beer and other foodstuffs and make them safe to take into your body. Pasteurisation is not strictly speaking a method of sterilisation, because it does not kill all the micro-organisms in the food. To pasteurise food it is heated to either 71.6 °C for at least 15 seconds or 62.9 °C for 30 minutes. Either way, pathogens and most of the micro-organisms that make your food go bad are destroyed, so the food is much safer to eat and lasts longer. However, because it is not sterile, it will eventually go bad.
- Dry heat, over a long time, kills all micro-organisms. Special ovens used in **microbiology** (the study of micro-organisms) use temperatures of 171 °C for an hour, or 160 °C for two hours, etc. The lower the temperature, the longer the time taken to sterilise things. They are used to sterilise scientific equipment. Incineration – burning substances at high temperatures in the air – also kills micro-organisms. You will use this technique to sterilise your inoculation loops in your practical work with bacteria.

A chemical approach to controlling micro-organisms

Heat is very useful for sterilising equipment, but it is very limited when it comes to controlling micro-organisms around you and certainly the pathogens which get into your body. However, there are other very effective ways of controlling micro-organisms that we can use. Possible pathogens can be attacked **chemically** in a number of ways. For example, antiseptics and disinfectants kill micro-organisms on the skin and in the environment around us, reducing the spread of disease and the infection of wounds.

A **disinfectant** is a chemical or physical agent that is applied to an inanimate object to kill micro-organisms. In other words, it is used on floors and surfaces, not on people! Disinfection means reducing the number of living micro-organisms present in a sample. The ideal disinfectant should have the following characteristics:

- fast acting
- effective against all types of infectious agents without destroying tissues or acting as a poison on the person using it
- able to easily penetrate material to be disinfected without damaging or discolouring it

- easy to prepare and stable on exposure to heat, light or other environmental factors
- not unpleasant to work with, either in terms of its smell or its feel

Bleach and calcium hypochlorite are common and widely used disinfectants. Dilute bleach and calcium hypochlorite can be used to disinfect our drinking water in Ethiopia, and household bleach can be used to keep sinks, toilets, milk containers and surfaces germ-free.

Antiseptics are chemical agents that are applied to living tissue to kill micro-organisms – disinfectants for the skin, in fact! Think back to when you last cut yourself. The cut may have become infected. An open cut is an invitation to micro-organisms as they have easy access to the inside of your body. An antiseptic will kill all the micro-organisms on your skin and over the cut, preventing infection from getting into your tissues. Antiseptics often sting your skin – this is because they not only kill bacteria, they also damage human tissue slightly.

Investigating disinfectants and antiseptics

Many micro-organisms can be grown in the laboratory. This allows you to learn a lot more about them and which chemicals will kill them.

If you want to find out more about micro-organisms you need to culture them – in other words grow very large numbers of them so that you can see the colony as whole.

To culture micro-organisms you must provide them with all they need. This usually involves providing a culture medium containing carbohydrate to act as an energy source, along with various mineral ions and in some cases extra protein and vitamins.

The nutrients are often contained in an agar medium – **agar** is a substance which dissolves in hot water and sets to form a jelly. You pour hot agar containing all the necessary nutrients into a petri dish and leave it to cool and set before you add any micro-organisms. The other way to provide nutrients for growing micro-organisms is as a broth in a culture flask. Whichever way you do it, warmth and oxygen usually need to be provided as well. If you give bacteria the right conditions they can grow and divide very rapidly – which is why it is relatively easy to culture them in the lab.

You have to take great care when you culture micro-organisms. Even when the micro-organisms you want to grow are completely harmless, there is always the risk that a mutation (you will learn more about this in Grade 10) may take place, resulting in a new and dangerous pathogen. Also your culture may be contaminated by disease-causing pathogens that are present in the air, soil or water around you. So whenever you are culturing micro-organisms, you must carry out very strict health and safety procedures.

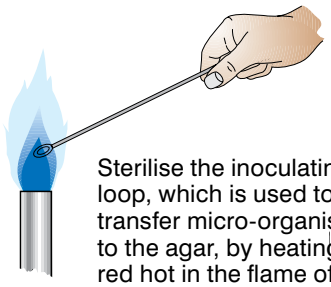
KEY WORDS

antiseptic *chemical applied to living tissue to kill micro-organisms*

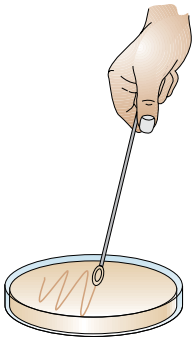
agar *substance which dissolves in hot water and sets to form a jelly*

Figure 4.6 *Disinfectants like these allow us to keep our surroundings safe from micro-organisms, while antiseptics protect you when you get a cut or graze.*

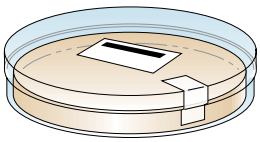
Figure 4.7 *Culturing micro-organisms like bacteria makes it possible for us to see what they are like and what they need to grow.*



Sterilise the inoculating loop, which is used to transfer micro-organisms to the agar, by heating it to red hot in the flame of a Bunsen and then leaving it to cool.



Dip the sterilised loop in a suspension of the bacteria you want to grow and then use it to make zigzag streaks across the surface of the agar. Tilt the lid of the petri dish to keep out unwanted microbes and close the lid as quickly as possible to avoid contamination.



Secure the lid of the Petri dish with short pieces of adhesive tape to prevent micro-organisms from the air contaminating the culture – or microbes from the culture escaping. Do not seal all the way around the edge.

Figure 4.8 *Culturing micro-organisms in the lab*

Activity 4.1: Culturing microbes

The petri dishes on which the micro-organisms are to be grown and the nutrient agar that will provide their food must be sterilised before they are used, to kill unwanted micro-organisms. You sterilise them using heat, often in a special oven known as an autoclave, which uses steam at high pressure.

Then inoculate the sterile nutrient agar with the micro-organism you want to grow following the steps shown below:

You will need:

- petri dishes with sterile agar
- Bunsen burner
- mounted inoculating loop
- solution of bacteria – either bought or filtered soil water
- tape
- marker pens or labels
- blotting paper
- disinfectant
- antiseptic

Method

1. Sterilise the inoculating loop that is used to transfer micro-organisms, to the agar by heating it to red hot in the flame of a Bunsen and then leaving it to cool.
2. Dip the sterilised loop in a suspension of the bacteria you want to grow and then use it to make zigzag streaks across the surface of the agar. Then replace the lid on your petri dish as quickly as possible to avoid contamination.
3. Repeat this process twice more so you have three inoculated petri dishes.
4. Dip two circles of blotting paper in disinfectant. Open one of your petri dishes quickly and place the circles on the inoculated agar. Close the dish again immediately.
5. Dip or cover two circles of blotting paper with antiseptic. Open another petri dish quickly and place the circles of blotting paper on the inoculated agar. Close the dish again immediately.
6. Leave the third dish as it is. This is your control.
7. Carefully label each petri dish. Then fasten the lid of your petri dishes with four strips of adhesive tape to prevent micro-organisms from the air contaminating your culture – or micro-organisms from your culture escaping.

8. Incubate the sealed petri dishes to allow the micro-organisms to grow. In schools and college laboratories the maximum temperature at which cultures should be incubated is 25 °C. This relatively low temperature greatly reduces the likelihood of pathogens growing which might be harmful to people. (In industrial conditions bacterial cultures are often grown at higher temperatures to promote rapid growth of the micro-organisms.)
9. After several days, observe the growth of micro-organisms on your dishes. NEVER open the petri dishes as harmful micro-organisms could escape. Draw what you can see. What does this tell you about disinfectant and antiseptics? How could you modify this experiment to find out about the best way to control micro-organisms in your home and on your skin? Suggest another experiment in which you could discover how effective washing your hands is at getting rid of germs.
10. Put your petri dishes in a bowl of disinfectant ready to be removed and resterilised by heating them to 100 °C.

KEY WORDS

crystal violet *stain for colouring bacteria purple*

Identifying bacteria using simple staining

One way in which scientists identify bacteria is by staining them so they show up more clearly. A simple stain, e.g. **crystal violet**, will stain all bacteria purple. This makes it easier to see what shape they are.

Activity 4.2: Staining bacteria

You will need:

- a culture of bacteria on an agar plate or broth – *Bacillus megaterium* is best because it can be seen at 400x magnification because it is so big, but any culture of harmless bacteria will do
- a wooden pick or needle
- an inoculating loop
- Bunsen burner
- crystal violet stain
- marker pen or label
- water
- tissue or cloth
- slide holder or tongs
- 250 cm^3 beaker

Method

1. Label your slide so you know which side the bacterial culture is on.
2. Place a drop of water in the centre of the slide.

DID YOU KNOW?

There are scientists who work with the most dangerous pathogens – micro-organisms that can cause deadly diseases like Ebola fever – and they have to take extreme safety measures. They work in labs with negative pressure gradients, so air moves in not out when doors are opened. They change their clothes before entering and leaving the lab. They also spend much of their time with their arms inside special sealed safety cabinets with the rest of their bodies on the outside!

3. If you are using an agar plate, take a tiny amount of the culture on your needle or pick and mix the bacterial cells with the drop of water on the slide with circular movements.
4. If you are using broth, place two to three loopfuls of culture on the centre of the slide. If you are going to use the culture again, you must flame and sterilise the loop between each transfer.
5. Allow your slide to dry in the air.
6. Hold the slide in the slide holder and pass it through a Bunsen flame several times to fix the bacteria onto the slide. Do not hold the slide in the flame. This heating denatures the enzymes of the bacteria and makes the bacteria stick to the slide better.
7. Place the slide bacteria side up on the beaker and add a few drops of crystal violet stain to the area where you put the bacteria.
8. Leave the stain on the slide for about one minute, then rinse off gently with water.
9. Gently blot the slide dry using the tissue. Blot, don't rub or the stained bacteria will be lost.
10. Do not use a cover slip on the slide, but now place it under a microscope and look at the bacteria.
11. At 400x you will only be able to see a purple stain unless you are looking at *Bacillus megabacterium* or another bigger micro-organism such as yeast.
12. To use the 100x objective lens you need to put a drop of immersion oil on the slide before moving the lens into place. Use only the fine focus knobs to get the image into focus and draw some examples of what you see.
13. When you have finished, clean the oil off the objective lens only with special lens tissue.

Some stains are used to identify particular types of bacteria. For example, if other chemicals are added to the simple crystal violet stain it gives a Gram stain. Different types of bacteria have different cell walls which take up the stains differently. There are four stages to making a Gram stain:

- Firstly you stain all the bacteria on the slide with crystal violet, the primary stain – see activity 4.2.
- Then you use Gram's iodine as a mordant and leave it on the slide for 1 minute. This combines with the crystal violet in the cell to form a violet–iodine complex.
- Without washing off the Gram's iodine you now add 95% ethanol, which acts as a decolouriser. It washes the primary stain out of some types of bacteria but not others. You then rinse the slide in water until no more colour washes off.
- Finally you use a secondary or counterstain called safranin. This is a basic dye that stains the decolourised bacteria red. Leave this on for one minute and then wash off with distilled water.
- Blot the slide gently dry and observe under the microscope.

The bacteria that are easily decolourised and so stain red are known as Gram-negative bacteria. The bacteria that keep the primary stain and so stain purple are called Gram-positive bacteria. You will be able to tell whether the bacteria are Gram-positive or Gram-negative whatever magnification you use, but you may not

be able to see the details of the bacteria unless you can use 1000x magnification. Staining bacteria is a very useful tool in helping us to identify them, and this in turn can help doctors decide how to treat an illness as Gram-positive and Gram-negative bacteria are affected by different types of antibiotics.

KEY WORD

antibiotics *drugs which kill bacteria but do not harm human cells*

Antibiotics

The other main way we can attack pathogens – in particular bacteria – is by **antibiotic** drugs. These are chemicals which kill bacteria but do not damage human cells. This is the big difference between antibiotics, antiseptics and disinfectants. If you swallow disinfectant or antiseptics, you will harm or even kill yourself as well as the bacteria that are making you ill. But you can take antibiotics into your body safely. They circulate in the blood and get to all the body tissues, including the site of infection. Antibiotics only damage bacteria and do not affect human cells. Penicillin was the first antibiotic to be discovered, and it is still in use today.

Figure 4.9 *Antibiotic medicines such as these have saved millions of lives around the world.*

Fungal infections can often be cured using anti-fungal chemicals which are similar to antibiotics but attack fungal cells. If you have ever suffered from athlete's foot between your toes, you will probably have used an anti-fungal cream to help you get rid of it.

The big problem remains diseases caused by viruses. Antibiotics have no effect on diseases caused by viruses, so they are not always the answer to our health problems. What is more, so far we have no drugs which are really effective against viruses. This is something scientists and doctors are working on all the time.

Artificial immunity

Drugs can be used to treat an infection once we have it. However, some diseases can cause permanent damage or even kill you, so an even better idea is to prevent you from getting ill in the first place. As you saw above, when your body has come into contact with a pathogen, some of the white blood cells develop antibodies against that micro-organism. Then if you meet that micro-organism again your body defences are ready and it is destroyed before it can cause the symptoms of disease. You are immune to the disease. You have acquired natural active immunity.

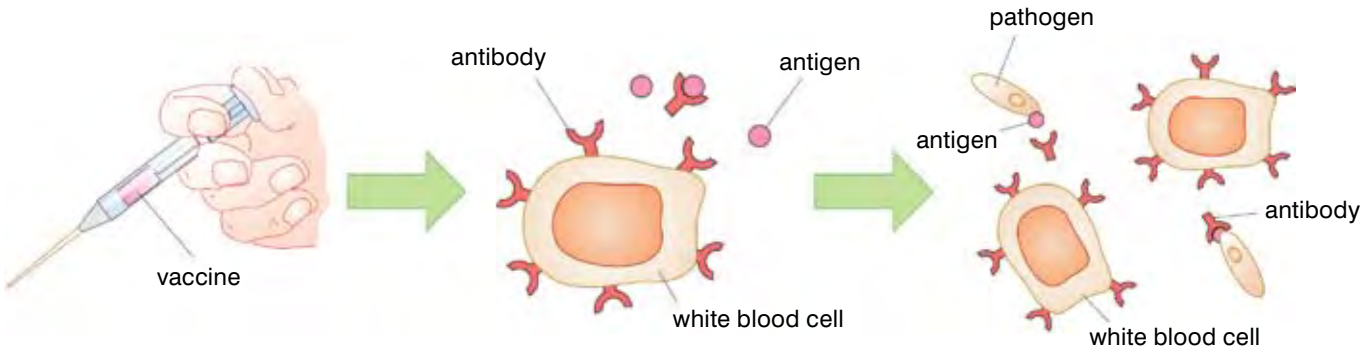
However, we now have ways in which we can protect ourselves against some of the most dangerous diseases artificially. Vaccination is one of the greatest achievements of medicine and has spared millions of people from the effects of devastating diseases. Vaccines allow you to be protected from a disease without experiencing the serious effects of that illness.

KEY WORD

vaccination (immunisation) *the use of dead or weakened strains of pathogens to produce immunity to dangerous diseases*

The immunity you need can be triggered artificially by the process known as **vaccination** (**immunisation**). When a disease is too serious to risk exposure to the real thing, vaccination gives people immunity. A weakened or dead strain of the pathogen is injected into your body. This triggers your immune response without the

risk of you developing the disease. Your white blood cells develop the antibodies to the disease. Then, if in future you meet the live pathogen, your body can destroy it before you become ill. This form of artificial immunity is known as artificial active immunity.



a) a weak or dead form of the infecting organism is put into the body by injection or by mouth

b) once in the body, the white blood cells respond by producing antibodies

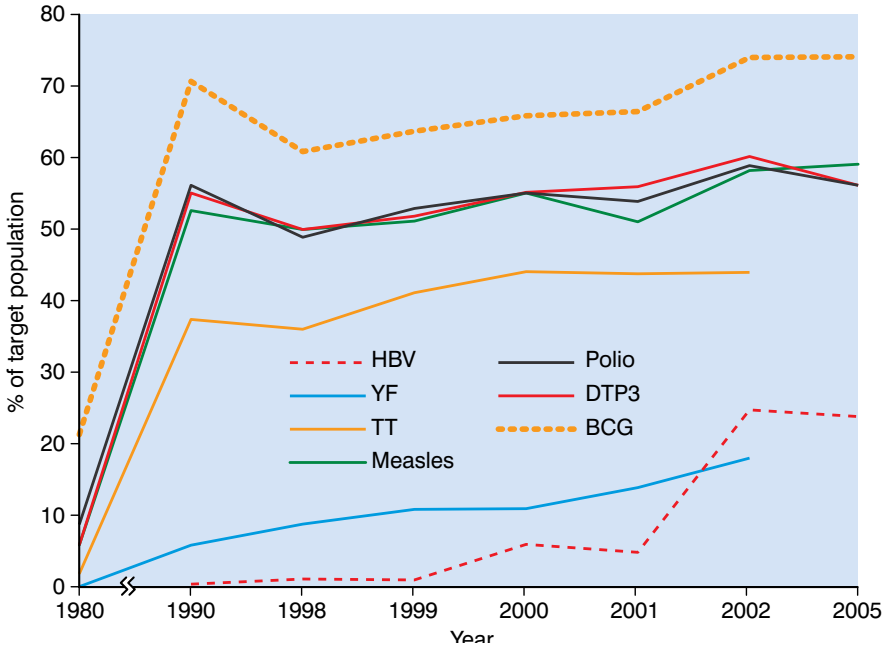
c) if the living micro-organism enters the body in the future, antibodies are produced very rapidly to destroy it and so the disease does not develop

Figure 4.10 *Vaccination is used to give immunity to a number of dangerous diseases.*

The sorts of diseases we vaccinate against are usually ones which can kill or disable. They include polio, which can leave you paralysed, tetanus, which can kill you, and tuberculosis, which can cause severe health problems and death. Measles too can cause brain damage and even death. These are all common diseases in Ethiopia.

Figure 4.11 *No one likes having an injection – but a quick jab when you have a vaccination is well worth it to avoid some terrible diseases. You can see from these figures how the numbers of people being vaccinated has climbed – now we must all work hard to get the numbers up even higher so the whole population is protected.*

In Ethiopia, as in many African countries, we are working hard to increase the numbers of our children who are vaccinated against these deadly diseases. Parents are bringing their babies to be vaccinated even when it means that they have to travel long distances to get to the clinics. Some people find it harder than others to get the help they need. But it is important for everyone to get their children vaccinated. Vaccinations protect each individual child who is vaccinated. But once most children are vaccinated, the whole population is protected from disease and this is what we are



aiming for. The more people who are immune to these diseases the sooner they will no longer threaten us here in Ethiopia.

Sometimes it is too late to give a normal vaccine. If you step on a rusty nail you are at risk of developing tetanus. In some countries, if you are bitten by a dog, there is a risk of rabies. If you have not already been vaccinated, all is not lost. You can be given a vaccine which contains the antibodies you need to combat the specific pathogen. This is known as artificial passive immunity. For example, you may have a tetanus shot if you step on a rusty nail or a series of rabies vaccines if you are bitten by a dog. However, passive immunity is short-lived. You need normal vaccination once the initial danger is over.

On the other hand, a mother gives a certain amount of natural passive immunity to her unborn baby via the placenta. Antibodies pass from the mother to her foetus. If the mother breastfeeds her baby once it is born, she can give it much more natural passive immunity. This is because breast milk – and in particular the colostrum that is produced in the first few days after the baby is born – is very rich in antibodies. These can protect the baby against many diseases until its own immune system gets going and starts to develop natural active immunity against pathogens. This will protect the child for as long as he/she continues to breastfeed.

Much of the early work on vaccines was done by the Frenchman Louis Pasteur. He was a real family man and he was broken-hearted when three of his five children died young of infectious diseases. He was determined to do something about it. The great Frenchman convinced people by his experiments that diseases were caused by micro-organisms. He developed vaccines against some of them – most dramatically against rabies – and by the end of his life was close to a vaccine against diphtheria, the disease which had killed his little girls.

How are vaccines produced?

Huge quantities of vaccines are used all over the world, so they are manufactured on an enormous scale. Vaccines need to trigger the immune system without actually causing disease symptoms. There are several ways in which this can be done.

Live vaccines are made from living micro-organisms which have been treated to weaken them. This means that they stimulate your immune system but do not cause the disease.

Dead vaccines use micro-organisms which have been killed. The micro-organisms are cultured and grown for a time and then killed.

More and more vaccines are being produced using just the surface antigens of the disease-causing micro-organisms. Because no disease-causing organisms go into your body, this type of vaccine gets rid of all the risks linked to using the actual micro-organisms themselves. In future it is hoped that this will lead to even more effective vaccines with virtually no risk attached to them.

DID YOU KNOW?

One example of a success story in Africa is the measles vaccine.

In the year 2000, about 56% of children were given at least one measles vaccine and around half a million people (500 000), mainly children, died of measles. By 2006, 73% of children had been given at least one dose of the vaccine – and the number of deaths from measles that year fell to less than 50 000 – 450 000 lives saved in that one year alone. This is why getting your children vaccinated is so important. The worldwide fall in deaths from measles was largely due to the efforts of the African countries. The same patterns can be seen for other diseases as well.

Summary

In this section you have learnt that:

- The symptoms of disease that you experience are the result of the effect of the micro-organisms on your body cells, and the reaction of your body to the invading pathogens.
- The germ theory of disease was developed over many years as people gradually learned about the micro-organisms that cause disease.
- The lymphocytes of your immune system produce antibodies in response to the antigens on the surface of the pathogens.
- Antibodies disable the pathogens which are then engulfed and digested by phagocytes.
- Some lymphocytes produce antitoxins.
- When our immune response meets and overcomes a pathogen, we acquire natural active immunity and should not get the same disease again.
- Bacteria can be cultured and grown in the laboratory.
- Stains can be used to help observe and identify bacteria such as Gram-positive and Gram-negative bacteria.
- Disinfectants are chemicals that can be used to kill micro-organisms or stop them growing on inanimate objects and surfaces.
- Antiseptics are chemicals that can be used to kill micro-organisms or stop them growing on your skin, cuts, etc.
- Antibiotics are chemicals that can safely be taken into your body. They destroy bacteria but do not harm human cells.
- Antifungal drugs are similar to antibiotics but they destroy fungal cells.
- Antibiotics do not affect viruses.
- Vaccination is used to protect us against diseases that can cause serious damage and death.
- Dead or weakened strains of bacteria are put into your body in a vaccination. Your immune system responds, so you are protected if you meet the live pathogen. You have artificial active immunity.
- If you are vaccinated with antibodies against a disease you will have temporary passive immunity.
- A baby gets natural passive immunity from its mother. Antibodies from the mother pass into her foetus across the placenta. Many more antibodies are passed to the baby through breast milk, protecting the baby in its early months of life.

Review questions

Select the correct answer from A to D.

1. Infectious diseases are caused by:
   - A poor diet
   - B genetic mutations
   - C micro-organisms
   - D curses
2. One major difference between viruses and bacteria is:
   - A viruses have no nucleus whereas bacteria do
   - B viruses are living organisms and bacteria are not
   - C viruses have membranes whereas bacteria do no not
   - D viruses can only reproduce in living cells whereas bacteria split in two
3. All of the following are examples of fungi except:
   - A mushrooms
   - B moulds
   - C yeast
   - D dandruff

4. Which scientists finally proved the germ theory of disease?
   A Robert Koch
   B Louis Pasteur
   C Edward Jenner
   D Anton van Leeuwenhoek
5. Which of the following would you use to clean up if your puppy was sick on the floor?
   A antiseptic
   B antibiotic
   C disinfectant
   D antidiuretic
6. Immunity passed from mother to foetus by way of the placenta is described as:
   A natural active
   B artificial active
   C natural passive
   D artificial passive
7. Immunity acquired by administering a tetanus shot is:
   A natural active
   B artificial active
   C natural passive
   D artificial passive

4.2 Diseases

By the end of this section you should be able to:

- Explain the role of parasites in causing disease.
- Describe the causes, symptoms, methods of transmission, prevention and control of a tapeworm infection.
- List the causes of tuberculosis, AWD, cholera and typhoid, and describe the signs and symptoms of these common infectious diseases.
- Explain how tuberculosis, AWD, cholera, typhoid and gastroenteritis are spread from one person to another and the methods of prevention and controlling them.
- Define the term vectors.
- Explain the effects of the *Anopheles* mosquito and malaria on the health of human beings and its methods of transmission, prevention and control.
- Describe the way in which behaviour and lifestyle choices affect the spread of STDs.
- State signs and symptoms, causative agents, methods of transmission, methods of limiting spread and possible treatment of the following infectious diseases: gonorrhoea, syphilis and chancroid.
- State the risks of taking self-prescribed medicines.
- Explain how both modern and traditional medicines should be used and handled, and discuss the advantages and disadvantages of both.

Whereas many diseases are caused by bacteria, viruses and fungi, some of the most damaging diseases worldwide are caused by a range of quite different organisms – mosquitoes, tapeworms and protoctista are just some of the groups of living things that can cause enormous damage to human health. The life cycles of many of these organisms often involve a number of different hosts – and when people are one of them, we're in trouble! Tapeworm is an example of a disease caused by **parasites**, the result of an attack by another organism on our tissues and cells.

Figure 4.12 *The head of a tapeworm is well adapted for holding on to the lining of your gut.*

DID YOU KNOW?

A person with a single tapeworm would pass about eight or nine segments each day – and this would release about 750 000 eggs!

KEY WORDS

parasites *organisms that live on or in another and take their nourishment from it*

tapeworm *parasitic worm that lives in the intestines of humans*

Figure 4.13 *Tapeworms can grow up to 5 metres in length. It's amazing that a worm this long can live in your gut!*

Tapeworm (*Cestoda*)

Some of the best-known human parasites are the tapeworms. Unlike ringworm, these really are worms. In fact they are flatworms (see page 187 that can grow many metres long. **Tapeworms** live in the intestines of their hosts. They do not feed off their host, but rather rob them of their digested food. Tapeworms do not have a digestive system so they have to absorb nutrients directly across their skin (cuticle). They also have a complex life cycle, which involves at least two different hosts. Two of the most common tapeworms that infect people are the beef tapeworm and the pork tapeworm.

How do people get tapeworms? The most common way is eating undercooked or raw meat that contains a young tapeworm. Tapeworms are found in many different animals, some of which we eat and some of which we keep as pets. Fish, cows, pigs, sheep, dogs and cats are just some of the species that can be infected.

Tapeworms are specially adapted to survive in the human gut. They have a head with fearsome-looking hooks and/or suckers and the worm uses these to attach firmly to the gut wall.

The rest of the body is made up of about 1000 very thin segments, which contain the reproductive organs. New segments are made all the time just behind the head, so the oldest and largest segments are pushed further and further back until they break off and are passed out in the faeces, full of eggs.

Problems arise when the tapeworm becomes too large and starts blocking your bowel or robbing the host of vital nutrients – very large tapeworms may cause deficiencies of vitamins such as B12 if left for too long. It can also be more serious if we play host to the intermediate stage of the parasite (see figure 4.14).

In regions with poor sanitation tapeworm eggs are commonly ingested by humans instead of animals like pigs. In such cases cysticerci (see page 139) can still develop. These may form large cysts, which can be life-threatening. Tapeworm cysts may grow to a reasonable size and, because they are found deep in the tissue, they may start taking up valuable space. If the cyst settles in the brain, eye or liver, normal function of these organs may be severely restricted. In fact these cysts can cause far more problems than a live parasite in your gut. It all depends on which part of the life cycle takes place in our bodies.

Symptoms

Signs of infection with large tapeworms include conditions associated with vitamin B12 deficiency (e.g. anaemia and feelings of weakness). There is often an unexplained weight loss, because the worm is absorbing a lot of your food. To make matters worse, one of the symptoms of having a large amount of tapeworm protein in the body is to generate an immune response in the form of a collection of fluid in the abdomen, resulting in a pot belly. The cysts may settle in the muscles and organs such as the liver and the brain, where they can cause severe symptoms including seizures.

Control and prevention

Anti-parasitic, anti-worm and anti-inflammatory drugs are all used to kill the parasite. It lets go of the gut wall and is passed out of the body. If large cysts have developed, doctors may operate to remove them.

However, prevention is better than cure. The most important way in which the spread of tapeworms can be prevented is by cooking meat properly before it is eaten. Here in Ethiopia the beef tapeworm is particularly prevalent as a result of the traditional practice of eating meals such as raw kifto and qurt siga. Deworming pets and farm animals thoroughly to make sure they are not carrying worms is another important preventative measure. Maintaining good sanitary conditions in and around the home will not only help prevent tapeworms but also protect against gut infections as well.

The beef tapeworm (*Taenia saginata*) is one of the most common tapeworms to infect people. It is a parasite that spends part of its life cycle in the muscles (meat) of cows. Looking at the life cycle of this animal can help us to understand just how these clever parasites get into our bodies and use our food for their own needs. Cows raised in unsanitary conditions (with access to human faeces) may contain **cysticerci** 'bladder worms' embedded in their muscles. These consist of a capsule containing a **scolex**. When a bladderworm is ingested (e.g. in undercooked beef), the gastric juice of your stomach dissolves the wall of the capsule. The scolex turns inside out and attaches by suckers and hooks to the wall of your intestine. It then begins to produce buds, called **proglottids**, which remain attached to each other for a time and, as they mature, each develops both male and female sex organs. The most mature proglottids eventually break loose and are passed out in the faeces. If conditions are such that cows get access to the human faeces, they take in the eggs and the whole cycle starts again.

KEY WORDS

cysticerci *a stage in the lifecycle of a tapeworm*

scolex *knob-like anterior end of a tapeworm*

proglottids *segments of a tapeworm, each segment having male and female organs*

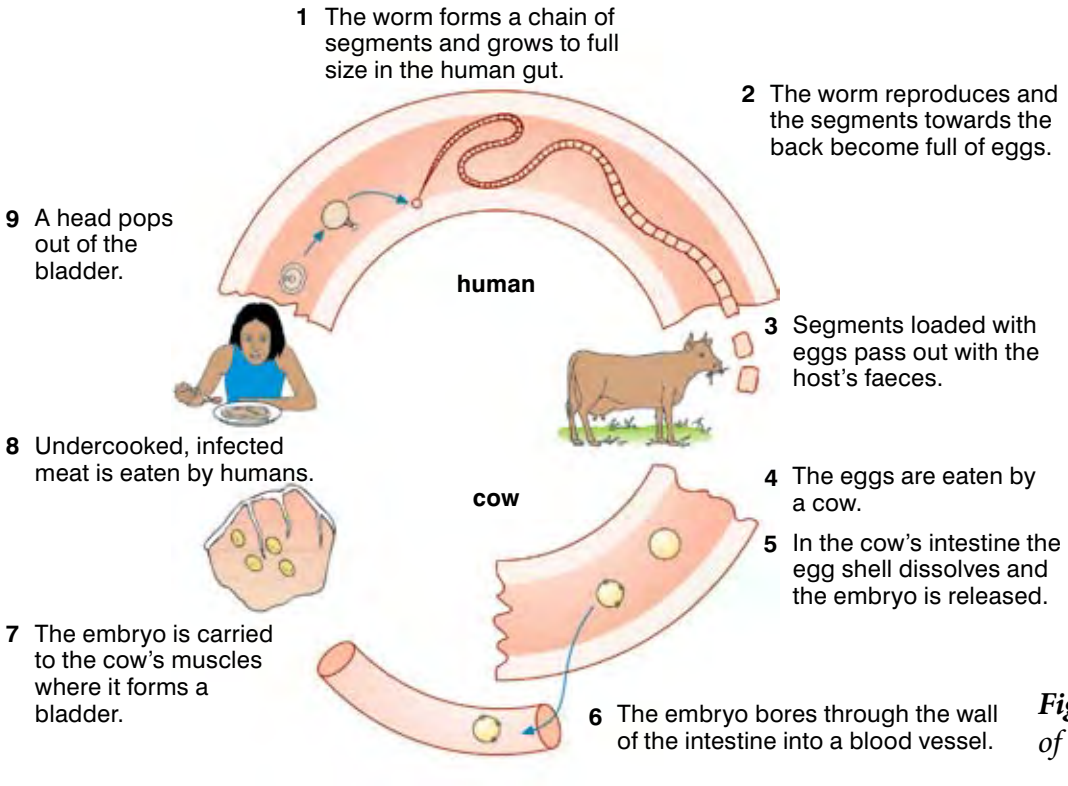


Figure 4.14 *The life cycle of a beef tapeworm*

Figure 4.15 Mycobacterium tuberculosis – *the bacterium that causes tuberculosis infects literally billions of people around the world.*

Figure 4.16 *If you have the bacteria which cause TB in your system, even if you have no symptoms of disease, you will react like this to the Mantoux skin test.*

DID YOU KNOW?

Tuberculosis is one of the most deadly and common major infectious diseases today, infecting two billion people or one third of the world's population. Nine million new cases of disease, resulting in around two million deaths, occur annually.

Tuberculosis

Many diseases are caused by micro-organisms such as bacteria. Tuberculosis, usually referred to as TB, has been a killer for centuries. For a time it seemed as if people were winning the battle with TB, using vaccinations and antibiotics. However, the arrival of HIV/AIDS and antibiotic-resistant bacteria means that TB has become a real problem again in many parts of the world. Ethiopia is badly affected – for example, in 2007 we had around 315 000 new TB cases.

TB is a disease that usually affects the lungs, when it is known as pulmonary TB. Other parts of your body can be affected – TB can infect your kidneys, lymph nodes, joints or bones. The causative agent is the bacterium called *Mycobacterium tuberculosis*.

Tuberculosis can affect anyone of any age. People with weakened immune systems (such as people suffering from HIV/AIDS) are at increased risk of catching it. TB is spread by droplet infection, but you usually need prolonged exposure to someone with TB for infection to occur. Because of the way TB is transmitted, it is spread more easily when people live or work in overcrowded conditions. If people do not have enough food to eat or their immune system is damaged (for example, by HIV/AIDS) then not only is the TB bacterium more likely to spread, but people are more likely to get the active disease.

Symptoms

The symptoms of TB include a low-grade fever, night sweats, fatigue, weight loss and a persistent cough, but some people may not have obvious symptoms (asymptomatic). Left alone, over a period of years it gradually damages the tissue of the lungs and weakens you so other infections take hold and you die.

Control and prevention

People with active TB disease must complete a course of antibiotic treatment for four months or more. This involves taking several different antibiotics at the same time! Each patient needs to have their treatment carefully monitored – it isn't easy to keep people on antibiotics for so long! But if patients stop taking their antibiotics before they are completely cured, not only may they fall ill again, but antibiotic-resistant strains of the bacterium may appear, which are more difficult to treat in future.

The most important way to stop the spread of tuberculosis is for TB patients to cover the mouth and nose when coughing. In social terms, countries need to move away from overcrowded living and working conditions as far as possible. There is also a very effective vaccination against TB which has been used very successfully in some areas of the world.

The role of vectors in disease

Some organisms are closely linked to the spread of infectious diseases, and yet do not cause them directly. They are known as **vectors**. A vector is an organism that transmits disease-forming micro-organisms from one host to another. Some organisms that act as vectors simply transport an infective organism from one host to another on its body – often the feet or mouthparts. A housefly is a good example, carrying bacteria from the faeces or rotting food in which it breeds onto the surface of food you are about to eat! On the other hand, some animals are biological vectors. They are needed as part of the life cycle of an infective organism. You have already met some examples of biological vectors in the pigs and cattle that spread tapeworms. Another well-known example is the *Anopheles* mosquito, which carries the malarial parasite. You are going to look at malaria in detail.

KEY WORDS

vector *something that transmits disease*

malaria *infectious disease carried by* Anopheles *mosquitoes*

Mosquitoes and malaria

Malaria is a disease where mosquitoes are the vector. The mosquito vector is the *Anopheles* mosquito. The disease itself is caused by the single-celled parasite *Plasmodium*, which has a very complicated life cycle. It spends part of its life cycle in a mosquito and part in the human body.

The life cycle of the mosquito means that the female needs two meals of human blood to provide protein for her developing eggs – and this is when she passes on her load of malarial parasites. If the first feed the mosquito takes is from someone infected with malaria, the *Plasmodium* parasites remain in her mouthparts. When a mosquito feeds, she passes saliva containing an anticoagulant into your blood. This stops your blood from clotting and blocking up her delicate mouthparts. So the next time she feeds, the *Plasmodium* parasites pass into the blood of the victim along with the saliva – and someone else is infected with malaria.

Figure 4.17 *It seems amazing to think that such a small insect can have such a devastating effect on human lives. Yet the female* Anopheles *mosquito is responsible for the illness of millions of Ethiopians every year.*

Symptoms

The parasites travel around the body in the circulatory system and they affect the liver and damage the red blood cells. When someone has malaria they have fevers, chills and sweats which make them feel exhausted. This and the damage which the parasites cause to the blood and the liver mean people affected by malaria cannot work effectively. Small children are particularly badly affected by malaria – 20% of our children under five who die each year are killed by malaria. If someone is HIV-positive, being infected by malaria also means they are more likely to develop a full-blown AIDS infection (see page 158).

DID YOU KNOW?

About 300–500 million people around the world are infected with malaria – and around one million people die of malaria every year. In Ethiopia in 2003, up to 16 million people were infected with malaria during the epidemic – and almost 100 000 children died.

Activity 4.3: Looking at a mosquito

Have a look at a mosquito under magnification and see if you can identify the biting mouthparts that make it such a successful parasite. You will need to find a female mosquito. If you have a male as well, compare their heads.

You will need:

- microscope (binocular microscopes are good for this if they are available) OR a hand lens
- prepared slides of mosquitoes OR mosquitoes which have been trapped

Method

Using whichever method of magnification suits you, carefully examine the heads of a male and a female mosquito. Make careful drawings of what you see and explain how the female mosquito is adapted to taking the blood meals that she needs to lay her eggs.

Control and prevention

So far no really effective vaccine has been developed against malaria, so we cannot protect ourselves against the disease. For many years there have been few effective treatments for malaria, but things are getting better. In a country like ours, drugs alone are not the answer. Many people live a long way from medical centres and cannot reach them easily, and medicines can be expensive. Methods of controlling malaria must involve controlling the *Anopheles* mosquitoes.

- Wherever possible avoid contact with mosquitoes. This can be done in a number of ways. Using mosquito repellents, having screens on doors and windows to prevent mosquitoes getting in and wearing clothes that protect the skin against mosquitoes – long sleeves and trousers – are all effective measures that can protect you against malaria. Well-made insecticide-treated mosquito nets can make a very big difference. They are a cheap and effective way to stop people becoming infected, and stop mosquitoes biting infected people. The Ministry of Health of the Ethiopian government with some international partners is working to provide insecticide-treated mosquito nets to at least 80% of the country.
- Minimise any opportunities for the mosquitoes to breed. They will lay eggs in any standing water – in a garden pond, old tyres, flower pots, old drink cans, etc. Remove the mosquito breeding places by removing as much standing water as possible. The simplest way to do this is to make sure you store rubbish out of the rain, and dispose of your rubbish properly. Some mosquitoes will breed in the water in a discarded bottle top – don't give them the opportunity! In this way the numbers of mosquitoes can be significantly reduced.

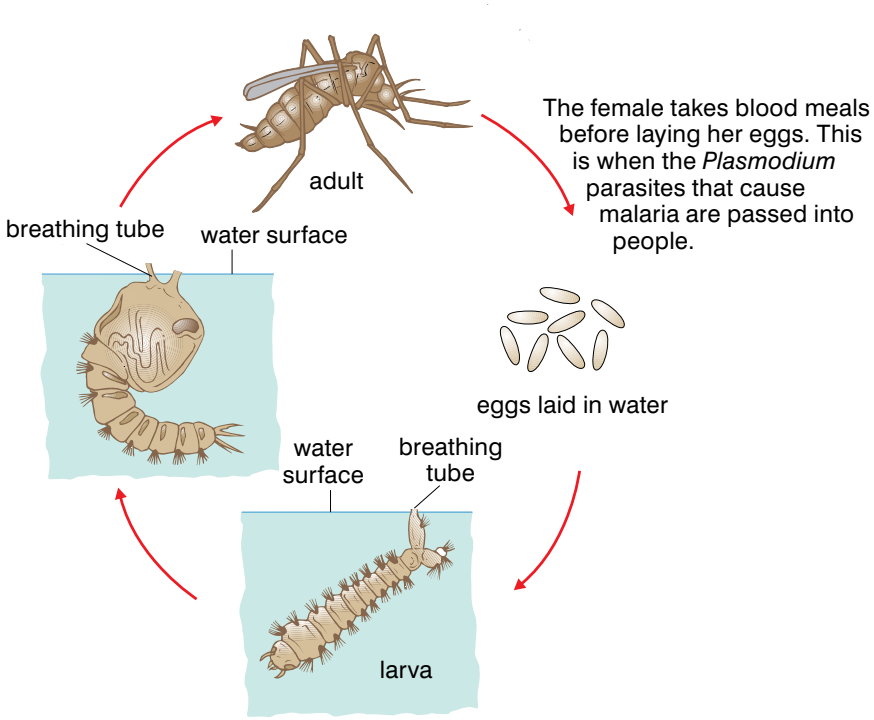


Figure 4.18 *Malaria kills millions of people world wide. It is a devastating disease carried by a biological vector, the* Anopheles *mosquito, whose life cycle is shown on the right.*

- Proper disposal of sewage – again, managing human waste so that foul water is not left around will reduce the breeding places for the mosquitoes.
- Biological control (where an organism that feeds on the larva is introduced into the water) and chemical control (pesticides) sprayed onto the water where the mosquitoes breed will kill the eggs and the larvae. This in turn reduces the numbers of mosquitoes and so lowers the infection rate.

Diarrhoea

Diarrhoea is a symptom rather than a disease itself. Diarrhoea is the production of very loose, runny faeces. It is particularly dangerous to the very young and the very old, both of whom can become dehydrated and even die within hours of the symptoms developing. Diarrhoea is a symptom of a number of different diseases and some of them are described below.

We take food and drink into our bodies regularly, and so our digestive system is a part of the body which can easily take in an infection. The acid in the stomach kills off most of the bacteria and viruses which get into the body by this route, but some of them can withstand the acid and survive to cause problems.

Gastroenteritis/acute watery diarrhoea (AWD)

Gastroenteritis, which is also known as acute watery diarrhoea (AWD), is an infection of your intestines that can be caused by viruses, bacteria and protoctists. It is very difficult to tell which is which. Some of the causative organisms include rotaviruses, the bacteria *Salmonella* and *Escherichia coli* (*E. coli*), or the protoctists *Giardia* and *Amoeba*.

KEY WORD

gastroenteritis *intestinal infection causing acute watery diarrhoea*

Figure 4.19 *This food looks wonderful – but if the salad has been washed in dirty water, the chicken wasn't properly cooked or the chefs didn't wash their hands after visits to the toilet, it could be covered in the micro-organisms that can cause gastroenteritis.*

> **DID YOU KNOW?**
>
> World wide, more children die from vomiting and diarrhoea than any other disease.

In someone suffering from AWD, the linings of their stomach, small intestine and large intestine become inflamed and painful, and as a result their body rejects and vomits out food. Also, water cannot be reabsorbed by the inflamed lining of their large intestine, resulting in liquid diarrhoea.

Whether your gastroenteritis is caused by viruses or bacteria, it is usually picked up by contact with someone who is already infected, or by eating contaminated food or water. In many cases, the gastroenteritis is passed on when someone with an infection prepares or handles food without washing their hands after going to the toilet – and then we eat the food and the micro-organisms together! Bacterial gastroenteritis in particular can be caught as a result of eating reheated meat dishes or poorly cooked and raw eggs if they are infected with bacteria such as *Salmonella*.

Gastroenteritis is most common if you live in or travel to areas where the sanitation is poor – but it is a problem all over the world.

Symptoms

The main symptoms of AWD (gastroenteritis) include:

- violent abdominal cramps and pain
- feeling nauseous, vomiting or often both
- watery diarrhoea which does not usually have blood in it
- slight fever
- general muscle aches and headache

Figure 4.20 *Rehydration drinks are cheap and can save lives.*

Control and prevention

There is no effective treatment for either viral or bacterial gastroenteritis, so it is very important to prevent it wherever possible. The best way to prevent the spread of AWD (gastroenteritis) is to follow some common-sense precautions.

- Always wash your hands thoroughly after using the toilet, and before preparing or eating food.
- Make sure you know that the water you drink and use to wash salad food and fruit is clean and safe.

- Avoid eating meat, eggs, shellfish, etc., which are undercooked or raw.
- If you know someone has AWD, keep well away from them!
- If you have to nurse them or visit, wash your hands thoroughly with soap and water afterwards.

Common sense, good toilet, kitchen and food hygiene and lots of hand washing should help you to avoid gastroenteritis most of the time!

Activity 4.4: Poster or information leaflet

You are going to produce some public information material to help reduce the levels of AWD in Ethiopia.

Method

Find out as much as you can about the disease and decide what health message you want to get across. Then design and produce either a poster or an information leaflet about gastroenteritis and how to prevent the disease which can be displayed in schools, churches, clinics and food shops.

Gastroenteritis is common the world over and in healthy people is not usually serious. But other gut infections such as cholera and typhoid are a very different story.

Cholera

Cholera is a bacterial infection that affects the intestinal tract. It is caused by bacteria called *Vibrio cholerae*. Cholera outbreaks are relatively common in Ethiopia and many other countries. It is a major problem in Central and South America.

KEY WORD

cholera *intestinal infection causing severe diarrhoea, vomiting and dehydration*

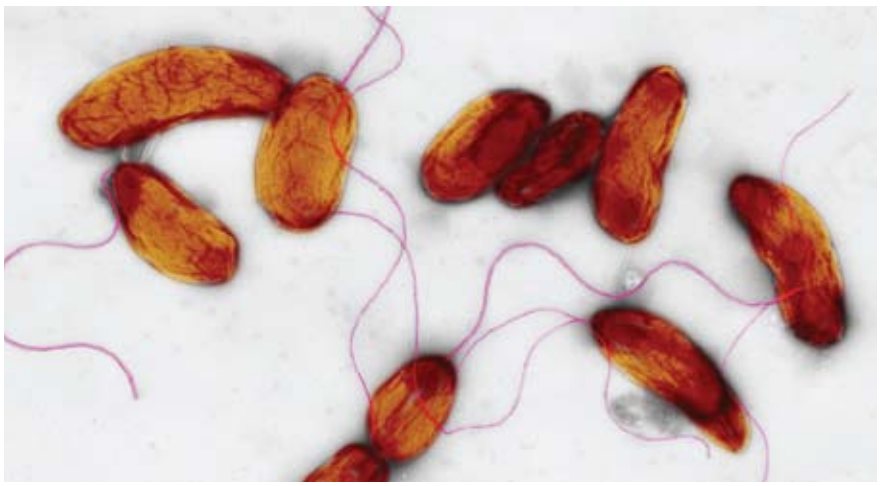


Figure 4.21 *The cholera bacteria, which can cause serious disease – but which can now be destroyed using antibiotics.*

Cholera bacteria are spread by eating or drinking food or water contaminated by the faecal waste of an infected person. This occurs more often in areas without clean water supplies and proper sewage disposal. It is a particular problem after disasters and at

Figure 4.22 *Conditions like these, where thousands of people lose their homes in a natural disaster or a war, are where cholera can do the most damage. Lack of sanitation and only dirty water to drink mean cholera can kill as many people or more than the original disaster unless rehydration fluids and antibiotics are made available.*

big celebrations and festivals, when many thousands of people are crowded together with little or no sanitation. Even in these situations the bacteria are not usually transmitted directly from one person to another – it is through drinking contaminated water.

Symptoms

Many people who pick up the cholera bacterium don't become ill and never know they have been infected – but they still pass bacteria out in their faeces which can infect other people. Others experience mild to severe diarrhoea, vomiting and dehydration, but generally no fever. The symptoms may appear from a few hours to five days after exposure. This type of infection is very difficult to distinguish from AWD – but again the cholera bacteria are shed in huge numbers in the faeces and can infect others. But about one person in every ten who gets infected will suffer from full-blown cholera. The pale, watery diarrhoea is so severe that it can kill vulnerable people from dehydration within hours. People can also vomit almost continuously. They suffer from severe muscle cramps from the loss of salts, dehydration and shock as their blood pressure plummets.

Control and prevention

The biggest problem with cholera is the severe dehydration that results from the diarrhoea. So the first priority when you treat the disease is to replace the fluids and salts which have been lost. This is done by mouth, encouraging patients to drink rehydration fluids, but often using an intravenous drip to put the liquid straight back into the blood is vital. Antibiotics are also used to treat the disease. They can reduce the time you have diarrhoea, and stop any more bacteria being shed in the faeces.

There is a cholera vaccine but it only gives partial protection (50%), which only lasts two to six months.

The single most important preventative measure is to make sure that worldwide everyone has a supply of clean, uncontaminated water and that sewage is disposed of effectively. Once people do not depend on drinking water that can easily be contaminated with sewage, the spread of cholera can be stopped almost completely.

For travellers, the simplest way to avoid cholera is to avoid consuming uncooked foods or water in foreign countries where cholera occurs, unless they are known to be safe or have been properly treated.

Cholera is only one of a number of infectious diseases that are passed from person to person through infected water. Another is **typhoid**.

Typhoid

Typhoid (or typhoid fever) is a bacterial infection of the intestinal tract that occasionally also affects the bloodstream. It is another cause of watery diarrhoea. Most cases are seen in Asia, Africa, Central and Southern America. The bacterium that causes typhoid is a unique human strain of salmonella called *Salmonella typhi* – in other words, typhoid ONLY affects humans.

Typhoid bacteria are passed in the faeces and, to some extent, the urine of infected people. Like other diarrhoeal diseases they are spread by eating foods or drinking water contaminated by faeces from an infected individual.

Symptoms

Symptoms generally appear one to three weeks after exposure to the bacterium, but you can carry it for years. Typhoid symptoms may be mild or very severe. They may include:

- A very high fever – 39–40 °C
- A painful abdomen
- Sore throat and headache
- Constipation or diarrhoea – adults tend to get constipation to begin with, followed by diarrhoea, whereas children get diarrhoea right from the beginning
- As the disease continues, rose-coloured spots may appear on your lower chest and abdomen
- An enlarged **spleen** and liver
- If untreated, you become delirious, weak and exhausted and may die

Untreated typhoid lasts for a long time (four to six weeks) and about 20% of the people affected will eventually die either of the typhoid itself or of other secondary infections that take hold. Some people continue to carry the typhoid bacteria in their system even when they are better. They have no symptoms but they can still spread the disease. Everyone who has typhoid should have samples of their faeces checked afterwards to make sure they are no longer carrying and spreading the bacteria.

Control and prevention

Typhoid is bacterial, and antibiotics are used as a very effective treatment. With antibiotic treatment fatalities are less than 1%. Unfortunately antibiotic-resistant strains of typhoid bacteria are beginning to appear, but at the moment we have enough different antibiotics to stay on top in the battle.

It is also important to manage typhoid patients well – they need plenty of fluids to replace the ones they lose, and small high-calorie meals to help them replace the minerals and energy they have lost.

KEY WORD

typhoid *intestinal infection causing acute watery diarrhoea*

spleen *organ in the abdomen producing cells needed in immune responses*

Figure 4.23 *Clean water, uncontaminated by sewage, is the answer to many disease problems. As soon as people all around the world have access to clean water, diseases like cholera and typhoid will almost disappear.*

KEY WORDS

venereal diseases (VD)
sexually transmitted diseases

sexually transmitted infections (STIs)
infectious diseases spread by sexual contact

As with so many diseases, the most effective way of dealing with typhoid is to prevent it being passed on from person to person.

All of the factors which affect the spread of cholera apply to typhoid as well – careful hand washing after toilet visits, clean drinking water and good sewage disposal available to everyone, good food hygiene in kitchens and care in eating raw or lightly cooked foods.

Sexually transmitted diseases (STDs)

Sexually transmitted diseases (STDs) are infectious diseases that are spread through sexual contact. They were previously known as **venereal diseases** or **VD**. Today the term **sexually transmitted infections** (**STIs**) is used by some authorities to indicate that the microbes responsible for them do not always cause symptoms and signs of disease. This is one of the great problems with sexually transmitted diseases. Often they have no symptoms or the symptoms in the early stages are very mild. They can easily be mistaken for something else. Yet many of the sexually transmitted diseases can cause great harm if they are not detected and treated in those early stages. They can cause infertility, brain damage and even death – yet several of the most common of them can be cured using antibiotics if caught in time. What is more, by sensible sexual behaviour, they can be avoided altogether.

Sexually transmitted diseases are a growing problem in Ethiopia – partly because sexual activity often starts relatively young, partly because people often have more than one sexual partner and partly because access to health care is often difficult. This means the pool of infection in the population just gets bigger all the time.

The examples that you will look at in this section include gonorrhoea, syphilis and chancroid.

Gonorrhoea (gonococcal infection)

Gonorrhoea is an infection that is caused by the bacterium *Neisseria gonorrhoeae*. The gonorrhoea germs are found in the mucus areas of the body (the vagina, penis, throat and rectum). Any sexually active person can be infected with gonorrhoea, but most often it is found in younger people (ages 15–30), and particularly in people who have many sex partners. Gonorrhoea is reported more frequently from urban areas than from rural areas.

Gonorrhoea is spread through sexual contact, whether this is vaginal, anal or oral sex. Having unprotected sex (without using a condom), and particularly having many sexual partners, increases the risk of picking up the infection. The more people you have sex with, the more likely you are to meet someone who is infected with gonorrhoea. The infection can also be passed from mother to child during birth. From the time someone is infected with gonorrhoea, they can spread the disease to any sexual partners they may have – and will continue to do so until properly treated.

Symptoms

The early symptoms of gonorrhoea are easier to pick up in men than they are in women. Men infected with gonorrhoea will have a burning sensation while urinating and a yellowish-white discharge from the penis. These symptoms usually appear from two to seven days after infection but it can take as long as 30 days for symptoms to begin. People don't always associate the symptoms with sex they had a month earlier! If women do experience any symptoms, they will have a discharge from the vagina and possibly some burning while urinating. Often, there are no early symptoms for people infected with gonorrhoea.

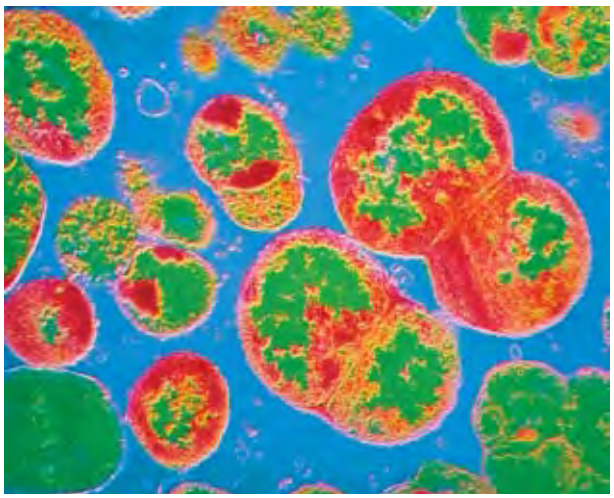


Figure 4.24 *The bacteria that cause gonorrhoea are invisible – but they can make you infertile.*

This means people are likely to spread the infection unknowingly, but also they do not get treatment and so put themselves at risk of developing more serious problems and complications later.

If a pregnant woman has untreated gonorrhoea, she can pass the infection on to her baby as it passes out along the birth canal. The infection will affect the baby's eyes, and if it is untreated can result in the child becoming blind.

Control and prevention

Gonorrhoea is caused by a bacterium so it can be treated effectively in the early stages using antibiotics. All strains of gonorrhoea are curable but some strains of the bacterium are becoming more and more resistant to many standard antibiotics. Unlike many illnesses, you are not immune to gonorrhoea just because you have had it before. In fact, past infection can allow complications to develop more rapidly.

The most effective ways to prevent the spread of gonorrhoea all involve a sensible and responsible approach to your sexual relationships:

- Be faithful to your sexual partner.
- Use a male or female condom – this prevents the bacteria passing from one person to the other.
- If you think you may be infected, avoid any sexual contact and visit a local clinic, hospital or doctor.
- If you are infected, notify all your sexual contacts immediately so that they can be examined and treated.
- If you are infected, do not have sex until your course of treatment is completed.

Another, potentially very serious STD is syphilis.

Figure 4.25 *The bacteria which cause syphilis have a very distinctive shape under the microscope, as you can clearly see in this micrograph. The early symptoms they produce are easily missed.*

Syphilis

Syphilis is another bacterial infection, caused by the spiral-shaped *Treponema pallidum*. Any sexually active person can be infected with this STD, although it is found more commonly among young people between the ages of 15 and 30 (because they are the group which are most likely to be very sexually active and to have a variety of partners).

Like gonorrhoea, the most common way in which syphilis is spread is by sexual contact with someone already infected with the bacteria. However – again like gonorrhoea – the exception is congenital syphilis, which is spread from mother to foetus. This can cause very serious problems for the baby when it is born.

However, syphilis cannot be spread by contact with toilet seats, baths, shared clothing or door knobs, no matter what your friends may tell you!

Symptoms

Syphilis progresses in distinct stages. In the earlier stages it can be treated, but in the late stages it cannot. The symptoms occur in stages called primary, secondary and tertiary (late). The first or primary sign of syphilis is usually a sore or sores, which are painless and appear at the site of initial contact. They are commonly found on the penis, on the entrance to the vagina, in the mouth, in the rectum or inside the vagina itself, where they are invisible. This stage may be accompanied by swollen glands, which usually develop within a week after the appearance of the initial sore. The sores may last from one to five weeks and may disappear by themselves even if no treatment is received, these sores are very infectious.

Approximately six weeks after the sore first appears, a person enters the second stage of the disease. The most common symptom during this stage is a rash. Other symptoms can include:

- tiredness
- fever
- sore throat
- headaches
- hoarseness
- loss of appetite
- patchy hair loss
- swollen glands

These signs and symptoms will last two to six weeks and generally disappear even without adequate treatment. Symptoms are often not noticed or if they are noticed, people tend to mistake them for other common minor illnesses such as heat rash, colds and flu. As a result they don't visit the doctor and the disease is not diagnosed.

Untreated the disease then goes into a long quiet phase, when there are no obvious symptoms although the bacteria are still active in the body.

The third stage, called tertiary or late syphilis (syphilis of over four years' duration), may involve illness in the skin, bones, central nervous system and heart. It causes severe and irreversible problems that cannot be treated successfully.

If a pregnant woman has untreated syphilis she may transmit the disease to her unborn child. This may result in death or deformity of the child. In many places around the world, pregnant women are tested to see if they have syphilis because if the infection is discovered and treated, any problems for the unborn child can be completely prevented.

Control and prevention

Because syphilis is a bacterial disease, it is treated easily with antibiotics such as penicillin or tetracycline. The amount of treatment depends on the stage of syphilis the patient is in and in tertiary (third stage) syphilis the damage already done to the tissues and organs cannot be undone. Pregnant women can be treated with antibiotics to cure them and protect their baby, while a baby born with the disease needs daily penicillin treatment for ten days. You do not develop natural immunity to syphilis, so past infection offers you no protection. If you make poor lifestyle choices, you can go out and catch syphilis again the very day you finish your treatment.

Figure 4.26 *It isn't always easy to get to a clinic where sexually transmitted diseases can be identified and treated in the early stages. However, if you think you might be infected it is important to make the effort before they have a major effect on your life and before you pass on the disease.*

Just as for gonorrhoea, there are a number of lifestyle choices you can make that will prevent the spread of syphilis. The choices are very similar as the diseases are spread in the same way:

- Be faithful to your sexual partner.
- Use a male or female condom. Remember that use of condoms may prevent the disease if the initial contact sore is on the penis or in the vaginal area. The bacteria cannot travel through the condom. However, transmission can still occur if there is a sore outside the areas covered by the condom – for example in the mouth.
- If you think you are infected, avoid sexual contact and visit your local STD clinic, hospital or doctor.
- Notify all sexual contacts immediately so they can obtain examination and treatment.
- All pregnant women should receive at least one prenatal blood test for syphilis so they can be cured and any potential damage to their baby prevented.
- Do not have sex until your treatment for syphilis is completed.

The next STD you are going to look at is, in some ways, much less serious than either gonorrhoea or syphilis. However, it is very important because it appears to be closely linked with the spread of HIV/AIDS in Ethiopia and other countries with high HIV infection rates.

Figure 4.27 *Chancroid may not be the most serious of the STDs but it can cause great discomfort and distress and increases your risk of becoming infected with HIV/AIDS.*

Chancroid

Chancroid is a bacterial STD that is more commonly seen in men than in women. It is caused by the bacterium *Haemophilus ducreyi*. Infection with *H. ducreyi* often produces painful sores, usually in the genital area (head of penis, labia, anus, cervix). Although the disease is not too serious in itself, and can be cured easily using antibiotics, it is a serious problem because the ulcers caused by chancroid increase the likelihood of becoming infected with HIV/AIDS. Chancroid is passed on by having sex with an infected person. And if you have sex with someone who is HIV-positive while you have open chancroid ulcers, you greatly increase your risk of becoming HIV-positive yourself (see section 4.3 for more information on HIV/AIDS).

Symptoms

The first symptoms of chancroid are sore ulcerations on the genitals, particularly the penis. They are soft and filled with pus with reddened edges. The ulcers bleed easily on contact, and can burst with pus draining out. They are painful, particularly for men.

The second stage of the infection is that the lymph glands in the groin also become infected – often on only one side of the body but sometimes both. The glands swell up to form 'buboes' filled with pus. These can also burst, releasing thick pus and forming large, painful ulcers. Eventually the body overcomes the infection but permanent loss of tissue from the penis or groin may take place before healing takes place.

Control and prevention

If chancroid is diagnosed early it can be treated easily with a dose of antibiotics. If the disease has spread and the lymph glands are infected, antibiotics will still cure the disease but the glands may need to be drained of their pus to help the healing process.

Preventing the spread of chancroid is very important because of the strong link between this condition and HIV/AIDS. The countries with the highest rates of HIV infection in the world are also the countries with the highest levels of chancroid (see table 4.1). In countries with little HIV, chancroid is almost unknown.

Table 4.1 *Prevalence of HIV and chancroid in some African countries*

Country	Adult HIV prevalence rate as % of population	Chancroid prevalence rate as % of population
Botswana	36	26
Zimbabwe	25	46
South Africa	20	70
Kenya	14	62
Ethiopia	11	19
Uganda	8	8.5

Prevention of the spread of chancroid is important both to stop the disease itself and more importantly to reduce the spread of HIV/AIDS. We can lower the rate or even get rid of this disease by taking some simple steps. The following steps are very important:

- Be faithful to your sexual partner – being celibate or having one partner is the best way to keep safe.
- Use a male or female condom when you have sex.
- Good genital hygiene – if you wash your genitals carefully after you have sex this greatly reduces the risk of catching chancroid.
- If men are circumcised this reduces the risk of getting chancroid and it is easier to keep the penis clean.
- If you think you might be infected, do not have sexual relations with anyone, visit a clinic, doctor or nurse as soon as you can to get antibiotic treatment and tell any sexual partners you may have so they can be treated too.

The most serious and damaging sexually transmitted disease of all is HIV/AIDS. You will be studying this in section 4.3.

Activity 4.5: Educating the community

It is very important that as many people as possible in Ethiopia understand the dangers of chancroid. Design a poster or leaflet that would help people look after their sexual health better and reduce the numbers of people infected by this disease. In this way you could help reduce the numbers of people infected with HIV/AIDS!

Using medicines correctly

Used properly, medicines are a great power for good. Modern medicines such as antibiotics mean we can cure many diseases that would have caused great harm and death in the past. Vaccines mean we can protect our children from diseases such as tetanus, polio and measles so that they no longer have to suffer. Traditional medicines too have an important part to play in keeping us healthy. In Ethiopia modern medicine is becoming increasingly important, but it is not easily available to many of us. For about 80% of the population of Ethiopia, traditional medicine is used because it is there in our communities and because people have confidence in the skills of their traditional healers. Traditional medicine is often holistic, based on treating the whole patient. The medicines have been known and used for many generations and are often based on extracts of plants including herbs and spices.

Medicines must be used properly if they are to cure us. Because medicines are powerful substances, if they are misused they can cause harm. So how do you use a modern medicine such as a course of antibiotics?

Modern medicines are made in very carefully controlled doses so it is important to take exactly the dose given to you at regular intervals through the day. Do not take more than you are prescribed, as the drug may be harmful in large amounts. Do not take less than you are given as the drug will not work properly if the dose is too low. Make sure you finish taking all the medicine. If you do not follow the instructions when you are given antibiotics, antibiotic-resistant bacteria may evolve which can be very serious indeed.

Activity 4.6: Looking at modern medicines

You may be provided with packets and leaflets for several modern medicines. Make a table and for each medicine give its name, the illness it treats, the dosage to be taken, how it should be stored and two possible side effects to look out for.

Figure 4.28 *Scientists at EHNRI are busy investigating the chemical compounds in many of our traditional medicines, and testing them to see how effective they are.*

It is very important to read the instructions that come on the packet with your medicine.

Medicines given to adults can be dangerous for small children, so it is important to keep all medicines well out of the way of children so they do not try them by mistake.

Some modern medicines have to be kept cool. Make sure you store medicines at the right temperature. If they get too hot the chemicals in the medicine may react or denature and then the medicine will not work as well.

Many of the medicines we use in Ethiopia are traditional medicines that we get from our healers. Medicines such as dingetegna and Koso can be very powerful. However, they can also interact with other modern drugs. These interactions can cause big problems. This may mean that neither medicine works very well and they may cause extra health problems. For example, chat interferes with a commonly used antibiotic so it is not absorbed properly by your body and cannot destroy bacteria. Traditional medicines also need to be used carefully. There is a lot of work going on in Ethiopia at the moment – for example at the Ethiopian Health and Nutrition Research Institute (EHNRI) and the Biofarm Project in Addis Ababa – looking at how traditional medicines work and how effective they are.

Activity 4.7: Collecting and testing traditional medicines

Work as a class to make a list of as many traditional Ethiopian medicines as you can and record what each medicine is used to treat.

Antibiotics are very important modern medicines because they can kill bacteria and so cure diseases such as TB and chancroid. Choose a traditional medicine used to help cure infections and plan how you would investigate to see how well it kills bacteria and what concentration is most effective.

Many people will see a traditional healer or a modern health worker when they are ill. But many people try to prescribe what they or their family need for themselves. You must be very careful with self-prescribing. There are many risks associated with the practice. Of course all of us have our own remedies for a simple headache or cold, and self-prescription works well for these simple illnesses. But if there is any doubt about the cause of symptoms, we need to see a doctor. If we self-prescribe, we may not realise exactly what is wrong with us and so use the wrong medicine. We may try to remember what someone else was given for some similar symptoms, and again take the wrong thing. We might use the right medicine but take the wrong dose. And most of all, there are many conditions which need a doctor to look at and treat. If you take self-prescribed medicines, or give them to your family, you increase

the risk that people will become seriously ill and even die. So only self-medicate if you are absolutely sure that you know what you are doing!

Sometimes modern medicine has the best answers – vaccinations and antibiotics mean we can eliminate some very serious diseases and prevent many people from suffering and dying. But traditional medicines are also very important in helping us to recover from many common illnesses. Hopefully in the future traditional medicine and modern medicines will work together to improve the health of everyone in Ethiopia.

Summary

In this section you have learnt that:

- **Tapeworms** are parasites with at least two hosts, which can include human beings. They often enter the human system when a bladder worm is ingested in under-cooked meat. Adult tapeworms live reasonably at peace with their hosts, but they but rob us of our digested food. Tapeworms can be treated with anti-worm medicines that kill them and they are then passed out in the faeces. Good sanitary conditions are recommended in preventing their spread.
- **Malaria** is a mosquito-borne disease caused by *Plasmodium* parasites. It is spread by the bite of an infected female *Anopheles* mosquito. It causes fevers, chills and sweating and damage to the liver and blood. Use of insecticide-treated mosquito netting and insect repellents and reducing the amount of standing water can greatly reduce the numbers of people infected.
- **Tuberculosis** is a bacterial disease usually affecting the lungs, transmitted through the air. It can be asymptomatic. It may present with a low-grade fever, night sweats, fatigue, weight loss and a persistent cough. Tuberculosis can be cured by a long course of antibiotics and prevented by vaccination.
- **AWD** (**acute watery diarrhoea/gastroenteritis**) can be caused by viruses or bacteria. People usually become infected with AWD by taking in contaminated food or water. The most effective method of treating this disorder is rehydration with copious fluids containing electrolytes. Good sensible hygiene practices will minimise the spread.
- **Cholera** is a bacterial disease that affects the intestinal tract. The cholera germ is passed in the stool. It is spread by entering or drinking contaminated food or water. Infected people may experience mild to severe diarrhoea. It can kill very quickly if it is severe. It is a particular risk in areas of overcrowding with no proper sewage disposal.

- **Typhoid fever** is a bacterial infection of the intestinal tract and sometimes the bloodstream. The germs are spread by eating or drinking contaminated water or foods. Symptoms may be mild or severe. Antibiotic treatment is recommended. Strict attention to food and water precautions is important. A vaccine is available.
- **Gonorrhoea** is spread by sexual contact. Infected men will have burning while urinating and yellowish-white discharge from the penis. Women with symptoms will have a vaginal discharge and burning while urinating. Antibiotic treatment is prescribed. Responsible sexual practices are also recommended.
- **Syphilis** is a bacterial infection. Any sexually active person can be infected with syphilis. The symptoms of syphilis occur in stages called primary, secondary and late. It is treated with penicillin or tetracycline. If untreated it can lead to destruction of soft tissue and bone, heart failure, blindness and a variety of other conditions. It can be prevented by healthy sexual practices.
- **Chancroid** is a bacterial sexually transmitted infection that produces painful ulcers in the genital area and in the lymph glands of the groin. It is treated by antibiotics. It can be prevented by healthy sexual practices. Having chancroid greatly increases your risk of becoming infected by HIV/AIDS.
- Both modern and traditional medicines can be very useful in relieving symptoms and curing diseases. It is important to use medicines carefully, taking the right dose, keeping them at the right temperature, keeping them away from children and avoiding self-medication except for the simplest conditions.

Review questions

Select the correct answer from A to D.

1. Which of the following is not a parasitic worm which can infect your gut?

   A beef tapeworm

   B ringworm

   C threadworm

   D pork tapeworm

2. Which of these statements is true about a tapeworm?

   I It is adapted to survive in the human gut.

   II It can have around a thousand segments to its body.

   III It is a roundworm.

   IV Each segment contains reproductive organs.

A I, II and III
B II, III and IV
C I, III and IV
D I, II and IV

3. Which of the following animals is the vector for malaria?
   A *Aedes aegypti* mosquito
   B housefly
   C *Anopheles* mosquito
   D flea
4. Which of the following processes will help to avoid the spread of food-borne diseases?
   I Use disposable cloths to wipe down surfaces.
   II Wash hands after visiting the toilet.
   III Wash hands three times a day.
   IV Use disinfectant on kitchen surfaces.
   A I, II and III
   B II, III and IV
   C I, II and IV
   D I, III and IV
5. Which of the following diseases is only caused by bacteria?
   A influenza
   B common cold
   C AWD
   D cholera
6. Which of the following diseases is not sexually transmitted?
   A HIV/AIDS
   B gonorrhoea
   C diarrhoea
   D syphilis
7. Which of these STDs are caused by viruses?
   I HIV/AIDS
   II gonorrhoea
   III chancroid
   IV syphilis
   A I, II and III
   B I, II and IV
   C II, III and IV
   D I only

4.3 HIV and AIDS

By the end of this section you should be able to:

- Describe the structures and functions of the lymphatic systems.
- Identify the white blood cells as the cells that are primarily attacked by HIV and explain how HIV affects the immune system.
- Show local, national and global distribution of HIV and AIDS.
- Explain the impacts of HIV and AIDS in Ethiopian society.
- Demonstrate methods of giving care and support to people living with HIV/AIDS (PLWHA) and ways of overcoming discrimination.
- Explain the importance of voluntary counselling and testing services (VCTs).
- Express willingness to participate in VCTs.
- Discuss the role of responsible sexual behaviour in preventing the spread of HIV/AIDS.
- Demonstrate the life skills such as assertiveness, decision making and problem solving to help prevent the spread of HIV/AIDS.

The sexually transmitted diseases (STDs) that you looked at in section 4.2 have been known for centuries, although we only discovered the details of what causes them and how to treat them effectively in the last century. However, the final STD that you are going to study has only been known for about 25 years. Yet, in spite of this, it already affects millions of people around the world and it is still a fatal disease for almost everyone who becomes infected. This new disease is HIV/AIDS and it raises some serious issues in Ethiopia, as it does all around the world.

HIV and AIDS in Ethiopia

Acquired Immune Deficiency Syndrome (AIDS) is the medical term for a combination of illnesses that result when the immune system is weakened or destroyed. It is the advanced form of an infection caused by Human Immunodeficiency Virus (HIV), a virus that attacks the immune system, making the sufferer susceptible to other diseases. The main way in which AIDS is spread from one person to another is by sexual intercourse. It can pass from a mother to her baby in the womb, during birth or when she breastfeeds. It can also be spread through infected blood on needles used for injecting illegal drugs, or knives used to carry out FGM or through infected blood transfusions, although in Ethiopia we screen our blood supplies so this does not happen.

HIV/AIDS is a big problem in Ethiopia. Between 60 000–70 000 people die of AIDS every year, at the moment, and well over a million people are infected with the virus.

Figure 4.29 *An HIV/AIDS prevention poster*

Around 33 million people worldwide are infected with HIV. Globally, around 16 000 people are being infected every day, 6500 of them between the ages of 15 and 24 years. Eleven people are infected every minute, five of whom are young people. Around 2 million people die of AIDS every year.

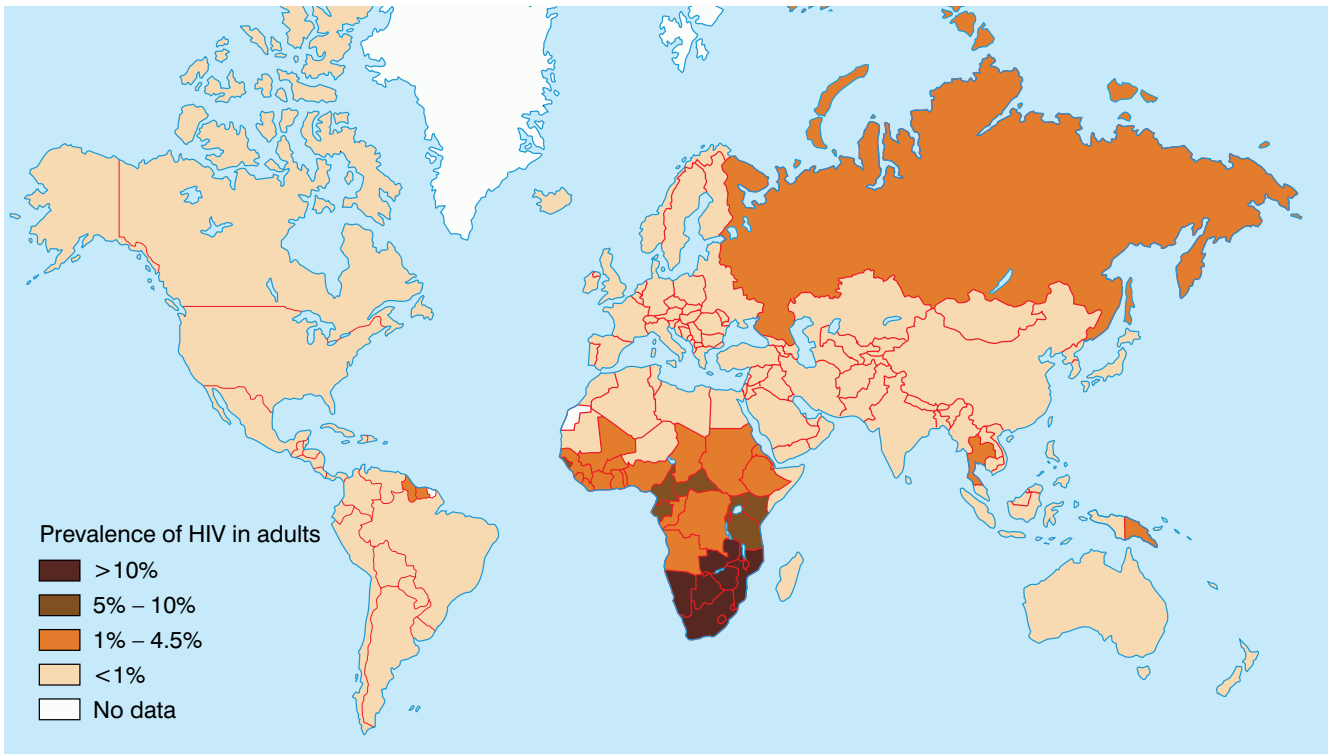


Figure 4.30 *Map showing the relative prevalence of HIV/AIDS infections around the world*

In Ethiopia AIDS is the leading cause of death in the 15–49 age group. This has enormous implications for the economy of the region, because so many of the working population are affected by the disease. Almost 72 000 people in Ethiopia died of AIDS in 2007. In the same year it was recorded that 898 350 children were orphans because their parents had died of HIV/AIDS. Around a million people in Ethiopia are living with HIV/AIDS. The social cost of HIV/AIDS to individual people, to families and to the whole country of Ethiopia cannot be underestimated.

Ethiopia is not alone in these problems – as figure 4.31 shows clearly, many countries in Africa face the same problems and even worse. Look back to section 4.2 to see how the prevalence of chancroid relates to the incidence of HIV/AIDS in certain countries.

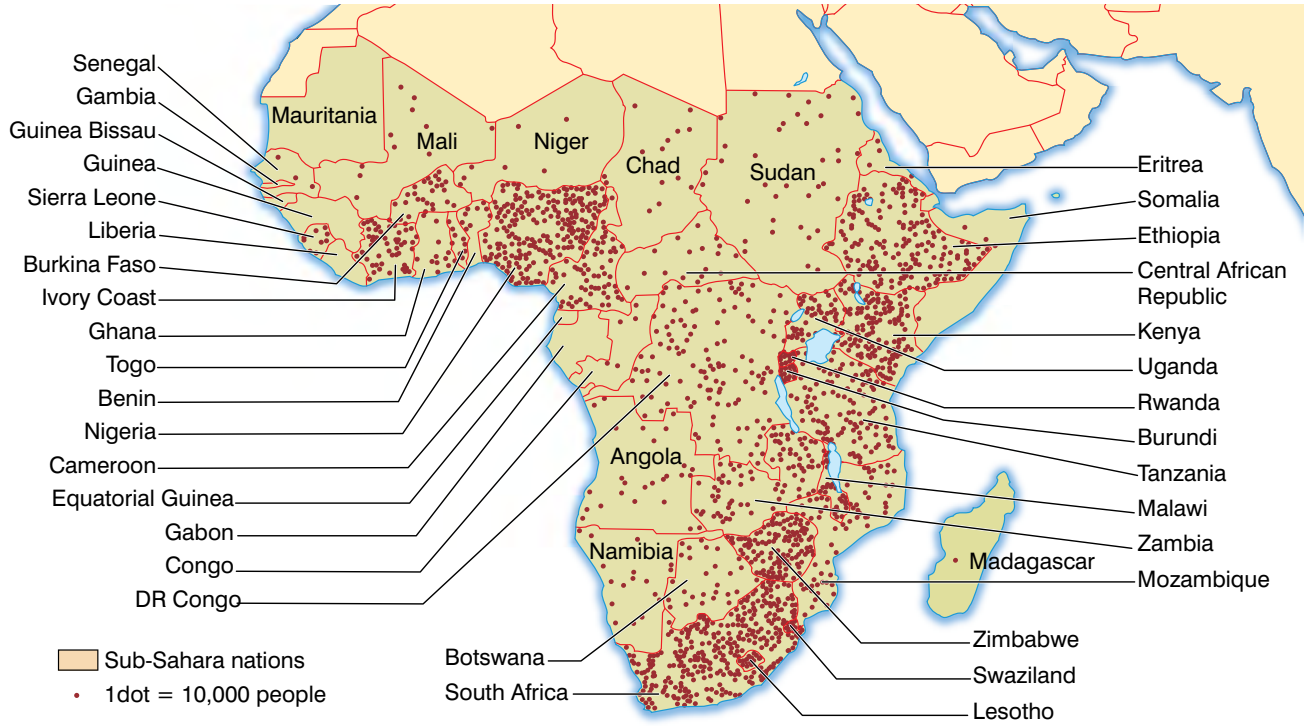


Figure 4.31 *A map that shows the density of people living with HIV/AIDS in African countries, including Ethiopia.*

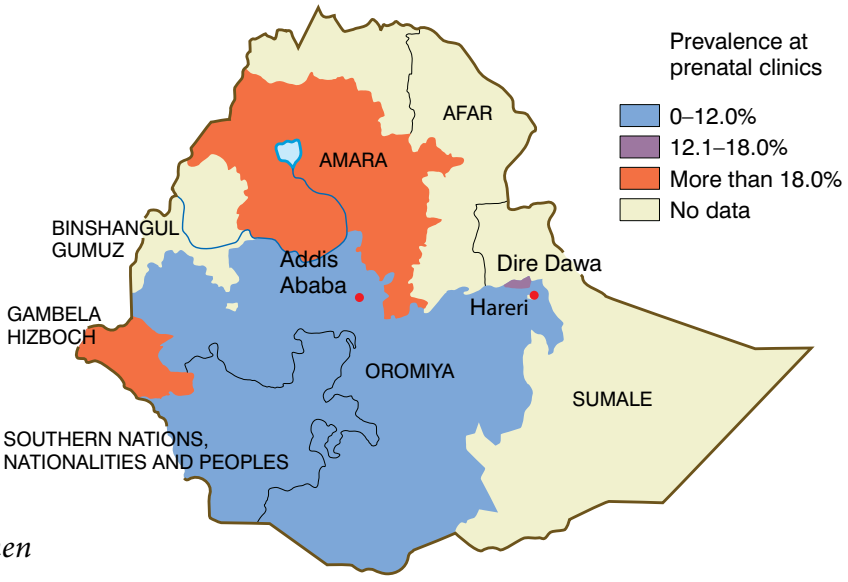


Figure 4.32 *A map that shows the prevalence of HIV/AIDS among women attending prenatal clinics in Ethiopia.*

Levels of HIV infections vary around Ethiopia. More people are infected in the cities than in rural areas, for example. Figure 4.32 shows the pattern clearly in the test results taken from pregnant women around the country. In some places, particularly cities such as Addis Ababa, more women are being given the antiretroviral drugs they need to prevent the disease from spreading to their unborn children.

HIV and the immune system

Your immune system is based in your lymph system which spreads all through your body. Your capillary walls are permeable to everything in your blood apart from the red blood cells and the large plasma proteins. As blood flows through your capillaries from the arterial system it is under pressure so fluid is squeezed out of the vessels. This fluid fills the spaces between the cells of your body and it is known as tissue fluid. It is through this fluid that all the diffusion between the blood and your cells takes place.

Most of this fluid is eventually returned to your blood. Some of it moves back into the blood capillaries as they near your veins, but a lot of it drains into a series of blind-ending tubes that are part of the lymph system. Once in these tubes the fluid is known as **lymph**. The lymph vessels join and get larger. The lymph is moved by the squeezing effect of muscle movements and the system has a series of valves – like those found in veins – to prevent the backflow of liquid. The lymph is finally returned to your blood in the neck area, where the lymph vessels join into the large veins.

Along your lymph vessels you will find your lymph glands. The white blood cells known as **lymphocytes** gather in these glands and produce antibodies against invading pathogens. These antibodies are carried in the lymph to the blood. The lymph glands also filter out bacteria and other microbes from the lymph to be ingested by the phagocytes. Enlarged lymph glands are a sign that the body is fighting off an invading pathogen. You can see from figure 4.33 why doctors often examine the neck, armpits, stomach and groin of their patients. These are the main sites of the lymph glands and enlarged lymph glands suggest you have an infection.

How does HIV attack the immune system? The human immune system is made up of special white blood cells which protect the body from infection. Normally when a virus enters the body, the cells which make up the immune system in the body begin to work at once. There are two main types of white blood cells in the immune system. **T-cells** actually bind to the antigens (see page 113/114) on the invading micro-organism and destroy it. **B-cells** make antibodies which bind to the antigen and destroy it. It can take some time for your body to make enough T and B lymphocytes with the right receptors to overcome a pathogen. It is while the immune system is producing our defences that we feel ill with the symptoms of the disease.

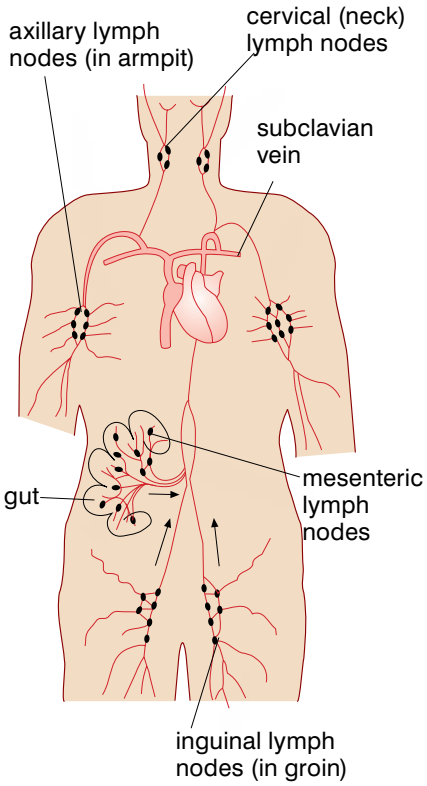


Figure 4.33 *The lymph system – it is important both in returning tissue fluid to your blood and in your immune responses to infection.*

KEY WORDS

lymph *fluid containing white blood cells which flows through the lymphatic system*

lymphocytes *white blood cells forming antibodies against microbes*

KEY WORDS

T-cells *recognise and attach to a cell carrying a foreign antigen and destroy it*

B-cells *recognise and attach to a foreign antigen, reproducing and forming many identical copies of themselves which all secrete antibodies to destroy the antigen*

HIV attacks the T-cells of your immune system. It gets inside them and so they can no longer work. You need both types of cells for your immune system to work properly, so as more and more T-cells are invaded by the virus, your immune system is less and less effective. This is why people with HIV/AIDS get so many other infections. In a healthy, well-fed person it can take many years before enough of the viruses are made to stop the immune system working completely.

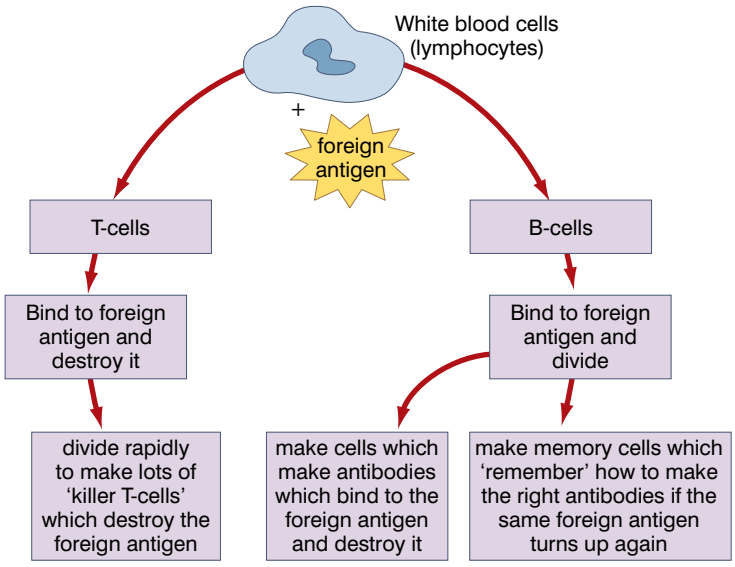


Figure 4.34 *The T- and B-cells of the immune system form a very good defence against most foreign antigens that get into the body.*

Stigma and discrimination

Figure 4.35 *Dr Teodros Adhanom and Dr Thomas Kenyon at the start of the new building project at the Zewditu Memorial Hospital where everyone will be treated together whatever their HIV status.*

One of the biggest problems with HIV/AIDS is the stigma that has been attached to the condition. People are afraid of discrimination if it is known that they are HIV-positive or that they have AIDS. They are afraid they will not be given jobs, or will lose their job or their children will not be allowed to go to school. People might not serve them in shops. So many people will not even be tested for the disease. This means that people with undiagnosed HIV/AIDS infect others both through sexual intercourse and by mothers infecting their children through pregnancy, childbirth and breastfeeding.

Now in Ethiopia people are working very hard to remove the stigma of HIV/AIDS. With help and support, people living with HIV/AIDS (PLWHA) can remain healthy for a long time. People need to eat as well as possible, to keep up their strength and allow their immune system to deal with the virus for as long as possible. Education means that people can learn how to avoid passing on the infection, so that the number of people living with HIV/AIDS gradually falls. In future more antiretroviral drugs will be made available so that people remain healthy for much longer. In 2009 work started on a new Integrated Outpatient Department Annex at the Zewditu Memorial Hospital where PLWHA can receive retroviral treatment and caring support alongside patients who are not HIV-positive.

Care and support

If people living with HIV/AIDS can receive plenty of care and support within their own communities, this will help them to live

longer and more healthily. It will also encourage others to be tested for the virus. The sooner treatment starts, the longer a person will stay healthy. Ethiopia is also developing its own online resources to help and support both people with HIV/AIDS and the people who care for them. As more and more people have computers and mobile phones, this type of resource will make information widely available.

Figure 4.36 *Counselling and supporting people through their HIV test makes a big difference to how they will cope.*

VCTs

An important part of caring for and supporting PLWHA is the development of VCTs, or Voluntary Counselling and Testing services. This gives people counselling before and after they have an HIV test. The process makes sure that people are prepared for the test and understand what the results mean. If it is good news and the test is negative, people can be shown how to avoid the risk of infection in the future. If the test is positive, people can learn how to live longer, healthier lives with HIV/AIDS. They can also learn how to avoid passing the virus on to others. A great deal of work is being done in Ethiopia to train people to act as counsellors and to encourage people to undergo VCT to find out their HIV status in the best possible circumstances. The Ethiopian government along with the World Health Organisation and other groups are all working together to reduce the burden of HIV/AIDS on individuals and on our country.

Responsible sexual behaviour and life skills

It is also important that you, our young people, develop the personal skills which will help you reduce the risk that HIV/AIDS poses both to you as individuals and to our society. It is important to be assertive. Using condoms is very effective at reducing the risk of HIV infection spreading. Girls and young women must be able to insist that their sexual partners use a condom for sex. Boys and young men must learn to respect their partners and to take responsibility for their own sexual health and that of others by using condoms. Ideally everyone would have an HIV test at the onset of establishing a new relationship. You need to develop the life skills of assertiveness and planning ahead to insist on this before you begin a new sexual relationship.

Figure 4.37 *The three main points of the safe sex message are shown clearly on this poster. These posters can help people in their decision making and greatly reduce the risk of getting HIV/AIDS.*

Being faithful within marriage or a relationship is the safest way to avoid HIV infection. The more partners you have, and the more times you have unprotected sex, the more you put yourself at risk. If you avoid the use of substances, such as alcohol, which can affect your judgement and make you more likely to take part in risky behaviour, fewer mistakes will be made. You need to develop the skill of decision making so that you can make the safe choices which will help you avoid being infected with HIV/AIDs, and then keep to them.

Problem solving is another important life skill. You need to be able to deal with the situation if your partner wants to have unprotected sex, or if you think you might have been infected with HIV. How can you make the best of the situation?

Young people need to make decisions about their own behaviour and that of their local community about how to care for and support people who are already living with HIV/AIDS, and how to reduce the risk of this terrible disease for future generations. Carry out these activities to help you develop the skills you need.

Activity 4.8: Planning a campaign to educate people on the threat of HIV/AIDS

Problem solving is an important life skill. One big way of solving the problem of the spread of HIV infection is to make sure that people understand the disease and know the best decisions to make to prevent its spread. How would you educate people in Ethiopia to help prevent the spread of HIV/AIDS? Think about the best ways to solve the problem of getting the message across to students in your school, or the local community – you might even plan how to protect any children you might have later from this terrible disease.

Method

1. Plan an education campaign. Think of all the different ways of getting a message across, from posters and leaflets to computers, televisions and mobile phones.
2. Then develop ONE part of your campaign to present to the rest of the class. You may write and perform a television advert, produce a poster or leaflet – whatever you like. Whatever you produce must contain some good science and some clear information to help people in Ethiopia make the right lifestyle choices to keep themselves and their family free from HIV/AIDS.

Activity 4.9: Assertiveness training

Make a poster to show different ways of behaving in the following situation. A young man wants his girlfriend to have a sexual relationship. Make a poster to show all the different answers she might make that would be assertive and show that she had made the right decisions to protect them both against the spread of HIV.

Activity 4.10: Role play on supporting people living with HIV/AIDS

- Work in a group. You are going to plan two role plays for the following situation. A person you know has just found out that they have tested positive for HIV.
- First of all act out the situation as if the person is given no support – think of some of the hurtful ways people can be treated. Different people can take on different roles and show how the person may be stigmatised.
- Now act out the same situation to show how you can support someone who is living with HIV/AIDS in your community. Look for as many ways to solve the problems and make the right decisions as you can. You may need to show assertiveness to overcome the prejudices of others.
- Perform your role plays in front of the class. See what other suggestions the class can make.

Summary

In this section you have learnt that:

- HIV is the virus that causes AIDS.
- HIV/AIDS is spread mainly through blood, semen, vaginal secretions and breast milk.
- Unprotected sex and transmission from an infected mother to her child are the two most common ways in which HIV is spread in Ethiopia.
- HIV attacks the white blood cells of the immune system – in particular, the helper T-cells.
- Patients often have few symptoms to begin with but eventually their weakened immune system means they get many diseases and die.
- AIDS affects millions of people all over the world. Sub-Saharan Africa and Russia are two of the areas that are most affected.
- Antiretroviral drugs can slow down the progress of HIV/AIDS and protect unborn babies from infection, but there is no cure or vaccine for AIDS. The sooner people can start taking antiretrovirals after infection, the longer they will stay healthy.
- Healthy lifestyle choices, e.g. abstinence, faithfulness to a partner and using a condom when having sex, all reduce the risk of becoming infected with HIV/AIDS.
- It is important to care for and support people who are living with HIV/AIDS. If the stigma of having the disease is removed, people will be more willing to have an HIV test. This means they can look after their health and reduce the risk of spreading the disease.
- Voluntary counselling and testing services are very important in educating and informing people about HIV/AIDS and supporting them both before and after an HIV test.
- It is important to develop personal skills such as assertiveness, decision making and problem solving to help you prevent HIV both personally and in society.

Review questions

Select the correct answer from A to D.

1. Which of the following is NOT a way to help prevent the spread of HIV/AIDS?
   A washing your hands after using the toilet
   B using a condom when you have sex
   C having only one sexual partner
   D not sharing needles for intravenous drug use
2. Which of the following best describes the cells which are attacked by the virus which causes HIV/AIDS?
   A white blood cells
   B lymphocytes
   C T-cells
   D B-cells
3. Which of these bodily fluids is not a source of HIV/AIDS infection?
   A semen
   B breast milk
   C blood
   D tears
4. The approximate total number of people infected with HIV in Ethiopia is:
   A a few hundred
   B a million
   C a thousand
   D a hundred thousand
5. What are the main ways in which HIV/AIDS can be spread from one person to another?
6. What are the main ways in which you can avoid the spread of HIV/AIDS?

End of unit questions

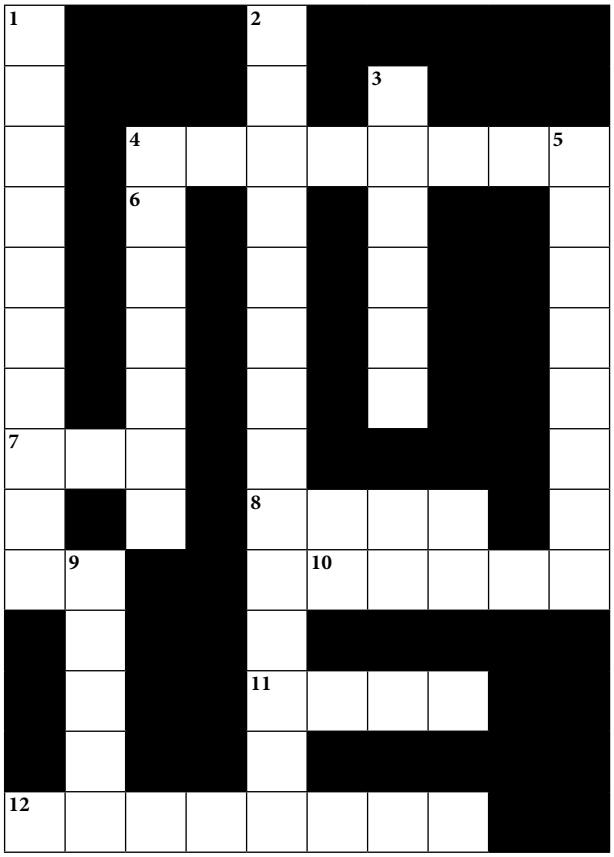
1. a) How did the work of Louis Pasteur help us understand how diseases are spread?
   b) Why is it so important that people in Ethiopia understand the germ theory of disease?
2. a) What is meant by the immune response of the body?
   b) Describe how you would develop natural active immunity to chickenpox.
3. Antibiotics have played a very important part in the successful treatment of many infectious diseases. Write an essay on antibiotics and the different ways in which they can destroy pathogens.
4. a) Describe how you would show that there are more bacteria on your hands before you wash them than after you wash them.
   b) How does the use of staining help doctors treat bacterial diseases better?
5. Doctors always try to use the lowest effective dose of an antibiotic. This makes the treatment as cheap as possible, and means there are higher doses to try if the disease persists.

   How could you investigate the lowest possible effective dose to use against a particular strain of bacteria?
6. a) What is a vaccine?
   b) Describe how a vaccine works.
   c) Would you say vaccines are effective? Explain your answer, giving suitable examples.
7. a) Define the term parasite.
   b) Explain how the pork tapeworm can infect a person, the symptoms of the disease, how it can be treated and how the spread of the disease can be prevented.
8. a) Which organ(s) are affected by tuberculosis?
   b) What is the causative agent for tuberculosis?
   c) What are the symptoms of a tuberculosis patient?
   d) How can tuberculosis be cured?
   e) How can i) individuals and ii) societies work to prevent the spread of tuberculosis?
9. Describe the stages of the lifecycle of the *Anopheles* mosquito and explain how it spreads disease and how it may be controlled.

10. a) What are the main similarities between cholera and typhoid?
    b) What are the main differences between cholera and typhoid?
    c) How can the spread of cholera and typhoid be prevented as far as possible?
11. Sexually transmitted diseases (STDs) are a problem in Ethiopia.
    a) Explain what is meant by the term 'sexually transmitted disease'.
    b) Syphilis is an example of sexually transmitted disease caused by a bacterium.
        i) Describe the signs and symptoms of this disease and explain how it is transmitted from one person to another.
        ii) How can an STD like syphilis be treated, and how can it be prevented?
12. Make a table comparing the advantages and disadvantages of modern and traditional medicines.
13. HIV/AIDS is a sexually transmitted disease that is a major problem in Ethiopia.
    a) How does HIV get into the body?
    b) How does HIV infect the body?
    c) Explain why HIV infection is such a problem.
14. a) What are the main stages and symptoms of HIV/AIDS?
    b) What treatments are available for HIV/AIDS?
    c) How can you reduce the risk of becoming infected with HIV?
15. Use figure 4.31 to help you answer this question.
    a) Name three African countries that have a higher prevalence of HIV/AIDS than Ethiopia.
    b) Name three African countries that have a lower prevalence of HIV/AIDS than Ethiopia.
    c) What is the approximate prevalence of HIV/AIDS in Ethiopia?
    d) Suggest three ways in which we could reduce the prevalence of HIV/AIDS in Ethiopia and for each method explain how it would work.
16. a) HIV/AIDS is very damaging both to individuals, to families and to the whole of Ethiopian society. Explain why.
    b) Explain how stigmatisation of people with HIV/AIDS makes the situation worse for individuals, families and the country.
    c) How can services such as VCTs improve the situation for individuals, families and society?

17. Use figure 4.32 to help you answer this question.
    a) What do these figures tell you about the incidence of HIV/AIDS infection in Ethiopia?
    b) What do these figures show you that needs to be done in Ethiopia as a priority?
    c) Why is it so important that pregnant women should be targeted and screened in the fight against HIV/AIDS?
18. Find out as much as you can about how the Government of Ethiopia is working to solve the problem of HIV/AIDS infection in the country.
19. Summarise the main ways in which young people can work together to keep themselves and others healthy and free from HIV infection, and help reduce the problems of HIV/AIDS in Ethiopia in the future.

Copy the crossword puzzle below into your exercise book (or your teacher may give you a photocopy) and solve the numbered clues to complete it.



Across

4 Single-celled organisms which may cause disease, be harmless or be useful to people (8)

7 Short form of tuberculosis (2)

8 The disease Aquired Immune Deficiency Syndrome is commonly known as **** (4)

10 What type of micro-organism causes HIV/AIDS? (5)

11 What class of disease are syphilis, gonorrhoea and chancroid? (4)

12 Large flatworm found in uncooked meat which can infect the human gut (8)

Down

1 Chemicals which can be used as medicines to cure bacterial diseases (10)

2 Organism which can only be seen under the microscope (13)

3 Organism which carries disease causing organisms from one host to another (6)

5 Unique protein markers on the surface of the cells (8)

6 Rubber protective used to prevent pregnancy and protect against STDs and HIV/AIDS (6)

9 VCTs offer counselling and support to ***** (5)