iBLaurel

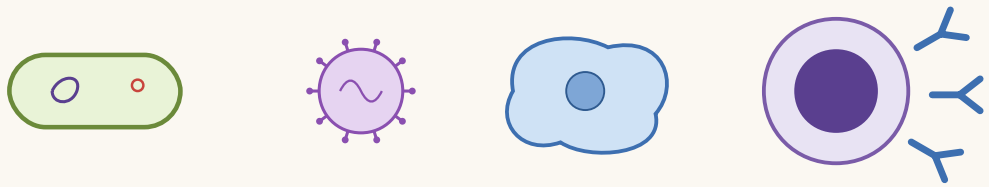
Specialist one-to-one Science, Maths & Economics tuition

AQA GCSE BIOLOGY · SPECIFICATION 4.3

Topic 3: Infection and Response

Complete revision & exam preparation guide — key points to memorise, clear diagrams, practice questions and full answers

Key-point notes | Memory hooks | Disease fact files | Data & maths skills | Exam questions + answers



Prepared by iBLaurel · Specialist one-to-one Science, Maths & Economics tuition
Suitable for Foundation and Higher tier · Combined Science (Trilogy) and Separate Biology

START HERE

Contents and how to use this guide

3.1 Pathogens and how they spread
3.2 Viral diseases: measles, HIV, TMV
3.3 Bacterial diseases: Salmonella, gonorrhoea
3.4 Fungal and protist diseases
3.5 Preventing the spread of disease
3.6 The body's first line of defence
3.7 The immune system
3.8 Vaccination
3.9 Antibiotics, painkillers and resistance
3.10 Discovering and developing drugs
3.11 Making monoclonal antibodies (Bio, HT)
3.12 Using monoclonal antibodies (Bio, HT)
3.13 Detecting plant disease (Bio only)
3.14 Plant defences (Bio only)
★ One-page memory sheet
✎ Summary questions
✓ Answers and mark scheme

How to use this guide

1. **Read** one section. Study the diagram and say the labels out loud.
2. **Learn the gold "Remember it" box** — short hooks that make facts stick.
3. **Cover and recall:** cover the page, write the key points from memory, then check and correct in a different colour.
4. **Read the green "Exam tip" and red "Common mistake" boxes** — they show where marks are won and lost.
5. Finish with the **summary questions** (no notes), then mark them with the **answers**. Re-test the ones you got wrong 2–3 days later.

THE BIG IDEA OF TOPIC 3

Pathogens cause communicable diseases and spread in different ways. Our body **defends** itself with barriers and the **immune system**. We help it with **hygiene, vaccines and drugs** — and every new drug must be **tested** before use. Plants get diseases too, and have their own defences.

Key boxes in this guide

Box	What it means
Remember it	Memory hook, rhyme or shortcut to memorise
Exam tip	How to write the answer to get the marks
Common mistake	Errors examiners see every year
Maths skill	Calculations and data skills you must be able to do
BIOLOGY ONLY	Only for Separate (Triple) Biology, not Combined Science
HIGHER TIER	Only examined on the Higher tier paper

Topic 3 has no required practical, but questions often ask you to **read graphs and tables** about disease, vaccines and drug trials.

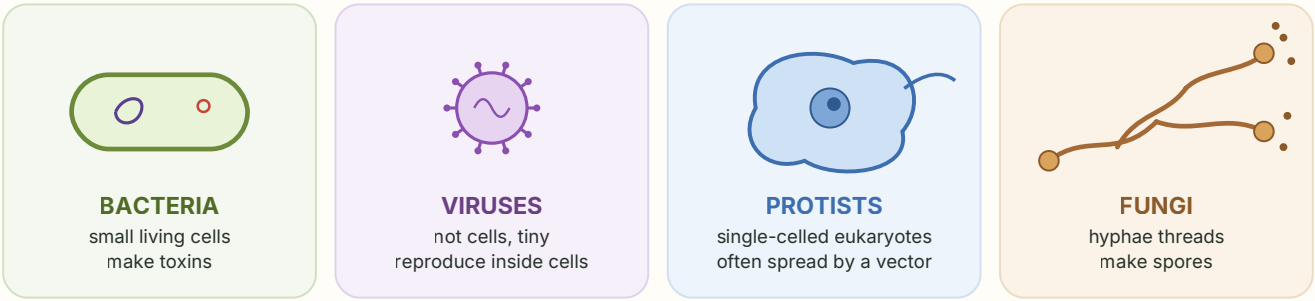
PART A

Communicable Diseases

3.1 Pathogens and how they spread

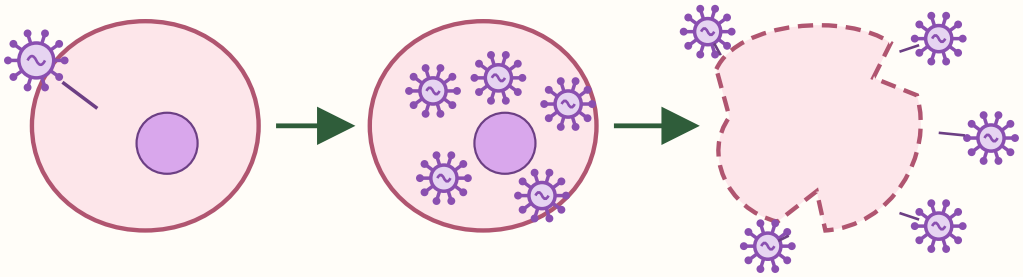
AQA 4.3.1.1

- **Pathogens** are **microorganisms** that cause **infectious disease**.
- A **communicable disease** can **spread** from person to person, or between animals and people.
- Pathogens can be **bacteria, viruses, protists or fungi**. They infect **both plants and animals**.



The four types of pathogen

Pathogen	Key facts	How it makes you ill
Bacteria	Very small **living cells** (about 1/100th the size of a body cell). Reproduce rapidly inside the body.	Produce **toxins** (poisons) that **damage tissues** and make us feel ill
Viruses	**Not cells** — much smaller than bacteria. They live and **reproduce inside cells**.	Copies burst out of the cell → **cell damage**
Protists	Single-celled **eukaryotes**. Some are **parasites** (live in or on another organism). Often carried by a **vector**.	Damage the host, e.g. malaria
Fungi	Some are single-celled; others have thread-like **hyphae** that grow into skin or plant surfaces and make **spores**.	Hyphae damage tissue; spores spread the disease

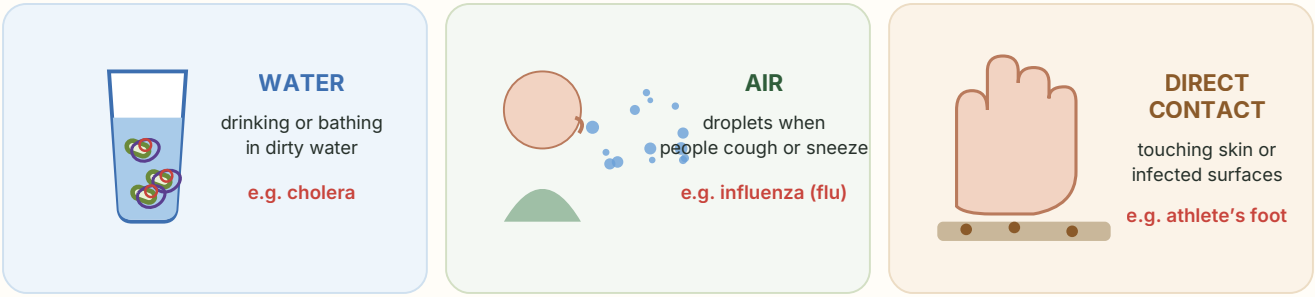


1. Virus gets into a body cell

2. Uses the cell to make many copies of itself

3. Cell bursts, releasing viruses → cell damage

How a virus damages body cells



How pathogens are spread: three main routes

REMEMBER IT

Four pathogens: **"Big Vicious Pests Fight"** → **B**acteria, **V**iruses, **P**rotists, **F**ungi.
Bacteria make **toxins**; viruses make **cells burst**.
Spread by **"WAD"**: **W**ater, **A**ir, **D**irect contact (plus vectors and body fluids).

COMMON MISTAKE

Viruses are **not** cells and are **not** alive in the normal sense — never call a virus a "cell". And antibiotics do **not** work on viruses (see 3.9).

3.2 Viral diseases: measles, HIV and TMV

AQA 4.3.1.2

Disease	Spread by	Symptoms / effects	Control
Measles (humans)	Inhaling **droplets** from sneezes and coughs	**Fever** and a **red skin rash**. Can be **fatal** if complications happen (e.g. pneumonia, brain infection).	No treatment — most young children are **vaccinated** (MMR)
HIV (humans)	**Sexual contact**, or exchange of **body fluids** such as blood (e.g. drug users **sharing needles**)	At first a **flu-like illness**. Then the virus attacks the body's **immune cells**. When the immune system is badly damaged it can't deal with other infections or cancers = **late stage HIV infection, or AIDS**.	**Antiretroviral drugs** stop the virus multiplying; condoms; not sharing needles
Tobacco mosaic virus (TMV) (plants)	Contact between plants; on tools and hands	A **'mosaic' pattern** of discoloured patches on leaves. These parts can't photosynthesise → **less growth**. Affects many plants, e.g. **tomatoes**.	Remove infected plants; good hygiene; grow resistant varieties

REMEMBER IT

Viral diseases: **"My House Tomato"** → **M**easles, **H**IV, **T**MV.
Measles = **rash + fever**. HIV → **AIDS** (attacks **immune cells**). TMV = **mosaic → less photosynthesis → less growth**.

EXAM TIP

"Explain why TMV reduces the growth of a plant" (3 marks): discoloured leaf areas have less **chlorophyll** (1) → less **photosynthesis** (1) → less **glucose** made for growth (1).

3.3 Bacterial diseases: Salmonella and gonorrhoea

AQA 4.3.1.3

Disease	Spread by	Symptoms	Control
Salmonella (food poisoning)	Eating food contaminated with the bacteria, e.g. undercooked chicken, or food prepared in **unhygienic** conditions	**Fever, stomach cramps, vomiting and diarrhoea** — caused by the bacteria and the **toxins** they release	In the UK, **poultry are vaccinated** against Salmonella; cook food thoroughly; wash hands
Gonorrhoea (an STD)	**Sexual contact** (unprotected sex)	**Thick yellow or green discharge** from the vagina or penis and **pain when urinating**	Treat with **antibiotics** (penicillin used to work, but many strains are now **resistant**); use **condoms** (barrier contraception)

REMEMBER IT

Two bacterial diseases: **"Sally's Gone"** → **S**almonella (food), **G**onorrhoea (sex). Salmonella = **chickens** (vaccinated poultry). Gonorrhoea = **condoms + antibiotics** (but beware resistance).

COMMON MISTAKE

Salmonella symptoms are caused by the **toxins** the bacteria release — mention toxins for full marks.

3.4 Fungal and protist diseases

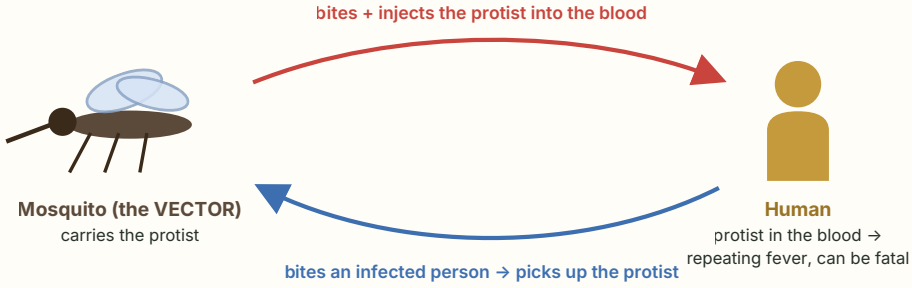
AQA 4.3.1.4–4.3.1.5

Rose black spot (a fungus)

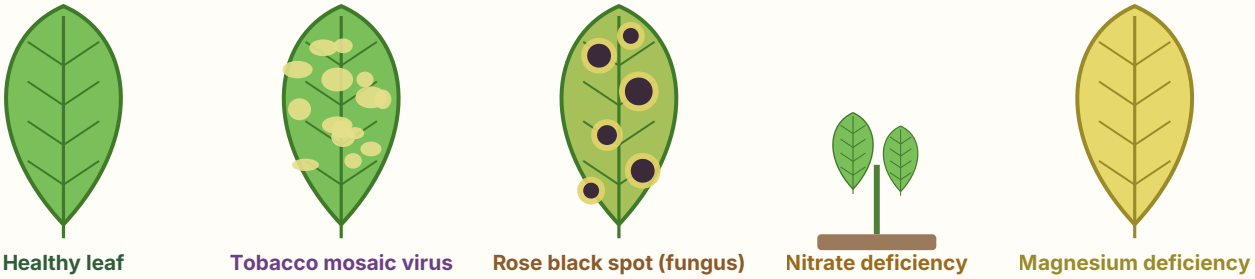
- **Purple or black spots** develop on rose leaves.
- Leaves often turn **yellow** and **drop early**.
- Less leaf area → less **photosynthesis** → plant doesn't grow well.
- Spores spread in the environment by **water** or **wind**.
- Treated with **fungicides** and/or by **removing and destroying** infected leaves.

Malaria (a protist)

- Caused by a **protist**. Part of its life cycle is inside **mosquitoes**.
- Mosquitoes are **vectors** — they carry the protist but don't get the disease.
- Causes **repeated episodes of fever**. It can be **fatal**.
- Spread reduced by stopping mosquitoes **breeding** (e.g. draining still water), **insecticides**, and using **mosquito nets** to stop bites.



The malaria cycle: the mosquito is the vector



Signs of plant disease and mineral deficiency (more in 3.13)

REMEMBER IT

Black spot = fungus (spores in water + wind). **Malaria = protist** (mosquito vector). Vector = **V**ehicle that carries the pathogen.

3.5 Preventing the spread of disease

AQA 4.3.1.1

Method	How it works	Example
Being hygienic	Simple hygiene stops pathogens passing from person to person	Washing hands before preparing food; covering coughs and sneezes
Destroying vectors	Kill the organisms that carry the disease, so it can't be passed on	Insecticides; destroying mosquito breeding sites
Isolating infected individuals	The infected person can't pass the pathogen to anyone else	Keeping a sick person at home or in hospital isolation
Vaccination	Vaccinated people (and animals) can't catch the disease, so can't spread it	MMR for children; Salmonella vaccine for chickens

REMEMBER IT

Stop the spread with **"HIVV"**: **H**ygiene, **I**solation, **V**ectors destroyed, **V**accination.

EXAM TIP

"Suggest why chefs must wash their hands" → to remove pathogens (bacteria) from their hands (1) so they are not transferred to food and cause food poisoning in customers (1).

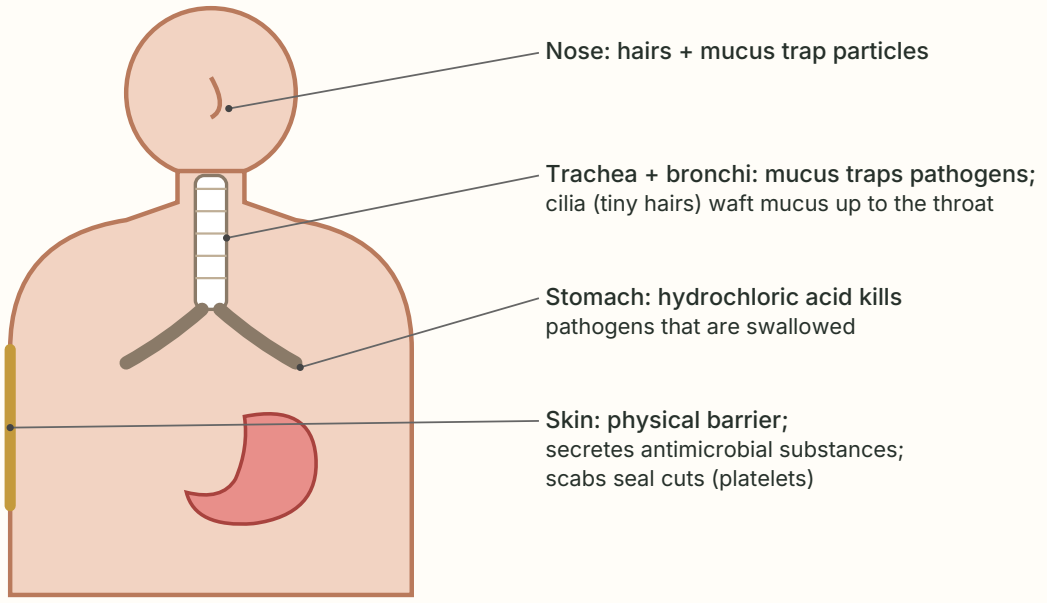
PART B

Fighting Disease

3.6 The body's first line of defence

AQA 4.3.1.6

The body has **non-specific** defences that try to **stop pathogens getting in**. They work against all pathogens.



Non-specific defences of the human body

- **Skin** — a physical **barrier**; also secretes **antimicrobial substances** that kill pathogens.
- **Nose** — **hairs** and **mucus** trap particles that may contain pathogens.
- **Trachea and bronchi** — secrete **mucus** to trap pathogens. They are lined with **cilia** (hair-like structures) that **waft the mucus up** to the back of the throat, where it is swallowed.
- **Stomach** — makes **hydrochloric acid**, which **kills** pathogens that are swallowed.

REMEMBER IT

Four barriers, top to bottom: **"Never Trust Smelly Skin"** → **N**ose, **T**rachea/bronchi, **S**tomach, **S**kin. Mucus **Traps**, cilia **Waft**, acid **Kills**.

COMMON MISTAKE

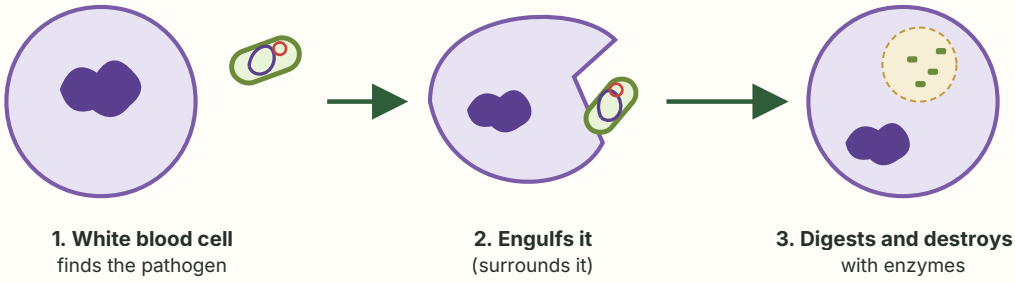
Cilia do **not** kill or trap pathogens — the **mucus traps** them; the cilia only **move** the mucus away.

3.7 The immune system: white blood cells

AQA 4.3.1.6

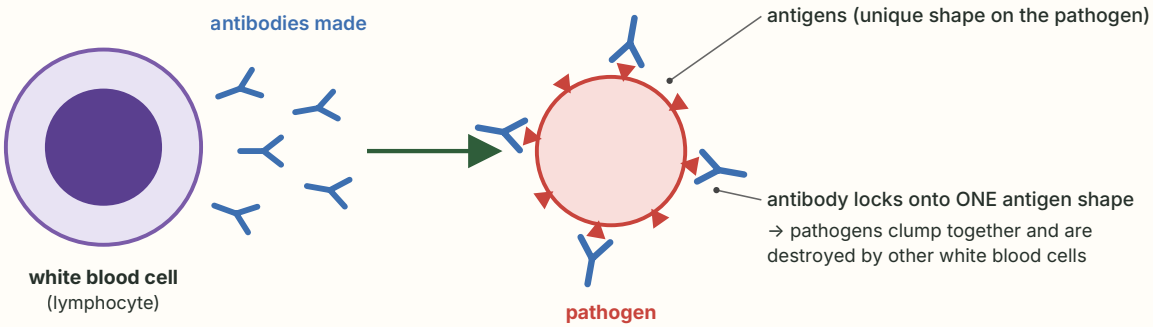
- If a pathogen gets into the body, the **immune system** tries to destroy it.
- The most important part is the **white blood cells**. They travel in the blood and attack invaders in **three ways**:

1. Phagocytosis — engulfing pathogens



Phagocytosis: the white blood cell engulfs and digests the pathogen

2. Producing antibodies



Antibodies are specific to one antigen

- Every pathogen has unique molecules on its surface called **antigens**.
- When white blood cells (lymphocytes) meet a **foreign antigen**, they make **antibodies** — proteins that **lock onto** that antigen.
- Antibodies are **specific**: each one only fits **one type of antigen**. They help other white blood cells find and destroy the pathogen.
- Antibodies are made rapidly and carried all round the body.
- Some white blood cells become **memory cells**. If the **same pathogen** enters again, they make the right antibodies **very quickly** → you are **naturally immune**.

3. Producing antitoxins

- **Antitoxins** **neutralise** (counteract) the **toxins** made by bacteria.

REMEMBER IT

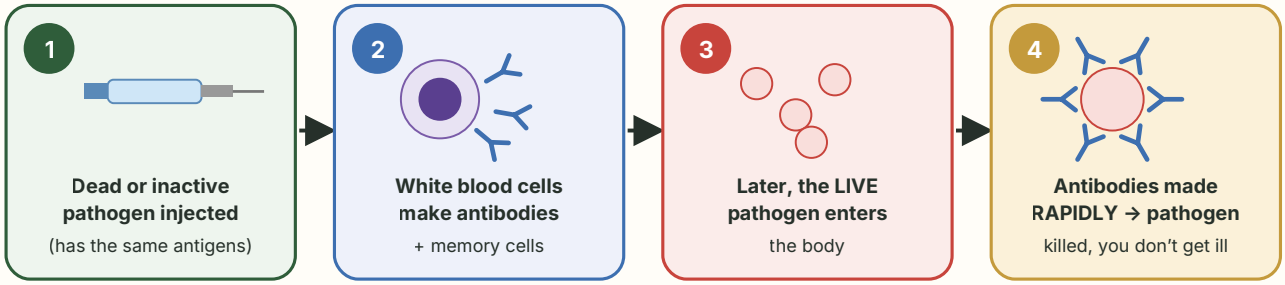
White blood cells fight with **"EAT"**: **E**ngulf (phagocytosis), **A**ntibodies, an**T**itoxins.
Antigen = on the **gen**erator of disease (the pathogen). **Antibody** = made by your **body**.

COMMON MISTAKE

Antibodies do **not** 'kill' pathogens directly and are **not** cells. They **bind to antigens** so pathogens are clumped together and destroyed by other white blood cells. Antitoxins act on **toxins**, not on the bacteria.

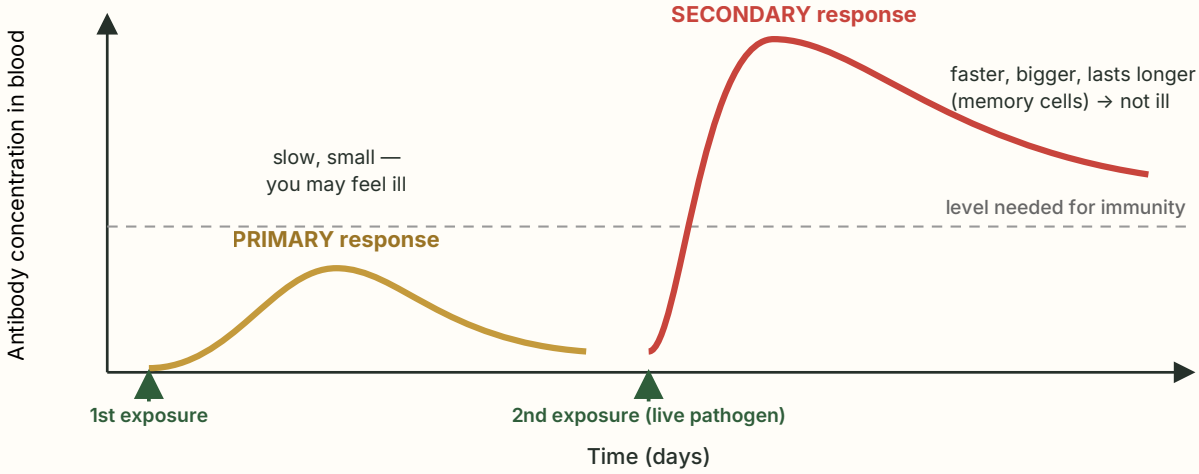
3.8 Vaccination

AQA 4.3.1.7



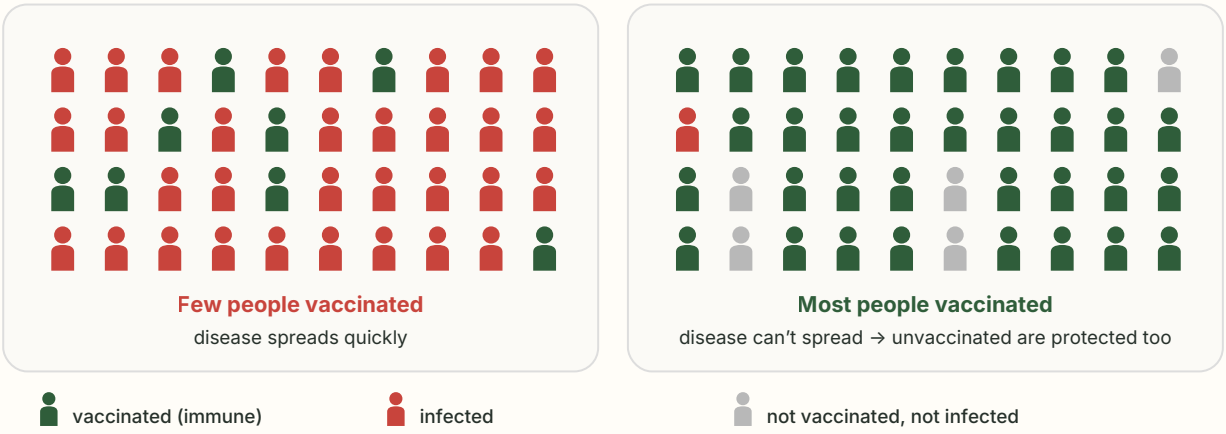
How vaccination prevents illness

- A vaccine contains **small amounts of dead or inactive** (weakened) pathogens.
- They carry the same **antigens**, so white blood cells make the right **antibodies** — even though the pathogen is harmless.
- If the **live** pathogen later infects the person, white blood cells respond **rapidly**, make the correct antibodies and destroy it **before you get ill**.
- Example: **MMR** vaccine protects against **measles, mumps and rubella**.



The secondary response (after a vaccine) is faster and bigger than the first

Herd immunity: if a **large proportion** of the population is immune, the spread of the pathogen is **very much reduced**. This protects the few people who aren't vaccinated.



Herd immunity

✓ Pros of vaccination	× Cons of vaccination
Has controlled lots of communicable diseases (e.g. **smallpox** is gone; polio cases have fallen by over 99%) · prevents **epidemics** through herd immunity · protects people who can't be vaccinated	Doesn't always give immunity · some people have a **bad reaction** (e.g. swelling, or rarely a fever or seizure) — but serious reactions are very rare

REMEMBER IT

Vaccine = a **"practice run"** for your immune system: **dead pathogen → antibodies + memory cells → fast response later**.

EXAM TIP — READING THE GRAPH

The second peak is **higher**, **steeper** (faster) and **lasts longer**, because **memory cells** recognise the antigen. The antibody level rises above the level needed for immunity **before** symptoms can appear.

PART C

Drugs: Treating Disease

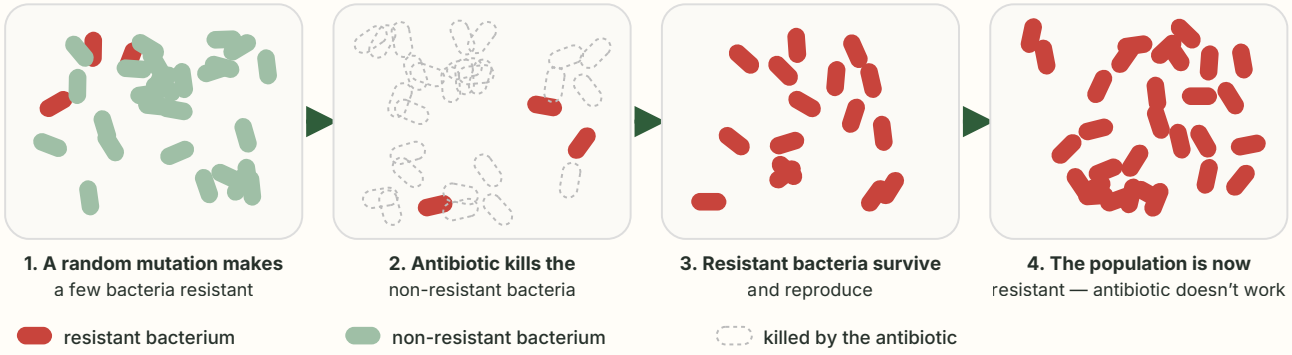
3.9 Antibiotics, painkillers and antibiotic resistance

AQA 4.3.1.8

	Painkillers and other medicines	Antibiotics
Example	Aspirin, paracetamol, cold remedies	**Penicillin**
What they do	Treat the **symptoms** only — do **not** kill pathogens	**Kill bacteria** inside the body → **cure** bacterial disease
Notes	Make you feel better while the immune system fights the pathogen	Specific bacteria need **specific antibiotics**. They have **greatly reduced deaths** from bacterial disease.

- Antibiotics **cannot kill viruses**. Viruses live and reproduce **inside body cells**, so it is **difficult to make drugs** that kill viruses **without damaging the body's own cells**.

Antibiotic resistance



How a resistant strain develops by natural selection

- Bacteria can **mutate**. A mutation may make some bacteria **resistant** (not killed) by an antibiotic.
- When the antibiotic is used, **non-resistant** bacteria are killed, but **resistant** ones **survive and reproduce**.
- The resistant strain spreads because people have **no immunity** and there is **no effective treatment**. Example: **MRSA** (resistant to the antibiotic methicillin).

Slowing down resistance: doctors should **not over-prescribe** antibiotics (e.g. never for colds or flu, which are viral); patients must **finish the whole course** so all bacteria are killed; farmers should use fewer antibiotics on animals.

REMEMBER IT

Antibiotics = Anti-bacteria (not anti-virus).
Resistance: **"Mutate, Survive, Multiply"**. Stop it: **don't over-prescribe, finish the course**.

COMMON MISTAKE

It is the **bacteria** that become resistant — **not the person**. Never write "the patient became immune to the antibiotic".

3.10 Discovering and developing drugs

AQA 4.3.1.9

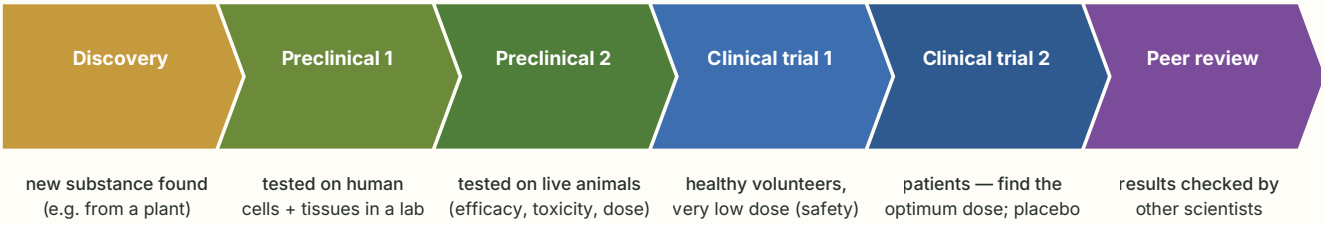
Where drugs came from: traditionally drugs were **extracted from plants and microorganisms**.

Drug	Origin	Use
Digitalis	**Foxglove** plant	Heart conditions
Aspirin	**Willow** tree	Painkiller; lowers fever
Penicillin	**Penicillium mould** — discovered by **Alexander Fleming** (1928), who saw bacteria didn't grow around mould on a Petri dish	Antibiotic

Today most new drugs are **made (synthesised) by chemists** in the **pharmaceutical industry** — but the starting point may still be a chemical from a plant.

Testing new drugs

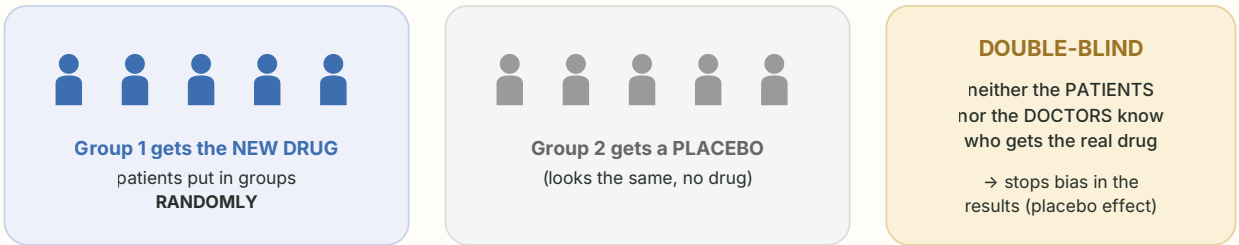
New drugs are tested for three things: **toxicity** (is it harmful?), **efficacy** (does it work?) and **dose** (how much should be given?).



The stages of developing a new drug

- **Preclinical testing** in a lab: first on human **cells and tissues**, then on **live animals** (to test a whole body system).
- **Clinical trials** on people: first **healthy volunteers** with a **very low dose** to check it is **safe** (no harmful side effects).
- Then **patients** with the illness, to find the **optimum dose** (most effective with fewest side effects).
- Results are **published** only after **peer review** — checked by other scientists — to prevent false claims.

Placebos and double-blind trials



A double-blind trial with a placebo

- A **placebo** looks like the drug but contains **no drug**. It lets doctors see the **real effect** of the drug (some patients feel better just because they think they're being treated — the **placebo effect**).
- **Double-blind**: neither the **patients** nor the **doctors** know who gets the drug or the placebo until the end. This stops **bias**.
- Patients are put into groups **randomly**.

REMEMBER IT

Test for **"TED"**: **T**oxicity, **E**fficacy, **D**ose.
Order: **Cells → Animals → Healthy people (low dose) → Patients (optimum dose) → Peer review**.
Plant drugs: **Fox**glove → **D**igitalis (heart); **Will**ow → **A**spirin; **Pen**icillium mould → **Pen**icillin.

MATHS SKILL — DRUG TRIAL DATA

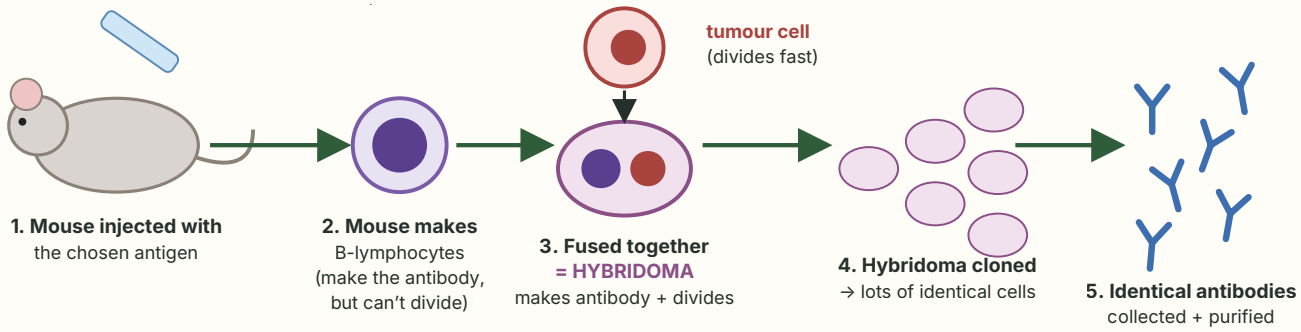
Percentage = part ÷ total × 100
Example: 84 of 120 patients on the new drug improved, and 30 of 120 on the placebo. Drug: 84 ÷ 120 × 100 = **70%**. Placebo: 30 ÷ 120 × 100 = **25%**. So the drug's real effect is about **45 percentage points** more than the placebo.

PART D

Monoclonal Antibodies

3.11 Making monoclonal antibodies BIOLOGY ONLY HIGHER TIER AQA 4.3.2.1

- **Monoclonal antibodies** are **identical antibodies** produced from a **single clone** of cells.
- They are **specific** to one binding site on **one protein antigen**, so they can **target a specific chemical or specific cells** in the body.



Making monoclonal antibodies

1. A **mouse** is injected with the chosen **antigen**.
2. The mouse's **lymphocytes** (B-lymphocytes, a type of white blood cell) make the matching antibody — but lymphocytes **don't divide** very easily.
3. A lymphocyte is **fused** with a **tumour cell**, which **divides very quickly**. The new cell is a **hybridoma**.
4. The hybridoma can both **make the antibody** AND **divide**. A single hybridoma is **cloned** → many identical cells.
5. All the cells make the **same antibody**. Large amounts are **collected and purified**.

REMEMBER IT

Hybridoma = Hybrid of a lymphocyte (makes the **antibody**) + a tumour cell (**divides fast**) — the best of both.
Steps: **"Mouse → Lymphocyte → Fuse → Clone → Collect"**.

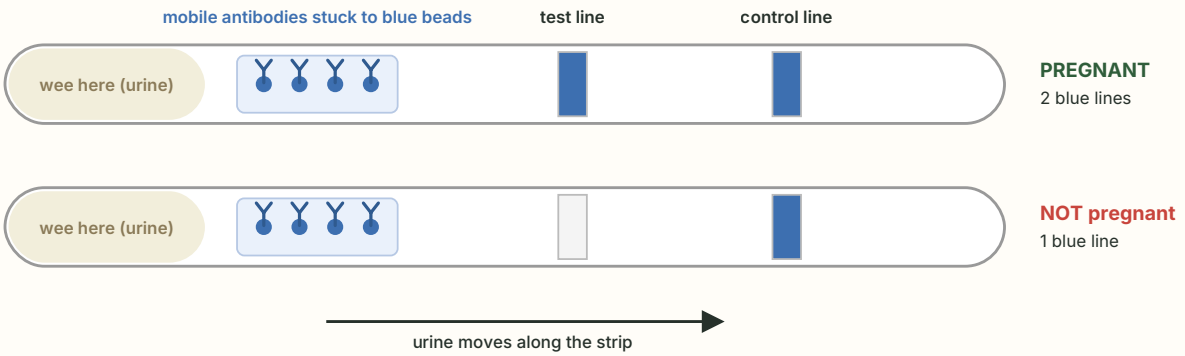
EXAM TIP

"Why is the lymphocyte fused with a tumour cell?" → lymphocytes make the antibody but can't divide (1); tumour cells divide rapidly, so the hybridoma makes lots of the antibody (1).

3.12 Using monoclonal antibodies BIOLOGY ONLY HIGHER TIER

AQA 4.3.2.2

1. Pregnancy tests



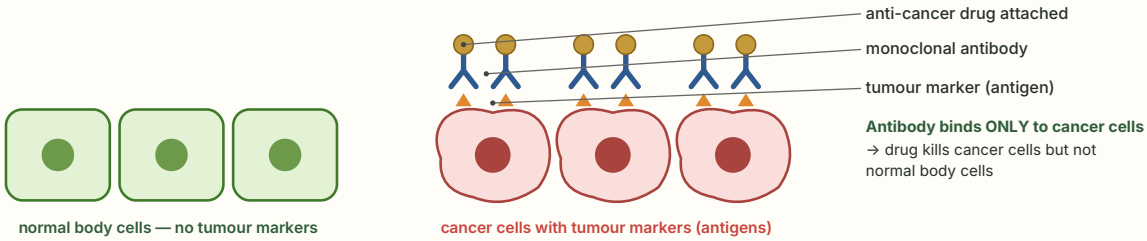
How a pregnancy test stick works

- A pregnant woman's urine contains the hormone **hCG**.
- The **wee zone** has monoclonal antibodies for hCG, stuck to **blue beads**. The beads can move.
- **Test line:** has antibodies for hCG **fixed** (stuck down). If hCG is present, it binds to the bead antibodies, moves up and **sticks to the test line** → blue line appears = **pregnant**.
- No hCG → beads flow past → test line stays white.
- **Control line:** has antibodies that bind to the bead antibodies, so it **always turns blue** → shows the test is working.

2. In laboratories and research

- To measure levels of **hormones and other chemicals in blood**.
- To **detect pathogens** in blood samples.
- In research, to **locate or identify specific molecules** in a cell or tissue: the antibodies are attached to a **fluorescent dye**, so the molecules glow and can be seen.

3. Treating diseases such as cancer



Monoclonal antibodies deliver a drug only to cancer cells

- Cancer cells have **antigens** on their membranes called **tumour markers** — not found on normal cells.
- Monoclonal antibodies are made to bind to these tumour markers. They can be attached to a **radioactive substance**, a **toxic drug** or a **chemical that stops cells growing and dividing**.
- The antibody carries the substance **only to the cancer cells**, so it doesn't harm other cells (unlike standard chemotherapy).

✓ Advantages	× Disadvantages
Bind only to **specific** cells → **fewer side effects** than chemotherapy or radiotherapy · can treat many different conditions · fast, accurate tests	Cause **more side effects than expected** (e.g. fever, vomiting, low blood pressure) · **expensive** to develop · not as **widely used** as scientists first hoped · use of mice raises **ethical** issues

REMEMBER IT

Uses: **"Pregnant Lab Rats Treated"** → **P**regnancy tests, **L**ab tests (hormones, pathogens), **R**esearch (fluorescent dye), **T**reating cancer.
Cancer: antibody = the **guided missile**; the drug = the **warhead**.

PART E

Plant Disease and Defences

3.13 Detecting and identifying plant disease BIOLOGY ONLY

AQA 4.3.3.1

- Plants can be infected by **viral, bacterial and fungal pathogens**, and damaged by **insects** (e.g. **aphids**, which feed on sap).

Signs of plant disease:

- **Stunted** growth
- **Spots** on leaves
- Areas of **decay** (rot)
- **Growths** (e.g. lumps)
- **Malformed** stems or leaves
- **Discolouration**
- Visible **pests**

How to identify the disease:

- Look up the signs in a **gardening manual** or on a **gardening website**.
- Take the infected plant to a **laboratory** to identify the pathogen.
- Use **testing kits** that contain **monoclonal antibodies** to identify the pathogen.

Mineral ion deficiencies

Plants need **mineral ions** from the soil. If they are short of them, they show **deficiency symptoms** (see the diagram in 3.4).

Ion	Needed for	Deficiency symptom
Nitrate	Making **proteins** → growth	**Stunted growth**
Magnesium	Making **chlorophyll** (for photosynthesis)	**Chlorosis** — yellow leaves

REMEMBER IT

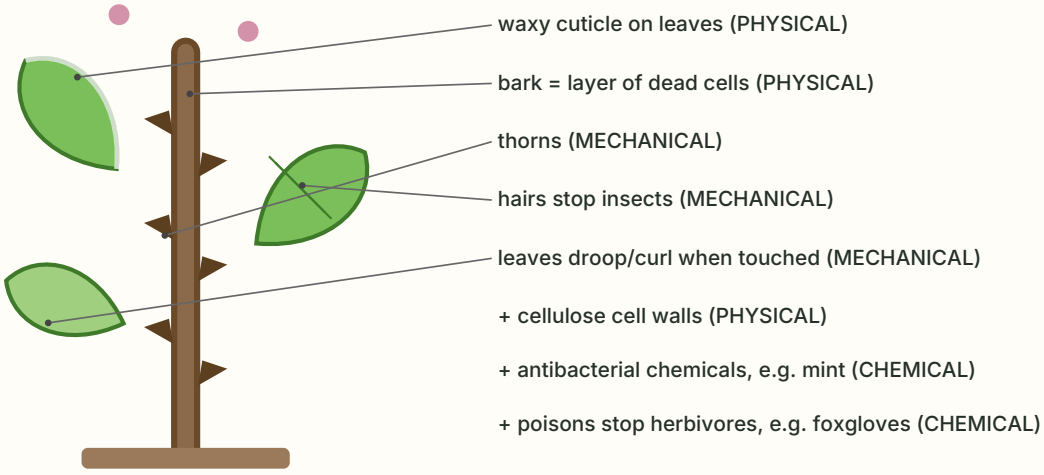
Nitrate → Nutrients for growth (proteins): no nitrate = **small** plant.
Magnesium → Makes chlorophyll: no magnesium = **yellow** leaves (chlorosis).

COMMON MISTAKE

A deficiency disease is **not** caused by a pathogen — it is caused by a **lack of mineral ions**, so it is **not communicable**.

3.14 Plant defences BIOLOGY ONLY

AQA 4.3.3.2



Physical, chemical and mechanical plant defences

Type	Defences
Physical — barriers that stop pathogens getting in	**Cellulose cell walls** · tough **waxy cuticle** on leaves · layers of **dead cells** on stems (e.g. **bark**), which fall off
Chemical	**Antibacterial chemicals** that kill bacteria (e.g. mint, witch hazel) · **poisons** to deter herbivores (e.g. tobacco plants, foxgloves, deadly nightshade)
Mechanical — adaptations that stop animals	**Thorns and hairs** deter animals from touching or eating them · leaves that **droop or curl** when touched (knocks insects off) · **mimicry** to trick animals (e.g. passion flower spots that look like butterfly eggs; 'living stones' that look like pebbles)

REMEMBER IT

Plant defences = **"PCM"** → **P**hysical (walls, wax, bark), **C**hemical (antibacterials, poisons), **M**echanical (thorns, hairs, drooping, mimicry).

EXAM TIP

Physical defences stop **pathogens**; mechanical defences stop **animals**. Chemical defences can stop both. Use these words to sort examples in exam questions.

★ LAST-MINUTE

One-page memory sheet

Topic	Must-know facts
Pathogens	Bacteria (toxins), viruses (cells burst), protists (often a vector), fungi (hyphae, spores). Spread by water, air, direct contact.
Viral diseases	Measles: fever + red rash, droplets, vaccinate. HIV: flu-like → attacks immune cells → AIDS; sex/body fluids; antiretrovirals. TMV: mosaic leaves → less photosynthesis → less growth.
Bacterial diseases	Salmonella: food; fever, cramps, vomiting, diarrhoea (toxins); poultry vaccinated. Gonorrhoea: STD; yellow/green discharge, pain urinating; antibiotics (resistance), condoms.
Fungus + protist	Rose black spot: purple/black spots, leaves yellow + drop; water/wind; fungicides, remove leaves. Malaria: protist, mosquito vector, fevers; nets, insecticides, stop breeding.
Stop the spread	Hygiene · isolation · destroy vectors · vaccination.
Non-specific defence	Skin (barrier, antimicrobials) · nose (hairs, mucus) · trachea/bronchi (mucus + cilia) · stomach (HCl).
White blood cells	Phagocytosis (engulf + digest) · antibodies (specific to antigens; memory cells) · antitoxins (neutralise toxins).
Vaccination	Dead/inactive pathogen → antibodies + memory cells → fast secondary response. Herd immunity. MMR. Pros vs cons.
Drugs	Painkillers treat symptoms. Antibiotics kill bacteria, not viruses. Resistance: mutation → survive → reproduce (MRSA). Don't over-prescribe; finish the course.
Drug origins	Digitalis (foxglove), aspirin (willow), penicillin (Penicillium, Fleming). Now synthesised by chemists.
Drug testing	Toxicity, efficacy, dose. Cells/tissues → animals → healthy volunteers (low dose) → patients (optimum dose) → peer review. Placebo, double-blind, random groups.
Monoclonal antibodies	Mouse + antigen → lymphocytes + tumour cell = hybridoma → clone → identical antibodies. Uses: pregnancy tests (hCG), lab tests, fluorescent research, cancer drugs. More side effects than expected.
Plant disease	Signs: stunted growth, spots, rot, growths, malformed, discolouration, pests (aphids). Identify: manual/website, lab, monoclonal antibody kits. Nitrate → stunted; magnesium → chlorosis.
Plant defences	Physical: cellulose walls, waxy cuticle, bark. Chemical: antibacterials, poisons. Mechanical: thorns, hairs, drooping leaves, mimicry.

PRACTICE

Summary questions

Try every question **without notes**. Tick each one you get fully right; redo the rest in 2–3 days. Answers are in the next section.

Section A — Quick recall (1–2 marks each)

1. What is a pathogen?
2. Name the four types of pathogen.
3. How do bacteria make us feel ill?
4. How do viruses cause cell damage?
5. Give three ways pathogens can be spread.
6. What are the symptoms of measles?
7. How is HIV spread?
8. What type of drug is used to control HIV?
9. What is the sign of tobacco mosaic virus on a plant?
10. Give two symptoms of Salmonella food poisoning.
11. How is the spread of Salmonella controlled in the UK?
12. Give two symptoms of gonorrhoea.
13. Give one way to reduce the spread of gonorrhoea.
14. What type of pathogen causes rose black spot?
15. How can rose black spot be treated?
16. What is a vector? Give the vector for malaria.
17. Give two ways to reduce the spread of malaria.
18. How does the skin defend against pathogens?
19. What is the job of cilia in the trachea?
20. What does the stomach produce to kill pathogens?
21. Give the three ways white blood cells defend the body.
22. What is an antigen?
23. What do antitoxins do?
24. What does a vaccine contain?
25. What is herd immunity?
26. Why can't antibiotics be used to treat flu?
27. Which drug comes from foxgloves and what is it used for?
28. Who discovered penicillin and where did it come from?
29. Name the three things new drugs are tested for.
30. What is a hybridoma?

31. Which hormone does a pregnancy test detect?
32. What is the symptom of magnesium deficiency in plants and why?

Section B — Exam-style questions

33. Describe how viruses cause illness and explain why it is difficult to develop drugs to kill them. [4 marks]
34. Explain how the spread of measles and malaria can be reduced. Your answer should refer to how each disease is spread. [4 marks]
35. HIV can lead to AIDS. Describe how. [3 marks]
36. Explain how the trachea and bronchi are adapted to stop pathogens entering the lungs. [3 marks]
37. Describe how white blood cells produce antibodies and explain how this makes a person immune to a disease. [4 marks]
38. Explain how vaccination protects a person from measles. [4 marks]
39. Evaluate the use of vaccination programmes. [6 marks]
40. Explain how a strain of bacteria becomes resistant to an antibiotic. [4 marks]
41. Suggest two ways in which the development of antibiotic-resistant bacteria could be slowed down. [2 marks]
42. Describe the stages in testing a new drug before it can be used by doctors. [6 marks]
43. Explain why new drugs are tested using a double-blind trial with a placebo. [3 marks]
44. (Bio, HT) Describe how monoclonal antibodies are produced. [5 marks]
45. (Bio, HT) Explain how monoclonal antibodies can be used to treat cancer, and why they may cause fewer side effects than chemotherapy. [4 marks]
46. (Bio) A gardener sees that a tomato plant has stunted growth and yellow leaves. Suggest two possible causes and how she could find out which is correct. [4 marks]
47. (Bio) Describe one physical, one chemical and one mechanical defence of plants. [3 marks]

Section C — Maths and data skills

48. In a town of 25 000 people, 22 500 are vaccinated against measles. Calculate the percentage vaccinated. [2 marks]
49. In a drug trial, 60 of 150 patients given the drug and 18 of 150 given the placebo got better. Calculate the percentage for each group and the difference. [3 marks]
50. The number of cases of a disease fell from 1240 to 310 after a vaccine was introduced. Calculate the percentage decrease. [2 marks]
51. The risk of a serious side effect from a vaccine is 1 in 1 000 000. The risk of a serious complication from the disease is 1 in 15. How many times more likely is a complication from the disease? [2 marks]
52. A bacterium divides every 20 minutes. If one antibiotic-resistant bacterium survives, how many resistant bacteria will there be after 4 hours? Give your answer in standard form. [3 marks]
53. Use the antibody graph in section 3.8. Give two differences between the primary and secondary response. [2 marks]

ANSWERS

Answers and mark scheme

Section A — Quick recall

1. **What is a pathogen?**
   A microorganism that causes infectious (communicable) disease.
2. **Name the four types of pathogen.**
   Bacteria, viruses, protists, fungi.
3. **How do bacteria make us feel ill?**
   They produce toxins (poisons) that damage tissues.
4. **How do viruses cause cell damage?**
   They reproduce inside cells; the cell bursts, releasing new viruses.
5. **Give three ways pathogens can be spread.**
   Water, air (droplets), direct contact (also vectors and body fluids).
6. **What are the symptoms of measles?**
   Fever and a red skin rash.
7. **How is HIV spread?**
   Sexual contact or exchange of body fluids such as blood, e.g. sharing needles.
8. **What type of drug is used to control HIV?**
   Antiretroviral drugs.
9. **What is the sign of tobacco mosaic virus on a plant?**
   A ‘mosaic’ pattern of discoloured patches on the leaves.
10. **Give two symptoms of Salmonella food poisoning.**
    Any two: fever, stomach cramps, vomiting, diarrhoea.
11. **How is the spread of Salmonella controlled in the UK?**
    Poultry are vaccinated against Salmonella (also: cooking food thoroughly, hygiene).
12. **Give two symptoms of gonorrhoea.**
    Thick yellow or green discharge from the vagina or penis; pain when urinating.
13. **Give one way to reduce the spread of gonorrhoea.**
    Use condoms (barrier contraception) or treat infected people with antibiotics.
14. **What type of pathogen causes rose black spot?**
    A fungus.
15. **How can rose black spot be treated?**
    Fungicides and/or removing and destroying infected leaves.
16. **What is a vector? Give the vector for malaria.**
    An organism that carries a pathogen without getting the disease; the mosquito.
17. **Give two ways to reduce the spread of malaria.**
    Mosquito nets; insecticides; stopping mosquitoes breeding (any two).
18. **How does the skin defend against pathogens?**
    Acts as a barrier and secretes antimicrobial substances.
19. **What is the job of cilia in the trachea?**
    To waft mucus (with trapped pathogens) up to the back of the throat to be swallowed.

20. **What does the stomach produce to kill pathogens?**
    Hydrochloric acid.
21. **Give the three ways white blood cells defend the body.**
    Phagocytosis, producing antibodies, producing antitoxins.
22. **What is an antigen?**
    A unique molecule (e.g. protein) on the surface of a pathogen/cell.
23. **What do antitoxins do?**
    Neutralise (counteract) toxins produced by bacteria.
24. **What does a vaccine contain?**
    Small amounts of dead or inactive forms of a pathogen.
25. **What is herd immunity?**
    When a large proportion of the population is immune, so the spread of the pathogen is greatly reduced, protecting unvaccinated people.
26. **Why can't antibiotics be used to treat flu?**
    Flu is caused by a virus; antibiotics only kill bacteria.
27. **Which drug comes from foxgloves and what is it used for?**
    Digitalis — heart conditions.
28. **Who discovered penicillin and where did it come from?**
    Alexander Fleming; Penicillium mould.
29. **Name the three things new drugs are tested for.**
    Toxicity, efficacy, dose.
30. **What is a hybridoma?**
    A cell made by fusing a lymphocyte with a tumour cell; it makes antibodies and divides rapidly.
31. **Which hormone does a pregnancy test detect?**
    hCG (human chorionic gonadotrophin).
32. **What is the symptom of magnesium deficiency in plants and why?**
    Chlorosis (yellow leaves) — magnesium is needed to make chlorophyll.

Section B — Exam-style questions

33. **Describe how viruses cause illness and explain why it is difficult to develop drugs to kill them.** [4]
    - Viruses enter body cells and reproduce/replicate inside them (1)
    - The cell bursts, releasing viruses → cell damage makes you ill (1)
    - Because viruses live inside body cells (1), drugs that kill them would also damage the body's own cells/tissues (1)
34. **Explain how the spread of measles and malaria can be reduced. Your answer should refer to how each disease is spread.** [4]
    - Measles spread by droplets from coughs/sneezes (1); reduced by vaccinating young children / isolating infected people (1)
    - Malaria spread by mosquito vectors (1); reduced by mosquito nets, insecticides or stopping mosquitoes breeding (1)
35. **HIV can lead to AIDS. Describe how.** [3]
    - HIV attacks the body's immune cells (1)
    - If not controlled with antiretroviral drugs, the immune system becomes badly damaged (1)
    - The body can no longer deal with other infections or cancers — this is late stage HIV / AIDS (1)

36. **Explain how the trachea and bronchi are adapted to stop pathogens entering the lungs.** [3]
    - They secrete mucus (1)
    - which traps pathogens (1)
    - They are lined with cilia that waft the mucus up to the throat where it is swallowed (1)
37. **Describe how white blood cells produce antibodies and explain how this makes a person immune to a disease.** [4]
    - White blood cells (lymphocytes) detect foreign antigens on the pathogen (1)
    - They make antibodies specific to/complementary to that antigen, which lock on so the pathogen is destroyed (1)
    - Memory cells remain after the infection (1)
    - If the same pathogen enters again, antibodies are made rapidly so it is destroyed before symptoms appear (1)
38. **Explain how vaccination protects a person from measles.** [4]
    - Vaccine contains dead/inactive measles virus (1) with the same antigens
    - White blood cells produce antibodies against the antigens (1) and memory cells are made
    - If the live virus enters, white blood cells respond quickly and make the correct antibodies rapidly (1)
    - The virus is destroyed before the person becomes ill (1)
39. **Evaluate the use of vaccination programmes.** [6]
    - **For:** controlled many diseases (e.g. smallpox eradicated, polio greatly reduced); herd immunity prevents epidemics and protects people who can't be vaccinated; reduces deaths and healthcare costs
    - **Against:** vaccines don't always give immunity; some people have side effects (usually mild, e.g. swelling; very rarely serious); some people refuse, reducing herd immunity
    - **Conclusion:** e.g. the risk of serious side effects is far smaller than the risk from the disease, so the benefits outweigh the risks
    - *Level marking: balanced points + justified conclusion for 5–6 marks.*
40. **Explain how a strain of bacteria becomes resistant to an antibiotic.** [4]
    - A random mutation makes some bacteria resistant (1)
    - The antibiotic kills the non-resistant bacteria (1)
    - Resistant bacteria survive and reproduce (1)
    - The population of resistant bacteria increases / passed on resistance gene (1)
41. **Suggest two ways in which the development of antibiotic-resistant bacteria could be slowed down.** [2]
    - Doctors should not prescribe antibiotics for viral or non-serious infections (1)
    - Patients should complete the full course of antibiotics (1) (also: fewer antibiotics in farming)

42. **Describe the stages in testing a new drug before it can be used by doctors.** [6]
    - Preclinical: tested on human cells and tissues in a lab
    - Then tested on live animals for efficacy, toxicity and dose
    - Clinical trial on healthy volunteers with a very low dose to check safety/side effects
    - Dose gradually increased; then trials on patients to find the optimum dose
    - Double-blind trials with placebo; patients randomly allocated
    - Results peer reviewed before publishing
    - *Level marking: correct order with detail for 5–6 marks.*

43. **Explain why new drugs are tested using a double-blind trial with a placebo.** [3]
    - A placebo allows comparison so the real effect of the drug can be seen / rules out the placebo effect (1)
    - Patients don't know which they get, so their expectations don't affect the results (1)
    - Doctors don't know, so they can't be biased when monitoring patients / analysing results (1)

44. **(Bio, HT) Describe how monoclonal antibodies are produced.** [5]
    - A mouse is injected with the antigen (1)
    - Mouse lymphocytes (B-lymphocytes) that make the specific antibody are collected (1)
    - They are fused with tumour cells to make hybridoma cells (1)
    - A single hybridoma cell is cloned to make many identical cells (1)
    - The antibodies made are collected and purified (1)

45. **(Bio, HT) Explain how monoclonal antibodies can be used to treat cancer, and why they may cause fewer side effects than chemotherapy.** [4]
    - Monoclonal antibodies are made that bind to tumour markers/antigens on cancer cells (1)
    - An anti-cancer drug, radioactive substance or toxic chemical is attached (1)
    - The antibody delivers the drug only to the cancer cells (1)
    - Normal body cells are not harmed, unlike chemotherapy which affects all dividing cells (1)

46. **(Bio) A gardener sees that a tomato plant has stunted growth and yellow leaves. Suggest two possible causes and how she could find out which is correct.** [4]
    - Nitrate deficiency → stunted growth (1)
    - Magnesium deficiency → yellow leaves / chlorosis; or a pathogen such as TMV (1)
    - Look up the symptoms in a gardening manual or website (1)
    - Send to a laboratory / use a testing kit with monoclonal antibodies to identify any pathogen (1)

47. **(Bio) Describe one physical, one chemical and one mechanical defence of plants.** [3]
    - Physical: cellulose cell walls / waxy cuticle / bark of dead cells (1)
    - Chemical: antibacterial chemicals / poisons to deter herbivores (1)
    - Mechanical: thorns or hairs / leaves droop or curl when touched / mimicry (1)

Section C — Maths and data skills

48. **In a town of 25 000 people, 22 500 are vaccinated against measles. Calculate the percentage vaccinated.** [2]
    22 500 ÷ 25 000 × 100 (1) = **90%** (1)

49. **In a drug trial, 60 of 150 patients given the drug and 18 of 150 given the placebo got better. Calculate the percentage for each group and the difference.** [3]
Drug: 60 ÷ 150 × 100 = **40%** (1); placebo: 18 ÷ 150 × 100 = **12%** (1); difference = **28 percentage points** (1)

50. **The number of cases of a disease fell from 1240 to 310 after a vaccine was introduced. Calculate the percentage decrease.** [2]
Decrease = 1240 − 310 = 930 (1) → 930 ÷ 1240 × 100 = **75%** (1)

51. **The risk of a serious side effect from a vaccine is 1 in 1 000 000. The risk of a serious complication from the disease is 1 in 15. How many times more likely is a complication from the disease?** [2]
1 000 000 ÷ 15 (1) = about **66 700 times** more likely (1)

52. **A bacterium divides every 20 minutes. If one antibiotic-resistant bacterium survives, how many resistant bacteria will there be after 4 hours? Give your answer in standard form.** [3]
4 hours = 240 min → 240 ÷ 20 = 12 divisions (1) → 2^{12} = 4096 (1) = **4.1×10^3** (1)

53. **Use the antibody graph in section 3.8. Give two differences between the primary and secondary response.** [2]
Secondary response is faster / begins sooner (1); antibody concentration is much higher / lasts longer (1)

FINAL EXAM ADVICE

Use the **key words** examiners look for: *pathogen, communicable, toxins, vector, antigen, antibody, antitoxin, phagocytosis, memory cells, specific, herd immunity, resistant strain, mutation, efficacy, toxicity, optimum dose, placebo, double-blind, peer review, hybridoma, tumour marker, chlorosis*. In "evaluate" questions give **both sides** and a **conclusion**.

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