Infectious diseases

A-Level Biology

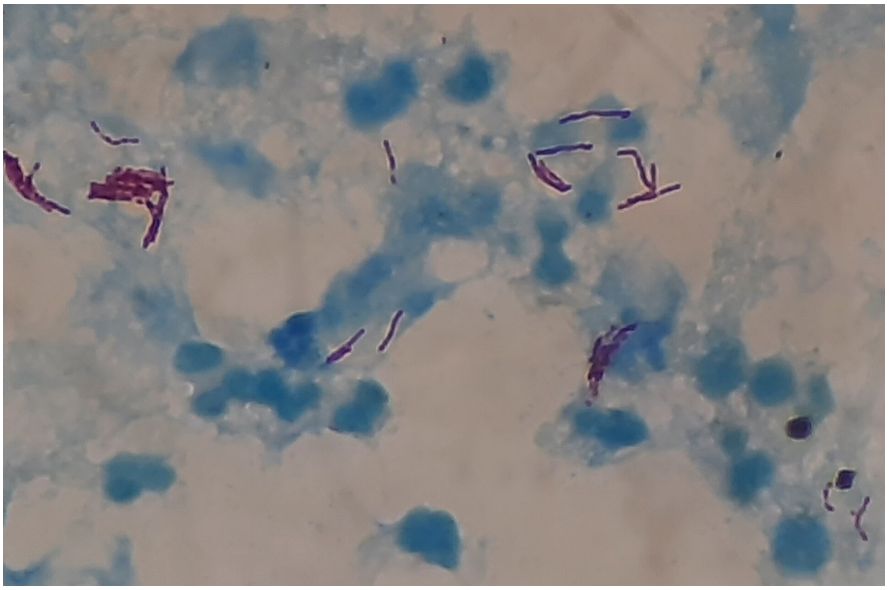
What causes infectious disease

An **infectious disease** 传染病 is caused by a **pathogen** 病原体—an organism that lives in or on a host and causes harm. Infectious diseases are **transmissible**: the pathogen can be **transmitted** 传播 (passed) from one person to another.

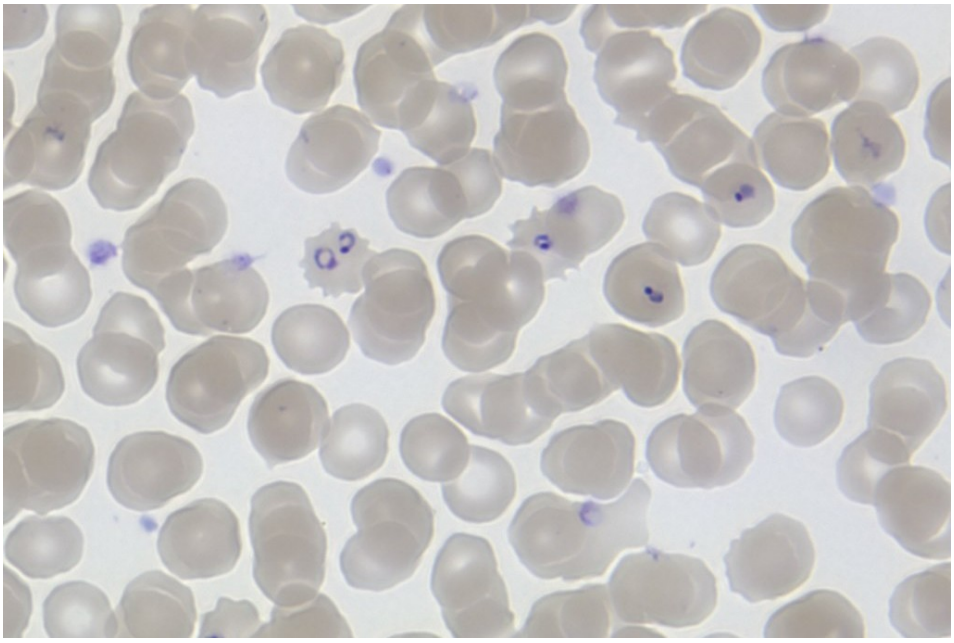
You need to know four diseases, the pathogen that causes each, and how each spreads.

Disease	Pathogen and type	How it spreads
cholera 霍乱	the **bacterium** 细菌 *Vibrio cholerae*	drinking water or food **contaminated** 污染 with **faeces** 粪便 (human waste)
malaria 疟疾	the **protoctist** 原生生物 *Plasmodium*	the bite of an infected **mosquito** 蚊子, which acts as a **vector** 媒介 (a carrier of the pathogen); also through infected blood
tuberculosis (TB) 结核病	the bacterium *Mycobacterium*	tiny airborne **droplets** 飞沫 from coughs and sneezes; spreads fast where people are crowded
HIV/AIDS	the **virus** 病毒 HIV (which leads to **AIDS** 艾滋病)	unprotected sex, infected blood (for example shared needles), and from mother to baby

HIV infects and destroys certain white blood cells, so it slowly weakens the body's **immune system** 免疫系统.

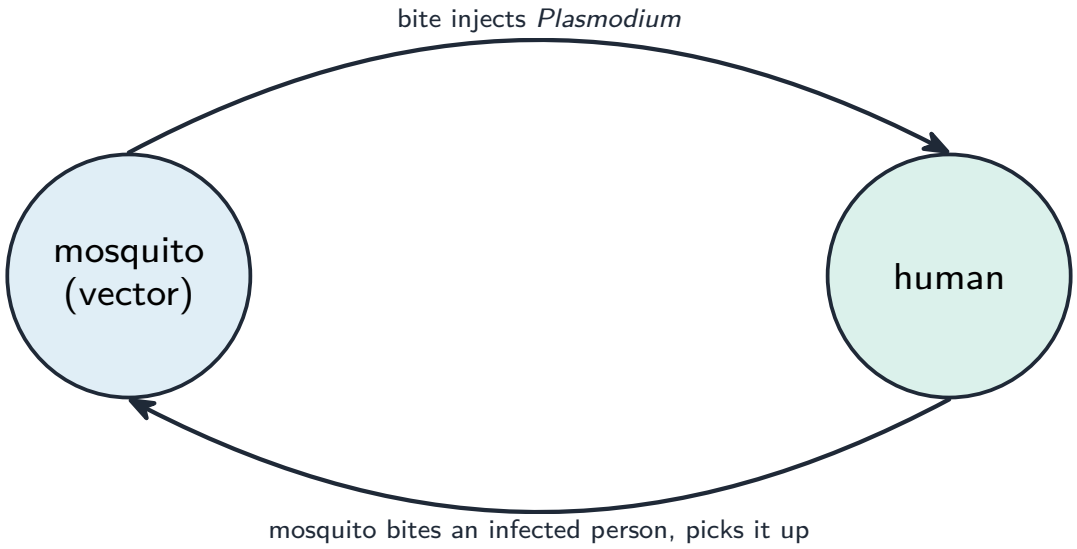


The bacterium Mycobacterium (red rods) that causes tuberculosis, stained in a sputum sample



The protoctist Plasmodium (small dark rings) that causes malaria, living inside red blood cells

Image: MichaelZahniser, Public domain (commons.wikimedia.org)



Malaria needs a mosquito vector: the parasite passes from human to mosquito to human with each bite —which is why control targets the mosquito

Preventing and controlling these diseases

Control has **biological**, **social** and **economic** sides —the science of the pathogen, people's behaviour and education, and the money and resources available. Examples:

- **cholera**: provide clean water and proper sewage treatment; good hygiene; **vaccines**

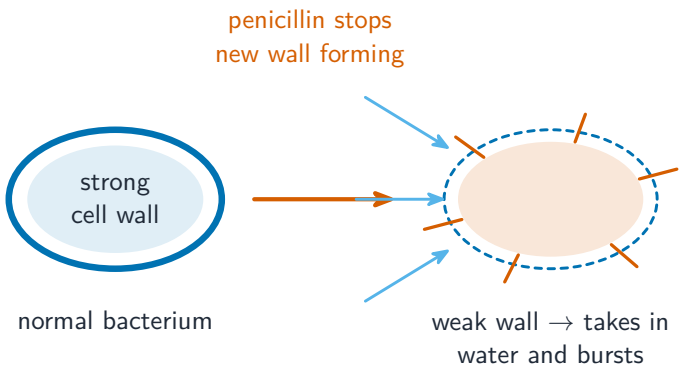
疫苗 in some areas.

- **malaria**: sleep under nets; remove pools of still water where mosquitoes breed; spray **insecticides** 杀虫剂; take anti-malarial drugs.
- **TB**: find and treat infected people with a long course of antibiotics; give the BCG vaccine; reduce overcrowding; trace contacts of patients.
- **HIV**: use condoms; use clean needles; test donated blood; educate people. There is no cure and no vaccine yet, but drugs can slow the virus down.

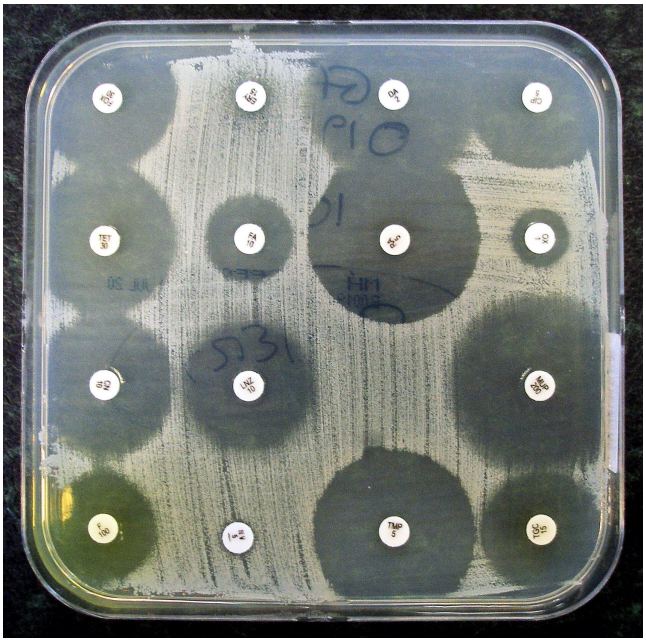
In every case, cost (economic), people's willingness to change behaviour (social) and the supply of drugs or vaccines (biological) all affect how well a disease can be controlled.

Antibiotics

An **antibiotic** 抗生素 is a drug that kills bacteria or stops them growing. For example, **penicillin** 青霉素 stops bacteria from building their **cell walls** 细胞壁. As the bacterium grows, its weak wall cannot hold it, so the cell takes in water and bursts.



Penicillin stops new cell wall forming, so the bacterium takes in water and bursts



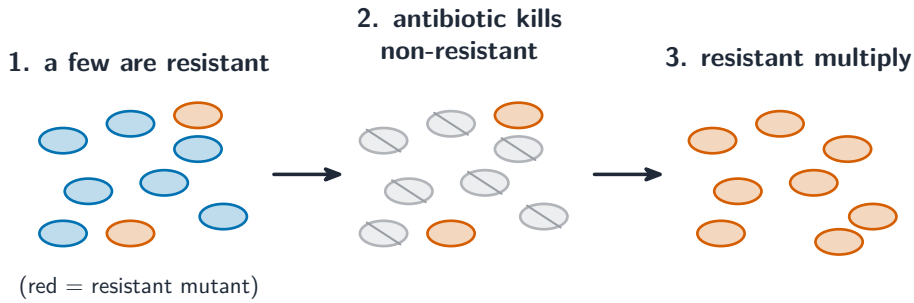
How we test which antibiotic works. Each paper disc holds a different antibiotic. A clear ring means that antibiotic killed the bacteria around it —the bigger the ring, the more effective the drug. Discs with no ring are ones the bacteria resist

Antibiotics do **not** work against **viruses**. A virus has no cell wall and no chemical reactions of its own to attack —it simply uses the machinery of the host cell. So there is no antibiotic target in a virus.

Antibiotic resistance

Sometimes a **mutation** 突变 makes a bacterium **resistant** to an antibiotic, which means the antibiotic no longer kills it. This **resistance** 耐药性 is a serious problem:

- when an antibiotic is used, the non-resistant bacteria die, but any resistant ones survive and multiply. Over time, more and more bacteria carry the resistance.
- some infections then become very hard, or impossible, to treat.



Antibiotic resistance spreads by natural selection: the antibiotic kills the rest, so the resistant survivors take over

Steps to slow resistance down:

- only use antibiotics when they are really needed (not for viral illnesses such as colds).
- always finish the full course, so no bacteria are left alive.
- use the correct antibiotic for the infection.
- reduce the heavy use of antibiotics in farming.

Worked example. A patient with influenza is prescribed an antibiotic. Explain why it will not help, and why it is actively harmful. Antibiotics work by attacking structures or processes that **bacteria** have and human cells do not - penicillin, for instance, blocks **cell wall** synthesis, so the growing bacterium bursts under osmotic pressure. A **virus** has no cell wall, no ribosomes of its own and no metabolism: it replicates **inside** the host's cells using the host's machinery, so there is simply no bacterial target for the drug to attack. Taking it anyway exposes the patient's harmless resident bacteria to the antibiotic, killing the susceptible ones and **selecting for resistant** ones - which is how resistance spreads through a population. Name the **target that is missing**: "viruses are not alive" is not the reason and earns nothing.

Exam tips

- For each named disease give the **pathogen and route** (cholera –bacterium, water; malaria –Plasmodium, mosquito vector; also TB, HIV/AIDS, measles).
- Explain why **antibiotics** work on bacteria only (they target cell walls/enzymes, not viruses).
- Explain **antibiotic resistance** as natural selection: a resistant mutant survives and reproduces; reduce it by finishing courses and avoiding overuse.