

Antibiotics, culturing microorganisms and new medicines

Revision notes · How antibiotics work, aseptic technique, the antimicrobial core practical, developing new medicines and monoclonal antibodies.

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. **Triple only** is not in Combined Science. **Higher tier** is only on the Higher paper.

Antibiotics, culturing microorganisms and new medicines **Spec 5.16–5.22B**

Antibiotics **Spec 5.16**

Antibiotics are medicines that treat bacterial infections. They work by **inhibiting cell processes** in the bacterium. They do not harm the host organism's own cells, because the host's cells work differently.

Antibiotics can **only** be used to treat bacterial infections. Viruses are not cells. They live and reproduce inside host cells, so the cell processes that antibiotics inhibit are not present in a virus. Antibiotics therefore do not work on viral diseases such as HIV or Ebola.

Common mistake: Antibiotics do not 'kill viruses', and they cannot treat a cold or flu. State that they act on processes in bacterial cells but not host cells.

Aseptic techniques **Spec 5.17B** **Triple only**

To grow (**culture**) microorganisms safely and get reliable results, you must stop unwanted microorganisms getting in and stop your culture escaping. This is called **aseptic technique**.

- Use an **autoclave** to prepare the sterile growth medium (agar jelly) and the petri dishes. An autoclave sterilises equipment using high-pressure steam, which kills microorganisms already present.
- Use a **sterile inoculating loop** to transfer microorganisms. The loop is sterilised by heating in a flame until red hot, then cooled before use.
- Keep petri dishes and culture vials **covered** as much as possible. Only lift the lid briefly when transferring microorganisms.
- After inoculating, fix the lid on with tape and incubate the dish upside down.
- Wash your hands and wipe the bench with disinfectant before and after.

Exam tip: Always give the reason. 'Flame the loop to kill any microorganisms on it, so the culture is not contaminated' scores; just 'flame the loop' does not.

Core practical: antiseptics, antibiotics and plant extracts **Spec 5.18B** **Triple only**

Core practical: Investigate the effects of antiseptics, antibiotics or plant extracts on microbial cultures.

The idea is to find out which substance is best at stopping bacteria growing. Bacteria are grown on agar jelly in a petri dish, and small paper discs soaked in different substances are placed on top.

1. Using aseptic technique, spread a sample of bacteria evenly over the surface of a sterile agar plate to make a bacterial **lawn**.
2. Using sterile forceps, place paper discs soaked in the different antiseptics, antibiotics or plant extracts on the agar, spaced apart.

3. Place a control disc soaked in sterile water on the agar.
4. Put the lid on and tape it in place. Label the base and incubate the dish upside down at 25 °C for about 48 hours.
5. Measure the diameter of the **clear zone** (inhibition zone) around each disc and calculate its area.

Variables	
Type of variable	In this investigation
Independent	The type of antiseptic, antibiotic or plant extract (or its concentration)
Dependent	The size of the clear zone
Control	Type and volume of bacteria; type and volume of agar; size of disc and volume of liquid on it; temperature and time of incubation

- **Results:** where the substance stops bacteria growing, a clear zone appears around the disc. The larger the clear zone, the more effective the substance. The water control disc should have no clear zone.
- **Why 25 °C:** a lower temperature makes it less likely that harmful pathogens that grow best at body temperature will grow.
- **Why the dish is taped:** to stop microorganisms escaping or entering; do not seal it fully, so that oxygen can enter.
- **Safety:** wear eye protection; do not open dishes after incubation; wash hands; disinfect the bench; sterilise used dishes in an autoclave; take care with flammable chemicals such as ethanol near a flame.

Exam tip: If you are asked why a control disc is used, say it shows that the water or the paper alone does not stop bacteria growing, so the clear zones are caused by the substances tested.

Calculating cross-sectional areas Spec 5.19B Triple only

Clear zones and bacterial colonies are roughly circular, so their area is calculated using the equation for the area of a circle. A larger area means a bigger effect (for a clear zone) or more growth (for a culture).

$$\text{area} = \pi r^2$$

The radius, r , is half the diameter. Measure the diameter across the middle of the zone, halve it, then square it and multiply by π .

Area of a clear zone

The clear zone around a disc soaked in antiseptic has a diameter of 14 mm. Calculate the area of the clear zone. Use $\pi = 3.14$.

1. radius = $14 \div 2 = 7$ mm
2. area = $\pi r^2 = 3.14 \times 7 \times 7$
3. area = $3.14 \times 49 = 153.86$ mm²

Answer: About 154 mm²

Maths skill: A very common slip is to use the diameter instead of the radius. Halve the diameter first, and give your answer in mm² (or cm²).

Developing new medicines Spec 5.20

Developing a new medicine, including a new antibiotic, takes many stages. Each stage checks that the medicine is safe and that it works.

1. **Discovery**: finding a chemical that might treat the disease. These may come from natural sources, such as plants or microorganisms, or be designed in a laboratory.
2. **Development**: the chemical is studied and improved, and a way to make it as a medicine is worked out.
3. **Preclinical testing**: the medicine is tested in the laboratory on cells and tissues, and then on live animals, to find out if it is toxic and whether it works.
4. **Clinical testing**: the medicine is tested on people. It is first given to a small number of healthy volunteers to check it is safe, then to patients to check that it works and to find the right dose.

Only a medicine that passes all the stages can be used to treat patients. The testing protects people from harmful or ineffective medicines.

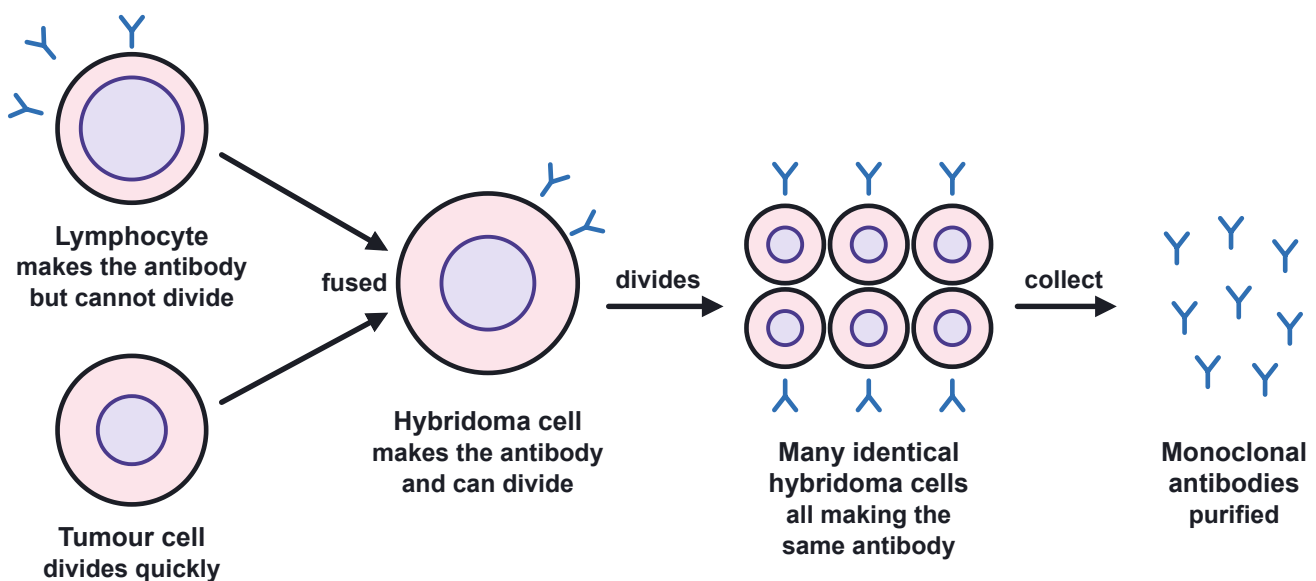
Exam tip: Learn the four stages in order: discovery, development, preclinical, clinical. Preclinical comes before any testing on humans.

Producing monoclonal antibodies Spec 5.21B Triple only Higher tier

Monoclonal antibodies are identical antibodies, all made from one type of cell, that bind to only one specific antigen.

1. An animal is exposed to the antigen, so it makes **lymphocytes** that produce the desired antibody.
2. These lymphocytes are collected. They make the right antibody but they **do not divide**.
3. They are fused with a tumour cell, which divides very quickly. This makes a **hybridoma cell**.
4. The hybridoma cells divide and so make many identical cells. As they divide, the hybridoma cells **produce antibodies**.
5. The antibodies are collected and purified.

A hybridoma cell has the properties of both its parent cells: it makes the desired antibody (from the lymphocyte) and it can divide again and again (from the tumour cell).



A **hybridoma cell** makes the antibody like a lymphocyte and divides like a tumour cell.

Uses of monoclonal antibodies

Spec 5.22B

Triple only

Higher tier

Monoclonal antibodies bind to one specific antigen only, so they can be used to find or target particular molecules or cells.

- **Pregnancy testing:** a test stick contains monoclonal antibodies that bind to a hormone found in the urine of pregnant women. When the hormone is present, it binds to the antibodies and a coloured line appears, so the test is positive.
- **Diagnosis:** monoclonal antibodies carrying a label can be given to a patient. They bind to a specific antigen, so the label shows the position of blood clots or cancer cells.
- **Treatment:** a drug can be attached to a monoclonal antibody that binds to antigens on cancer cells. The antibody carries the drug directly to the cancer cells.

Advantages over drug and radiotherapy treatments

Drugs and radiotherapy can damage healthy cells as well as cancer cells, which causes side effects. Monoclonal antibodies **target specific cells**, so the cancer cells are attacked and fewer healthy cells are damaged.

Exam tip: The key word is 'specific'. Each monoclonal antibody binds to one antigen, and that is why it can target one type of cell.

Quick check

1. Why can antibiotics not be used to treat viral infections?
2. Triple only: why is an inoculating loop heated in a flame before use?
3. Triple only: in the core practical, what does a larger clear zone show?
4. Name the four stages in developing a new medicine in order.
5. Triple only, Higher tier: what is a hybridoma cell?

Quick check answers

Antibiotics, culturing microorganisms and new medicines

1. Antibiotics inhibit cell processes in bacteria; viruses are not cells and reproduce inside host cells.
2. To sterilise it by killing any microorganisms on it.
3. The substance is more effective at stopping bacteria growing.
4. Discovery, development, preclinical testing, clinical testing.
5. A cell made by fusing an antibody-producing lymphocyte with a tumour cell; it divides and produces antibodies.