

Antibiotics and infection control

Revision notes · Bacteriostatic and bactericidal antibiotics, core practical 14, and how hospital-acquired infections shape antibiotic prescribing and hospital practice.

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Antibiotics and infection control Spec 6.13–6.15 A Level only

Bacteriostatic and bactericidal antibiotics Spec 6.13

Bacteriostatic compared with bactericidal antibiotics		
Feature	Bacteriostatic	Bactericidal
Effect on bacteria	Prevents growth and reproduction; bacteria stay alive	Kills bacteria
Typical mechanism	Inhibits protein synthesis by binding to bacterial (70S) ribosomes, or blocks folic acid synthesis (sulfonamides)	Prevents formation of cross-links in the peptidoglycan cell wall, so the wall is weak and the bacterium bursts by osmosis; or damages the cell membrane; or blocks DNA or RNA synthesis (rifampicin inhibits bacterial RNA polymerase)
Examples	Tetracycline, chloramphenicol	Penicillin, rifampicin
Depends on host immune system?	Yes: the immune system must remove the bacteria once they stop multiplying	Less so: important when the immune system is weak

Antibiotics show **selective toxicity**: they target structures or processes in bacteria that human cells do not have (a peptidoglycan cell wall, 70S ribosomes). This is why they do little harm to human cells, and why they have no effect on **viruses**, which have no cell wall or ribosomes of their own and replicate inside human cells.

Overuse and misuse of antibiotics exerts selection pressure: bacteria with a mutation that gives resistance survive, reproduce and pass the allele on, producing antibiotic-resistant strains such as MRSA.

Common mistake: Do not say 'penicillin kills bacteria by bursting the cell'. Say it stops the cell wall being formed or repaired, so water enters by osmosis and the weakened wall cannot resist, and the bacterium bursts.

Core practical 14: effect of antibiotics on bacteria Spec 6.14

Core practical: Core practical 14: Investigate the effect of different antibiotics on bacteria.

Method

1. Use aseptic technique. Sterilise Petri dishes of nutrient agar; label the base with names of antibiotics, date and your initials.

2. Use a sterile pipette to put a measured volume (for example 0.1 cm³) of a broth culture of a non-pathogenic bacterium, such as *Escherichia coli* K12, on to the agar and spread it evenly over the surface with a sterile spreader to give a lawn.
3. Using sterile forceps (flamed and cooled), place sterile paper discs soaked in different antibiotics at equal spacing on the lawn, and press gently. Include a control disc soaked in sterile water (or no antibiotic).
4. Replace the lid, tape it with two or four short pieces of tape, invert the plate and incubate at 25 °C for 24 to 48 hours (not above 30 °C).
5. Measure the diameter of each clear zone (zone of inhibition) with a ruler, across the centre of the disc, in two directions at right angles, and take the mean. Calculate the area of the zone using πr^2 if needed.
6. Disinfect or autoclave the plates before disposal. Do not open the plates after incubation.

Variables	
Type	Examples
Independent variable	Type of antibiotic (or concentration of one antibiotic)
Dependent variable	Diameter or area of the zone of inhibition
Controlled variables	Volume and type of bacterial culture; agar type and depth; disc size and volume of antibiotic; incubation time and temperature; spacing of discs
Control	A disc without antibiotic (sterile water) shows that the disc and the water do not themselves stop growth

Interpreting results

Around an effective antibiotic the bacteria cannot grow, leaving a clear **zone of inhibition**. A bigger zone means the bacteria are more susceptible to that antibiotic (or the antibiotic diffuses well), so the bigger the zone, the more effective the antibiotic. No zone means the bacteria are resistant. Colonies growing within the zone suggest resistant mutants.

Area of a zone of inhibition

The diameter of a zone of inhibition around a disc was 22 mm. Calculate the area of the zone.

1. Radius = $22 \div 2 = 11$ mm.
2. Area = $\pi r^2 = \pi \times 11^2 = \pi \times 121$.
3. Area = 380 mm² (to 3 significant figures).

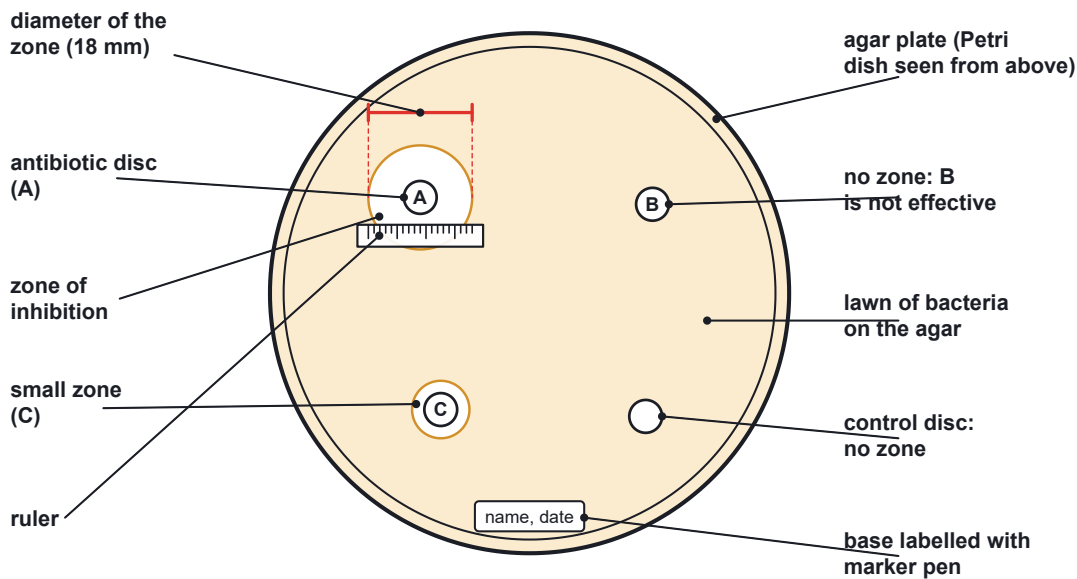
Answer: 380 mm²

Maths skill: Compare areas, not diameters, if the question asks 'how many times larger'. Remember to halve the diameter before squaring.

Safety and limitations

- Use only non-pathogenic bacteria; do not incubate at 37 °C; keep plates taped and closed after incubation; wash hands; disinfect bench; autoclave plates.
- The zone depends on how fast each antibiotic diffuses through agar, not only on how effective it is, which limits the comparison. Zones may overlap if discs are too close.

- Results can be improved with repeats (several plates per antibiotic), a standard concentration, and standard disc size.



Core practical 14: the diameter of the **zone of inhibition** around each antibiotic disc is measured.

Hospital-acquired infections and codes of practice Spec 6.15

A **hospital-acquired infection** (HAI) is an infection that is acquired in hospital, not present when the patient arrived. Common examples are MRSA (meticillin-resistant *Staphylococcus aureus*) and *Clostridioides difficile* (C. difficile).

Contributory causes and the codes of practice that follow	
Contributory cause	Code of practice
Many patients have weakened immune systems (elderly, very young, after surgery, on immunosuppressant drugs)	Isolate vulnerable and infected patients; screen patients for MRSA on admission; protective clothing for staff and visitors
Close contact between patients, and staff moving between patients, spreads pathogens by hands and equipment	Hand washing with soap or alcohol gel before and after contact with each patient; bare below the elbow; limited visiting; barrier nursing
Open wounds, surgery, catheters, drips and ventilators give pathogens a route into the body	Sterilise surgical instruments; use aseptic technique; remove invasive devices as soon as possible; cover wounds
Contaminated surfaces and equipment, and dirty air	Regular cleaning and disinfection; single-use items; good ventilation
Overuse and misuse of antibiotics selects for antibiotic-resistant bacteria; killing of gut flora allows C. difficile to grow	Antibiotic stewardship: prescribe only when necessary (never for viral infections); use narrow-spectrum antibiotics where possible; take cultures and test sensitivity first; follow local guidelines; patients take the course exactly as prescribed; keep some antibiotics in reserve

Hospitals also carry out surveillance (monitoring infection rates and the species involved) so that outbreaks are found early and codes of practice are reviewed.

Exam tip: In a six-mark question, give both parts: cause (for example, 'weakened immune systems') and the matching measure (for example, 'isolate patients'). Marks are for the link.

Quick check

- 1 . What is the difference between bacteriostatic and bactericidal?
- 2 . Why do antibiotics not harm human cells?
- 3 . What is a zone of inhibition?
- 4 . Why is a control disc of sterile water used?
- 5 . Give two contributory causes of hospital-acquired infections.

Quick check answers

Antibiotics and infection control

- 1 . Bacteriostatic antibiotics stop bacteria growing and dividing. Bactericidal antibiotics kill them.
- 2 . They show selective toxicity: they target structures that bacteria have and human cells lack, such as the peptidoglycan wall and 70S ribosomes.
- 3 . The clear area around an antibiotic disc where bacteria cannot grow.
- 4 . To show that the disc and water do not themselves stop bacterial growth.
- 5 . Weakened patients; poor hygiene or contact between patients; use of invasive devices; overuse of antibiotics.