●●●●○ Level 4 · Science S4.4

Health, disease and immunity

What makes people ill, how the body fights back, and how medicines and clean habits help.

Sort diseases into those that pass from person to person and those that do not, and meet the four kinds of germ. Follow how germs spread and how clean water, soap and nets stop them. See how the body defends itself, how vaccines train it, and how antibiotics and new medicines work and are tested. Then look at malaria, HIV and tuberculosis, at the habits that raise the risk of heart disease, and at sexual health.

YOU ARE READY FOR THIS BOOK IF

You can explain how washing hands stops germs spreading.

One step up	S5.4 Physiology
This book	**S4.4 Health, disease and immunity**
One step down	S3.4 Growing up: puberty and reproduction

Contents

S4.4.1 Kinds of disease

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S4.4.5 Antibiotics and medicines

S4.4.6 Malaria, HIV and tuberculosis

S4.4.7 Lifestyle and disease

S4.4.8 Sexual health

Key words, A to Z

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S4.4.1 CHAPTER 1

Kinds of disease

> **Why can I catch a cold from a friend, but nobody can catch heart disease from me?**

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Every disease is caused by a germ, so every disease can pass from person to person.
- ☐ **B** Some diseases are caused by germs and pass between people. Others have different causes and cannot be caught.
- ☐ **C** A disease can pass from one person to another only by touch.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Cells, S3.1.8. It names bacteria and yeast and says that some microbes cause disease while others are useful.
- Level 4, Cells, photosynthesis and respiration, S4.1.1. It compares animal, plant and bacterial cells, which helps with the pathogens here.
- Level 1, My body, my senses, keeping well, S1.3.5, coming soon. It shows how washing gets rid of germs that make us ill.

BY THE END YOU CAN

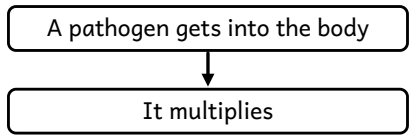
- Sort diseases into communicable and non-communicable
- Name the four kinds of pathogen with one disease each

A **disease** is a condition that stops part of the body from working as it should. Some diseases pass from one person to another. Others never do. This chapter sorts diseases into those two groups. Then it meets the tiny things that cause the first group.

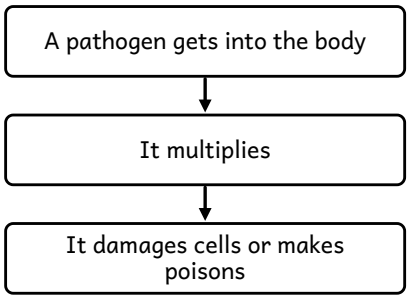
A **pathogen** is a germ that causes disease. A single pathogen is too small to see without a microscope. When enough of them get into a body, they can make a person ill.

DRAW IT FIRST

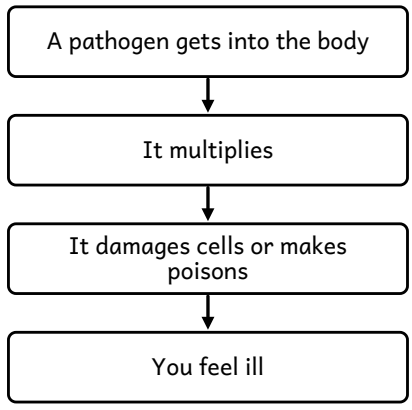
How a pathogen makes you ill



1 A pathogen gets into the body, for example in air that is breathed in. It multiplies, so one pathogen becomes many.



2 It damages cells or makes poisons. A poison made by a pathogen is called a toxin.



3 Then you feel ill, for example with a fever or a rash.

A **communicable disease** is caused by a pathogen and can pass from one person, or animal, to another. It is also called an infectious disease. Measles, influenza, cholera and malaria are communicable diseases.

A **non-communicable disease** cannot be passed from one person to another. Its causes include the genes you inherit, too little of a vitamin in your food, and tobacco smoke. Heart disease, sickle cell disease and scurvy are examples. Scurvy comes from too little vitamin C. An inherited disease passes from parents to a child in their genes, not by infection, so it is still non-communicable.

Disease	Passes on?
measles	yes
cholera	yes
heart disease	no
scurvy	no

Yes means the disease can pass from one person to another, so it is communicable. No means it is non-communicable.

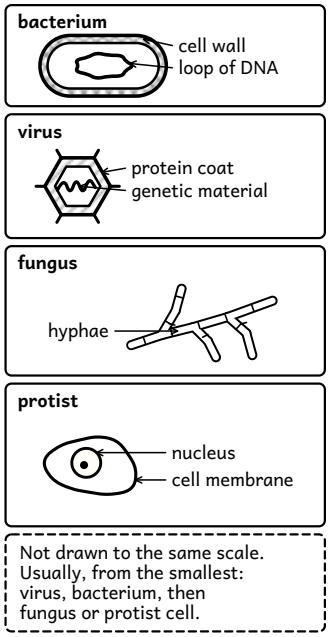
There are four kinds of pathogen. They are very different from each other. We meet them in order, starting with the one that most people have heard of.

Bacteria are single cells with no nucleus. Each has a cell wall and a loop of DNA. Most bacteria are harmless or helpful. A few cause diseases such as tuberculosis and cholera.

A **virus** is not a cell. It is genetic material inside a coat of protein. A virus can multiply only inside the living cells of another organism. Measles, influenza and HIV are caused by viruses.

Fungi include moulds and yeast. Some fungi live on the skin and cause athlete's foot and ringworm. Ringworm is not a worm. It is caused by a fungus.

A **protist** is a single celled living thing with a nucleus. Most protists are harmless. One kind causes malaria, a disease that a mosquito carries from person to person.



The four kinds of pathogen. Sizes vary a lot inside each kind. Hyphae are the thin threads that make up a fungus.

Most viruses are between about 20 nm and 300 nm across. Most bacteria are about 1 µm to 5 µm long. One micrometre is 1 000 nm. So a virus is usually many times smaller than a bacterium.

SEE IT THREE WAYS

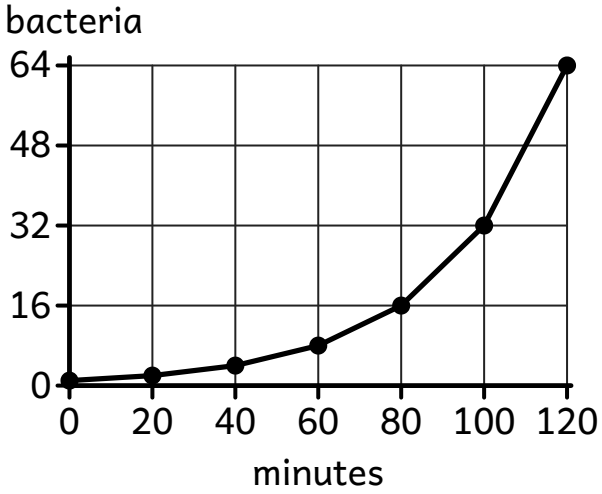
As a picture

Pathogen	One disease
bacterium	tuberculosis
virus	measles
fungus	athlete's foot
protist	malaria

In words

Each kind of pathogen causes its own diseases. Learn one disease for each kind and you can sort many others.

Bacteria multiply by dividing in two. In warm, moist food, some kinds divide about every 20 minutes. The graph shows one bacterium that does this. The number doubles with each division, so it grows faster and faster.



One bacterium that divides every 20 minutes, with none dying. The line bends upward because each division doubles the number.

WORKED EXAMPLE

A bacterium divides in two every 20 minutes. Use the graph to find how many bacteria there are after 100 minutes.

1. Find 100 minutes on the x axis, and go up to the line.
2. Read across to the y axis. The line is at 32.
3. Check by doubling. 100 ÷ 20 = 5 divisions, so 1 × 2 × 2 × 2 × 2 × 2 = 32.

Answer: 32 bacteria

WORKED EXAMPLE

Mei puts 5 bacteria on some warm food. Each one divides every 20 minutes. How many bacteria are there after 3 hours, if none die and the food does not run out?

1. 3 hours = 3 × 60 = 180 minutes.
2. Divisions: 180 ÷ 20 = 9.
3. Each division doubles the number. After 9 divisions it is multiplied by 512.
4. Number of bacteria: 5 × 512 = 2 560.

Answer: 2 560 bacteria

This cannot go on for ever. Real food runs out, and waste builds up. The sum shows why a few bacteria can make a person ill in a day, and why the body needs defences. The next chapters take up both.

TRY IT

Sort the diseases

You need: a sheet of paper, a pencil.

1. Tear the paper into eight slips.
2. Write one disease on each slip: measles, cholera, heart disease, malaria, scurvy, influenza, athlete's foot, sickle cell disease.
3. Make two piles. Put a disease in the first pile if a pathogen causes it and it can pass between people. Put the rest in the second pile.
4. For each slip in the first pile, write the kind of pathogen: bacterium, virus, fungus or protist.

What you will see: Five slips go in the first pile and three in the second. In the first pile, a bacterium causes cholera. Viruses cause measles and influenza. A fungus causes athlete's foot, and a protist causes malaria.

If you cannot try it, this is what happens.

Slip	Pile
measles	first
cholera	first
malaria	first
influenza	first
athlete's foot	first
heart disease	second
scurvy	second
sickle cell disease	second

A WRONG IDEA MANY PEOPLE HAVE

~~All germs make us ill.~~

Why it feels right: We mostly hear about germs when someone is ill, so they seem to be always harmful.

The test that breaks it: Yoghurt is made with the help of bacteria. Bread dough rises because yeast, a fungus, grows in it. Bacteria live in your gut all your life and cause no harm.

What is true: Only a small share of bacteria, fungi and other microbes are pathogens. Most are harmless, and many are useful.

KEY WORDS

disease
a condition that stops part of the body working as it should.

pathogen
a germ that causes disease.

communicable disease
a disease caused by a pathogen that can pass from one person to another.

non-communicable disease
a disease that no pathogen causes, so nobody catches it from another person.

bacteria
single cells with no nucleus. A few cause disease.

virus
genetic material in a protein coat. It multiplies only inside living cells.

fungi
moulds and yeast. Some cause skin diseases.

protist
a single celled living thing with a nucleus. One kind causes malaria.

BACK TO YOUR GUESS

The answer is B: Some diseases are caused by germs and pass between people. Others have different causes and cannot be caught.

Only a disease caused by a pathogen can pass from person to person. Heart disease has other causes, so nobody can catch it. And a pathogen does not need touch: some travel in air, in water or in food.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which of these is a communicable disease?

    A Heart disease

    B Sickle cell disease

    C Measles

    D Scurvy

    Answer at the back of the book.

2. What does non-communicable mean?

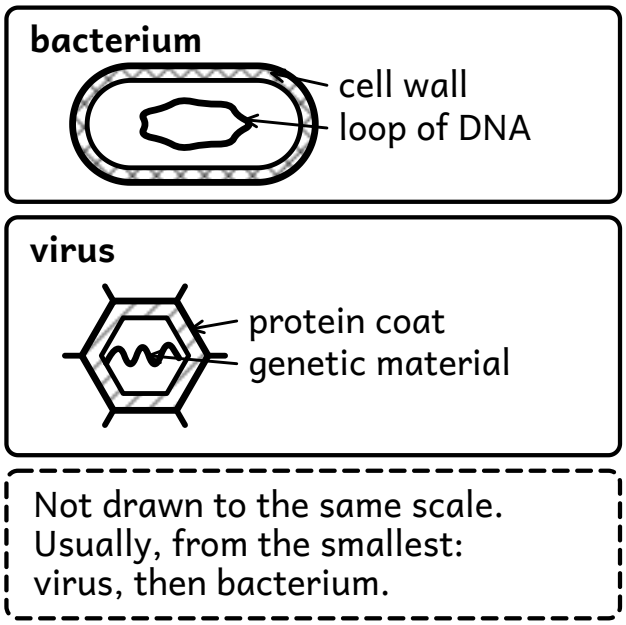
    A It cannot be passed from one person to another.

    B It cannot be treated by a health worker.

    C It is caused by a virus.

    Answer at the back of the book.

3. Look at the picture of two pathogens. Which one is not a cell?



A The bacterium

B The virus

C Both are cells.

Answer at the back of the book.

4. Which kind of pathogen causes malaria?

A A bacterium

B A virus

C A fungus

D A protist

Answer at the back of the book.

5. Which pair of disease and pathogen is right?

A Measles: a bacterium

B Cholera: a virus

C Tuberculosis: a bacterium

D Athlete's foot: a protist

Answer at the back of the book.

6. Which statement about bacteria is true?

   A Most are harmless or helpful, and a few cause disease.

   B All bacteria cause disease.

   C Bacteria are the smallest kind of pathogen.

   Answer at the back of the book.

7. How can a virus multiply?

   A By dividing in two, as a bacterium does.

   B Only inside the living cells of another organism.

   C In any warm, moist food.

   D In water, if it is clean.

   Answer at the back of the book.

8. A bacterium divides in two every 20 minutes. How many bacteria come from one bacterium after 2 hours, if none die?

   Answer at the back of the book.

9. 50 people ate the same meal. 20 of them became ill with an infection caused by bacteria. What percentage of the people became ill?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A disease that a pathogen causes and that passes between people is communicable. Other diseases are non-communicable. The pathogens are bacteria, viruses, fungi and protists. Tuberculosis, measles, athlete's foot and malaria are one example of each.

Draw: Four boxes named bacteria, virus, fungus and protist, each with one disease written beside it.

S4.4.2 CHAPTER 2

How diseases spread

How does a germ get from one person to another when nobody even touches?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Germs pass only when two people touch.
- ☐ **B** Germs travel only through the air.
- ☐ **C** Germs can travel in the air, in water, in food, on hands, in blood and on insects.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Cells, S3.1.8. It says that some microbes cause disease and others are useful.
- Level 2, Bones, muscles, teeth and food, S2.3.8. It explains how flies and dirty hands carry germs to food.
- Level 1, My body, my senses, keeping well, S1.3.5, coming soon. It shows how to wash hands well with soap and water.

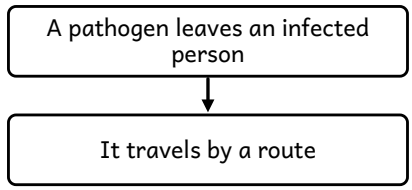
BY THE END YOU CAN

- Explain how diseases spread by air, water, food, touch, blood and insects
- Explain how mosquito nets, clean water and toilets cut disease

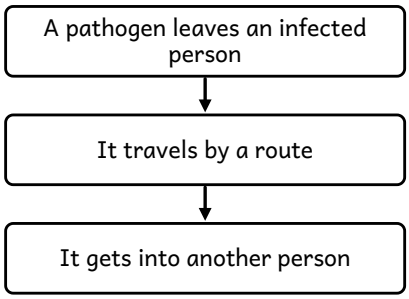
In the last chapter you met pathogens. A pathogen causes disease only when it gets into a body and multiplies there. This is an **infection**. For a communicable disease to spread, a pathogen must leave one body and get into another. The way it travels is its **route**.

DRAW IT FIRST

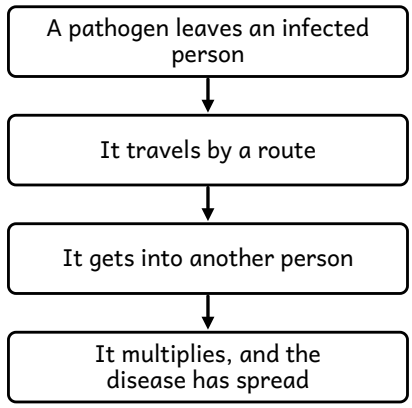
A pathogen on the move



1 A pathogen leaves an infected person, for example in a cough or in waste from the body. It then travels by one of the routes.

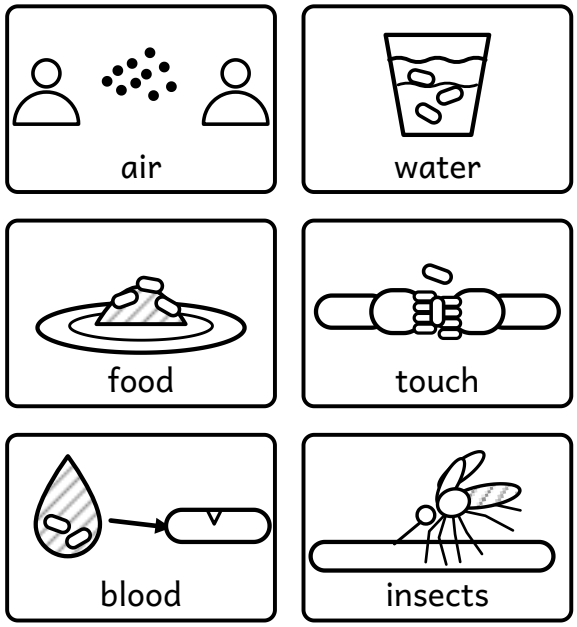


2 It gets into another person, who is now infected.



3 It multiplies in that person, who may now pass it on. Cutting any step stops the spread.

There are six main routes. The picture shows all six. A rod stands for a pathogen. Rods are not to scale: real pathogens are far smaller.



The six routes. A rod is a pathogen, drawn much too large to see.

The air route. A person with influenza, measles or tuberculosis breathes out tiny **droplets** of liquid when they cough, sneeze or talk. The droplets carry pathogens. A person nearby breathes them in. Covering the mouth when coughing, and fresh air in a room, cut this route.

The water route. Some pathogens leave the body in faeces. If faeces get into a river, a pool or a well, the water is **contaminated**, which means it carries pathogens. Cholera spreads this way. Anyone who drinks the water can be infected.

The food route. Pathogens can get onto food from dirty hands, from dirty water or from flies. Bacteria then multiply on the food, fastest when it is warm. Cooking food fully, keeping it covered and keeping it cool cut this route.

The touch route. Some pathogens pass when skin touches skin, or when a hand touches a surface and then your face. Athlete's foot and ringworm spread this way, and so do many colds. Washing hands cuts this route.

The blood route. A few pathogens, such as HIV, are in the blood of an infected person. They pass when infected blood gets into another person's body, for example through a shared needle. HIV also passes in some other body fluids, as chapter 6 explains. These pathogens do not pass by a touch, a hug or a shared cup.

The insect route. An animal that carries a pathogen from one host to another is a **vector**. The mosquito is the vector of malaria. It bites an infected person and takes up pathogens. Later it bites another person and passes them on.

Each route can be cut. Good **hygiene**, which means habits that keep you and your surroundings clean, blocks many routes at once.

SEE IT THREE WAYS

As a picture

Control	Route cut
covering coughs	air
clean water	water
toilets	water
cooked food	food
hand washing	touch
bed nets	insects

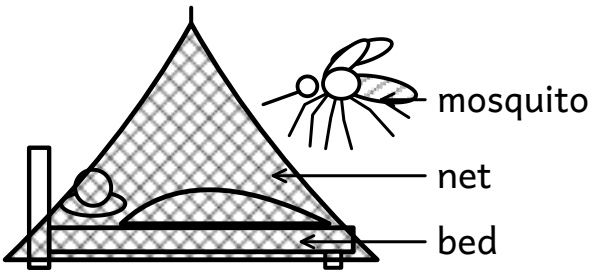
In words

Each control cuts one route. A toilet keeps faeces away from water, food and hands. Clean water has no pathogens in it. Soap and water lift pathogens off the hands. A net keeps mosquitoes off a sleeping person.

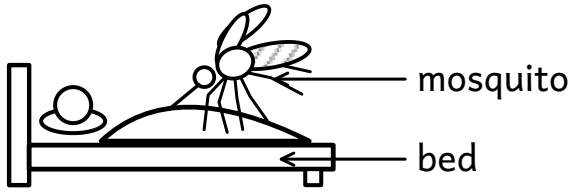
Clean water is treated or protected so that faeces cannot get into it. Water that may be contaminated can be made safer by boiling it. Toilets and drains take faeces away from people, water and food. Together these cut the water route, which is why cholera is now rare where they are in place.

Hand washing needs soap and water. Soap lifts dirt and pathogens off the skin, and the water rinses them away. Water alone removes less. The best times to wash are after using the toilet and before cooking or eating.

In places with malaria, a bed net hangs over the bed. Many of the mosquitoes that carry malaria bite at night. The net is a barrier between the mosquito and the sleeper. Removing standing water also helps, because mosquitoes lay their eggs in it.

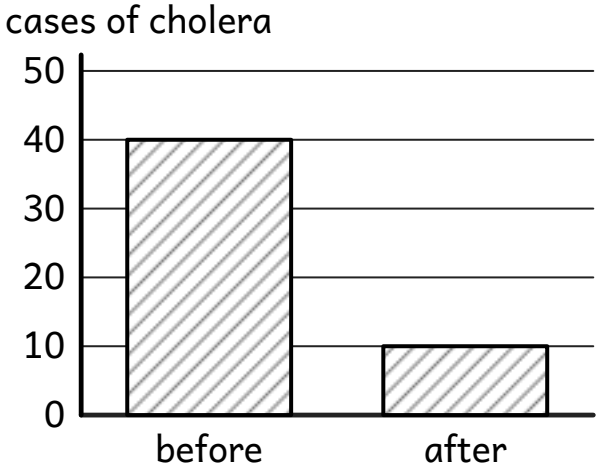


The net blocks the mosquito, as long as it has no holes and is tucked in all round.



The same bed with no net. Nothing stands between the mosquito and the sleeper.

We can measure how well a control works. The bar chart shows cases of cholera in a village each year, before and after a clean well was built. The numbers are an example, made up to show the method.



Cases of cholera in one village in the year before and the year after a clean well. Example numbers.

WORKED EXAMPLE

Use the bar chart. By what percentage did the cases of cholera fall after the well was built?

1. Read the bars. Before: 40 cases. After: 10 cases.
2. The fall is 40 − 10 = 30 cases.
3. Percentage fall = fall ÷ before × 100 = 30 ÷ 40 × 100 = 75.

Answer: 75%

WORKED EXAMPLE

The village has 800 people. How many cases of cholera were there for every 1 000 people in the year before the well?

1. There were 40 cases among 800 people.
2. Divide the cases by the people: 40 ÷ 800 = 0.05.
3. Multiply by 1 000: 0.05 × 1 000 = 50.

Answer: 50 cases

TRY IT

Watch a touch spread

You need: a little flour on a plate, a cup, a tray or a big sheet of paper, a bowl of water and soap, a clean cloth.

Be safe: Keep flour away from your eyes, nose and mouth, and do not taste it. Do not do this if flour makes you ill. Clean up with a damp cloth, not a dry brush that lifts dust. An adult should be near.

1. Work over the tray. Rub a pinch of flour on both hands. The flour stands for pathogens.
2. Pick up the cup, then touch a door handle or a table. Look at what you leave behind.
3. Dip your hands in water only. Rub them for a few seconds and look at them.
4. Now wash with soap and water. Rub the palms, backs and between the fingers for about 20 seconds, then rinse. Look again.

What you will see: The flour spreads to everything you touch. Water alone leaves some flour on your hands. Soap and water removes almost all of it. Flour is only a model. Real pathogens are too small to see, so wash even when your hands look clean.

If you cannot try it, this is what happens.

Step	Flour on
rub on hands	hands
touch a cup	cup
touch a door	door
rinse in water	some left
wash with soap	almost none

A WRONG IDEA MANY PEOPLE HAVE

~~Malaria is caught from bad air near a swamp, or from a sick person who breathes on you.~~

Why it feels right: People get malaria most near still water. A person with malaria has a fever, which looks like a disease that spreads through the air.

The test that breaks it: Put a net over the bed in the same place and fewer people get malaria, even though the air is the same. A sick person cannot give you malaria by breathing on you or touching you. Nearly every case needs the mosquito.

What is true: Malaria is spread by the bite of an infected mosquito, which breeds in still water. It does not travel through the air or pass by touch.

KEY WORDS

infection
a pathogen that has got into the body and is multiplying.

route
the way a pathogen travels from one person to another.

droplets
tiny drops of liquid breathed out in a cough or sneeze. They can carry pathogens.

contaminated
carrying pathogens or other harmful things. Water can be contaminated.

vector
an animal that carries a pathogen from one host to another.

hygiene
habits that keep you and your surroundings clean and so cut the spread of disease.

BACK TO YOUR GUESS

The answer is C: Germs can travel in the air, in water, in food, on hands, in blood and on insects.

A pathogen must leave one body and get into another. There are six main routes: air, water, food, touch, blood and insects. Each route can be cut, and that is how clean habits and nets protect people.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. A person with influenza sneezes. How can the pathogen reach other people in the room?

   A In blood.

   B By mosquitoes.

   C In drinking water.

   D In droplets that other people breathe in.

   Answer at the back of the book.

2. Why do toilets cut the spread of cholera?

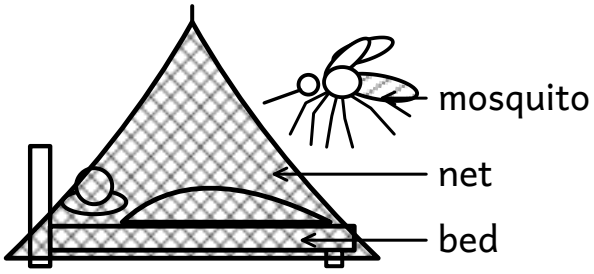
   A They keep faeces away from water, food and hands.

   B They kill the bacterium in the water.

   C They stop mosquitoes from biting.

   Answer at the back of the book.

3. Look at the picture of the bed with a net. Why does the net protect the sleeper from malaria?



A It kills the malaria pathogens in the air.

B It stops the mosquito reaching the sleeper to bite.

C It keeps out the air that carries malaria.

Answer at the back of the book.

4. Why is washing hands with soap and water better than a quick rinse in water?

A Soap kills every pathogen on the skin at once.

B Water alone washes off nothing.

C Soap lifts pathogens off the skin, and the water rinses them away.

D Soap makes the skin tough, so pathogens cannot get in.

Answer at the back of the book.

5. Which word means an animal that carries a pathogen from one host to another?

A A vector

B A toxin

C A droplet

Answer at the back of the book.

6. Which action cuts the spread of disease through food?

A Leaving cooked food in a warm place until later.

B Cooking food fully and keeping it covered.

C Washing hands only after eating.

D Covering a cough with the same hand that handles the food.

Answer at the back of the book.

7. **From an earlier chapter**

   Why can nobody catch scurvy from another person? Use what you learned in the last chapter.

   A It is a non-communicable disease, so a pathogen does not pass it on.

   B It is caused by a bacterium in old food.

   C It is caused by a fungus that only lives on the skin.

   Answer at the back of the book.

8. In a village, 80 cases of a disease in one year fell to 20 cases in the next, after clean water came. By what percentage did the cases fall?

   Answer at the back of the book.

9. A town of 500 people had 30 cases of a disease in a year. How many cases is that for every 1 000 people?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Pathogens spread by air, water, food, touch, blood and insects. Each route can be cut: covered coughs, clean water, toilets, cooked food, soap and water, and bed nets.

Draw: Six small boxes, one for each route, each with the control that cuts it written under it.

S4.4.3 CHAPTER 3

The body's defences

Germs are everywhere. Why are we not ill all the time?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** The body has barriers that keep most pathogens out, and cells that destroy the ones that get in.
- ☐ **B** Germs cannot live in or on a human body, so none ever get in.
- ☐ **C** Germs only harm people who are dirty, and clean people are never infected.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Body systems, S3.3.6. It names what blood carries and the cells in it.
- Level 3, Body systems, S3.3.2. It follows food into the stomach, where the acid is.
- Level 3, Body systems, S3.3.5. It shows the airways that mucus and cilia line.
- Level 3, Cells, S3.1.5. It shows how cells are shaped for their jobs, as white blood cells are.

BY THE END YOU CAN

- Describe skin, mucus and stomach acid as defences
- Explain how white blood cells engulf pathogens and make antibodies

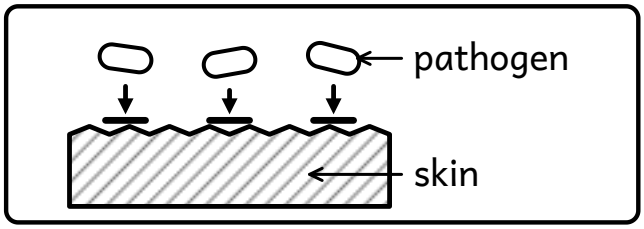
You breathe in pathogens, swallow them and pick them up on your skin every day. Most days you do not become ill. The body has two lines of defence. The first line keeps pathogens out. The second line destroys the ones that get in.

Line	What it does
first	keeps pathogens out
second	kills those inside

The two lines of defence.

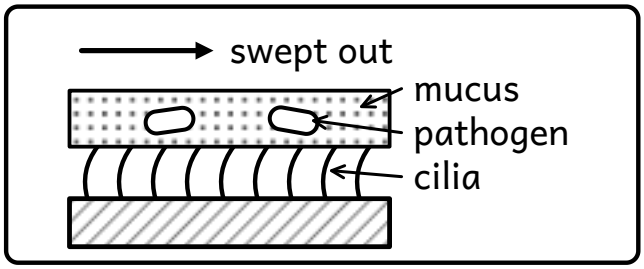
The first line has three parts. We take them in turn. Look at each picture and find the labels.

The skin is a tough barrier that most pathogens cannot get through. If the skin is cut, the blood clots and a scab seals the cut. This stops pathogens getting in while the skin heals.



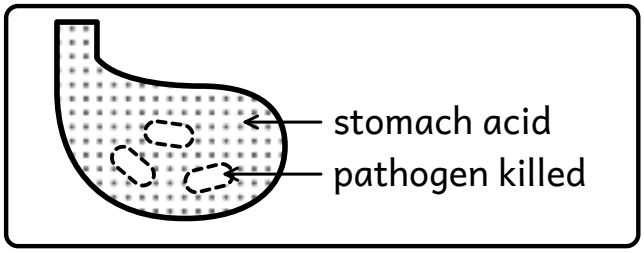
Skin is a barrier. A rod is a pathogen, drawn much too large. An arrow that ends at a bar is a pathogen that cannot pass.

You must breathe, so the airways cannot be closed. Instead, the airways are lined with cells that make **mucus**, a sticky liquid. Pathogens and dust stick to the mucus. Other cells in the lining have **cilia**, which are tiny hairs. The cilia beat together and sweep the mucus up and out of the airways to the throat. There it is swallowed or coughed out.



Mucus traps pathogens. Cilia sweep the mucus out of the airway.

Mucus that is swallowed, and pathogens that come in with food and drink, reach the stomach. The stomach makes a strong acid. It kills most of the pathogens that reach it.



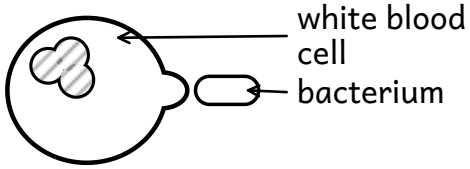
Stomach acid kills pathogens. A rod with a broken outline is a dead pathogen.

Some pathogens still get in, for example through a cut or in a breath. Then the second line begins. Blood carries **white blood cells**. They are fewer than red blood cells, but they are the cells that defend the body. They have three jobs, and we take them in turn.

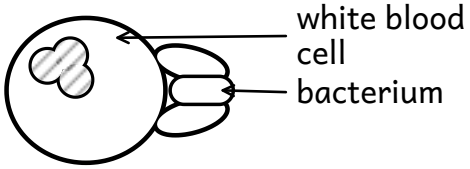
The first job is to take in pathogens. A **phagocyte** is a white blood cell that reaches out, wraps round a pathogen and takes it inside. Enzymes in the cell then digest the pathogen, which means they break it down. The picture shows the three steps.

DRAW IT FIRST

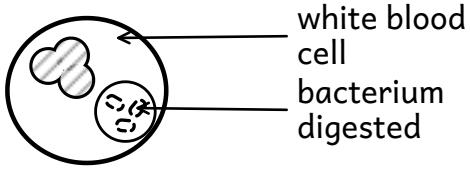
A phagocyte takes in a bacterium



1 The white blood cell reaches out towards a bacterium.

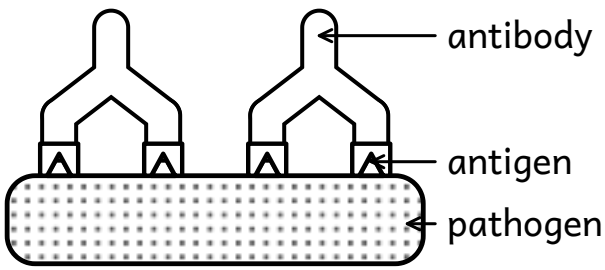


2 It wraps round the bacterium.



3 The bacterium is now inside the cell. The cell digests it, and the pieces are shown broken apart.

The second job is to make antibodies. Every pathogen has chemicals on its surface called ***antigens***. Your body does not make them. White blood cells notice an antigen they do not know and make ***antibodies*** against it. An antibody is a protein with a tip of one shape. It fits one kind of antigen, as a key fits one lock.

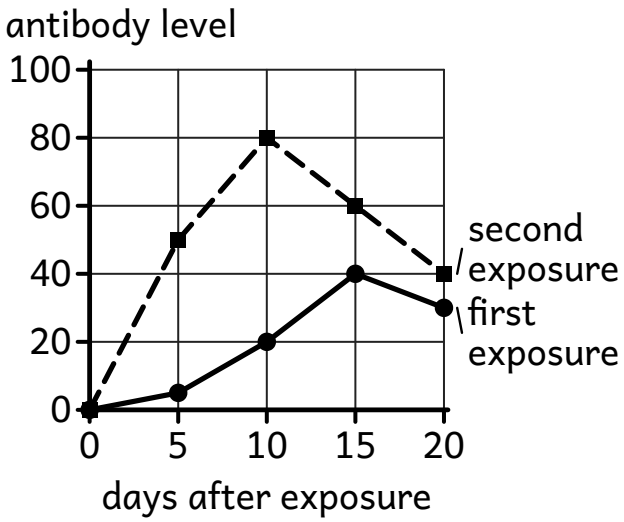


An antibody fits its antigen. A different antibody, with a different tip, would not fit.

Antibodies stick to the pathogens. This can clump the pathogens together, so that phagocytes can find them. The third job is to make antitoxins. An antitoxin cancels a poison that a pathogen makes.

The body takes days to make enough antibodies against a new pathogen. By then the pathogen may have multiplied, and you may feel ill. After the infection, a few of the white blood cells stay in the blood for years. These are **memory cells**. They remember the antigen.

If the same pathogen gets in again, the memory cells make the right antibody quickly and in large amounts. The pathogen is destroyed before it can make you ill. You are then immune to that disease. This protection is called **immunity**. The graph shows the pattern. The numbers are an example.



Antibody level after a first and a second exposure to the same pathogen. A typical pattern with example numbers, not a measurement.

WORKED EXAMPLE

Use the graph. How many times higher is the highest antibody level after the second exposure than after the first?

1. The solid line peaks at 40. The dashed line peaks at 80.
2. Divide the second peak by the first: 80 ÷ 40 = 2.

Answer: 2 times

WORKED EXAMPLE

Use the graph. How many days sooner does the antibody level peak after the second exposure than after the first?

1. The solid line peaks on day 15.
2. The dashed line peaks on day 10.
3. The second peak comes 15 − 10 = 5 days sooner.

Answer: 5 days

Blood holds far more red cells than white cells. Take 1 mm^3 of blood from a healthy adult. A count might find about 5 000 000 red blood cells and 7 000 white blood cells. There are few white cells, but they work all the time.

TRY IT

A sticky trap for dust

You need: two pieces of card or stiff paper, a few drops of cooking oil, a pinch of flour, a tray.

Be safe: Do not blow the flour or breathe in the dust. Keep it away from your face and do not taste it. Wipe up with a damp cloth. Do not do this if flour makes you ill.

1. Rub a thin film of oil over one card. Leave the other card dry.
2. Hold both cards over the tray. Sprinkle a pinch of flour on each.
3. Tilt both cards and tap them gently. Watch the flour.

What you will see: The flour slides off the dry card. It sticks to the oiled card. Mucus is sticky in the same way, so it holds dust and pathogens until the cilia sweep them away. This is only a model. Real mucus is not oil.

If you cannot try it, this is what happens.

Card	Flour after tilting
dry	slides off
oiled	sticks

A WRONG IDEA MANY PEOPLE HAVE

~~Antibodies are cells that swallow pathogens.~~

Why it feels right: The words antibody and white blood cell are used together, and both fight pathogens.

The test that breaks it: Look at the picture of the antibody and the picture of the phagocyte. An antibody is a small protein with a Y shape. A phagocyte is a whole cell with a nucleus.

What is true: An antibody is a protein made by a white blood cell. It sticks to an antigen. A phagocyte is a white blood cell that takes pathogens in.

KEY WORDS

mucus
a sticky liquid in the *a*irways that traps pathogens *a*nd dust.

cili*a*
tiny h*a*irs on cells that sweep mucus out of the *a*irways.

white blood cells
cells in the blood that defend the body *a*gainst pathogens.

phagocyte
a white blood cell that t*a*kes in *a* p*a*thogen *a*nd digests it.

***a*ntigens**
chemic*a*ls on the surf*a*ce of *a* p*a*thogen that the body does not m*a*ke.

***a*ntibodies**
proteins that fit one *a*ntigen *a*nd stick to the p*a*thogen.

memory cells
white blood cells that st*a*y in the blood *a*nd remember *a*n *a*ntigen.

immunity
protection from *a* dise*a*se, bec*a*use the body c*a*n m*a*ke the right *a*ntibody quickly.

BACK TO YOUR GUESS

The answer is A: The body has barriers that keep most pathogens out, and cells that destroy the ones that get in.

Pathogens do get on and into the body every day. The body has two lines of defence. The first keeps most of them out. The second is made of white blood cells, which destroy the ones that get in.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which defence kills pathogens that are swallowed?

   A Skin

   B Cilia

   C Stomach acid

   Answer at the back of the book.

2. What do cilia do in the airways?

   A They make antibodies against pathogens.

   B They kill pathogens with acid.

   C They take oxygen from the air into the blood.

   D They sweep the mucus, with the pathogens in it, out of the airways.

   Answer at the back of the book.

3. What does a phagocyte do?

   A It makes antibodies.

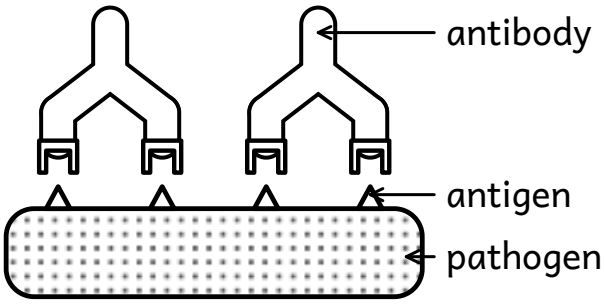
   B It takes a pathogen into itself and digests it.

   C It carries oxygen round the body.

   D It makes the mucus in the airways.

   Answer at the back of the book.

4. Look at the picture. Why will these antibodies not stick to the pathogen?



   A The pathogen is too big for any antibody.

   B The tips of the antibodies are not the shape of the antigens.

   C Antibodies can stick only to a pathogen that is already dead.

   Answer at the back of the book.

5. Why is a person usually not ill the second time the same pathogen gets in?

   A Antibodies from the first time stay in the blood at a high level for ever.

   B Skin gets tougher after the first infection.

   C The body can now fight off every kind of pathogen.

   D Memory cells make the right antibodies quickly and in large amounts.

   Answer at the back of the book.

6. Which statement about an antibody is true?

   A It fits one kind of antigen.

   B It fits every kind of antigen.

   C It is a cell that takes in pathogens.

   D It is made by the pathogen.

   Answer at the back of the book.

7. **From an earlier chapter**

   Which control cuts the spread of cholera?

   A A bed net

   B Toilets that keep faeces away from drinking water

   C Covering the mouth when coughing

   Answer at the back of the book.

8. A count of 1 mm^3 of blood finds 5 000 000 red blood cells and 8 000 white blood cells. About how many red cells are there for each white cell?

   Answer at the back of the book.

9. After a first infection the antibody level peaks at 20. After a second infection by the same pathogen it peaks at 60. How many times higher is the second peak?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

First line: skin, mucus with cilia, stomach acid. Second line: white blood cells. Phagocytes take pathogens in. Antibodies fit one antigen. Memory cells give a faster, bigger response next time.

Draw: A pathogen with a triangle antigen, and a Y shaped antibody with a triangle tip fitted onto it.

S4.4.4 CHAPTER 4

Vaccination

How can a vaccine protect me from a disease I have never had?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** A vaccine kills the pathogen after it gets into the body.
- ☐ **B** A vaccine gives you antibodies that other people made.
- ☐ **C** A vaccine makes the skin tougher, so pathogens cannot get in.
- ☐ **D** A vaccine shows the body a harmless form of the pathogen, so it learns to defend itself before the real one comes.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Cells, S3.1.5. It shows how cells are shaped for their jobs, as white blood cells are.
- Level 3, Body systems, S3.3.6. It names what blood carries and the cells in it.
- Level 1, My body, my senses, keeping well, S1.3.5, coming soon. It shows how to wash hands well with soap and water.

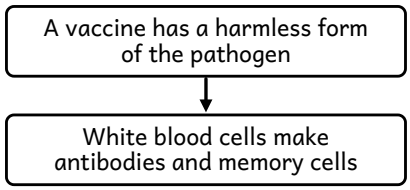
BY THE END YOU CAN

- Explain how a vaccine trains the body to respond faster
- Explain how herd immunity protects people who cannot be vaccinated

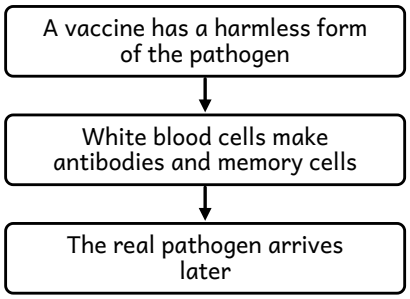
In the last chapter, memory cells gave a fast response the second time a pathogen got in. The first time, the response was slow, and the person may have been ill. A **vaccine** gives the body that first meeting safely. This is **vaccination**.

DRAW IT FIRST

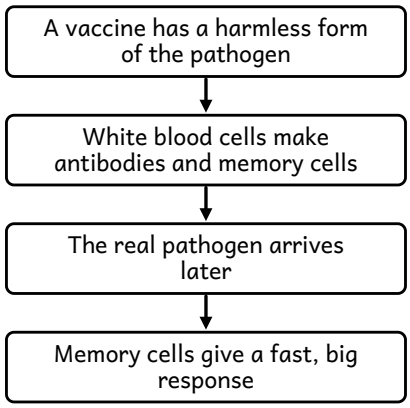
How *a* vaccine works



1 The vaccine holds *a* harmless form of the pathogen. White blood cells meet its antigens, make antibodies and leave memory cells.



2 Days or weeks later, the real pathogen gets into the body.

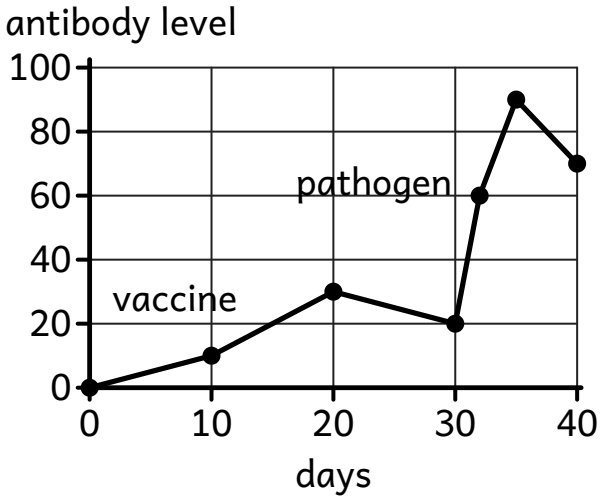


3 The memory cells make the right antibodies quickly and in large amounts. The pathogen is destroyed before it can make the person ill.

What is in *a* vaccine? It holds the antigens of *a* pathogen, but it cannot cause the full disease. There are several ways to do this. The pathogen may be dead. It may be weakened. The vaccine may hold only *a* part of the pathogen, such as *a* protein

from its surface. Some newer vaccines give the body's cells instructions to make just one antigen.

Because of this, a vaccine is given to prevent a disease. It is not a cure for someone who is already ill. It prepares the body before the real pathogen comes.



Antibody level after a vaccine on day 0 and the real pathogen on day 30. The rise after the vaccine is slow and small. The rise after the pathogen is fast and large. Antibody level is in made up units. Example numbers.

Vaccines are tested for safety before they are used, in the way that you will see in the next chapter. Mild effects are common, such as a sore arm or a short fever. They are signs that the body is responding. A **side effect** is an effect of a medicine that is not the one wanted. Serious side effects are rare. Health workers keep watching and recording them after a vaccine is in use.

No vaccine works on every person every time. Some people cannot be vaccinated. Babies may be too young. Some people have an illness or a treatment that weakens their white blood cells. For them, a vaccine would not work, or would not be safe. How are they protected?

A pathogen needs a path from person to person. Each person who is **immune** is a break in the path. If enough people are immune, the pathogen reaches few people. The people who cannot be vaccinated are then protected by the rest. This is **herd immunity**.

We can show it with a model. People stand in a grid. A person who is infected passes the disease to each neighbour who is not vaccinated. A neighbour is the

person next to them, above, below, left or right. Vaccinated people are hatched. A cross marks an infected person.



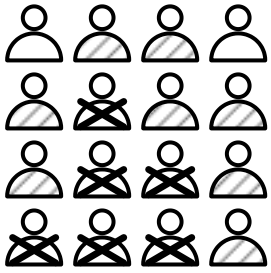
 vaccinated

 infected

 not vaccinated

16 of 16 people infected

Nobody is vaccinated. The infection starts with one person and spreads to everybody.



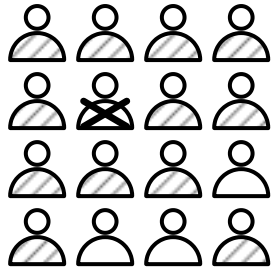
 vaccinated

 infected

 not vaccinated

6 of 16 people infected

Half of the people are vaccinated. The infection reaches only some of the people who are not. Two of them stay well.



vaccinated

infected

not vaccinated

1 of 16 people infected

Three quarters of the people are vaccinated. Only the first person is infected. The others who are not vaccinated are protected by the people around them.

SEE IT THREE WAYS

As a picture

Vaccinated	Infected
0 of 16	16 of 16
8 of 16	6 of 16
12 of 16	1 of 16

In words

The more people are vaccinated, the fewer people are infected, and the people who cannot be vaccinated are safer. The grids are a model. Real people meet in many ways, so real numbers differ.

How many people need to be immune? It depends on the disease. The more infectious a disease is, the larger the share must be. Measles is highly infectious, so about 19 people in every 20 need to be immune.

WORKED EXAMPLE

Use the grid where three quarters of the people are vaccinated. What percentage of the 16 people are vaccinated?

1. The grid has 4 rows of 4 people, so 4 × 4 = 16 people.
2. Vaccinated people: 12.
3. Percentage = 12 ÷ 16 × 100 = 75.

Answer: 75%

WORKED EXAMPLE

Use the grid where half of the people are vaccinated. Six people are infected. How many people who are not vaccinated stayed well?

1. People not vaccinated: 16 − 8 = 8.
2. People infected: 6, all of them not vaccinated.
3. Not vaccinated and still well: 8 − 6 = 2.

Answer: 2 people

TRY IT

Spread an infection on paper

You need: a sheet of paper and a pencil, a cup of dry beans: 12 of one kind and 8 of another, a ruler.

Be safe: Keep beans out of mouths, and away from small children. Do not eat the beans you used.

1. Draw a grid of 4 rows and 4 columns of squares on the paper. That is 16 squares, each one a person.
2. Use 12 of the first kind and 4 of the second. Shake these 16 beans in the cup. Tip them out and put one bean on each square. The first kind stands for a vaccinated person.
3. Pick any square with a bean of the other kind. That person is infected. Mark it with a cross.
4. Mark a cross on each square next to it, above, below, left or right, that holds a bean of the other kind. Keep going from every new cross until no more squares can be marked.
5. Count the crosses. Then repeat with 8 of each kind, and compare.

What you will see: With 12 vaccinated people, the infection usually reaches only a few. With only 8, it usually reaches more. Your result changes with how the beans fall, so repeat it a few times. The picture is one example.

If you cannot try it, this is what happens.

Vaccinated	Crosses
12 of 16	a few
8 of 16	more

A WRONG IDEA MANY PEOPLE HAVE

~~A vaccine gives you the disease it protects against.~~

Why it feels right: A vaccine does hold a form of the pathogen, and some people have a sore arm or a short fever afterwards.

The test that breaks it: Many vaccines hold only dead pathogens or a part of one, which cannot multiply or cause the disease. Where a weakened pathogen is used, it is weakened so that it cannot cause the full disease in a healthy person.

What is true: A vaccine trains the body without causing the disease. A mild effect such as a sore arm shows that the white blood cells are responding.

KEY WORDS

vaccine
a harmless form of a pathogen, or a part of one, given to prepare the body.

vaccination
giving a vaccine, so that the body can make memory cells before the real pathogen comes.

side effect
an effect of a medicine that is not the one wanted.

immune
able to destroy a pathogen quickly, because memory cells can make the right antibody at once.

herd immunity
protection of people who are not immune, because enough of the others are immune that the pathogen cannot spread.

BACK TO YOUR GUESS

The answer is D: A vaccine shows the body a harmless form of the pathogen, so it learns to defend itself before the real one comes.

A vaccine trains the body. It holds a dead or weakened pathogen, or a part of one. White blood cells make antibodies against it and leave memory cells. When the real pathogen comes, the response is fast and big.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What does a vaccine hold?

   A A harmless form of a pathogen, or a part of one.

   B Ready made antibodies from another person.

   C A medicine that kills the pathogen.

   D The living, fully active pathogen.

   Answer at the back of the book.

2. Why is a person vaccinated against a disease often safe from it later?

   A The vaccine stays in the body and kills the pathogen when it arrives.

   B The skin changes so that the pathogen cannot get in.

   C Memory cells make the right antibody quickly and in large amounts.

   Answer at the back of the book.

3. What is herd immunity?

   A Immunity that only animals have.

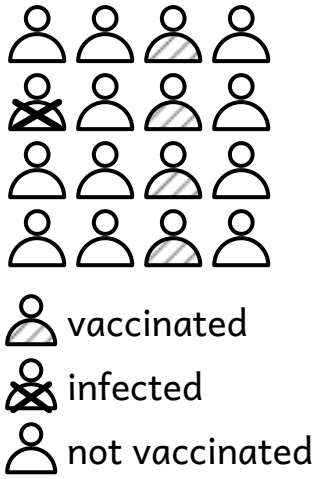
   B When everybody has caught the disease.

   C When enough people are immune that the pathogen cannot spread far, so people who are not immune are protected too.

   D When one person's antibodies pass into another person.

   Answer at the back of the book.

4. Look at the grid. How many people are infected when the infection stops spreading?



Answer at the back of the book.

5. Look back at the grid where three quarters of the 16 people are vaccinated. How many of the 16 people are not infected?

Answer at the back of the book.

6. A grid has a column of vaccinated people between the first infected person and the last column. Why are the people in the last column not infected, although they are not vaccinated?

A They are far from the first person.

B Their neighbours on the other side are vaccinated, so the infection cannot reach them.

C People who are not vaccinated can never be infected.

Answer at the back of the book.

7. Which people does herd immunity help most?

A People who cannot be vaccinated, such as babies who are too young.

B Nobody, unless every single person is vaccinated.

C Only the people who were vaccinated.

Answer at the back of the book.

8. Which statement about vaccines is true?

   A They are tested for safety. Mild effects such as a sore arm are common, and serious effects are rare.

   B They are not tested, because they hold only dead pathogens.

   C A vaccine is a cure for a person who is already ill.

   D They usually give the disease that they protect against.

   Answer at the back of the book.

9. **From an earlier chapter**

   What is an antigen?

   A A cell that takes in pathogens.

   B A chemical on the surface of a pathogen that the body does not make.

   C A protein made by white blood cells to fit a pathogen.

   Answer at the back of the book.

10. In a town of 200 people, 150 are vaccinated. What percentage of the people are vaccinated?

    Answer at the back of the book.

11. About 95 in every 100 people need to be immune to stop a disease spreading. How many people is that in a town of 400?

    Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A vaccine holds a harmless form of a pathogen. White blood cells make antibodies and memory cells. The real pathogen then meets a fast, big response. Herd immunity protects people who cannot be vaccinated.

Draw: A row of people with the vaccinated ones shaded, and an arrow of infection that stops at the shaded people.

S4.4.5 CHAPTER 5

Antibiotics and medicines

Why did the health worker say that antibiotics will not help my cold?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Antibiotics work on every pathogen, but only if they are taken for a long time.
- ☐ **B** Antibiotics work only on people who are not very ill.
- ☐ **C** A cold is caused by a virus, and antibiotics kill bacteria, not viruses.

IF THIS FEELS HARD, READ THIS FIRST

- Level 4, Evolution and ecology, S4.3.1. It explains natural selection, which is how bacteria become resistant.
- Level 4, Cells, photosynthesis and respiration, S4.1.1. It compares bacterial cells with animal cells.
- Level 3, Body systems, S3.3.8. It explains why medicines must be taken only as directed.

BY THE END YOU CAN

- Explain why antibiotics kill bacteria but not viruses
- Explain how misuse of antibiotics leads to resistance
- Describe how new medicines are tested in trials

A **medicine** is a substance used to treat, cure or prevent a disease, or to ease its symptoms. This chapter looks at three kinds of medicine and how a new one is tested. A health worker decides which medicine a person needs, and how it is used.

Medicine	Job
antibiotic	kills bacteria
painkiller	eases pain
vaccine	prevents

Three kinds of medicine and the job of each.

A **painkiller** eases pain. It does not kill pathogens. Medicines for a cold or a fever ease symptoms in the same way, while the white blood cells destroy the pathogen. The body, not the painkiller, defeats the infection.

An **antibiotic** is a medicine that kills bacteria or stops them growing. The first one was found in a mould, and antibiotics have saved very many lives. Today they treat infections that bacteria cause, such as tuberculosis and some chest and skin infections.

How does an antibiotic work? Bacteria have parts that human cells do not have, such as a cell wall. Some antibiotics stop the cell wall from forming, so the bacterium bursts. Others stop the bacterium making its proteins. They harm the bacteria and do little harm to human cells, though side effects can happen.

A virus is different. It has no cell wall and makes no proteins of its own. It lives inside the cells of the body and uses them to multiply. An antibiotic has nothing to attack. A medicine that harmed a virus inside a cell would risk harming the cell too.

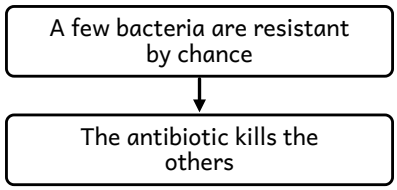
So antibiotics do not work on viruses, for example the viruses that cause colds, influenza and measles. For some viruses, such as HIV, there are other medicines made for those viruses. A health worker decides when they are needed.

Be safe. Medicines can harm if they are used wrongly. Use a medicine only as a health worker or the label directs, and only your own. Never share a medicine. Keep all medicines away from children.

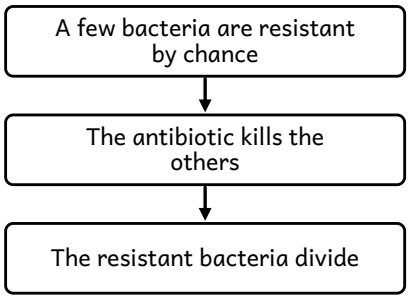
Antibiotics have a problem. Over time some bacteria stop being killed by them. This is **antibiotic resistance**. It is natural selection, which you met in the evolution book, working on bacteria.

DRAW IT FIRST

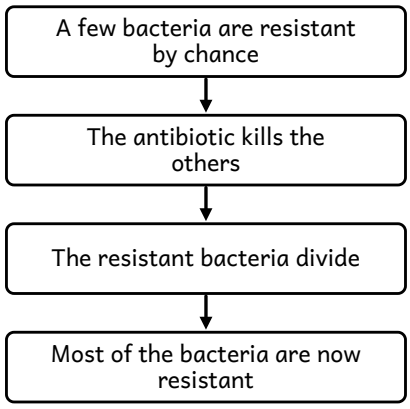
How resistance spreads



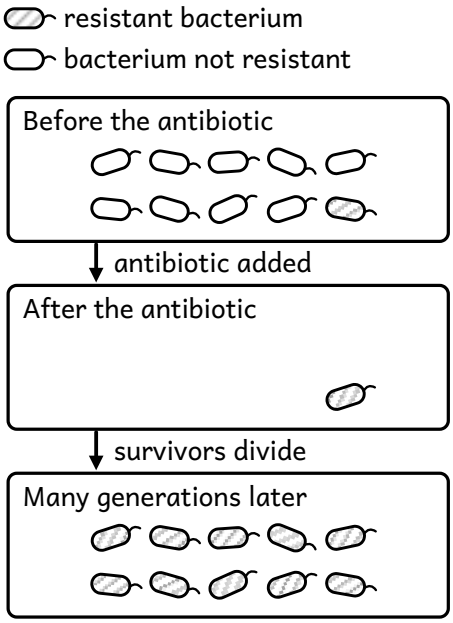
1 In a large group of bacteria, a few are resistant by chance, because of a mutation in their DNA. The antibiotic kills the others.



2 The resistant bacteria are left with plenty of food and room. They divide.



3 All of their offspring are resistant. The group is now mostly resistant, and the antibiotic no longer works.



The antibiotic does not make bacteria resistant. It kills the others and leaves the resistant ones to divide.

Resistance is in the bacteria, not in the person. A person does not become resistant. A person can be infected by bacteria that are already resistant, and then the usual antibiotic will not help.

Some uses of antibiotics make resistance spread faster. Taking them for a cold or influenza does nothing against a virus, but it gives resistant bacteria in the body a chance. Stopping a course early can leave some bacteria alive, and these are more likely to be resistant. Sharing antibiotics or using old ones is also wrong, because it may be the wrong medicine. A health worker says how long to take an antibiotic, and the course should last that long.

Resistant bacteria are a serious problem. Some infections, including some forms of tuberculosis, are now hard to treat. New antibiotics are slow and hard to find. So antibiotics are used only when needed, and as directed.

TRY IT

A bean model of resistance

You need: 20 dry beans, 18 of one kind and 2 of another, a cup, a sheet of paper and a pencil, a spare handful of both kinds of bean.

Be safe: Keep beans out of mouths, and away from small children. Do not eat the beans you used.

1. Put the 18 beans of one kind and the 2 of the other kind into the cup. The 2 stand for resistant bacteria. Write the numbers as round 1.
2. The antibiotic arrives. Take out all 18 beans of the first kind. Write what is left as round 2.
3. The survivors divide. For each bean in the cup, add one more bean of the same kind from your spare handful. Write the numbers as round 3.
4. Let them divide once more, and write the numbers as round 4.

What you will see: The resistant beans are the only ones left after the antibiotic. After they divide, there are more of them each time. The whole group now carries resistance. Real bacteria divide much faster than you can add beans.

If you cannot try it, this is what happens.

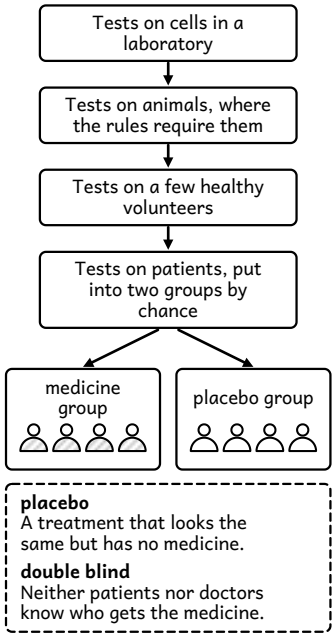
Round	Resistant	Others
1	2	18
2	2	0
3	4	0
4	8	0

Now we turn to new medicines. Before a new medicine is used, scientists must show that it works and that it is safe. They test it in steps, called a trial. The picture shows them.

First, the medicine is tested in a laboratory, on cells. This shows whether it works against the disease, and whether it harms cells. Then, in most places, the medicine must be tested on animals before any person takes it. Rules aim to limit harm and to use as few animals as possible.

Next, a few healthy volunteers take small amounts. This checks that the medicine is safe for people. Everyone who takes part has been told what the test involves, and chooses to take part.

Last, the medicine is tested on patients who have the disease. They are put into two groups by chance. One group gets the medicine. The other gets a **placebo**, which looks the same but has no medicine in it. When a good treatment already exists, the second group gets that treatment instead of a placebo, so that nobody goes without care.

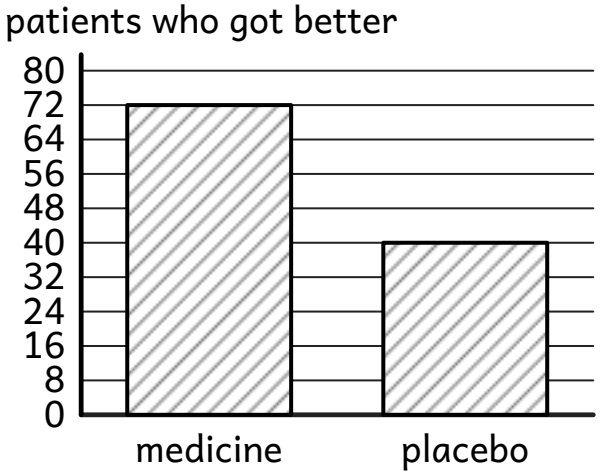


How a new medicine is tested. The medicine group has hatched people. The placebo group has white people.

Why a placebo group? Some people in any group get better, because many illnesses get better on their own. And people who expect to get better may feel better. Only a comparison with the placebo group shows how much the medicine itself helps.

The trial is also **double blind**. Neither the patients nor the doctors who check them know who is in which group until the end. This stops hopes and guesses from changing what people report or notice. Many patients are needed, so that chance does not decide the result.

The bar chart shows a made up result for a trial with 100 patients in each group. It shows how many patients in each group got better.



Patients who got better, out of 100 in each group. Each line is 8 patients. Example numbers.

WORKED EXAMPLE

Use the bar chart. How many more patients got better in the medicine group than in the placebo group?

1. Read the bars. Medicine group: 72. Placebo group: 40.
2. Subtract: 72 − 40 = 32.

Answer: 32 patients

WORKED EXAMPLE

In another trial, 60 of the 80 patients in the medicine group got better. In the placebo group, 48 of the 120 patients got better. By how many percentage points is the share in the medicine group higher?

1. The groups are not the same size, so use percentages. Medicine group: 60 ÷ 80 × 100 = 75.
2. Placebo group: 48 ÷ 120 × 100 = 40.
3. Subtract: 75 − 40 = 35 percentage points.

Answer: 35 percentage points

A WRONG IDEA MANY PEOPLE HAVE

~~**If I take antibiotics a lot, my body becomes resistant to them.**~~

Why it feels right: A medicine can seem to work less well each time, and people say that the body gets used to it.

The test that breaks it: The cells of your body do not change when you take an antibiotic. Resistance is a feature of bacteria. A mutation in a bacterium makes it resistant, and its offspring inherit the mutation.

What is true: The bacteria become resistant, not the person. Using antibiotics only when needed keeps them working for everyone.

KEY WORDS

medicine
a substance used to treat, cure or prevent a disease, or to ease its symptoms.

painkiller
a medicine that eases pain. It does not kill pathogens.

antibiotic
a medicine that kills bacteria or stops them growing. It does not work on viruses.

antibiotic resistance
bacteria that an antibiotic can no longer kill.

placebo
a treatment that looks the same as a medicine but has no medicine in it.

double blind
a trial in which neither the patients nor the doctors know who gets the medicine.

BACK TO YOUR GUESS

The answer is C: A cold is caused by a virus, and antibiotics kill bacteria, not viruses.

Antibiotics work by harming bacteria. A virus is not a bacterium, and it multiplies inside the cells of the body, so antibiotics have no effect on it. A cold

is caused by a virus.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Why will an antibiotic not help a person with a cold?

    A A cold is too mild for any medicine.

    B A cold is caused by a virus, and antibiotics do not work on viruses.

    C A cold is caused by a fungus, and antibiotics kill only bacteria.

    D Viruses are too big for an antibiotic to reach.

    Answer at the back of the book.

2. What does an antibiotic do?

    A It kills every kind of pathogen, including viruses.

    B It makes antibodies in the blood.

    C It kills bacteria or stops them growing.

    Answer at the back of the book.

3. What is antibiotic resistance?

    A A person's body gets used to antibiotics and stops responding.

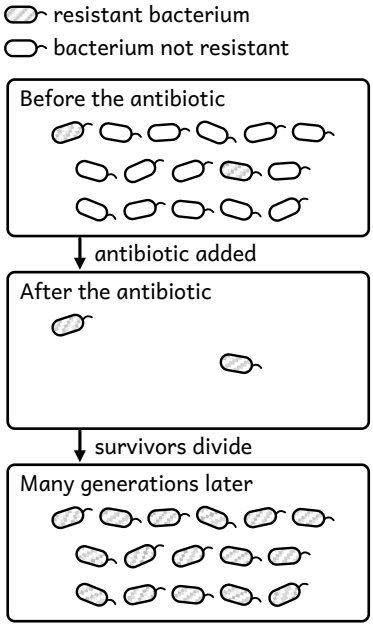
    B When an antibiotic harms the person's own cells instead.

    C The ability of a virus to survive an antibiotic.

    D Bacteria that an antibiotic can no longer kill.

    Answer at the back of the book.

4. Look at the picture. What percentage of the bacteria in the first panel are resistant?



Answer at the back of the book.

5. Which of these helps resistance spread?

   A Finishing a course of antibiotics as the health worker directs.

   B Using an antibiotic only when a health worker says the infection is caused by bacteria.

   C Using an antibiotic for a cold.

Answer at the back of the book.

6. Why does a medicine trial have a placebo group?

   A To compare, so that any extra improvement can be put down to the medicine.

   B To keep half of the patients safe from side effects.

   C So that nobody in the trial gets worse.

Answer at the back of the book.

7. What does double blind mean in a medicine trial?

   A The patients wear blindfolds and so do the doctors.

   B Two different medicines are tested together.

   C The trial is done twice.

   D Neither the patients nor the doctors know who is getting the medicine.

   Answer at the back of the book.

8. **From an earlier chapter**

   Which kind of medicine is given to prevent a disease before the pathogen comes?

   A An antibiotic

   B A vaccine

   C A painkiller

   Answer at the back of the book.

9. In a trial, 64 of 80 patients who took a medicine got better. What percentage got better?

   Answer at the back of the book.

10. In a trial, 100 patients took a medicine and 70 got better. 100 patients took a placebo and 45 got better. By how many percentage points is the share who got better higher in the medicine group?

    Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Antibiotics kill bacteria, not viruses. Misuse lets resistant bacteria survive and multiply. New medicines are tested on cells, usually on animals, then volunteers, then patients, with a placebo group and double blind.

Draw: Two boxes of bacteria, one before and one after an antibiotic, with the resistant ones hatched.

S4.4.6 CHAPTER 6

Malaria, HIV and tuberculosis

How can we stop malaria, HIV and tuberculosis from spreading?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** All three spread through the air, so a mask stops all of them.
- ☐ **B** All three spread by touch, so staying away from ill people stops them.
- ☐ **C** They cannot be stopped. Luck decides who gets them.
- ☐ **D** Each spreads in its own way, so each is stopped in its own way.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Cells, S3.1.8. It names bacteria and other microbes that cause disease.
- Level 3, Body systems, S3.3.5. It shows the lungs, which tuberculosis mainly infects.
- Level 3, Body systems, S3.3.6. It names the cells in blood, which malaria and HIV both attack.

BY THE END YOU CAN

- Describe how malaria spreads and how to prevent it
- Explain how HIV spreads and how treatment helps
- Explain how tuberculosis spreads and is treated

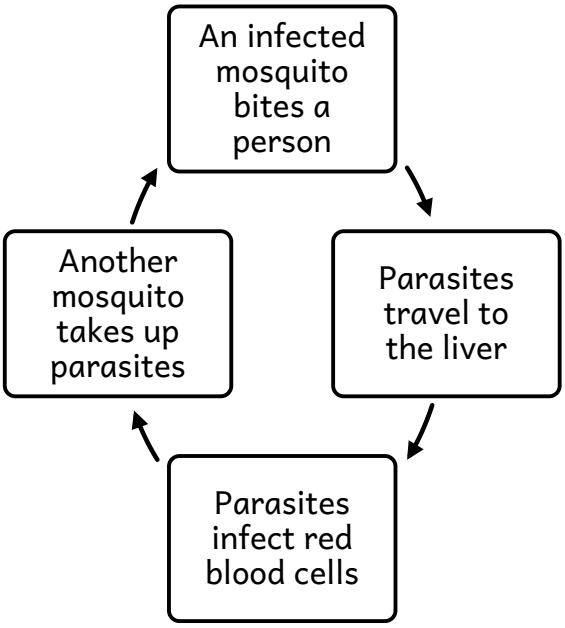
Three diseases affect millions of people. Each is caused by a different kind of pathogen and spreads in a different way. So each is stopped in a different way. This

chapter takes them one at a time. Where a person may be ill, the advice is the same: see a health worker.

Disease	Spreads by
malaria	mosquitoes
HIV	body fluids
tuberculosis	air

Three diseases and how each mainly spreads. Malaria is caused by a protist, HIV by a virus and tuberculosis by a bacterium.

Malaria is caused by a **parasite**, which is an organism that lives in or on another organism and harms it. The parasite is a protist. It is carried by female Anopheles mosquitoes, which live in warm places. A female needs blood to make her eggs, so she bites people.

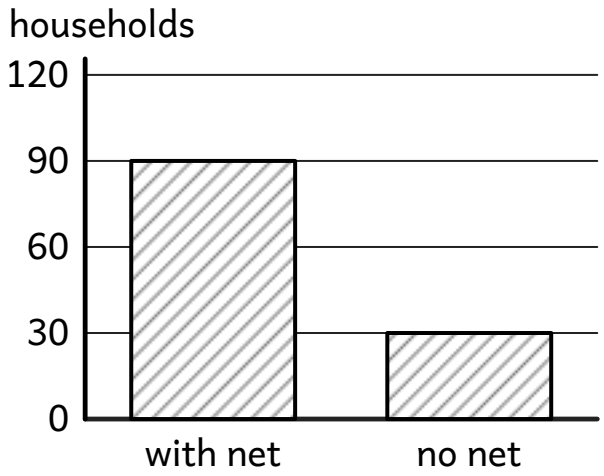


The malaria cycle. The parasite lives in people and in mosquitoes, and the mosquito carries it between people.

The cycle goes round and round. The parasites first multiply in the liver. Then they infect red blood cells, multiply inside them and burst them. This releases more parasites, and the person has a fever and chills. A mosquito that bites an infected person takes up parasites, and passes them on with its next bite.

Malaria is not spread by air, by touch or by sharing food. Almost always it needs the mosquito. Very rarely it passes in blood, for example from a mother to her baby or in a transfusion. So prevention is aimed at the mosquito. Sleeping under a bed net stops bites at night, when many of these mosquitoes bite. Many nets are treated to kill mosquitoes that land on them.

Mosquitoes lay their eggs in still water, so getting rid of standing water means fewer mosquitoes. A **repellent** on skin and clothes keeps mosquitoes from biting, and covering arms and legs from dusk to dawn also helps. Vaccines against malaria now exist, but they give only partial protection. Nets and the other steps still matter.



Households in one village, with and without a bed net. Each line is 30 households. Example numbers.

WORKED EXAMPLE

A village has 120 households. The bar chart shows how many have a bed net. What percentage of the households have a net? The numbers are an example.

1. Households with a net: 90. Households in all: 120.
2. Percentage = 90 ÷ 120 × 100 = 75.

Answer: 75%

A person in a place with malaria who has a fever should see a health worker quickly. Malaria can be tested for and treated, and it can become severe fast if it is not

treated. Young children and pregnant women are at higher risk, so they need care sooner.

TRY IT

Find the standing water

You need: a pencil and a sheet of paper, an adult to walk round with you.

Be safe: Do not climb to reach a roof or a gutter. Ask an adult. Do not use a chemical to clean the places.

1. Walk round your home and the yard with an adult. Look for places where water can stand for days. Examples are buckets, old tins and saucers under plants.
2. Write down each place you find.
3. Next to each one, write what to do: turn it over, empty it, or cover it. A water store that is needed should have a tight cover.
4. Look again after a week and empty the places that filled up.

What you will see: You will find more places than you expect. A mosquito needs only a small amount of still water to lay eggs. Emptying a place at least once a week breaks the cycle, because the young need days in the water to grow.

If you cannot try it, this is what happens.

Place	What to do
bucket	turn it over
old tin	empty it
plant saucer	empty it
water store	cover it

HIV is a virus. Its full name is Human Immunodeficiency Virus. It attacks a kind of white blood cell that helps to run the body's defences. Over time, if it is not treated, the defences weaken, until the body cannot fight infections that it normally fights off. This late stage is called AIDS.

HIV is in the blood and in some other body fluids of a person who has it. It passes only when these fluids get into another person's body. This can happen in four main ways. Blood from an infected person can get into a cut or onto a shared needle. It can pass during sex without a condom. It can pass from a mother to her baby in pregnancy, at birth or in breast milk. And it can pass through blood that was not tested before a transfusion.

HIV does not spread by touch, hugs, handshakes, sharing food or cups, coughing, toilets or insects. You cannot catch it from living or working with a person who has it. A mosquito that bites an infected person does not pass HIV on. There is no reason to avoid anyone who has HIV, and every person should be treated with respect.

Contact	Spreads?
shared needles	yes
blood to blood	yes
mother to baby	yes
sex, no condom	yes
touch or a hug	no
sharing a cup	no
mosquito bite	no
coughing	no

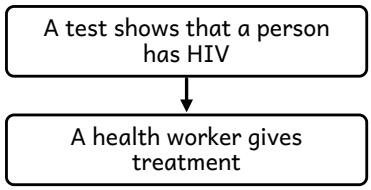
Which kinds of contact spread HIV, and which do not. Clean needles, tested blood, condoms and treatment each cut one of the ways it spreads.

There are ways to prevent it. Never share needles. Use only blood that has been tested. A condom used correctly every time is very effective at stopping HIV passing during sex. A pregnant woman with HIV can be treated, which greatly lowers the chance of passing it to her baby.

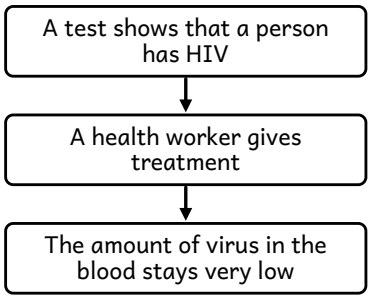
The only way to know whether a person has HIV is a **test**. A health worker can test a small sample of blood or saliva. A test taken soon after HIV gets in may not find it yet. A health worker may ask for a second test some weeks later. Testing should be private, and a health worker explains the result. If the result is positive, treatment can start at once.

DRAW IT FIRST

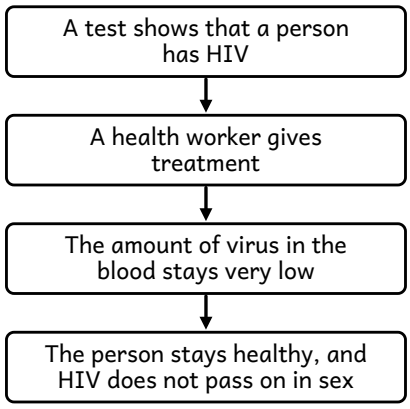
How treatment helps



1 A test shows that a person has HIV. A health worker gives treatment, which is a combination of medicines taken as the health worker directs.



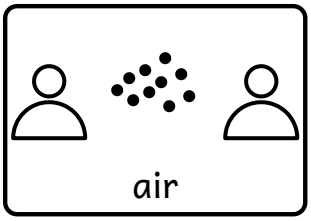
2 The medicines keep the amount of virus in the blood very low. The white blood cells are not destroyed, so the defences stay strong.



3 The person stays healthy and lives a long life. Taken as directed, treatment can lower the virus until a test cannot find it. Then HIV does not pass to a sexual partner.

There is no cure for HIV yet, and no vaccine. Treatment does not remove the virus, so it must be kept up for life, as the health worker directs. Scientists are still searching for a cure.

Tuberculosis is caused by a bacterium. It mostly affects the lungs, but it can affect other parts of the body. It spreads through the air. When a person with tuberculosis in the lungs coughs, tiny droplets with the bacterium enter the air. Others breathe them in. It spreads most in crowded, closed rooms with little fresh air.



Tuberculosis spreads as droplets in the air. Fresh air and covered coughs cut this route.

Tuberculosis does not spread by touch or by sharing dishes. Many people who breathe in the bacterium do not become ill, because their white blood cells hold it in check. While it is held in check, they cannot pass it on. The bacteria can stay asleep in the body for years, then wake up. This is most likely when the defences weaken, for example in a person with HIV who has no treatment. In others the bacteria multiply, and the person has a cough that lasts for weeks, a fever, night sweats and weight loss.

A person with a cough that lasts for weeks should see a health worker. The health worker can test for tuberculosis, with tests on what is coughed up and an X-ray picture of the lungs. Tuberculosis is treated with a long course of antibiotics from a health worker. The course lasts several months, often six, and longer when the bacteria are resistant.

The course is long because the bacteria divide slowly and hide inside cells. Several antibiotics are used together. People feel better after a few weeks, but the bacteria are not all dead yet. The course must be taken to the end. Stopping early can leave bacteria alive, and the ones left are the most likely to be resistant. That makes the disease much harder to treat. After the first weeks of treatment, a person is much less likely to pass it on.

WORKED EXAMPLE

A town of 24 000 people had 36 cases of tuberculosis in a year. How many cases is that for every 100 000 people? The numbers are an example.

1. There were 36 cases among 24 000 people.
2. Divide the cases by the people: 36 ÷ 24 000 = 0.0015.
3. Multiply by 100 000: 0.0015 × 100 000 = 150.

Answer: 150 cases

A WRONG IDEA MANY PEOPLE HAVE

~~You can catch HIV by sharing a cup, a toilet or a hug with a person who has it.~~

Why it feels right: HIV is a serious disease, and many diseases do spread through the air, through touch or through shared things.

The test that breaks it: HIV passes only when infected blood or certain body fluids get into another person's body. Millions of people live, work and eat with a person who has HIV, and do not become infected.

What is true: HIV does not spread by touch, hugs, cups, food, toilets, coughing or insects. A person with HIV needs respect, not distance.

Where to get help. A health worker can test for malaria, HIV and tuberculosis, and treat all three. Testing should be private. If you think you have been exposed to HIV, see a health worker as soon as possible, within three days. Medicine to prevent HIV must start in that time. See a health worker quickly for a fever in a malaria area, and for a cough that lasts for weeks. Nobody may touch you without your yes. If someone does, or if you are afraid, tell an adult you trust or a health worker as soon as you can. It is not your fault.

KEY WORDS

malaria
a disease caused by a protist that female Anopheles mosquitoes carry from person to person.

parasite
an organism that lives in or on another organism and harms it.

repellent
something put on skin or clothes that keeps mosquitoes from biting.

HIV
a virus that attacks white blood cells and weakens the body's defences.

test
a way for a health worker to find out whether a person has a disease.

tuberculosis
a disease caused by a bacterium, usually in the lungs, that spreads in droplets from a cough.

BACK TO YOUR GUESS

The answer is D: Each spreads in its own way, so each is stopped in its own way.

Malaria is spread by mosquito bites, HIV by blood and some body fluids, and tuberculosis by coughs. Each has its own ways to stop it, and each can be tested for and treated by a health worker.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What causes malaria, and how does it reach people?

   A A virus, in the air.

   B A bacterium, in dirty water.

   C A protist, carried by the bite of an infected female mosquito.

   D A fungus, from damp soil.

   Answer at the back of the book.

2. Why does removing standing water help to prevent malaria?

   A Mosquitoes lay their eggs in still water, so fewer mosquitoes develop.

   B The malaria parasite lives in the water and is drunk.

   C Standing water makes the air damp, and damp air carries malaria.

   Answer at the back of the book.

3. A person in a place with malaria has a fever. What is the best thing to do?

   A See a health worker quickly, who can test and treat.

   B Wait for two weeks to see if it passes.

   C Use a medicine left over from another person.

   D Sit in a cool, dark room and say nothing.

   Answer at the back of the book.

4. Which of these can spread HIV?

   A Sharing a cup.

   B A mosquito bite.

   C Sharing a needle with a person who has HIV.

   D A hug or a handshake.

   Answer at the back of the book.

5. What does treatment do for a person with HIV?

   A It cures HIV, so treatment can stop after a time.

   B It helps only people who are already very ill.

   C It makes the virus stronger over time.

   D It keeps the virus very low, so the person stays healthy. When a test can no longer find the virus, HIV does not pass to a sexual partner.

   Answer at the back of the book.

6. How does tuberculosis spread?

   A By touching a person who has it.

   B In droplets in the air, when a person with it in the lungs coughs.

   C By mosquito bites.

   Answer at the back of the book.

7. Why must tuberculosis treatment be taken for months, to the end?

   A The medicines work only after a month.

   B Stopping early can leave bacteria alive, and the ones left are the most likely to be resistant.

   C Once the cough stops, the course can end.

   Answer at the back of the book.

8. **From an earlier chapter**

   Why do antibiotics not work against HIV?

   A HIV is a virus, and antibiotics do not work on viruses.

   B HIV is too small to be seen.

   C HIV is a fungus.

   Answer at the back of the book.

9. A village has 80 households, and 60 of them have a bed net. What percentage of the households have a net?

   Answer at the back of the book.

10. A town of 50 000 people had 80 cases of a disease in a year. How many cases is that for every 100 000 people?

    Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Malaria: a protist, carried by female mosquitoes. HIV: a virus, passed by blood and some body fluids, never by touch. Tuberculosis: a bacterium, spread by coughs. Each can be tested for and treated by a health worker.

Draw: Three boxes: a mosquito for malaria, a drop of blood for HIV and a cough for tuberculosis. Write one way to stop each.

S4.4.7 CHAPTER 7

Lifestyle and disease

Can the way I live make me ill, even if I never catch a germ?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** No. Only germs and the genes we inherit make people ill.
- ☐ **B** Yes, but only for people who are already ill.
- ☐ **C** Yes. Diet, smoking, alcohol and too little exercise can raise the risk of diseases such as heart disease.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Body systems, S3.3.6. It traces the path of blood through the heart, lungs and body.
- Level 3, Body systems, S3.3.8. It explains how tobacco and alcohol harm the body.
- Level 3, Body systems, S3.3.3. It explains what carbohydrates, proteins, fats and minerals do.
- Level 2, Bones, muscles, teeth and food, S2.3.7. It shows how the pulse changes with exercise.

BY THE END YOU CAN

- Explain links between diet, smoking, alcohol and heart disease
- Calculate body mass index and explain its limits

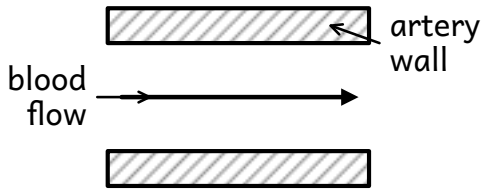
In the first chapter, you met non-communicable diseases. No pathogen causes them and nobody can catch them. Many have more than one cause. Some causes are in your genes, and some are in how you live. This chapter follows one disease, **heart disease**, and then a way to measure body size.

A **risk factor** is something that raises the chance of getting a disease. It does not decide it. Some people with risk factors never become ill, and some people with none do. The more risk factors a person has, the higher the chance. Some risk factors, such as age and the genes you inherit, cannot be changed. Others can.

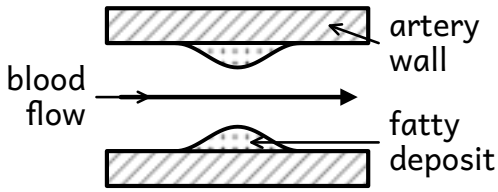
The heart is a muscle, and it needs oxygen like any other. It gets blood through arteries on its own surface. In heart disease, these arteries narrow. A **fatty deposit** builds up inside the wall of an artery, as the picture shows, and the space for blood gets smaller.

DRAW IT FIRST

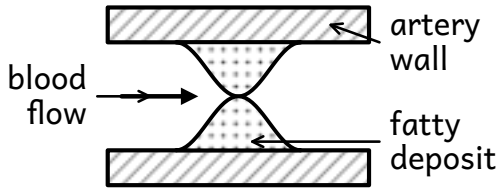
An artery narrows and blocks



1 A healthy artery has smooth walls. Blood flows freely along it.



2 A fatty deposit builds up on the wall. The space is narrower, so less blood passes. The heart muscle may get too little oxygen when it works hard.



3 In time the deposit can block the artery. The part of the heart muscle that the artery feeds then gets no blood. The muscle there can be damaged. This is a heart attack.

Fatty deposits can also build up in arteries that go to the brain. A blockage there can cause a stroke. The same habits that raise the risk of heart disease also raise the risk of stroke.

Which habits raise the risk? A diet with a lot of **saturated fat** does. Saturated fat is found in fatty meat, butter and some oils. It helps the deposits to form. A lot of salt in the diet raises **blood pressure**, which is the pressure of the blood on the artery walls. High blood pressure strains the heart and damages the arteries.

Smoking harms the arteries. Chemicals in the smoke damage their walls, which helps deposits to form. Smoking also raises the heart rate and the blood pressure, and it lowers the oxygen that the blood can carry. Smoke is harmful to people nearby, too. A person who smokes and wants to stop can ask a health worker for help. The risk falls after stopping.

Drinking a lot of alcohol over many years raises the blood pressure and can damage the heart muscle and the liver. Alcohol also adds energy to the diet and can lead to weight gain. Too little exercise lets the heart muscle weaken, and exercise helps to control weight and blood pressure.

Habit	Harm
fatty food	deposits
salty food	blood pressure
smoking	artery damage
alcohol	blood pressure
no exercise	weak heart

Habits that raise the risk of heart disease and the harm each does. Fatty food means food with a lot of saturated fat. Deposits are fatty deposits.

A balanced diet with little saturated fat and salt, no smoking, little alcohol and regular exercise all lower the risk. None of these guarantees good health. They change the odds.

TRY IT

Find the fat in food

You need: plain paper, a pencil, a drop of cooking oil, a little margarine, a slice of bread, a slice of apple.

Be safe: Do not taste the food you rubbed on the paper. Wash your hands afterwards. Do not use nuts, because some people are allergic to them.

1. Write the name of each food on the paper, in a row, with space beside it.
2. Rub each food once on the paper beside its name. Do not press hard.
3. Leave the paper in a warm, dry place until all the marks have dried. This takes some time.
4. Hold the paper up to the light. Look for a spot that stays clear, so that you can see through it.

What you will see: The oil and the margarine leave a clear spot, which is fat. The bread and the apple leave none once they have dried. The test finds fat. It does not say whether the fat is saturated. The body needs some fat, so the point is how much and which kind.

If you cannot try it, this is what happens.

Food	Spot
cooking oil	clear
margarine	clear
bread	none
apple	none

Now to measure body size. **Body mass index**, or BMI, compares a person's mass with their height. The formula is mass in kilograms divided by the square of height in metres. A square means a number multiplied by itself.

SEE IT THREE WAYS

As a picture

BMI	Band
under 18.5	underweight
18.5 to 24.9	healthy weight
25 to 29.9	overweight
30 or more	obese

In words

BMI is mass divided by height squared. The table gives the usual bands for adults. Health workers use it as a quick check on the body size of a group or a person. It is a screening number, not a diagnosis.

In symbols

BMI = mass in kg ÷ height in m ÷ height in m. For 60 kg and 1.60 m, BMI = 60 ÷ 1.60 ÷ 1.60 = 23.4.

The bands are for adults. For children and teenagers, health workers use charts for age and sex instead, because their bodies are still growing. In some places the cut offs differ a little for some groups of people.

WORKED EXAMPLE

Ana has a mass of 60 kg and a height of 1.60 m. Work out her BMI, and say which adult band it is in.

1. Height squared: 1.60 × 1.60 = 2.56.
2. BMI = mass ÷ height squared = 60 ÷ 2.56 = 23.4, to one decimal place.
3. 23.4 is from 18.5 up to 25, so the band is healthy weight.

Answer: 23.4, in the healthy weight band

WORKED EXAMPLE

Kofi has a mass of 95 kg and a height of 1.80 m. Work out his BMI, and say which adult band it is in.

1. Height squared: 1.80 × 1.80 = 3.24.
2. BMI = mass ÷ height squared = 95 ÷ 3.24 = 29.3, to one decimal place.
3. 29.3 is from 25 up to 30, so the band is overweight.

Answer: 29.3, in the overweight band

Mass	Height	BMI
60 kg	1.60 m	23.4
95 kg	1.80 m	29.3

The two examples above, in one table. BMI is rounded to one decimal place.

BMI has limits. Muscle weighs more than fat of the same size. A person with a lot of muscle can have a high BMI and little fat. BMI does not show where fat is carried, and fat around the waist raises risk the most. A waist measurement adds that information.

BMI is not used on its own for children and teenagers, who need age charts. Nor is it used in pregnancy, when the mass rises for a good reason. In older adults, muscle loss can hide extra fat. And BMI says nothing about diet, fitness or blood pressure. A health worker looks at all of these.

A WRONG IDEA MANY PEOPLE HAVE

~~BMI tells you exactly whether a person is healthy.~~

Why it feels right: It gives one clear number and a named band, so it looks like a final answer.

The test that breaks it: Take two adults with the same BMI. One is a runner with strong muscles. The other has little muscle and carries fat round the waist. Their BMI is the same, but their health may be very different.

What is true: BMI is a quick check, not a diagnosis. It is one number that a health worker uses with others.

KEY WORDS

heart disease
a disease in which arteries that feed the heart muscle narrow, so less blood reaches it.

risk factor
something that raises the chance of getting a disease.

fatty deposit
fatty material that builds up in the wall of an artery and narrows it.

saturated fat
a kind of fat found in fatty meat, butter and some oils. A lot of it raises the risk of heart disease.

blood pressure
the pressure of the blood on the walls of the arteries.

body mass index
mass in kilograms divided by the square of height in metres.

BACK TO YOUR GUESS

The answer is C: Yes. Diet, smoking, alcohol and too little exercise can raise the risk of diseases such as heart disease.

Many non-communicable diseases have several causes. Genes and age matter, and so do what we eat and drink, whether we smoke and how active we are. These habits raise or lower the risk. They do not decide it.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. What narrows an artery in heart disease?

   A White blood cells that have grown too many.

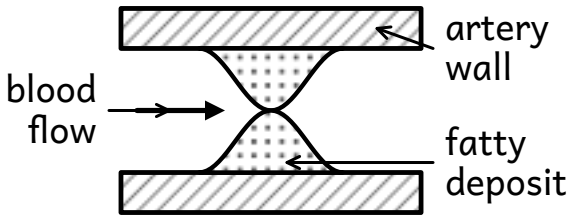
   B A fatty deposit that builds up in the wall.

   C Mucus from the airways.

   D A virus that infects the artery.

   Answer at the back of the book.

2. Look at the picture of an artery. What is the likely result for the heart muscle that this artery feeds?



   A It gets extra blood, so it grows stronger.

   B Nothing, because blood always finds a way round.

   C It gets too little blood and oxygen, and may be damaged.

   Answer at the back of the book.

3. Why does smoking raise the risk of heart disease?

   A Smoking harms only the lungs, so it makes no difference to the heart.

   B Chemicals in smoke damage artery walls, and smoking raises blood pressure.

   C Smoke turns into fat inside the arteries.

   Answer at the back of the book.

4. Which of these does not raise the risk of heart disease?

   A A lot of salt in the diet.

   B A diet with a lot of saturated fat.

   C Drinking a lot of alcohol for many years.

   D Regular exercise.

   Answer at the back of the book.

5. What does it mean to call something a risk factor?

   A It always causes the disease.

   B It raises the chance of getting the disease.

   C It is a pathogen.

   Answer at the back of the book.

6. Why can BMI mislead for a person with a lot of muscle?

   A Muscle weighs less than fat.

   B BMI uses only height.

   C Muscle weighs more than fat, so mass can be high without much fat.

   D BMI is only for people who do no exercise.

   Answer at the back of the book.

7. Which group should not be judged by the adult BMI bands alone?

   A Adult men.

   B Children and teenagers, who need charts for age and sex.

   C Short adults.

   Answer at the back of the book.

8. **From an earlier chapter**

   Heart disease and influenza are both diseases. What is the main difference?

   A Influenza is caused by a pathogen and can pass between people. Heart disease is not and cannot.

   B Heart disease can be caught from other people, and influenza cannot.

   C Both are caused by bacteria.

   Answer at the back of the book.

9. An adult has a mass of 70 kg and a height of 1.75 m. What is the BMI, to one decimal place?

   Answer at the back of the book.

10. An adult has a BMI of 27.5. Which band is this: underweight, healthy weight, overweight or obese?

    Answer at the back of the book.

11. An adult is 1.60 m tall. What mass, to the nearest whole kilogram, gives a BMI of 25?

    Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Fatty deposits narrow the arteries that feed the heart. Saturated fat, salt, smoking, heavy drinking and little exercise raise the risk. BMI is mass in kilograms divided by height in metres squared. It cannot tell muscle from fat.

Draw: An artery with a fatty deposit narrowing the space for blood, with an arrow showing the blood flow.

S4.4.8 CHAPTER 8

Sexual health

How do people protect themselves from infections and pregnancy during sex?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Washing straight after sex prevents both.
- ☐ **B** The pill prevents both pregnancy and infections.
- ☐ **C** A condom, used correctly every time, greatly cuts the risk of both.
- ☐ **D** If both people look healthy, there is nothing to prevent.

IF THIS FEELS HARD, READ THIS FIRST

- Level 3, Growing up: puberty and reproduction, S3.4.4. It names every part of the female and male reproductive systems.
- Level 3, Growing up: puberty and reproduction, S3.4.6. It shows how a sperm meets an egg and how a pregnancy starts.
- Level 3, Growing up: puberty and reproduction, S3.4.8. It explains consent and who to tell when a touch feels wrong.

BY THE END YOU CAN

- Explain how sexually transmitted infections spread and how to prevent them
- Describe how common methods of contraception prevent pregnancy

Some infections pass from one person to another mainly through sex. They are called **sexually transmitted infections**, or STIs. Anyone who has sex can catch one. Most can be cured or kept under control, and the risk of catching one can be cut.

The pathogens live in body fluids, such as semen, fluid from the vagina and blood. Some also live in sores or on the skin of the genitals. They pass between people in vaginal, anal and oral sex.

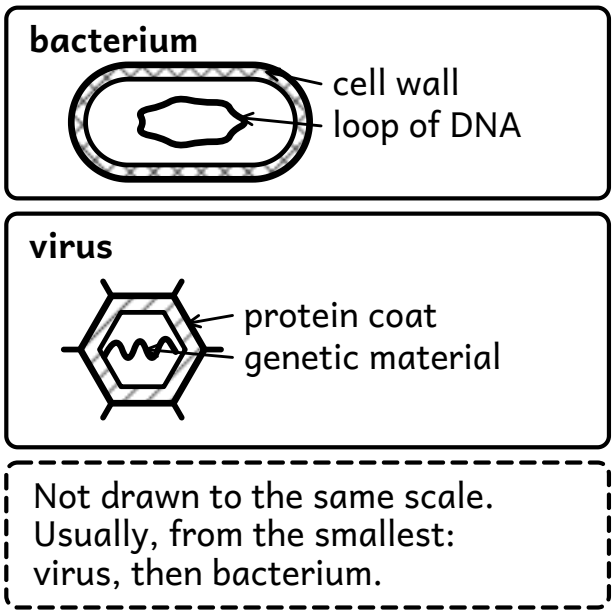
Genital herpes, HPV and syphilis can also pass by close contact between the skin of the genitals. HIV, syphilis and hepatitis B can pass in blood, for example on a shared needle.

Several can pass from a mother to her baby, in pregnancy or at birth. HIV can also pass in breast milk. STIs do not spread by hugging, shaking hands or sharing cups and plates.

Three common STIs are caused by bacteria: chlamydia, gonorrhoea and syphilis. Three are caused by viruses: genital herpes, HPV and HIV. HPV is short for human papillomavirus. HIV is short for human immunodeficiency virus.

SEE IT THREE WAYS

As a picture



In words

A bacterium is a living cell, so antibiotics can kill it. Chlamydia, gonorrhoea and syphilis are cured this way. A virus is not a cell. It has none of the parts that antibiotics attack, so antibiotics do not harm it. Herpes and HIV cannot yet be cured, but medicines can control them. The body often clears HPV by itself.

---

infection	pathogen
chlamydia	bacterium
gonorrhoea	bacterium
syphilis	bacterium
genital herpes	virus
HPV	virus
HIV	virus

Antibiotics cure the three caused by bacteria. The three caused by viruses have no cure yet.

Signs can include sores, warts, an unusual discharge from the penis or vagina, itching, or pain when passing urine. But many people with an STI have no signs at all, often for months or years.

Chlamydia, the most common STI caused by bacteria, often shows no signs. So a person can look and feel well and still pass an infection on. Only a test shows for sure. A health worker or a clinic can test, using urine, a swab or a little blood.

> **A WRONG IDEA MANY PEOPLE HAVE**
>
> ~~**You can tell if someone has an STI by looking at them.**~~
>
> **Why it feels right:** People who are ill often look ill. Sores and rashes can be seen.
>
> **The test that breaks it:** Many people with chlamydia, gonorrhoea or HIV have no signs at all for a long time. They look and feel well, yet they can pass the infection on.
>
> **What is true:** Nobody can tell by looking, not even a doctor. Only a test shows whether a person has an STI.

Left untreated, some STIs cause lasting harm. Chlamydia and gonorrhoea can damage the oviducts, so that a woman may not be able to become pregnant. This is called infertility. They can also harm the epididymis, the coiled tube beside each testis.

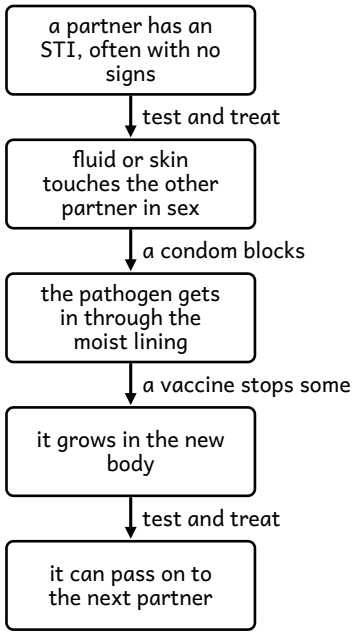
Untreated syphilis can damage the heart, the brain and the nerves years later. Some kinds of HPV can cause cancer of the cervix and some other cancers. Several STIs can harm a baby in pregnancy or at birth.

A screening test of the cervix can find cells that HPV has changed, long before a cancer starts. A health worker can then remove them.

STIs caused by bacteria are cured with antibiotics from a health worker. They are taken exactly as the health worker says, to the end. Some gonorrhoea has become resistant to several antibiotics, so a health worker chooses the medicine. Old or shared medicine is not used. Being cured of an STI does not protect a person for the future. They can catch the same infection again. So both partners are tested and treated before they have sex again.

STIs caused by viruses cannot yet be cured. Medicines can control herpes and HIV. Herpes sores can be made shorter and less frequent. HIV treatment lets people live long, healthy lives. Taken as a health worker directs, it lowers the virus until a test cannot find it. Then HIV does not pass on through sex.

The chapter Malaria, HIV and tuberculosis explains how HIV attacks the immune system.



The words by each arrow are ways to break the chain at that step.

A **condom** is a thin cover that stops semen, fluid from the vagina and blood passing between partners. A male condom fits over the erect penis. A female condom lines the vagina.

Used correctly every time, condoms greatly lower the risk of STIs, including HIV. Correctly means a new condom each time, put on before any genital contact and kept on to the end.

Never use two condoms at once, because they rub together and tear. Condoms protect less against herpes, HPV and syphilis on skin that the condom does not cover.

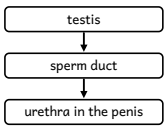
Vaccines protect against HPV and hepatitis B. They train the body before it ever meets the virus, so they work best given before a person has ever had sex. Not having sex removes the risk from sex. Having sex with one partner, when both have been tested and neither has other partners, lowers it a lot.

Some ideas do not work. Washing after sex, or passing urine after it, does not prevent infection. By then the pathogens have reached the moist lining inside the body, where washing cannot reach. The pill and every other method of contraception except condoms give no protection against STIs.

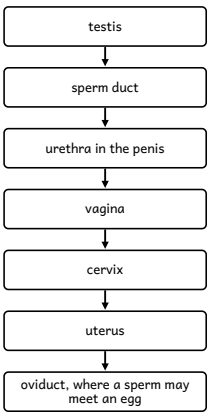
Contraception means ways to prevent pregnancy. A pregnancy starts when a sperm meets an egg in an oviduct, and the fertilised egg settles in the uterus lining. Each method breaks this path at one place or more.

DRAW IT FIRST

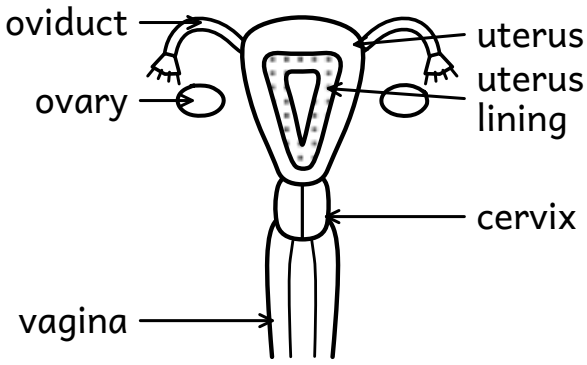
Draw the route from sperm to egg



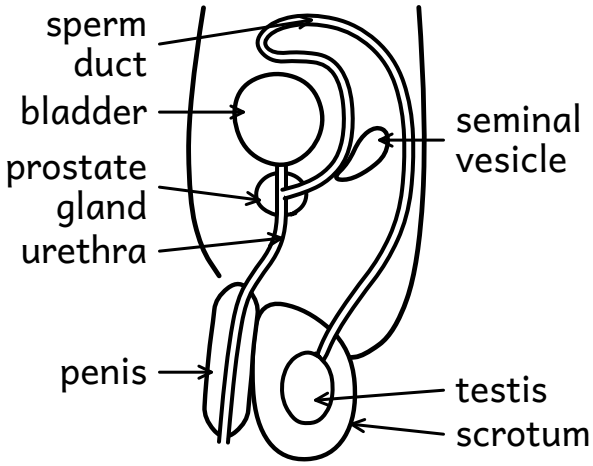
1 Sperm are made in a testis. They travel along the sperm duct and out through the urethra in the penis.



2 In sex, semen goes into the vagina. Sperm swim through the cervix and the uterus into an oviduct, where one may meet an egg. Hormonal methods also act at the ovary, by stopping an egg being let go.



The cervix is where hormones thicken the mucus and a diaphragm sits. A coil sits in the uterus. Female sterilisation cuts or blocks the oviducts.



A vasectomy cuts or blocks each sperm duct. A male condom covers the penis and catches the semen.

A **barrier method** puts something in the way of the sperm. Male and female condoms catch the semen, so sperm never reach the cervix.

A diaphragm is a soft dome put over the cervix before sex and left in place for some hours after. It is used with a gel that kills sperm. A health worker shows how to fit it.

A **hormonal method** gives the body hormones like the ones the ovaries make. The pill is taken by mouth on a regular plan. The injection is given every few months. The implant is a small, soft rod under the skin of the upper arm and lasts some years.

Most hormonal methods stop ovulation, which is when an ovary lets go of an egg. With no egg, there is nothing to fertilise. They also make the mucus at the cervix thick, so sperm cannot swim through it.

The chapter Hormones and the menstrual cycle, in the book Nerves, hormones and balance, explains how these hormones work. Vomiting, bad diarrhoea and some other medicines can stop the pill working. A health worker can say which.

A **coil** is a small device that a health worker places inside the uterus. It can stay there for years. A hormonal coil thickens the mucus at the cervix and keeps the uterus lining thin.

A copper coil has no hormones. The copper harms sperm, so they rarely reach or fertilise an egg. It may also stop a fertilised egg settling in the uterus lining. This is why a copper coil fitted a few days after sex still works as emergency contraception.

Sterilisation is an operation that is meant to be permanent. In a man, each sperm duct is cut or blocked. This is called a vasectomy. Semen still comes out, but with no sperm in it.

For some weeks after a vasectomy, sperm are still in the tubes. Other contraception is needed until a test shows none are left. In a woman, each oviduct is cut, blocked or sealed, so egg and sperm cannot meet.

breaks at	method
penis	male condom
vagina	female condom
cervix	diaphragm
cervix	hormones
ovaries	hormones
uterus	coils
oviducts	sterilisation
sperm ducts	vasectomy

At the cervix, hormones make the mucus thick. At the ovaries, no egg is let go, because the hormones hold back FSH and LH from the pituitary gland.

Natural methods mean avoiding sex on the days when an egg could be fertilised. An egg lives for up to about a day after ovulation, but sperm can live for several days inside the body.

cell	lives for
egg	up to about a day
sperm	several days

The egg lives after ovulation, and sperm live inside the body. So sex several days before ovulation can still lead to pregnancy.

Cycles vary, so these days are hard to know. Pulling the penis out before semen comes is not reliable either, because some sperm can come out earlier. So natural methods are much less reliable than the others.

Emergency contraception can prevent pregnancy after sex with no contraception, or when a condom breaks. There is an emergency pill, or a health worker can fit a copper coil. The coil is the most effective. The pill works best the sooner it is taken.

A health worker, a clinic or a pharmacy can help quickly. The emergency pill mainly delays ovulation. So it does not work if an egg has already been let go. It does not work once a pregnancy has started, and it does not harm one.

method	how
pill	delays ovulation
coil	harms sperm

The copper coil is the most effective. It is fitted by a health worker. Both are used within a few days of sex.

Washing the vagina after sex does not prevent pregnancy, because sperm reach the cervix within minutes.

How well does each method work? The implant, the coils and sterilisation work very well, because there is nothing to remember. The pill, the injection and the male condom work very well when they are used correctly every time.

In real life people forget pills or slip with condoms, so these fail more often. The diaphragm, the female condom and natural methods are less reliable. Every method can have side effects, and these vary between people. A health worker can explain the choices.

method	how	STIs
condoms	barrier	yes
diaphragm	barrier	no
pill, implant	hormone	no
injection	hormone	no
hormonal coil	hormone	no
copper coil	copper	no
sterilisation	cutting	no
natural	timing	no

The STIs column says whether the method also stops STIs. Only condoms do. Some people use a condom as well as another method.

how well	method
very well	implant
very well	coils
very well	sterilisation
if used right	pill
if used right	injection
if used right	male condom
less well	female condom
less well	diaphragm
less well	natural

If used right means they work very well when used correctly every time. A missed pill, a late injection or a slip with a condom makes them fail more often. The diaphragm and the female condom fail more often than these even when used right.

TRY IT

Sort the slips

You need: paper, a pencil.

1. Tear paper into slips. Write one on each: condom, diaphragm, combined pill, implant, vaccine, test and treat.
2. Write three headings. A: stops sperm meeting the egg. B: stops an egg being released. C: stops an infection passing.
3. Put each slip under every heading it fits. If a slip fits two headings, write it again for the second one.
4. On another slip, write a help list. Write kinds of people and places that can help, such as a health worker or a clinic.

What you will see: The combined pill and the implant land under A and B, because they stop ovulation and thicken the mucus. Only the condom lands under a pregnancy heading and under C.

If you cannot try it, this is what happens.

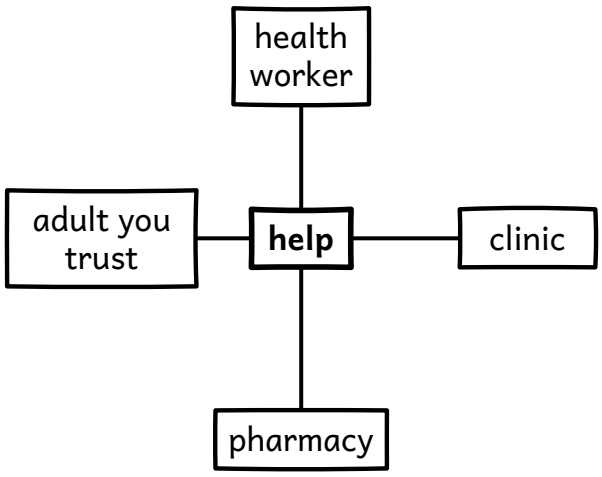
slip	headings
condom	A and C
diaphragm	A
combined pill	A and B
implant	A and B
vaccine	C
test and treat	C

Sex needs consent from both people. Consent is a free yes, with no fear and no pressure. A person who is asleep, very drunk or scared cannot give it. A child cannot consent to sex, and sex with a child is always wrong.

Be safe. Nobody may touch you without your yes. You may change your mind at any time, even after saying yes, and even with a partner. Pressure

or force is never acceptable, and it is never your fault. Tell an adult you trust or a health worker.

See a health worker soon after sex with no condom, or if a condom breaks. See one too if you notice sores, an unusual discharge or pain when passing urine. After forced sex, go as soon as you can. A health worker can help prevent pregnancy and HIV, test and treat infections, and treat any injury. Medicine to prevent HIV must start as soon as possible, within three days, so do not wait.



If one person does not listen, tell another, and keep telling until someone helps.

Where to get help. A health worker, a clinic or a pharmacy can test for STIs, treat them and give contraception. They deal with these questions every day, calmly. You can also talk to an adult you trust.

KEY WORDS

sexually transmitted infections
infections that pass from person to person mainly through sex. Also called STIs.

condom
a thin cover that stops semen and body fluids passing between partners.

contraception
ways to prevent pregnancy.

barrier method
contraception that puts something in the way of the sperm.

hormonal method

contraception that uses hormones to stop ovulation or thicken the mucus at the cervix.

coil
a small device placed in the uterus by a health worker. It may hold copper or a hormone.

sterilisation
an operation that cuts or blocks the sperm ducts or the oviducts, meant to be permanent.

emergency contraception
a pill or a copper coil that can prevent pregnancy after sex with no contraception.

BACK TO YOUR GUESS

The answer is C: A condom, used correctly every time, greatly cuts the risk of both.

Washing prevents neither. The pill prevents pregnancy but not infections. Many infections show no signs at all. Of all the methods of contraception, only condoms also protect against infections.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Kofi feels well and has no sores or discharge. Can he still have a sexually transmitted infection?

   A No. An STI always shows signs.

   B Yes. Many STIs show no signs, so only a test can tell.

   C No. He would have a fever if he had one.

   Answer at the back of the book.

2. Which of these can pass on HIV?

    A Sharing a cup or a plate

    B A mosquito bite

    C Sex with no condom, or a shared needle

    D Shaking hands or hugging

    Answer at the back of the book.

3. Which of these greatly lowers the risk of catching an STI during sex?

    A A condom, used correctly every time

    B Washing the genitals straight after sex

    C Taking the pill

    Answer at the back of the book.

4. A test shows that Lucía has chlamydia. What will cure it?

    A Waiting for it to go away

    B Antibiotics left over from an earlier illness

    C Antibiotics from a health worker, taken to the end

    Answer at the back of the book.

5. How does the contraceptive implant prevent pregnancy?

    A Its hormone stops ovulation and thickens the mucus at the cervix.

    B It blocks the oviducts.

    C It stops the person ever having a baby, even after it is taken out.

    Answer at the back of the book.

6. Joseph has a vasectomy. What is cut or blocked?

    A The urethra

    B Each sperm duct

    C The testes are taken out.

    Answer at the back of the book.

7. Amina had sex with no contraception, and she does not want to become pregnant. What can help?

   A Washing the vagina straight after

   B Emergency contraception, as soon as possible, from a health worker or a pharmacy

   C Passing urine straight after

   Answer at the back of the book.

8. **From an earlier chapter**

   The HPV vaccine is given before a person ever meets the virus. Why does that protect them?

   A It trains white blood cells, so they make antibodies fast if the virus comes.

   B It is an antibiotic that kills the virus.

   C It cures the infection after it has started.

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Many STIs show no signs, so testing matters. Bacterial ones are cured. Herpes and HIV can be controlled. Contraception breaks the path from sperm to egg. Only condoms also stop STIs. Nobody may touch you without your yes.

Draw: Draw the route testis, sperm duct, penis, vagina, cervix, uterus, oviduct. Draw the ovary beside the oviduct. Mark where each method breaks the path.

Key words, A to Z

Every key word in this book, what it means, and the chapter that teaches it.

antibiotic
a medicine that kills bacteria or stops them growing. It does not work on viruses. S4.4.5

antibiotic resistance
bacteria that an antibiotic can no longer kill. S4.4.5

antibodies
proteins that fit one antigen and stick to the pathogen. S4.4.3

antigens
chemicals on the surface of a pathogen that the body does not make. S4.4.3

bacteria
single cells with no nucleus. A few cause disease. S4.4.1

barrier method
contraception that puts something in the way of the sperm. S4.4.8

blood pressure
the pressure of the blood on the walls of the arteries. S4.4.7

body mass index
mass in kilograms divided by the square of height in metres. S4.4.7

cilia
tiny hairs on cells that sweep mucus out of the airways. S4.4.3

coil
a small device placed in the uterus by a health worker. It may hold copper or a hormone. S4.4.8

communicable disease
a disease caused by a pathogen that can pass from one person to another. S4.4.1

condom
a thin cover that stops semen and body fluids passing between partners. S4.4.8

contaminated
carrying pathogens or other harmful things. Water can be contaminated. S4.4.2

contraception
ways to prevent pregnancy. S4.4.8

disease
a condition that stops part of the body working as it should. S4.4.1

double blind
a trial in which neither the patients nor the doctors know who gets the medicine. S4.4.5

droplets
tiny drops of liquid breathed out in a cough or sneeze. They can carry pathogens. S4.4.2

emergency contraception
a pill or a copper coil that can prevent pregnancy after sex with no contraception. S4.4.8

fatty deposit
fatty material that builds up in the wall of an artery and narrows it. S4.4.7

fungi
moulds and yeast. Some cause skin diseases. S4.4.1

heart disease
a disease in which arteries that feed the heart muscle narrow, so less blood reaches it. S4.4.7

herd immunity
protection of people who are not immune, because enough of the others are immune that the pathogen cannot spread. S4.4.4

HIV
a virus that attacks white blood cells and weakens the body's defences. S4.4.6

hormonal method
contraception that uses hormones to stop ovulation or thicken the mucus at the cervix. S4.4.8

hygiene
habits that keep you and your surroundings clean and so cut the spread of disease. S4.4.2

immune
able to destroy a pathogen quickly, because memory cells can make the right antibody at once. S4.4.4

immunity
protection from a disease, because the body can make the right antibody quickly. S4.4.3

infection
a pathogen that has got into the body and is multiplying. S4.4.2

malaria
a disease caused by *a* protist that female Anopheles mosquitoes carry from person to person. S4.4.6

medicine
a substance used to treat, cure or prevent *a* disease, or to ease its symptoms. S4.4.5

memory cells
white blood cells that stay in the blood and remember an antigen. S4.4.3

mucus
a sticky liquid in the airways that traps pathogens and dust. S4.4.3

non-communicable disease
a disease that no pathogen causes, so nobody catches it from another person. S4.4.1

painkiller
a medicine that eases pain. It does not kill pathogens. S4.4.5

parasite
an organism that lives in or on another organism and harms it. S4.4.6

pathogen
a germ that causes disease. S4.4.1

phagocyte
a white blood cell that takes in *a* pathogen and digests it. S4.4.3

placebo
a treatment that looks the same as *a* medicine but has no medicine in it. S4.4.5

protist
a single celled living thing with *a* nucleus. One kind causes malaria. S4.4.1

repellent
something put on skin or clothes that keeps mosquitoes from biting. S4.4.6

risk factor
something that raises the chance of getting *a* disease. S4.4.7

route
the way *a* pathogen travels from one person to another. S4.4.2

saturated fat

a kind of fat found in fatty meat, butter and some oils. A lot of it raises the risk of heart disease. S4.4.7

sexually transmitted infections
infections that pass from person to person mainly through sex. Also called STIs. S4.4.8

side effect
an effect of a medicine that is not the one wanted. S4.4.4

sterilisation
an operation that cuts or blocks the sperm ducts or the oviducts, meant to be permanent. S4.4.8

test
a way for a health worker to find out whether a person has a disease. S4.4.6

tuberculosis
a disease caused by a bacterium, usually in the lungs, that spreads in droplets from a cough. S4.4.6

vaccination
giving a vaccine, so that the body can make memory cells before the real pathogen comes. S4.4.4

vaccine
a harmless form of a pathogen, or a part of one, given to prepare the body. S4.4.4

vector
an animal that carries a pathogen from one host to another. S4.4.2

virus
genetic material in a protein coat. It multiplies only inside living cells. S4.4.1

white blood cells
cells in the blood that defend the body against pathogens. S4.4.3

Answers

S4.4.1. Kinds of disease

1. **Measles**

   Measles is caused by a virus, and it passes from one person to another. The other three have causes that cannot be caught.

   - **If you chose A:** Heart disease has causes such as diet and smoking. Nobody can catch it from another person.
   - **If you chose B:** It is inherited through genes. It is not caused by a pathogen, so it cannot be caught.
   - **If you chose D:** Scurvy comes from too little vitamin C in the food. It is not caused by a pathogen. Go to S3.3.3.

2. **It cannot be passed from one person to another.**

   Non-communicable describes a disease that is not passed on. Its causes are things such as genes, diet and tobacco smoke.

   - **If you chose B:** Many non-communicable diseases can be treated. The word is about whether the disease passes between people.
   - **If you chose C:** A disease caused by a virus is communicable. Non-communicable diseases are not passed on.

3. **The virus**

   A virus is genetic material inside a protein coat, and it has no cell parts. It can multiply only inside the living cells of another organism.

   - **If you chose A:** A bacterium is a single cell. It has a cell wall and a loop of DNA.
   - **If you chose C:** Only the bacterium is a cell. A virus is genetic material in a protein coat.

4. **A protist**

   Malaria is caused by a single celled living thing with a nucleus, which is a protist. A mosquito carries it from person to person.

   - **If you chose A:** Bacteria cause diseases such as tuberculosis and cholera. Malaria has a different cause. Go to S3.1.8.
   - **If you chose B:** Measles, influenza and HIV are caused by viruses. Malaria is not.
   - **If you chose C:** Fungi cause skin diseases such as athlete's foot. Malaria is not a fungus disease.

5. **Tuberculosis: a bacterium**

   Tuberculosis is caused by a bacterium. Measles is caused by a virus, cholera by a bacterium and athlete's foot by a fungus.

   - **If you chose A:** Measles is caused by a virus.
   - **If you chose B:** Cholera is caused by a bacterium.
   - **If you chose D:** Athlete's foot is caused by a fungus that lives on the skin.

6. **Most are harmless or helpful, and a few cause disease.**

   Only a small share of bacteria are pathogens. Many live in the gut or in soil and do no harm.

   - **If you chose B:** Most bacteria do no harm, and some are useful. Yoghurt is made with their help. Go to S3.1.8.
   - **If you chose C:** Viruses are usually much smaller than bacteria.

7. **Only inside the living cells of another organism.**

   A virus has no cell parts of its own. It uses the living cells of another organism to make more viruses.

   - **If you chose A:** A bacterium is a cell and divides in two. A virus is not a cell, so it cannot divide.
   - **If you chose C:** Bacteria and fungi can grow in food. A virus needs a living cell to multiply.
   - **If you chose D:** A virus cannot multiply in water, clean or not. It needs a living cell.

8. **64 bacteria**

   2 hours = 120 minutes. 120 ÷ 20 = 6 divisions. The number doubles 6 times: 2 × 2 × 2 × 2 × 2 × 2 = 64.

9. **40%**

   20 ÷ 50 × 100 = 40.

S4.4.2. How diseases spread

1. **In droplets that other people breathe in.**

   A sneeze sends out tiny droplets of liquid. They carry pathogens, and a person nearby can breathe them in. This is the air route.

   - **If you chose A:** Blood carries a few pathogens, such as HIV. Influenza does not pass in blood.
   - **If you chose B:** Mosquitoes carry malaria. Influenza passes in droplets, not by insects.
   - **If you chose C:** Water spreads diseases such as cholera. The sneeze puts the pathogen in the air.

2. **They keep faeces away from water, food and hands.**

   The cholera bacterium leaves the body in faeces. A toilet and drains keep the faeces away from water, so people do not drink the bacterium.

   - **If you chose B:** A toilet does not kill the bacterium. It takes faeces away so that they cannot reach drinking water.
   - **If you chose C:** Mosquitoes spread malaria. Cholera spreads through water and food.

3. **It stops the mosquito reaching the sleeper to bite.**

   Malaria passes through the bite of an infected mosquito. The net is a barrier, so the mosquito cannot reach the skin.

   - **If you chose A:** Malaria does not travel in the air. It passes by the bite of a mosquito.
   - **If you chose C:** Malaria does not travel in the air. The net stops the mosquito.

4. **Soap lifts pathogens off the skin, and the water rinses them away.**

   Soap lifts dirt and pathogens off the skin so that water can carry them away. A rinse in water alone leaves more behind.

   - **If you chose A:** Soap does not kill every pathogen. It lifts them off the skin, and the water rinses them away.
   - **If you chose B:** Water alone washes off some pathogens, but less than soap and water does.
   - **If you chose D:** Soap does not toughen the skin. Its job is to lift dirt and pathogens off.

5. **A vector**

   A vector is an animal, such as a mosquito, that carries a pathogen from one host to another.

   - **If you chose B:** A toxin is a poison made by a pathogen. It does not carry the pathogen.
   - **If you chose C:** A droplet is a tiny drop of liquid breathed out in a cough. It is not an animal.

6. **Cooking food fully and keeping it covered.**

   Cooking kills most pathogens in food. A cover keeps off flies and dirty hands.

   - **If you chose A:** Warm food is where bacteria multiply fastest, so it should be kept covered and cool.
   - **If you chose C:** Hands should be washed before cooking and eating, so that pathogens do not get onto the food.
   - **If you chose D:** That puts pathogens on the hand, which then put them on the food. Wash the hands afterwards.

7. **It is a non-communicable disease, so a pathogen does not pass it on.**

   Scurvy comes from too little vitamin C in the food. No pathogen causes it, so it cannot pass from one person to another.

   - **If you chose B:** Scurvy is not caused by any pathogen. It comes from too little vitamin C.
   - **If you chose C:** Scurvy is not caused by any pathogen. It comes from too little vitamin C in the food.

8. **75%**

   80 − 20 = 60. 60 ÷ 80 × 100 = 75.

9. **60 cases**

   30 ÷ 500 = 0.06. 0.06 × 1 000 = 60.

S4.4.3. The body's defences

1. **Stomach acid**

   The stomach makes a strong acid that kills most of the pathogens that reach it in food, drink and swallowed mucus.

   - **If you chose A:** Skin keeps pathogens out of the body. It does not kill the ones that are swallowed.
   - **If you chose B:** Cilia sweep mucus out of the airways. They do not kill pathogens.

2. **They sweep the mucus, with the pathogens in it, out of the airways.**

   Mucus traps pathogens and dust. Cilia beat together and move the mucus up to the throat, where it is swallowed or coughed out.

   - **If you chose A:** Antibodies are made by white blood cells. Cilia are tiny hairs on cells that line the airways.
   - **If you chose B:** Acid is made in the stomach. Cilia do not kill pathogens.
   - **If you chose C:** Oxygen enters the blood in the lungs, through very thin walls. Cilia do not do that. Go to S3.3.5.

3. **It takes a pathogen into itself and digests it.**

   A phagocyte reaches out, wraps round a pathogen and takes it inside. Enzymes then break the pathogen down.

   - **If you chose A:** Other white blood cells make antibodies. A phagocyte takes pathogens in.
   - **If you chose C:** Red blood cells carry oxygen. A phagocyte is a white blood cell. Go to S3.3.6.
   - **If you chose D:** Mucus is made by cells that line the airways. A phagocyte is a white blood cell.

4. **The tips of the antibodies are not the shape of the antigens.**

   An antibody fits only one kind of antigen. These tips are square, and the antigens are triangles, so they do not match.

   - **If you chose A:** The size of the pathogen does not matter. Antibodies stick to antigens on its surface.
   - **If you chose C:** Antibodies stick to living pathogens. They help the body to destroy them.

5. **Memory cells make the right antibodies quickly and in large amounts.**

   Memory cells stay in the blood after an infection. If the pathogen returns, they make the right antibody sooner and in larger amounts.

   - **If you chose A:** The antibody level falls after an infection. What stays are memory cells, which can make antibodies again quickly.
   - **If you chose B:** The skin does not change. The second response is made by white blood cells.
   - **If you chose C:** Memory cells remember only the antigen they met. They do not protect against other pathogens.

6. **It fits one kind of antigen.**

   The tip of an antibody has a shape that fits one antigen only, as a key fits one lock. That is why the body needs a different antibody for each pathogen.

   - **If you chose B:** An antibody has a tip of one shape, so it fits only one kind of antigen.
   - **If you chose C:** A phagocyte is a cell that takes in pathogens. An antibody is a protein.
   - **If you chose D:** Antibodies are made by the body's white blood cells, not by the pathogen.

7. **Toilets that keep faeces away from drinking water**

   Cholera spreads through water that has faeces in it. Toilets and drains keep the faeces away from the water people drink.

   - **If you chose A:** A bed net stops mosquitoes. Cholera does not spread by mosquitoes. Go to S4.4.2.
   - **If you chose C:** That cuts the air route, for diseases such as influenza. Cholera spreads through water. Go to S4.4.2.

8. **about 625 red cells**

   5 000 000 ÷ 8 000 = 625.

9. **3 times**

   60 ÷ 20 = 3.

S4.4.4. Vaccination

1. **A harmless form of a pathogen, or a part of one.**

   The antigens in a vaccine let white blood cells make antibodies and memory cells, but the vaccine cannot cause the full disease.

   - **If you chose B:** A vaccine does not hold antibodies. It trains your own white blood cells to make them.
   - **If you chose C:** A vaccine does not kill a pathogen that is already in the body. It prepares the body before the pathogen comes.
   - **If you chose D:** That would cause the disease. A vaccine holds a dead or weakened pathogen, or only a part of one.

2. **Memory cells make the right antibody quickly and in large amounts.**

   Vaccination leaves memory cells in the blood. If the real pathogen arrives, they respond fast, before it can make the person ill.

   - **If you chose A:** The vaccine does not kill pathogens. It leaves memory cells in the blood.
   - **If you chose B:** The skin does not change. The protection comes from white blood cells.

3. **When enough people are immune that the pathogen cannot spread far, so people who are not immune are protected too.**

   Each immune person is a break in the path of the pathogen. When there are enough breaks, those who are not immune are protected too.

   - **If you chose A:** The word herd is used because it is about a group. It applies to people too.
   - **If you chose B:** Herd immunity does not need anyone to be ill. Vaccination can make enough people immune.
   - **If you chose D:** Herd immunity is not about antibodies passing between people. It works because the pathogen finds too few people to infect.

4. **8 people**

   The infection starts in the left column and spreads only to unvaccinated neighbours. It fills the two left columns, which is 4 + 4 = 8 people. It cannot pass the vaccinated column, so the people on the right stay well.

5. **15 people**

   The picture shows 1 person infected out of 16 people. 16 − 1 = 15.

6. **Their neighbours on the other side are vaccinated, so the infection cannot reach them.**

   The vaccinated column is a break in every path to the last column. That is how herd immunity protects people who are not vaccinated.

   - **If you chose A:** Distance alone does not protect them. The infection reaches anyone it can pass to, one neighbour at a time.
   - **If you chose C:** People who are not vaccinated can be infected, as the first two columns show. These four are protected only because of the vaccinated column.

7. **People who cannot be vaccinated, such as babies who are too young.**

   These people have no memory cells of their own. When most of the people around them are immune, a pathogen rarely reaches them.

   - **If you chose B:** It does not need every person. A large share of immune people is enough to stop most spread, and the share depends on the disease.
   - **If you chose C:** The vaccinated people have their own protection. Herd immunity is the extra protection for those who are not immune.

8. **They are tested for safety. Mild effects such as a sore arm are common, and serious effects are rare.**

   Vaccines are tested before they are used and checked afterwards. Mild effects show the body responding, and serious effects are rare.

   - **If you chose B:** Every vaccine is tested for safety, and health workers keep watching after it is in use.
   - **If you chose C:** A vaccine prepares the body before the pathogen comes. It is not a cure.
   - **If you chose D:** A vaccine cannot cause the full disease. A mild effect is the body responding.

9. **A chemical on the surface of a pathogen that the body does not make.**

   White blood cells notice an antigen as foreign and make an antibody that fits it.

   - **If you chose A:** That is a phagocyte. An antigen is a chemical on the surface of a pathogen. Go to S4.4.3.
   - **If you chose C:** That is an antibody. An antigen is on the pathogen, and the antibody fits it. Go to S4.4.3.

10. **75%**

    150 ÷ 200 × 100 = 75.

11. **380 people**

    95 ÷ 100 × 400 = 380.

S4.4.5. Antibiotics and medicines

1. **A cold is caused by a virus, and antibiotics do not work on viruses.**

   A virus has no cell wall and makes no proteins of its own, so an antibiotic has nothing to attack. It multiplies inside body cells.

   - **If you chose A:** Mildness is not the reason. A cold is caused by a virus, and antibiotics do not work on viruses.
   - **If you chose C:** A cold is caused by a virus, not a fungus.
   - **If you chose D:** Viruses are usually much smaller than bacteria. An antibiotic has nothing to attack in a virus, because it has no cell wall or protein making of its own.

2. **It kills bacteria or stops them growing.**

   Antibiotics harm parts of bacteria that human cells do not have, such as the cell wall.

   - **If you chose A:** Antibiotics work on bacteria only.
   - **If you chose B:** Antibodies are made by white blood cells. A vaccine helps the body make them. Go to S4.4.3.

3. **Bacteria that an antibiotic can no longer kill.**

   A mutation can make some bacteria resistant. They survive the antibiotic and multiply, and so the group is soon mostly resistant.

   - **If you chose A:** The person does not become resistant. The bacteria do.
   - **If you chose B:** Resistance is about bacteria that survive the antibiotic, not harm to the person.
   - **If you chose C:** Antibiotics do not work on viruses at all. Resistance is about bacteria.

4. **12.5%**

   The first panel shows 16 bacteria, and 2 of them are hatched, which means resistant. 2 ÷ 16 × 100 = 12.5.

5. **Using an antibiotic for a cold.**

   A cold is caused by a virus, so the antibiotic does no good. It still gives resistant bacteria in the body a chance to multiply.

   - **If you chose A:** Finishing the course kills the infection. It is the right thing to do.
   - **If you chose B:** That is the right way to use them. It keeps antibiotics working.

6. **To compare, so that any extra improvement can be put down to the medicine.**

   Some patients get better anyway. Only a comparison with a group that has a placebo shows what the medicine itself does.

   - **If you chose B:** Safety is checked earlier, on volunteers. The placebo group is there for a fair comparison.
   - **If you chose C:** A placebo does not make anyone better or worse by being a medicine. It is there for comparison.

7. **Neither the patients nor the doctors know who is getting the medicine.**

   If nobody knows who gets the medicine, hopes and guesses cannot change what people report or notice.

   - **If you chose A:** Blind here means not knowing, not not seeing.
   - **If you chose B:** Double blind is about who knows, not about how many medicines there are.
   - **If you chose C:** Double blind is not about repeating the trial.

8. **A vaccine**

   A vaccine trains the body, so that the response to the real pathogen is fast. Antibiotics treat a bacterial infection that has already started.

   - **If you chose A:** An antibiotic treats a bacterial infection that is already there.
   - **If you chose C:** A painkiller eases pain. It does not prevent a disease. Go to S4.4.4.

9. **80%**

   64 ÷ 80 × 100 = 80.

10. **25 percentage points**

    Medicine group: 70 ÷ 100 × 100 = 70. Placebo group: 45 ÷ 100 × 100 = 45. 70 − 45 = 25.

S4.4.6. Malaria, HIV and tuberculosis

1. **A protist, carried by the bite of an infected female mosquito.**

   The malaria parasite is a protist. Female Anopheles mosquitoes carry it from one person to another when they bite.

   - **If you chose A:** Malaria is not caused by a virus, and it does not spread in the air.
   - **If you chose B:** Cholera spreads this way. Malaria is caused by a protist and spreads by mosquito bites. Go to S4.4.1.
   - **If you chose D:** Fungi cause skin diseases. Malaria is caused by a protist.

2. **Mosquitoes lay their eggs in still water, so fewer mosquitoes develop.**

   Mosquito young grow in still water. With less standing water there are fewer mosquitoes, and so fewer bites that pass on the parasite.

   - **If you chose B:** People do not catch malaria by drinking water. The parasite is carried by mosquitoes.
   - **If you chose C:** Malaria does not travel in the air. The water matters because mosquitoes breed in it.

3. **See a health worker quickly, who can test and treat.**

   Malaria can be tested for and treated. It is best treated early, because it can become severe quickly.

   - **If you chose B:** Malaria can become severe fast. A fever in a malaria area needs a health worker soon.
   - **If you chose C:** It may be the wrong medicine. Only a health worker can say which treatment a person needs.
   - **If you chose D:** Rest helps, but the person also needs a test and treatment from a health worker.

4. **Sharing a needle with a person who has HIV.**

   A shared needle can carry blood from one person to another. HIV does not pass by cups, insects, hugs or handshakes.

   - **If you chose A:** HIV does not pass through shared cups or food.
   - **If you chose B:** HIV does not pass by insects. Malaria does, but HIV does not.
   - **If you chose D:** HIV does not pass by touch. It passes only when infected blood or certain body fluids get into another person's body.

5. **It keeps the virus very low, so the person stays healthy. When a test can no longer find the virus, HIV does not pass to a sexual partner.**

   Treatment keeps the amount of virus very low. The person stays healthy and lives a long life. Once a test cannot find the virus, HIV does not pass in sex. The chance of passing it to a baby is much lower.

   - **If you chose A:** There is no cure for HIV yet. Treatment keeps the virus low, and it has to continue.
   - **If you chose B:** Treatment helps most when it starts early. It keeps the defences strong.
   - **If you chose C:** Treatment lowers the amount of virus. It does not make the virus stronger.

6. **In droplets in the air, when a person with it in the lungs coughs.**

   A cough puts droplets with the bacterium into the air, and other people breathe them in.

   - **If you chose A:** Tuberculosis does not spread by touch. It spreads in droplets in the air.
   - **If you chose C:** Mosquitoes carry malaria. They do not spread tuberculosis.

7. **Stopping early can leave bacteria alive, and the ones left are the most likely to be resistant.**

   The bacteria divide slowly and hide inside cells, so it takes months to kill them all. If some are left, they are the most likely to be resistant, and the disease is then much harder to treat.

   - **If you chose A:** They work from the start. The course is long because the bacteria divide slowly and hide in cells.
   - **If you chose C:** People feel better after a few weeks, but bacteria are still alive. The course must be finished.

8. **HIV is a virus, and antibiotics do not work on viruses.**

   Antibiotics kill bacteria. A virus has no cell wall and makes no proteins of its own, so an antibiotic has nothing to attack.

   - **If you chose B:** Size is not the reason. A virus has no cell wall or protein making of its own for an antibiotic to attack. Go to S4.4.5.
   - **If you chose C:** HIV is a virus. Antibiotics do not work on viruses. Go to S4.4.1.

9. **75%**

   60 ÷ 80 × 100 = 75.

10. **160 cases**

    80 ÷ 50 000 = 0.0016. 0.0016 × 100 000 = 160.

S4.4.7. Lifestyle and disease

1. **A fatty deposit that builds up in the wall.**

   Fatty material builds up inside the wall of an artery. The space for blood gets smaller, and less blood reaches the heart muscle.

   - **If you chose A:** White blood cells fight pathogens. They do not block arteries in heart disease.
   - **If you chose C:** Mucus is made in the airways to trap pathogens. It does not enter the arteries.
   - **If you chose D:** Heart disease is non-communicable. It is not caused by a pathogen. Go to S4.4.1.

2. **It gets too little blood and oxygen, and may be damaged.**

   The deposits block the artery, so the part of the heart muscle that it feeds gets no blood and no oxygen. That is a heart attack.

   - **If you chose A:** A blocked artery lets no blood through, so the muscle gets less blood, not more.
   - **If you chose B:** Blood cannot pass a block. The muscle beyond it can be damaged.

3. **Chemicals in smoke damage artery walls, and smoking raises blood pressure.**

   Chemicals in smoke damage the wall of an artery, and nicotine raises blood pressure. Both raise the risk of heart disease.

   - **If you chose A:** Smoke also harms the arteries and raises blood pressure. It harms the heart as well. Go to S3.3.8.
   - **If you chose C:** Smoke does not turn into fat. It damages the artery wall, which helps deposits to form.

4. **Regular exercise.**

   Exercise strengthens the heart, helps to control weight and blood pressure, and so lowers the risk.

   - **If you chose A:** A lot of salt raises blood pressure, which raises the risk.
   - **If you chose B:** Saturated fat helps fatty deposits to form, which raises the risk.
   - **If you chose C:** It raises blood pressure and can damage the heart, so it raises the risk.

5. **It raises the chance of getting the disease.**

   Smoking and too little exercise are risk factors for heart disease. They raise the chance. They do not decide whether a person becomes ill.

   - **If you chose A:** A risk factor raises the chance. Some people with it never become ill.
   - **If you chose C:** A pathogen is a germ. A risk factor can be anything that raises the chance, such as a habit.

6. **Muscle weighs more than fat, so mass can be high without much fat.**

   BMI uses mass, and it cannot tell muscle from fat. A very muscular person can have a high BMI and little fat.

   - **If you chose A:** It is the other way round. Muscle weighs more than fat for the same size.
   - **If you chose B:** BMI uses both mass and height.
   - **If you chose D:** BMI is for any adult. It is only limited because it cannot tell muscle from fat.

7. **Children and teenagers, who need charts for age and sex.**

   Their bodies are still growing, so health workers compare them with charts for their age and sex.

   - **If you chose A:** The adult bands are the same for men and women.
   - **If you chose C:** BMI already allows for height. The adult bands are the same for short and tall adults.

8. **Influenza is caused by a pathogen and can pass between people. Heart disease is not and cannot.**

   Influenza is communicable. Heart disease has causes such as fatty deposits and habits, and nobody can catch it.

   - **If you chose B:** It is the other way round. A virus causes influenza, and it spreads between people. Go to S4.4.1.
   - **If you chose C:** Influenza is caused by a virus, and heart disease is not caused by a pathogen. Go to S4.4.1.

9. **22.9**

   1.75 × 1.75 = 3.0625. 70 ÷ 3.0625 = 22.9.

10. **overweight**

    27.5 is from 25 up to 30, which is the overweight band.

11. **about 64 kg**

    BMI = mass ÷ height squared, so mass = BMI × height squared. 1.60 × 1.60 = 2.56. 25 × 2.56 = 64.

S4.4.8. Sexual health

1. **Yes. Many STIs show no signs, so only a test can tell.**

   Chlamydia, gonorrhoea and HIV often show no signs for a long time. A health worker can test, using urine, a swab or a little blood.

   - **If you chose A:** Many STIs, such as chlamydia, often show no signs for months or years. Only a test shows for sure.
   - **If you chose C:** A fever is not a sign of most STIs. A person can feel well and still have one.

2. **Sex with no condom, or a shared needle**

   HIV lives in semen, fluid from the vagina, blood and breast milk. It passes in sex, in blood on a shared needle, and from a mother to her baby.

   - **If you chose A:** HIV does not spread by sharing food, cups or plates. It passes in sex, in blood and from a mother to her baby. Go to S4.4.6.
   - **If you chose B:** Mosquitoes carry malaria, but they do not pass on HIV. Go to S4.4.6.
   - **If you chose D:** HIV does not pass by touch. It needs body fluids such as semen, fluid from the vagina or blood. Go to S4.4.6.

3. **A condom, used correctly every time**

   A condom stops semen, fluid from the vagina and blood passing between partners. Of all the methods of contraception, only condoms protect against STIs.

   - **If you chose B:** Washing feels clean, but by then the pathogens have reached the moist lining inside the body.
   - **If you chose C:** The pill prevents pregnancy with hormones. Nothing in it blocks or kills pathogens.

4. **Antibiotics from a health worker, taken to the end**

   Chlamydia is caused by a bacterium, so antibiotics cure it. Her partner is tested and treated too, so it does not pass back to her.

   - **If you chose A:** Chlamydia can stay for months with no signs, and it can damage the oviducts. It is cured with antibiotics.
   - **If you chose B:** Old medicine may be the wrong one, or too little to finish the job. A health worker chooses the right antibiotic. Go to S4.4.5.

5. **Its hormone stops ovulation and thickens the mucus at the cervix.**

   The implant releases a hormone into the blood. With no ovulation there is no egg to fertilise, and thick mucus stops sperm getting through the cervix.

   - **If you chose B:** Blocking the oviducts is female sterilisation, an operation. The implant is a small rod in the arm that releases a hormone.
   - **If you chose C:** The hormone works only while the implant is in. After a health worker takes it out, a person can become pregnant again soon.

6. **Each sperm duct**

   The sperm ducts carry sperm from the testes to the urethra. Once they are cut or blocked, semen comes out with no sperm in it.

   - **If you chose A:** The urethra still carries urine and semen out through the penis. It is not cut. Go to S3.4.4.
   - **If you chose C:** The testes stay and keep making hormones. Only the sperm ducts are cut or blocked. Go to S3.4.4.

7. **Emergency contraception, as soon as possible, from a health worker or a pharmacy**

   An emergency pill or a copper coil can prevent pregnancy after sex. A health worker can also test for STIs.

   - **If you chose A:** Sperm swim into the cervix within minutes, beyond the reach of water. Washing does not prevent pregnancy. Go to S3.4.6.
   - **If you chose C:** Urine leaves through the urethra, which is a separate opening from the vagina. It does not wash out sperm. Go to S3.4.4.

8. **It trains white blood cells, so they make antibodies fast if the virus comes.**

   A vaccine shows the body a harmless form or part of the pathogen. White blood cells learn to make the right antibodies, so the body responds faster when the real virus comes.

   - **If you chose B:** Antibiotics kill bacteria, not viruses. A vaccine kills nothing. It trains the body to respond. Go to S4.4.5.
   - **If you chose C:** A vaccine prepares the body before the pathogen arrives. It does not cure an infection already there. Go to S4.4.4.

About this book

For learners who can follow a written argument and have met the body and living things in earlier books. In many schools this fits learners of about 14 to 16, and older learners can use it as a reference. Each chapter takes two or three short sessions. A learner can work alone: every exercise has its answer and the reason for it. The book states established medical science plainly, as a school textbook does. It names no dose, no brand and no medicine for a reader to take, and it never offers a home cure. Where it says that someone may be ill, it says to see a health worker. Each chapter has a Try it made from household things: paper and a pencil for sorting, flour on hands and on oiled card, dry beans, food rubbed on paper, and a walk round the home with an adult to look for standing water. An adult should be near. Beans stay away from small children,

nothing is tasted, and no nuts are used. The last chapter, on sexual health, uses the correct names for the parts of the body and says in every section how to stay safe, that nobody may touch you without your yes, and to tell an adult you trust or a health worker when something is wrong.

Written and drawn by attnom. Edition 1.0, 2026-11-12.

This book is free. You may read it, print it, copy it and share it with anyone.

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