

Diseases and immunity

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Read first: **Blood vessels and blood**, **Movement into and out of cells**

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What you need to know

Questions on this topic appear on almost every paper. Papers 1 and 2 ask one-mark multiple choice ("which of these is a pathogen?", "which is an example of passive immunity?"); Papers 3 and 4 build longer questions around a disease such as cholera, measles or HIV, often with a graph or a pie chart of cases. Outcomes marked **Extended only** are tested on Papers 2 and 4 only. By the end of this topic you should be able to:

Core

1. **Describe a pathogen** as an organism that causes disease.
2. **Describe a transmissible disease** as one in which the pathogen can be passed from one host to another.
3. **State how pathogens are transmitted:** by **direct contact** (including through blood and other body fluids) or **indirectly** (including from contaminated surfaces, food, animals and air).
4. **Describe the body's defences**, limited to: the skin, hairs in the nose, mucus, stomach acid and white blood cells.
5. **Explain why these control the spread of disease:** a clean water supply, hygienic food preparation, good personal hygiene, waste disposal and sewage treatment (you don't need the stages of sewage treatment).

Extended only

6. **Describe active immunity** as defence against a pathogen by antibodies made in the body.
7. **State that each pathogen has its own antigens**, with specific shapes.
8. **Describe antibodies** as proteins that bind to antigens, which leads either to the pathogen being destroyed directly or to it being marked so that phagocytes destroy it.
9. **State that specific antibodies have complementary shapes** that fit specific antigens.
10. **Explain that active immunity is gained** after an infection by a pathogen or after vaccination.
11. **Outline vaccination:** weakened pathogens or their antigens are put into the body; the antigens stimulate lymphocytes to make antibodies; memory cells are made, which give long-term immunity.
12. **Explain the role of vaccination** in controlling the spread of disease.
13. **Explain passive immunity** as short-term defence by antibodies acquired from another individual, including across the placenta and in breast milk.
14. **Explain why breast-feeding matters** for passive immunity in babies.
15. **State that memory cells are not made** in passive immunity.

16. **Describe cholera** as a disease caused by a bacterium and transmitted in contaminated water.
17. **Explain how cholera makes you ill**: the bacterium's toxin causes chloride ions to be secreted into the small intestine, water follows by osmosis into the gut, and this causes diarrhoea, dehydration and loss of ions from the blood.

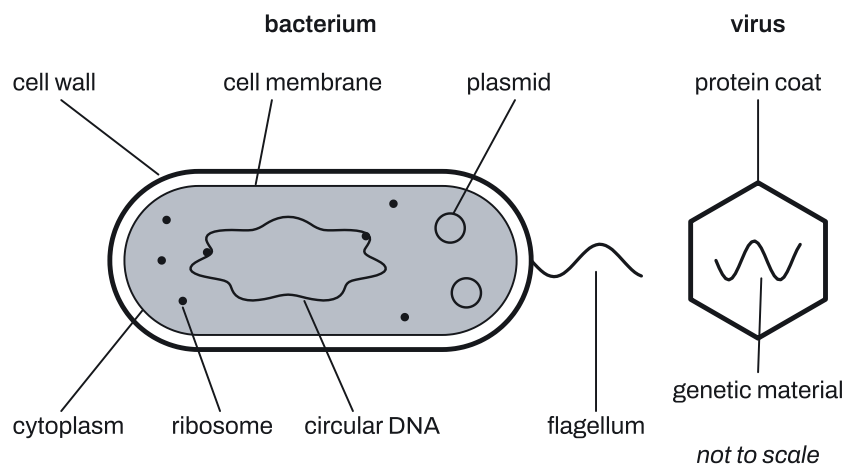
The white blood cells and blood clotting themselves are in Blood vessels and blood; mucus, cilia and goblet cells in the airways are in Gas exchange in humans; HIV and other sexually transmitted infections are in Human reproduction. This note uses them only where questions on this topic do.

Understand it

Pathogens and transmissible diseases

A **pathogen** is any organism that causes disease. Most are microorganisms: **bacteria** (cholera, tuberculosis, *Salmonella* food poisoning), **viruses** (measles, influenza, HIV) and **fungi** (athlete's foot). "Bacteria" is not a definition of a pathogen: plenty of bacteria are harmless, and plenty of pathogens are not bacteria.

A **transmissible disease** is one where **the pathogen** can be passed from **one host to another**. Both parts matter: a disease that spreads needs a pathogen to spread. Diseases with no pathogen are **not** transmissible, however common they are: coronary heart disease, lung cancer, scurvy and other deficiency diseases, and chronic obstructive pulmonary disease (COPD).



You met the structure of a bacterium in Characteristics and classification; questions here sometimes ask you to label one again. A bacterium is a single **prokaryotic** cell: a **cell wall**, **cell membrane**, **cytoplasm**, **ribosomes**, **circular DNA** and **plasmids**, but **no nucleus**. A virus is not a cell at all: just a **protein coat** around **genetic material** (DNA or RNA), and it can only reproduce inside a host's cells. The cholera pathogen is a bacterium called *Vibrio cholerae*; its genus is *Vibrio*.

How pathogens get from host to host

Transmission	What it means	Examples
Direct contact	the pathogen passes straight from one person's body to another's, in blood or other body fluids	blood transfusion, sharing needles, sex (HIV)
Indirect	the pathogen travels on or in something else first	contaminated surfaces (door handles, towels), food, water, air (droplets from coughs and sneezes), animals (insects, rats, pets)

The test: did the pathogen go **straight from one person's body fluid into another** (direct), or spend time **outside the body** first (indirect)? Contaminated water, food, droplets and taps are all indirect.

Plant pathogens spread the same ways: by leaves and roots touching, and indirectly by wind, water, soil, insects and dirty tools.

The body's defences

The body keeps most pathogens out, and deals with those that get in.

Defence	How it protects	Kind
Skin	a tough outer layer that pathogens can't get through while it is unbroken	mechanical barrier
Hairs in the nose	trap dust and pathogens in the air breathed in	mechanical barrier
Mucus	sticky; traps pathogens in the nose and airways before they reach the lungs	chemical barrier
Stomach acid	the hydrochloric acid in gastric juice kills pathogens swallowed in food and water	chemical barrier
White blood cells	phagocytes engulf and digest pathogens; lymphocytes make antibodies	cells

Older papers sort defences into **mechanical barriers** (skin, nose hairs), **chemical barriers** (mucus, stomach acid) and **cells** (phagocytes, lymphocytes), so learn that grouping. The barriers **stop pathogens entering** the body's tissues; white blood cells act **after** a pathogen has got in. When the skin is cut, **blood clotting** seals the gap so pathogens can't get in (Blood vessels and blood).

Controlling the spread of disease

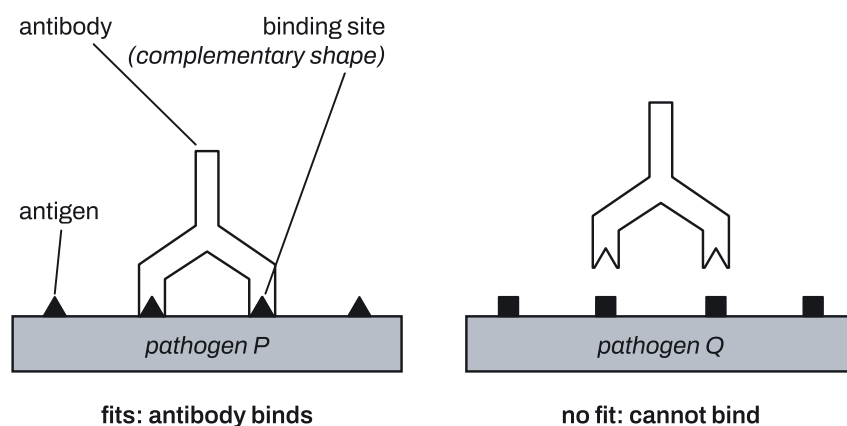
Every control method breaks a route of transmission.

- **A clean water supply.** Water is treated (filtered and chlorinated) or boiled, so pathogens such as the cholera bacterium, which come from faeces, are killed before anyone drinks the water.
- **Hygienic food preparation.** Wash hands before handling food; cook food thoroughly (high temperatures kill pathogens); keep raw and cooked food apart and use separate boards and knives; keep food covered and in a fridge (cold slows bacteria reproducing); clean surfaces. This stops pathogens reaching food, or kills them before it is eaten.
- **Good personal hygiene.** Wash hands with soap after using the toilet, after sneezing or coughing, and before eating; don't share towels or cups. This removes pathogens before they reach the mouth, food or other people.
- **Waste disposal.** Rubbish is collected and kept in closed bins, then buried or burned, so it doesn't attract flies and rats that carry pathogens to food.
- **Sewage treatment.** Sewage contains faeces full of pathogens; treating it removes and kills them before the water goes back into rivers, so drinking water and food crops are not contaminated.

Extended: antigens and antibodies

Every pathogen carries molecules on its surface called **antigens**. Each type of pathogen has its **own antigens**, with their own **specific shapes**.

Lymphocytes make **antibodies**: **proteins** with a binding site whose shape is **complementary** to one particular antigen. That antibody fits that antigen and no other, like a key in a lock. So an antibody against the measles virus is useless against the influenza virus.



When antibodies bind to the antigens they either:

- **destroy the pathogen directly** (for example by breaking it open), or
- **mark** it: pathogens coated with antibodies are clumped together and recognised, so **phagocytes** engulf and destroy them.

Antibodies can also bind to and neutralise the toxins that some bacteria release (these antibodies are called antitoxins).

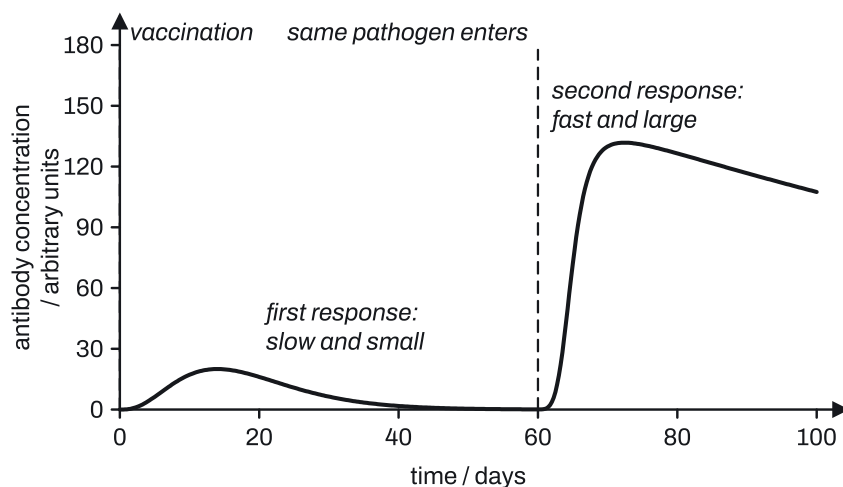
Extended: active immunity and vaccination

Active immunity is defence against a pathogen by **antibodies made in your own body**. You gain it in two ways:

- **after an infection**: the pathogen's antigens stimulate your lymphocytes, but you may be ill while they catch up;
- **after vaccination**, without having the disease.

Vaccination:

1. **Weakened** (or dead) **pathogens**, or just their **antigens**, are put into the body, usually by injection.
2. The **antigens stimulate an immune response**: the lymphocytes with the matching shape **make antibodies** against them. This first response is **slow** and small; it takes days to weeks.
3. **Memory cells** are made. They stay in the blood for years and give **long-term immunity**.
4. If the real pathogen enters later, the memory cells cause a **faster, larger** response: antibodies are made so quickly that the pathogen is destroyed before it can cause disease.



The antibodies from the first response don't last, which is why the curve falls. What lasts are the **memory cells**; they explain the second, bigger peak.

Why vaccination controls the spread of disease. A vaccinated person does not become ill and doesn't carry and pass on the pathogen. When **most of a population** is vaccinated, the pathogen has few people it can infect, so it can't pass from host to host and the number of cases falls. This also protects people who can't be vaccinated (such as very young babies). If vaccination rates fall, cases rise again.

Extended: passive immunity

Passive immunity is short-term defence by **antibodies acquired from another individual**. Your own lymphocytes make nothing, so **no memory cells** are made; the antibodies work **immediately** but are broken down within weeks or months and not replaced.

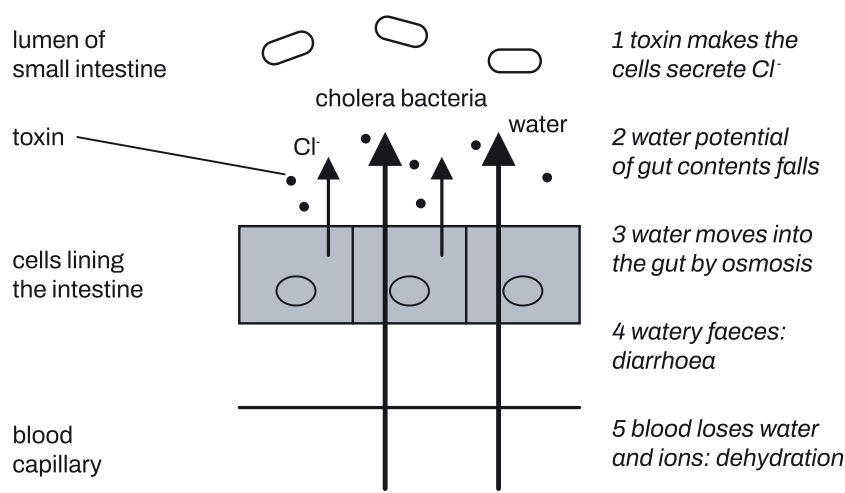
It comes **across the placenta** (before birth), **in breast milk**, or from an **injection of antibodies** when there is no time to wait for active immunity.

Why breast-feeding matters. A newborn baby's immune system has met very few pathogens and makes antibodies slowly. Breast milk gives the baby a supply of its mother's ready-made antibodies against the pathogens she has met, which are likely to be the ones around the baby. Because they are not replaced by the baby, the baby needs a **regular supply**, so feeding has to continue; and it only protects against pathogens the **mother** has antibodies to.

	Active immunity	Passive immunity
Antibodies made by	the person's own lymphocytes	another individual (mother, donor)
Gained by	infection or vaccination	placenta, breast milk, injection of antibodies
Memory cells	yes	no
How long it lasts	long-term	short-term
How fast it works	slow the first time	immediate

Extended: cholera

Cholera is caused by a **bacterium** (*Vibrio cholerae*) and is transmitted in **water** (and food) **contaminated with faeces** from an infected person. That is why it spreads where sewage gets into drinking water, for example after floods or in crowded camps.



1. The bacteria multiply in the **small intestine** and release a **toxin**.
2. The toxin makes the **cells lining the small intestine** secrete **chloride ions** into the lumen of the gut. (The bacteria don't release chloride ions, and the ions aren't the poison: the toxin is.)
3. The extra ions **lower the water potential** of the gut contents, below that of the cells and blood.
4. Water moves **by osmosis** out of the cells and blood **into the gut**.
5. The large volume of watery gut contents leaves as **diarrhoea**.
6. The body loses water and **ions** from the blood: **dehydration**. Without treatment this can kill within hours.

Diarrhoea is the loss of **watery faeces**. It is treated with **oral rehydration therapy**: drinking water containing **salts** (ions) and **glucose**, which replaces the water and ions lost.

Key facts and formulas

There is no formula list in the IGCSE Biology exam. Everything below must be learnt.

Formula	Status
Pathogen = disease-causing organism; transmissible disease = the pathogen can be passed from one host to another	Learn it
Direct transmission: blood and other body fluids. Indirect: contaminated surfaces, food, water, air, animals	Learn it
Defences: skin and nose hairs (mechanical), mucus and stomach acid (chemical), white blood cells (cells)	Learn it
Clean water, food hygiene, personal hygiene, waste disposal and sewage treatment each break a route of transmission	Learn it
Extended: each pathogen has its own antigens; antibodies are proteins with a complementary shape to one antigen	Learn it
Extended: antibodies destroy pathogens directly or mark them for phagocytes	Learn it
Extended: vaccine (weakened pathogen or antigens) → lymphocytes make antibodies → memory cells → long-term immunity	Learn it
Extended: active = own antibodies, memory cells, long-term; passive = antibodies from another individual, no memory cells, short-term	Learn it
Extended: cholera toxin → Cl ⁻ secreted into small intestine → water potential falls → water into gut by osmosis → diarrhoea, dehydration	Learn it
Percentage = $\frac{\text{part}}{\text{total}} \times 100$; percentage change = $\frac{\text{new} - \text{original}}{\text{original}} \times 100$; pie chart slices add to 100%	Learn it

How to do it

We tagged 99 questions for this topic (2021–2025, Papers 1–4; 83 different, since some multiple-choice questions appear on more than one paper). 24 of them mix types, so the counts add up to 146.

Question type	Questions
Name and classify body defences	24
Define pathogen and transmissible disease; name the type of pathogen	22

Question type	Questions
Explain how cholera causes diarrhoea and dehydration (Extended)	20
Classify transmission as direct or indirect	14
Explain how vaccination gives immunity (Extended)	14
Distinguish active and passive immunity (Extended)	13
Describe ways to control the spread of disease	11
Read, calculate from and describe disease data	10
Explain how antibodies act: specificity (Extended)	10
Identify the parts of a bacterium or virus	5
Describe diarrhoea and its treatment	3

1. Name and classify body defences (24 questions)

1. **Match the defence to the route:** food → **stomach acid** (kills); air → **nose hairs** and **mucus** (trap); body surface → **skin**; inside the body → **white blood cells**.
2. **Say what it does** with a verb: traps, kills, engulfs, produces antibodies. "Fights" earns nothing.

Variations you will meet:

- **Which defences keep pathogens out?** Only the barriers (and a clot over a cut). Phagocytosis and antibodies act after entry, so they are wrong here.
- **Chemical or mechanical?** Mucus and stomach acid are chemical; skin and nose hairs mechanical; phagocytes and lymphocytes are specialised cells.
- **Gastric juice** (2 marks): it contains acid (**1**) that kills the pathogens (**1**).
- **True/false statements:** check each cell's job (lymphocytes make antibodies, phagocytes engulf) and the clotting direction (fibrinogen becomes fibrin). A statement that swaps either pair is false. Red blood cells are never a defence.
- **More white cells during an infection:** more phagocytosis and more antibodies.

2. Define pathogen and transmissible disease; name the type of pathogen (22 questions)

1. **Pathogen:** a disease-causing organism.
2. **Transmissible disease:** the **pathogen** passes from **one host to another**; use both words.
3. **Type:** bacterium (cholera, TB), virus (measles, influenza, rubella, HIV) or fungus.

Variations you will meet: picking the one disease with a pathogen from a list of deficiency, heart or lung diseases; naming a food-poisoning bacterium as a "pathogen" (not a symptom or disease); "the type of pathogen that causes cholera" is **bacterium**, not *Vibrio* and not virus.

3. Explain how cholera causes diarrhoea and dehydration (20 questions, Extended)

Write the chain from "Extended: cholera" above, one mark per link: **toxin** → **chloride ions** secreted **into the small intestine** → **water potential** in the gut **falls** → water enters the gut **by osmosis** → **diarrhoea, dehydration, loss of ions**.

Variations you will meet: multiple choice on direction (ions and water both move **into the small intestine**, never into the blood, large intestine or gall bladder); which water potential falls (the gut contents'); putting the events in order; pointing to the small intestine on a diagram; the genus name *Vibrio*.

4. Classify transmission as direct or indirect (14 questions)

1. **Direct:** blood or other body fluids (transfusion, shared needles, sex).

2. **Indirect:** surfaces, food, water, air, animals.

Variations you will meet: "name a pathogen passed in blood" (HIV); "state two indirect routes"; HIV routes from Human reproduction (sex, needles, blood, mother to baby); plant pathogens (touching, wind, water, soil, insects, tools).

5. Explain how vaccination gives immunity (14 questions, Extended)

Use the four steps in "Extended: active immunity and vaccination": weakened pathogen or **antigens** → **lymphocytes** make **antibodies** → **memory cells** → faster, larger response later.

Variations you will meet:

- **What triggers the response** is the **antigens** in the vaccine.
- **Flow diagrams and gap fills:** the vaccine's antigens make lymphocytes produce antibodies, and it is **active** immunity; the long-term cells are **memory cells**; the cells that destroy marked pathogens are **phagocytes**.
- **Antibody graphs:** a second, taller, steeper peak means the same pathogen met memory cells.
- **Not protected straight away:** antibodies and memory cells take days to weeks to make.
- **Trial design:** volunteers who had the disease before already have memory cells, which would hide the vaccine's effect.
- **Controlling spread:** vaccinated people don't fall ill or pass the pathogen on, so transmission stops.
- **Rubella:** girls are vaccinated before pregnancy because the virus crosses the placenta.

6. Distinguish active and passive immunity (13 questions, Extended)

Use the table in "Extended: passive immunity". Compare both sides with "whereas": own antibodies / from another individual; memory cells / none; long-term / short-term; slow / immediate.

Variations you will meet: classify an example (antibodies after infection or a vaccine = active; placenta, breast milk, antibody injection = passive); a statement giving passive immunity memory cells is false; an injection after a bite or toxin is used because it is **immediate**; describing how babies gain passive immunity (up to 4 marks, from "Why breast-feeding matters").

7. Describe ways to control the spread of disease (11 questions)

Pick the route in the question and give one precise action per mark, from "Controlling the spread of disease": wash hands; treated or boiled water; cook food thoroughly; cover and refrigerate food; separate raw and cooked food; clean surfaces; closed bins; treat sewage. If asked to **explain**, add how it breaks the route. For mother-to-baby HIV (from Human reproduction): medication, no breast-feeding, Caesarean birth.

8. Read, calculate from and describe disease data (10 questions)

1. **Percentage** = $\frac{\text{part}}{\text{total}} \times 100$. **Missing pie slice** = $100 - \text{the others}$. **Number** = $\text{percentage} \div 100 \times \text{total}$.
2. **Percentage change** = $\frac{\text{new} - \text{original}}{\text{original}} \times 100$; say increase or decrease.
3. **Describe** the whole trend (rise, peak, fall, plateau) and **quote values with units**.
4. **Compare two groups** category by category, note where the difference is small or reversed, and compare totals.

Variations you will meet: a pie chart with slices of 30%, 15% and 40% leaves $100 - 85 = 15\%$, and 15% of 400 people is 60; linking a fall in cases to the start of vaccination; judging a trial (sample size, equal groups, size of the difference).

9. Explain how antibodies act: specificity (10 questions, Extended)

1. Each pathogen has **antigens** of a **specific shape**.
2. Lymphocytes make **antibodies** with a **complementary** shape that **bind** to them.
3. Binding **destroys** the pathogen directly or **marks** it for **phagocytes**; antibodies also neutralise toxins.

Variations you will meet: statement questions test where each molecule is (antigens belong to the pathogen, antibodies come from lymphocytes), the shape word (complementary, not identical), that each antibody fits one antigen only, and that antibodies never engulf anything. HIV destroys lymphocytes, so fewer antibodies are made and other infections follow (AIDS).

10. Identify the parts of a bacterium or virus (5 questions)

Use the bacterium diagram: **cell wall**, **cell membrane**, **cytoplasm**, **ribosomes**, **circular DNA**, **plasmids**, **flagellum**. Prokaryote features: cell wall, circular DNA, plasmids, no nucleus. A virus: **protein coat** and **genetic material**.

11. Describe diarrhoea and its treatment (3 questions)

Diarrhoea is the loss of watery faeces; treat it with **oral rehydration therapy** (water with salts and glucose) to replace the water and ions lost.

Worked examples

The bold codes show where marks are earned, as in Cambridge mark schemes. The number is how many marks.

- **M1** method mark: for a correct method, even if the numbers slip.
 - **A1** accuracy mark: for a correct answer; it needs the M mark before it.
 - **B1** mark for a correct result on its own, with no method needed.
-

Example 1

Core. Tuberculosis (TB) is caused by a bacterium that infects the lungs. It spreads when an infected person coughs.

(a) Explain what is meant by a *transmissible disease*. **[2]**

(b) State whether TB is spread by direct or indirect transmission. Give a reason. **[1]**

(c) Some medicines dry out the lining of the airways, so it makes less mucus. Suggest why a person taking one might catch TB more easily. **[2]**

(d) Some bacteria do reach the lungs. Describe two ways white blood cells can protect the body against them. **[2]**

(e) A town of 25 000 people had 40 new cases of TB in one year and 30 the next year. Calculate the number of cases per 100 000 people in the first year, and the percentage change in cases. **[3]**

(a) A disease caused by a pathogen **B1** that can be passed from one host to another **B1**.

(b) Indirect: the bacteria travel through the air, in droplets, not in blood or body fluids **B1**.

(c) Mucus traps bacteria in the airways **B1**; with less mucus, more bacteria in the air breathed in reach the lungs **B1**.

(d) Phagocytes engulf and digest the bacteria **B1**; lymphocytes produce antibodies against them **B1**.

(e) $\frac{40}{25\,000} \times 100\,000 = 160$ cases per 100 000 people **B1**. $\frac{30 - 40}{40} \times 100$ **M1** = -25% , a decrease of 25% **A1**.

Example 2

Core, with an Extended part. After a flood damaged a town's sewage pipes, doctors recorded new cases of cholera each week.

Week	1	2	3	4	5
New cases	3	18	41	27	9

- (a) Describe the changes in the number of new cases. [2]
- (b) Calculate the total number of cases in the five weeks, and the percentage decrease in weekly cases from the peak to week 5. [3]
- (c) Suggest why the outbreak began after the sewage pipes were damaged. [2]
- (d) Explain two ways the town could reduce the spread of cholera. [4]
- (e) **Extended:** a doctor noticed that the patients' blood had become more concentrated, even though they were drinking plenty of water. Explain, starting from the bacterium, why water leaves their blood. [4]
- (a) New cases rose to a peak of 41 in week 3 **B1**, then fell to 9 by week 5 **B1**.
- (b) $3 + 18 + 41 + 27 + 9 = 98$ cases **B1**. $\frac{9 - 41}{41} \times 100$ **M1** = -78% , a decrease of 78% **A1**.
- (c) Cholera is transmitted in water contaminated with faeces **B1**; sewage from infected people leaked into the drinking water **B1**.
- (d) Supply clean water by treating it (chlorinating) or telling people to boil it **B1**, which kills the bacteria before the water is drunk **B1**. Repair the pipes and treat the sewage **B1**, so faeces with bacteria don't reach the water supply **B1**. (Hand washing before eating, so bacteria aren't carried to the mouth, would also score.)
- (e) The bacterium releases a toxin **B1**, which causes chloride ions to be secreted into the small intestine **B1**. This lowers the water potential of the gut contents, so water moves from the blood into the gut by osmosis **B1**, and is lost in diarrhoea faster than it is drunk, taking ions with it **B1**.

Example 3

Extended. A volunteer was given a new vaccine on day 0. On day 50 she was exposed to the pathogen the vaccine protects against. The table shows the antibody concentration in her blood.

Day	0	7	14	21	35	50	54	58	65
Antibody concentration / arbitrary units	0	6	24	18	5	1	70	150	168

- (a) State the name of the cells that made these antibodies. [1]
- (b) Calculate how many times greater the highest concentration after day 50 is than the highest concentration before day 50. [1]

- (c) Explain the difference between her responses after day 0 and after day 50. **[3]**
- (d) Use the idea of shape to explain how the antibodies made after day 50 attach to this pathogen and to nothing else in her body. **[2]**
- (e) Explain why vaccinating most people in a country reduces the number of cases, even among people who were not vaccinated. **[2]**

(a) Lymphocytes **B1**.

(b) $\frac{168}{24} = 7$ times **B1**.

(c) After day 0 the antigens stimulated lymphocytes for the first time, so antibodies were made slowly and in small amounts **B1**. Memory cells were made during this first response **B1**. After day 50 the memory cells caused antibodies to be made much faster and in larger amounts (70 units within 4 days, already above the first peak) **B1**.

(d) The pathogen's antigens have a specific shape **B1**; the antibodies have a complementary shape, so they fit and bind to those antigens only **B1**.

(e) Vaccinated people don't become ill or pass on the pathogen **B1**, so the pathogen can't spread from host to host and unvaccinated people are less likely to meet it **B1**.

Example 4

Extended. Two children live in a town where measles has just broken out. Ravi is 6 and was vaccinated against measles at the age of 1. His sister Leela is 3 months old, too young for the vaccine, and is breast-fed by their mother, who had measles as a child.

(a) State the type of immunity each child has against measles, and where each child's antibodies came from. **[2]**

(b) Their mother decides to stop breast-feeding when Leela is 5 months old. Explain why Leela's protection then fades but Ravi's does not. **[3]**

(c) The measles virus gets into Ravi's blood. Describe what happens from the moment his body meets the virus until the virus is destroyed. **[4]**

(a) Ravi: active immunity; his own lymphocytes made the antibodies **B1**. Leela: passive immunity; the antibodies came from her mother, across the placenta and in breast milk **B1**.

(b) Leela's antibodies came from another individual, so no memory cells were made **B1**; the antibodies are broken down and are no longer replaced once feeding stops **B1**. Ravi's vaccination produced memory cells, which give long-term immunity **B1**.

(c) Memory cells recognise the measles antigens **B1** and lymphocytes quickly make large amounts of antibodies **B1**. The antibodies have a shape complementary to the antigens and bind to them **B1**, destroying the virus directly or marking it so that phagocytes engulf it **B1**.

Common mistakes

- **Defining a pathogen as "a bacterium" or "a germ", or leaving the pathogen out of "transmissible disease".** A pathogen is a disease-causing organism. Examiners want the word **pathogen** in a definition of transmissible disease, and **host** rather than "person" or "organism".
- **Mixing up direct and indirect.** Only blood and other body fluids are direct. Air, food, water and surfaces are indirect.
- **Saying "hairs" or "cilia" without a place.** Write "hairs in the nose".
- **Naming lymphocytes or phagocytes as chemical barriers.** Chemical barriers are mucus and stomach acid.
- **Muddling antigens, antibodies and antibiotics.** Antigens are on the pathogen; antibodies are proteins made by lymphocytes; antibiotics are medicines.
- **Writing about antibodies as if they were cells.** Antibodies don't engulf pathogens, secrete chemicals, have active sites or turn into memory cells.
- **Saying the antibody has "the same shape" as the antigen, or that phagocytes make antibodies.** It has a **complementary** shape, and lymphocytes make it.
- **Saying the cholera bacterium releases chloride ions, or that chloride ions are toxic.** The bacterium releases a **toxin**; the toxin makes the **gut lining** secrete chloride ions.
- **Getting the water potential backwards.** The ions **lower** the water potential in the gut, so water moves **into** the gut.
- **Answering a passive immunity question with active immunity.** An injection of antibodies gives passive immunity: immediate, short-term, no memory cells.
- **Describing only part of a graph** or giving rough readings. Quote exact values and cover every change, including any later rise or plateau.

How to get the marks

- **"State" or "name":** one word or phrase ("pathogen", "bacterium", "antigens", "memory cells"). Don't list alternatives; a wrong one cancels a right one.
- **"Describe"** a defence or a control method: name it **and** what it does ("stomach acid **kills** pathogens"). One point per mark.
- **"Explain"** a process (cholera, vaccination, antibodies): a chain of linked steps using the key words, in order. Each link is usually a mark.
- **Compare** active and passive immunity: write both sides or use "whereas"; the mark schemes accept a point made either way round.
- **Definitions:** use the syllabus words: "disease-causing organism"; "pathogen passed from one host to another"; "antibodies acquired from another individual".
- **Don't repeat the stem.** If the question tells you antibodies neutralise a toxin, saying so again earns nothing; add what the question asks (for example, "passive, so it works immediately").

- **Data:** quote figures with units, give the trend and any exceptions, and show working in calculations. Round as the question says (for example, to 2 significant figures).
- **Use the exact terms:** pathogen, host, transmissible, direct, indirect, antigen, antibody, complementary, lymphocyte, phagocyte, memory cells, active, passive, toxin, chloride ions, water potential, osmosis, dehydration.

Quick check

1. Say which of these diseases are caused by a pathogen, and name the type of pathogen: athlete's foot, rickets, chickenpox, heart attack.
2. **Extended:** A student wrote: "Cholera bacteria release chloride ions, which are poisonous and make water leave the gut." Correct the two mistakes.
3. **Extended:** In a trial, 6 of 400 vaccinated people and 48 of 320 unvaccinated people caught a disease. Calculate the percentage of each group that caught it, and how many times more likely an unvaccinated person was to catch it.
4. Name the defence described: (a) kills bacteria swallowed in food; (b) stops pathogens entering through unbroken body surface; (c) sticky substance that traps pathogens in the airways; (d) cells that engulf bacteria.
5. **Extended:** Explain why babies who are breast-fed get some infections less often in their first months, and why this protection doesn't last once feeding stops.

Answers

1. Athlete's foot (a fungus) and chickenpox (a virus) are caused by pathogens. Rickets (a vitamin D deficiency) and a heart attack (coronary heart disease) are not.
2. The bacteria release a **toxin**, which makes the cells lining the small intestine secrete the chloride ions; the ions are not the poison. Water moves **into** the gut (from the blood) by osmosis, not out of it.
3. Vaccinated: $\frac{6}{400} \times 100 = 1.5\%$. Unvaccinated: $\frac{48}{320} \times 100 = 15\%$. $\frac{15}{1.5} = 10$ times more likely.
4. (a) Stomach acid. (b) Skin. (c) Mucus. (d) Phagocytes (white blood cells).
5. Breast milk contains the mother's antibodies, which give the baby passive immunity against pathogens she has met. The baby's lymphocytes didn't make them, so no memory cells are made; the antibodies are broken down and are not replaced once feeding stops.

Past questions to try

- **0610/42/M/J/25 Q2**: direct and indirect transmission, the role of antibodies and active versus passive immunity (Extended).
- **0610/41/M/J/24 Q6**: a graph of polio cases after vaccination, and how vaccination works (Extended).
- **0610/41/O/N/21 Q4**: a cholera vaccine trial, how cholera causes diarrhoea, and its treatment (Extended).
- **0610/32/M/J/21 Q7**: defining a transmissible disease, a pie chart of cases, and the body's defences (Core).