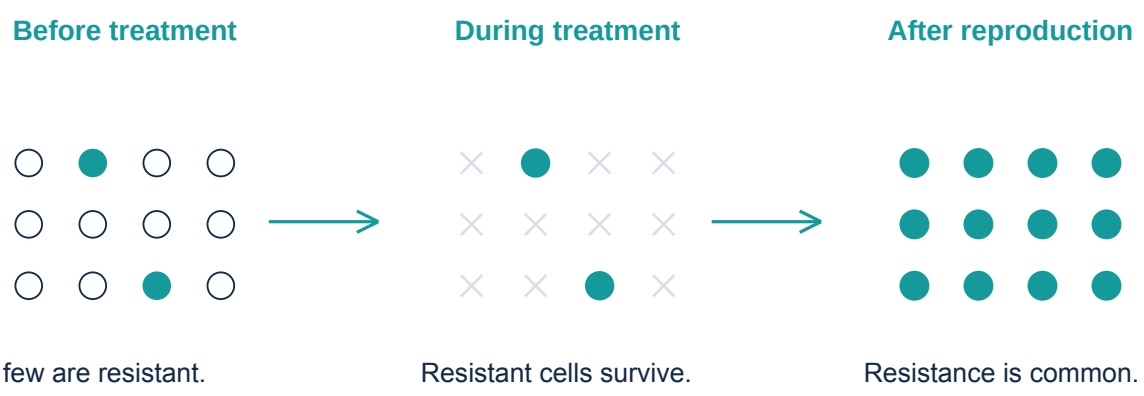
Selection changes a population

Antibiotic resistance is the ability of bacteria to survive or grow despite an antibiotic that would normally kill or inhibit them. The bacteria are resistant, not the patient.

1. VARIATION, SELECTION, REPRODUCTION



Key: open circles = susceptible; filled teal = resistant; crosses = removed susceptible cells. This is a simplified example, not measured population data.

2. EXPLAIN THE CHANGE

Antibiotic exposure is a selection pressure. Susceptible bacteria are killed or inhibited; resistant bacteria are more likely to survive and reproduce by binary fission. Their descendants inherit resistance genes, increasing the resistant proportion.

3. WHERE DOES RESISTANCE COME FROM?

Genetic variation can arise through mutation or acquisition of resistance genes from other bacteria. Some genes travel on plasmids, for example through conjugation. Antibiotics do not make bacteria mutate deliberately because they "need" resistance.

Two routes of spread: resistant bacteria reproduce and move between hosts; resistance genes can also move between bacterial cells.

Selection and spread of resistance traits: CDC, About Antimicrobial Resistance.
Mutation and gene transfer: OpenStax, Microbiology 14.5.

Scope: Cambridge Biology 9700 syllabus, section 10.2, outcome 2, p. 30.

Why resistance matters

If an antibiotic no longer controls a bacterial infection, treatment becomes less reliable. Resistance to one drug does not automatically mean resistance to every antibiotic.

1. FOR THE PATIENT

The usual treatment may fail. Illness can persist, with a greater risk of complications or death. Alternative drugs may have more adverse effects, and hospital care may last longer.

2. FOR OTHER PEOPLE

An infection that remains uncontrolled can create more opportunities for transmission. A person can acquire resistant bacteria from someone else without previously taking that antibiotic.

3. FOR HEALTHCARE AND SOCIETY

Extra tests, different medicines and prolonged care increase costs. Lost work or school time adds to the burden. Surgery, cancer treatment and transplants become riskier when infections are difficult to treat.

4. AN EXAMPLE: MULTIDRUG-RESISTANT TB

MDR-TB involves bacteria resistant to at least isoniazid and rifampicin, two major first-line TB drugs. Other treatment options exist, but effective diagnosis, suitable medicines and reliable access to care are essential. "Resistant" does not always mean "untreatable".

Keep the scale clear: antibiotic resistance concerns bacteria; antimicrobial resistance is broader and also includes resistance to antiviral, antifungal and antiparasitic medicines.

Clinical, economic and MDR-TB consequences: WHO, Antimicrobial resistance.
Spread between people, animals and environments: CDC, Causes and How It Spreads.

Scope: Cambridge Biology 9700 syllabus, section 10.2, outcome 2, p. 30.

Reduce selection and spread

Use antibiotics when needed, use them appropriately, and prevent infections. These approaches work together; simply avoiding all antibiotics is not the solution.

1. LINK EACH ACTION TO ITS EFFECT

Avoid unnecessary use	Do not use antibiotics for viral infections. Reducing needless exposure reduces selection pressure without withholding necessary treatment.
Use the right treatment	Clinical assessment and susceptibility testing help guide drug choice. Take medicines exactly as prescribed, including dose and duration; ask the prescriber before changing treatment.
Prevent transmission	Hand hygiene, sanitation, cleaning and appropriate hospital infection-control measures reduce the movement of resistant bacteria between people.
Prevent infections	Vaccination against relevant infections and safe food and water reduce disease, so fewer antibiotic courses are needed.
Monitor and respond	Surveillance tracks resistance patterns. Laboratories, research and new treatments help health services recognise problems and adapt treatment policies.

2. ACCESS AND RESPONSIBILITY BOTH MATTER

Do not share antibiotics or save them for later self-treatment. Reliable access to diagnosis and effective medicines matters too: patients need practical support to follow the prescribed plan, not blame.

One Health link: people, animals and environments are connected. Responsible veterinary use, farm hygiene and safe waste management also help limit resistant bacteria and antibiotic residues.

Taking antibiotics safely and appropriately: CDC, Antibiotic Do's and Don'ts.
Infection prevention and community spread: CDC, Causes and How It Spreads.

Scope: Cambridge Biology 9700 syllabus, section 10.2, outcome 2, p. 30.