

Infectious diseases

A-Level Biology 9700 · Topic 10 revision notes

Everything from the 3 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

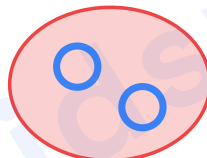
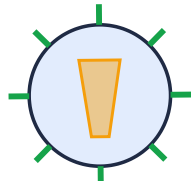
1. Pathogens and how they are transmitted
2. Preventing and controlling infectious diseases
3. Antibiotics: penicillin and resistance

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1 Pathogens and how they are transmitted

Syllabus 10.1

An **infectious disease** is caused by a **pathogen**, an organism or virus that causes disease, and it is **transmissible**: it can be passed from one host to another. **Cholera** is caused by the bacterium *Vibrio cholerae* and spreads by the **faecal-oral route** in contaminated water and food. **Malaria** is caused by the protoctists *Plasmodium falciparum*, *P. malariae*, *P. ovale* and *P. vivax* and is carried by a **vector**, the female *Anopheles* mosquito. **Tuberculosis (TB)** is caused by the bacteria *Mycobacterium tuberculosis* and *M. bovis* and spreads in **airborne droplets**, with *M. bovis* also caught from infected cattle in unpasteurised milk or undercooked meat. **HIV/AIDS** is caused by the **human immunodeficiency virus** and is passed in **body fluids**: unprotected sex, shared needles and infected blood, and from mother to baby.

cholera	malaria	TB	HIV/AIDS
			
<i>Vibrio cholerae</i> bacterium	<i>Plasmodium</i> (four species) protoctist	<i>M. tuberculosis</i> and <i>M. bovis</i> bacteria	human immunodeficiency virus
faecal-oral: water, food	vector: female <i>Anopheles</i>	droplets in air; milk (<i>M. bovis</i>)	body fluids: sex, blood, birth

pathogen, type and main route of transmission (not to scale)

Fig. 1: the four pathogens named in the syllabus, the type of each and its main route of transmission

Disease, pathogen, type, route.

- ✓ **Cholera:** *Vibrio cholerae*, bacterium; faecal-oral in water and food.
- ✓ **Malaria:** four *Plasmodium* species, protoctist; female *Anopheles* mosquito vector.
- ✓ **TB:** *Mycobacterium tuberculosis* and *M. bovis*, bacteria; droplets, unpasteurised milk.
- ✓ **HIV/AIDS:** HIV, virus; sex, blood and needles, mother to baby.

Watch out!

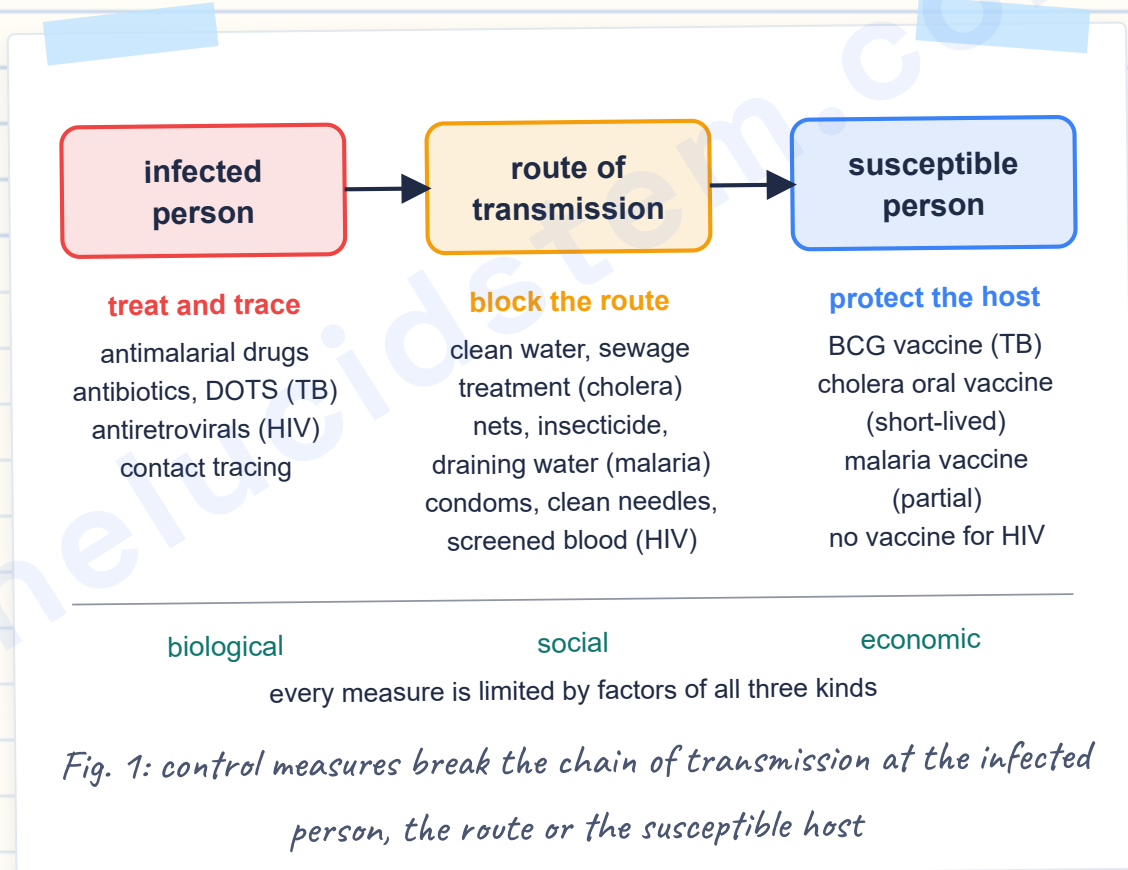
Malaria is **not** caused by a bacterium or by the mosquito. The pathogen is the protoctist *Plasmodium*; the mosquito is only the **vector** that carries it. Name the pathogen with its genus (and species where asked), written in italics or underlined.

HIV does not survive long outside the body and is not spread by touching, coughing, sharing cups or by mosquitoes. A mosquito transmits *Plasmodium* because the parasite completes part of its life cycle inside the insect; HIV does not.

2 Preventing and controlling infectious diseases

Syllabus 10.1

Control measures break the chain of transmission at one of three points: **treating infected people** so they stop passing the pathogen on, **blocking the route** (clean water, mosquito nets, condoms) or **protecting the next host** (vaccination). Each one is limited by **biological** factors (drug and insecticide resistance, pathogens hiding inside cells, many strains or changing antigens, symptomless carriers, no vaccine for HIV), **social** factors (crowding in refugee camps and cities, natural disasters and war, stigma, whether people use nets or condoms or finish treatment) and **economic** factors (the cost of sewage systems, drugs, nets and long courses of treatment, often in the poorest countries). Details of the malaria life cycle are not needed.



Measure, factor, effect.

- ✓ **Point of attack:** treat the infected, block the route or protect the host.
- ✓ **Biological:** resistance, hiding in cells, changing antigens, carriers, vectors.
- ✓ **Social:** crowding, disasters, stigma, behaviour, access to clinics.
- ✓ **Economic:** cost of infrastructure, drugs and long treatment in poor countries.

Watch out!

A treatment that saves lives does not always reduce **transmission**.

Oral rehydration solution prevents death from dehydration in cholera, but the patient still releases bacteria in faeces. In the model the curves do not change when only that box is ticked.

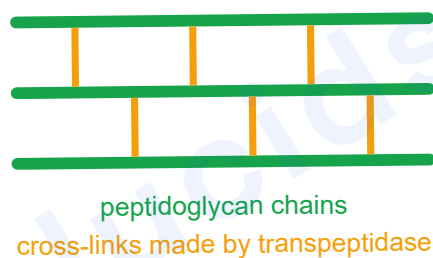
Do not just list measures. A **discuss** question needs the factor and its effect: for example, mosquitoes have become resistant to insecticides **so** spraying kills fewer of them and the vector survives to transmit *Plasmodium*.

3 Antibiotics: penicillin and resistance

Syllabus 10.2

An **antibiotic** is a chemical that kills or stops the growth of bacteria without harming human cells. **Penicillin** acts on **growing** bacteria: it **inhibits the transpeptidase enzymes** that form **cross-links** between the peptidoglycan chains of new cell wall. The wall becomes weak, water enters the cell by **osmosis**, and the cell swells and bursts (**osmotic lysis**). Human cells have no cell wall or peptidoglycan, so they are not affected. **Antibiotics do not affect viruses**: viruses have no cell wall, no peptidoglycan, no ribosomes and no metabolism of their own, and they replicate inside host cells using the host's enzymes. **Antibiotic resistance** arises by chance mutation; each use of an antibiotic **selects** resistant bacteria, which multiply and pass on the resistance gene. The consequences are infections such as MRSA and MDR-TB that are hard or impossible to treat. The impact is reduced by prescribing antibiotics only when needed, finishing the course, hospital hygiene, less use in farming, changing the antibiotic used and developing new ones.

growing wall, no penicillin



growing wall + penicillin

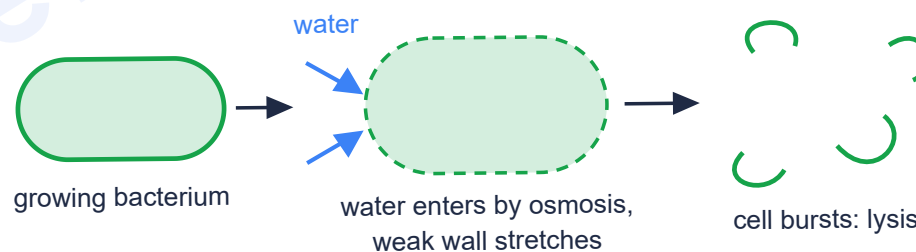
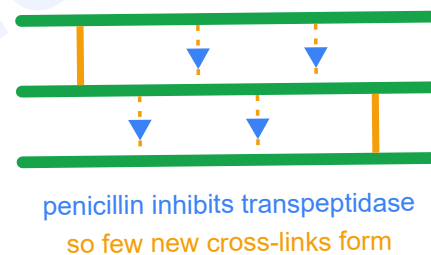


Fig. 1: penicillin blocks cross-linking of peptidoglycan in a growing wall, so water entering by osmosis bursts the cell

Enzyme, wall, water, burst.

- ✓ **Penicillin:** inhibits transpeptidase, so no new peptidoglycan cross-links in growing bacteria.
- ✓ **Lysis:** weak wall, water enters by osmosis, cell bursts; human cells have no wall.
- ✓ **Viruses:** no wall, no ribosomes, no metabolism of their own: nothing to target.
- ✓ **Resistance:** random mutation, selection by the antibiotic, spread on plasmids.

Watch out!

Penicillin does not dissolve or digest the wall that is already there. It stops **new** cross-links forming, so it works only on bacteria that are **growing**. The cell is killed by water entering by osmosis, not by penicillin entering the cytoplasm.

Bacteria do not become resistant because they "get used to" an antibiotic, and people do not become resistant: **bacteria** carry resistance genes that arose by chance mutation, and the antibiotic selects them.