Resistant bacteria

4.6.3.7 · Inheritance, variation and evolution · revision notes

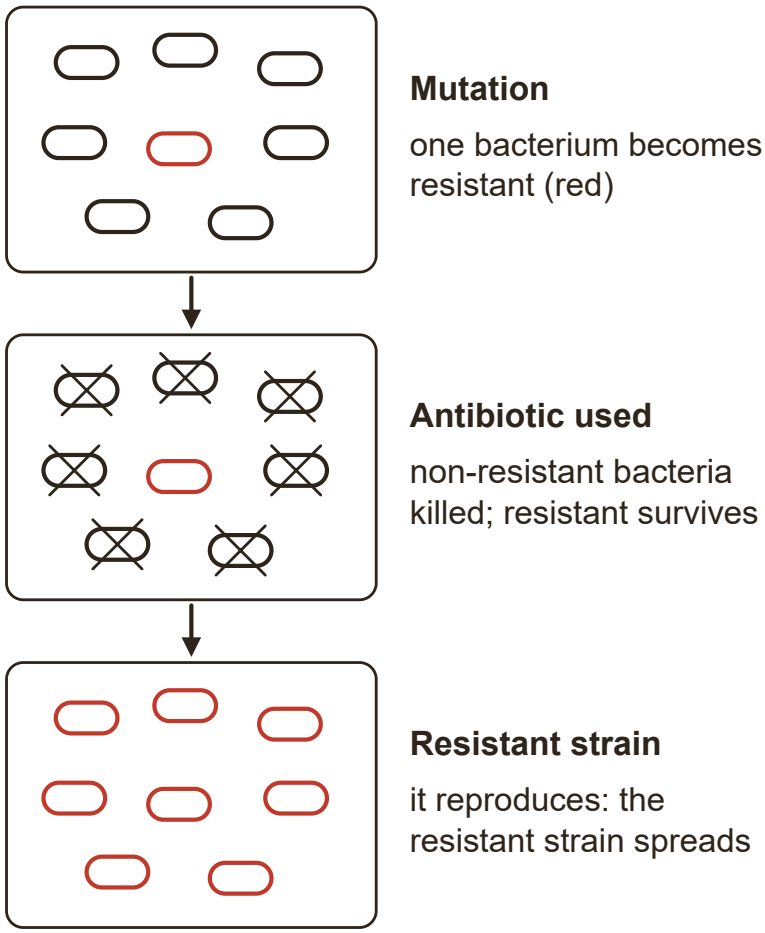
How bacteria evolve resistance to antibiotics by natural selection, why resistant strains such as MRSA spread, and how to slow down the development of resistance. Very common: 2 to 6 mark 'explain' questions and data on resistant infections.

Key facts

- Bacteria evolve rapidly because they reproduce at a fast rate
- Resistant strains spread: people are not immune and there is no effective treatment
- Reduce resistance: no antibiotics for viral or non-serious infections; complete the course; restrict agricultural use
- Mutation → new strain → some resistant → survive the antibiotic → reproduce → resistant population rises
- MRSA = a bacterium resistant to antibiotics
- New antibiotics are costly and slow to develop, so they are unlikely to keep up

How resistance develops

- Bacteria can **evolve rapidly** because they **reproduce at a fast rate**.
- **Mutations** (changes in DNA) of bacterial pathogens produce **new strains**. Some strains might be **resistant to antibiotics**, and so are not killed.
- When an antibiotic is used, the non-resistant bacteria are killed. The resistant bacteria **survive and reproduce**, so the **population of the resistant strain rises**. This is natural selection.
- The resistant strain then **spreads** because people are **not immune** to it and there is **no effective treatment**.
- **MRSA** is a bacterium that is resistant to antibiotics.
- The antibiotic does not cause the mutation. It only kills the bacteria that are not resistant.



Resistance evolves by natural selection. The antibiotic does not cause the mutation.

Slowing the development of resistant strains

- Doctors should **not prescribe antibiotics inappropriately**, such as for non-serious or **viral** infections. Antibiotics do not kill viruses.
- Patients should **complete their course** of antibiotics, so all the bacteria are killed and none survive to mutate and form resistant strains.
- The **agricultural use** of antibiotics should be restricted: antibiotics given to farm animals select resistant bacteria, which can pass to humans and cause diseases that cannot be treated.

New antibiotics

- The development of **new antibiotics is costly and slow**.
- It is **unlikely to keep up** with the emergence of new resistant strains.

How to answer each type of question

Explain a way of reducing antibiotic resistance 2 marks **Grade 5**

1. Say what should be done (complete the course, don't use antibiotics for viral infections, restrict use in farming).
2. Explain why: all bacteria killed, or fewer chances for resistant strains to be selected.

Example. A doctor tells a patient to finish their course of antibiotics, even if they feel better. Explain why. [2 marks]

Model answer. So that all the bacteria are killed (1), and none survive to mutate and form resistant strains (1).

Explain why antibiotics should not be used for viral infections 2 marks **Grade 5**

1. Antibiotics do not kill viruses.
2. Unnecessary use kills non-resistant bacteria and leaves resistant bacteria to survive and reproduce.

Example. Explain why doctors should not prescribe antibiotics to treat a cold. [2 marks]

Model answer. Colds are caused by viruses, and antibiotics do not kill viruses (1). Using antibiotics when they are not needed increases the chance of antibiotic-resistant strains of bacteria developing (1).

Explain how a resistant strain develops 3 to 4 marks **Grade 5**

1. A mutation makes a bacterium resistant.
2. The antibiotic kills the non-resistant bacteria; the resistant ones survive.
3. The resistant bacteria reproduce.
4. The population of the resistant strain rises.

Example. Explain how a population of bacteria can become resistant to an antibiotic. [4 marks]

Model answer. A mutation causes some bacteria to be resistant to the antibiotic (1). When the antibiotic is used, the non-resistant bacteria are killed (1). The resistant bacteria survive and reproduce, passing on the resistance (1). So the population of the resistant strain increases (1).

Explain why resistance is hard to overcome 2 to 3 marks **Grade 5**

1. Resistant strains spread because people are not immune and there is no effective treatment.
2. New antibiotics are costly and slow to develop.
3. Resistant strains appear quickly because bacteria reproduce fast, so new antibiotics are unlikely to keep up.

Example. Scientists are trying to develop new antibiotics to treat MRSA.
Explain why developing new antibiotics is unlikely to solve the problem of antibiotic resistance.
[2 marks]

Model answer. Developing new antibiotics is costly and slow (1). New resistant strains keep appearing because bacteria reproduce quickly and mutate, so new antibiotics are unlikely to keep up (1).

Don’t lose marks

- Saying bacteria 'become immune'. Bacteria become resistant; immunity is about your white blood cells.
- Saying the antibiotic causes the mutation. The mutation happens by chance; the antibiotic kills the non-resistant bacteria.
- Saying people become resistant to antibiotics. It is the bacteria that are resistant.
- Saying antibiotics can treat viral infections such as colds and flu.

More tips

Memory tricks

- Resistance in four steps: mutate, survive, reproduce, spread.
- Three ways to slow it: don't use antibiotics for viruses, finish the course, restrict use on farms.
- Antibiotics kill bacteria, not viruses.

Exam technique

- Use 'resistant', not 'immune', for bacteria.
- When explaining how resistance develops, always include both 'survive' and 'reproduce'.
- If a graph shows resistant infections rising, link it to the use of antibiotics and natural selection.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Name an antibiotic-resistant bacterium**
MRSA is resistant to antibiotics.

Grade 4 — **State ways to reduce antibiotic resistance**
Don't prescribe antibiotics for viral or non-serious infections, complete the course, and restrict their use in farming.

Grade 5 — **Explain why bacteria evolve rapidly**
They reproduce at a fast rate, so there are many generations in a short time.

Grade 5 — **Explain how resistant strains develop**
A mutation makes some bacteria resistant; they survive the antibiotic and reproduce, so the resistant population rises.

Grade 5 — **Explain why new antibiotics won't solve it**
Developing new antibiotics is costly and slow, so it is unlikely to keep up with new resistant strains.

Grade 7 — **Explain why resistant strains spread**
People are not immune to the new strain and there is no effective treatment.

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