Cambridge (CIE) IGCSE Biology

Your notes

Diseases & Immunity

Contents

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Pathogens

- A pathogen is a **disease-causing organism**
- Pathogens are passed on from one host to another and therefore the diseases they cause are known as **transmissible diseases**
- Pathogens can be passed on from host to host in different ways, including:
  - **Direct contact** - the pathogen is passed directly from one host to another by transfer of body fluids such as blood or semen (eg HIV, gonorrhoea, hepatitis B & C)
  - **Indirect contact** - the pathogen leaves the host and is carried by an intermediate medium or vector, such as contaminated surfaces, air (via droplets or aerosols), food, water, or organisms like insects (e.g., mosquitoes carrying malaria or dengue)

Methods of Transmission Table

METHOD OF TRANSMISSION	EXAMPLES OF DISEASES SPREAD IN THIS WAY
DROPLETS IN AIR	COMMON COLD, INFLUENZA
FOOD OR WATER	CHOLERA, TYPHOID, DYSENTERY
TOUCHING CONTAMINATED SURFACES	ATHLETES FOOT, SALMONELLA (CAN BE TRANSMITTED ON THE FEET OF FLIES WHO LAND ON FOOD THAT IS THEN EATEN)
INSECT BITES	MALARIA, DENGUE FEVER

The Body Defences

There are **3** main ways in which the body defends itself against disease:

1. **Mechanical barriers** – structures that make it difficult for pathogens to get past them and into the body
   1. **Skin** - covers almost all parts of your body to prevent infection from pathogens. If it is cut or grazed, it immediately begins to heal itself, often by forming a scab
   2. **Hairs in the nose** - these make it difficult for pathogens to get past them further up the nose so they are not inhaled into the lungs

2. **Chemical barriers** – substances produced by the body cells that trap / kill pathogens before they can get further into the body and cause disease
    1. **Mucus** - made in various places in the body, pathogens get trapped in the mucus and can then be removed from the body (by coughing, blowing the nose, swallowing etc)
    2. **Stomach acid** - contains hydrochloric acid which is strong enough to kill any pathogens that have been caught in mucus in the airways and then swallowed or have been consumed in food or water
3. **Cells** - different types of white blood cell work to prevent pathogens reaching areas of the body they can replicate in
    1. By **phagocytosis** - engulfing and digesting pathogenic cells
    2. By producing **antibodies** - which clump pathogenic cells together so they can't move as easily (known as **agglutination**) and releasing chemicals that signal to other cells that they must be destroyed

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Controlling the Spread of Disease

- The simplest way to prevent disease is to **stop pathogens from spreading**
- This means using simple measures such as **good hygiene** and **effective sanitation and waste disposal** to contain pathogens and dispose of them safely

Preventing the Spread of Disease Table

Measure to prevent spread	Importance
Clean water supply	Safe drinking water ensures water is free of pathogens which will prevent waterborne diseases e.g. cholera.
Hygienic food preparation	Washing hands with soap, correct food cooking methods and hygienic preparation of food will help to prevent contamination of food with harmful bacteria and fungi,
Personal hygiene	Washing with soap or using tissues to catch sneezes and coughs and then disposing of them will reduce transmission of diseases such as colds and flu.
Waste disposal	Proper disposal of waste e.g. food waste will reduce the prevalence of pests e.g. flies that can act as vectors for transmissible diseases.
Sewage treatment	Treatment of sewage removes harmful pathogens from waste before it is released into the environment. This reduces the risk of diseases spreading in contaminated water.

FlashcardsNext topic

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Active Immunity: Extended

Extended Tier Only

- Making antibodies and developing memory cells for future response to infection is known as **active immunity**
- There are **two ways** in which this active immune response happens:
  - The body has become **infected with a pathogen** and so the lymphocytes go through the process of making antibodies specific to that pathogen
  - **Vaccination**
- Active immunity is **slow acting** and provides **long-lasting immunity**

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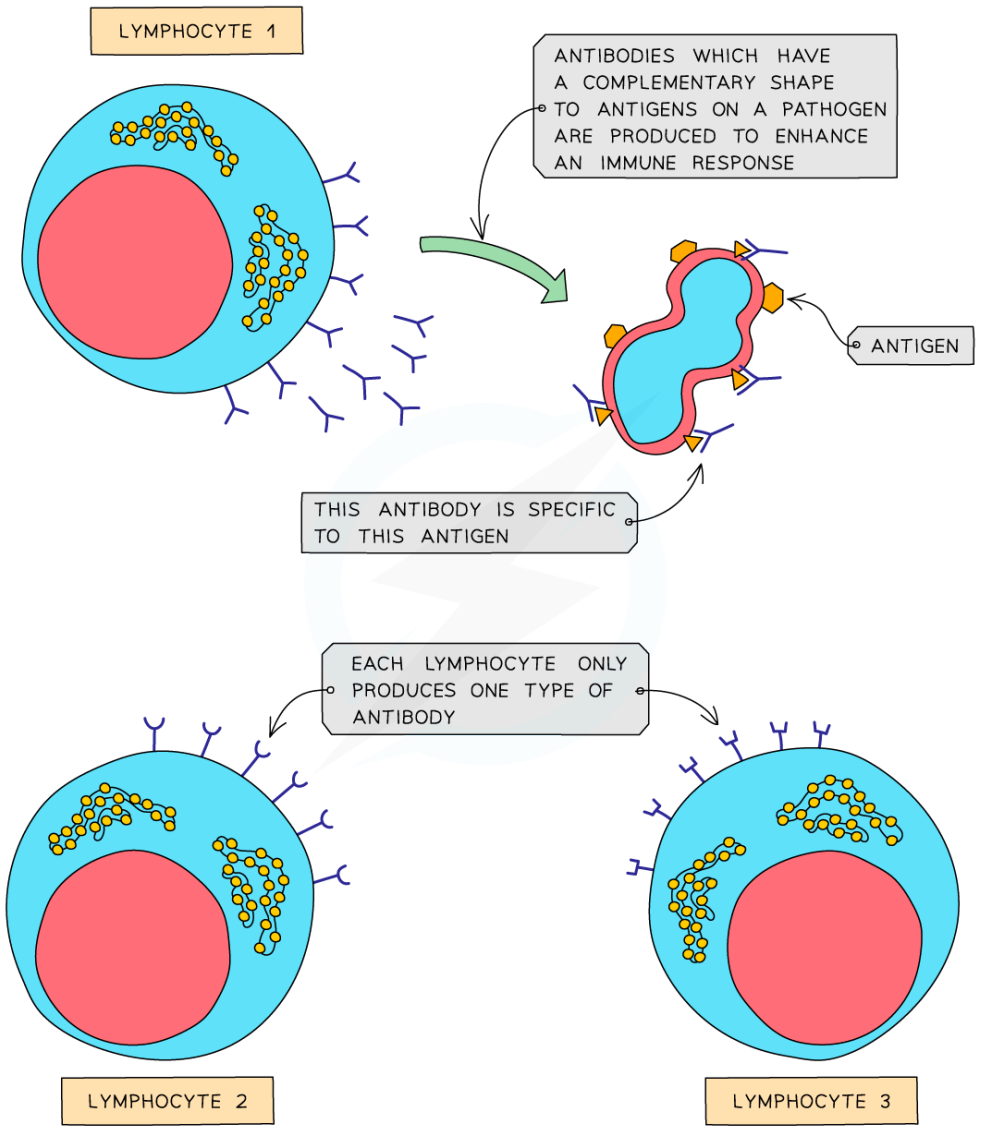
Antigens & Antibodies: Extended

Extended Tier Only

- All cells have molecules, such as proteins, projecting from their cell membranes
- These are known as **antigens**
- Different individuals have **different antigens** on their cell surface membranes
- Lymphocytes can recognise **foreign antigens**, e.g. the antigens of a pathogen inside the body
- In response to foreign antigens lymphocytes make **antibodies** which are **complementary** in shape to the antigens on the surface of the pathogenic cell

Lymphocytes producing antibodies diagram



Lymphocytes produce antibodies that are specific to a particular type of antigen

The role of antibodies

- Antibodies can **attach to antigens** and cause **agglutination** of pathogens
  - This means the pathogenic cells cannot move around very easily
- At the same time **chemicals** are released that signal the presence of pathogens to **phagocytes**
- Phagocytes move towards the site of an infection where they **engulf and destroy** pathogens
  - Many pathogens can be engulfed together due to agglutination

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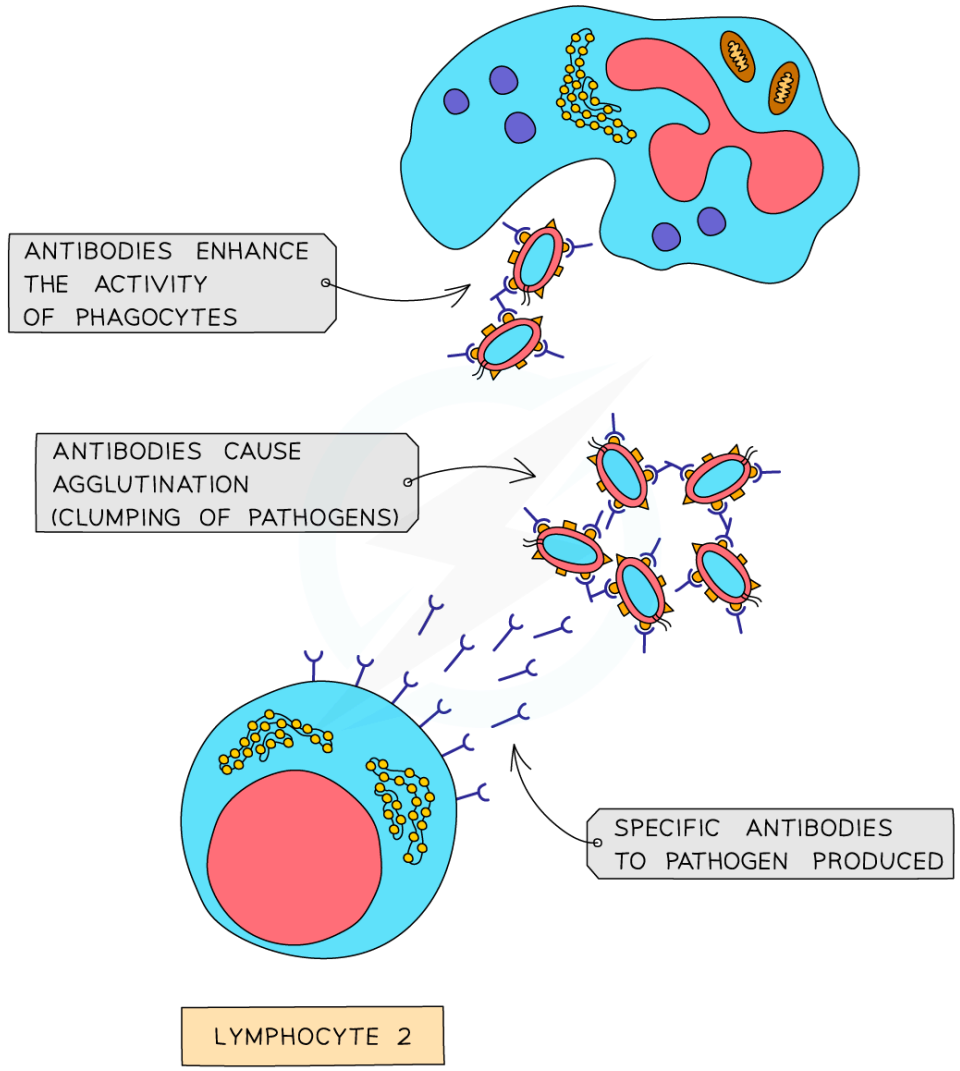
Phagocytes and agglutination diagram



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Agglutinated pathogens cannot move around so phagocytosis can occur more easily

Immunity

- The **initial response** of a lymphocyte encountering a pathogen for the first time can take **a few days**, during which time an individual may get sick
- After an initial encounter with a pathogen, lymphocytes can give rise to **memory cells** that retain the instructions for making specific antibodies
- This means that in the case of reinfection by the same type of pathogen, **antibodies can be made very quickly** and in **greater quantities**; the pathogens are destroyed before they multiply and cause illness
  - This is how people become **immune** to certain diseases after only having them once

- Note that this does not work with all disease-causing microorganisms as some of them **mutate** quickly and change the antigens on their cell surface
    - Therefore, if they invade the body for a second time the memory cells made in the first infection will not produce antibodies that match the new antigens

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Examiner Tips and Tricks

Make sure you know the difference between antigen, antibody and antitoxin:

- An **antigen** is a molecule found on the surface of a cell
- An **antibody** is a protein made by lymphocytes that is complementary to an antigen and, when attached, clumps them together and signals the cells they are on for destruction
- An **antitoxin** is a protein that neutralises the toxins produced by bacteria

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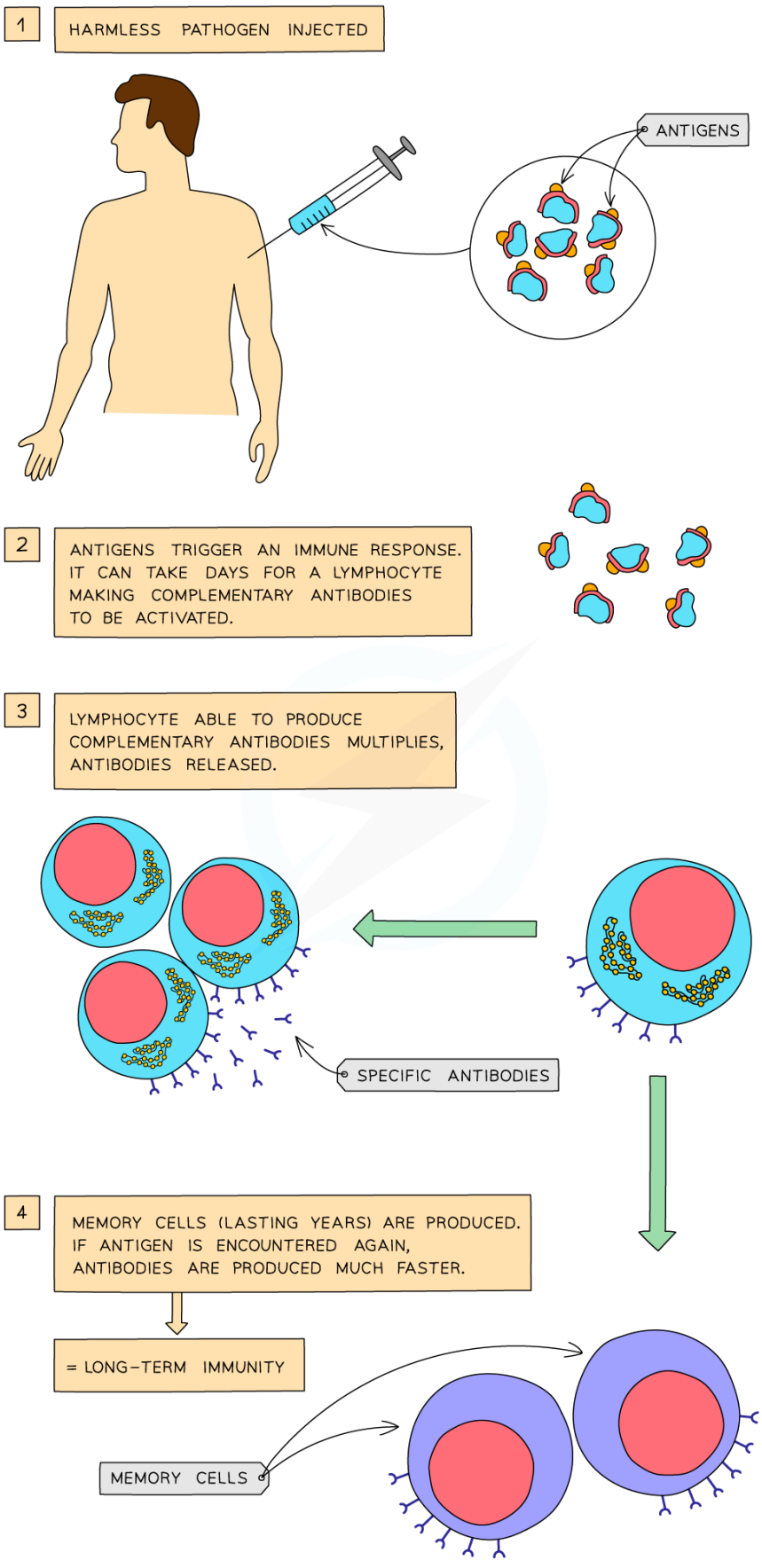
Vaccination: Extended

Extended Tier Only

- Vaccinations give **protection against specific diseases** and **boost the body's defence against infection** from pathogens without the need to be exposed to dangerous diseases that can lead to death
- The level of protection in a population depends on the **proportion of people vaccinated**
- Vaccines allow a **dead or altered form** of the disease-causing pathogen, which contains specific **antigens**, to be introduced into the body
- In this weakened state, the pathogen **cannot cause illness** but can **provoke an immune response**
- Lymphocytes produce **complementary antibodies** for the antigens
- The antibodies target the antigen and attach themselves to it in order to create **memory cells**
- The memory cells remain in the blood and will **quickly respond** to the antigen if it is encountered again in an infection by a 'live' pathogen
- As memory cells have been produced, this immunity is **long-lasting**



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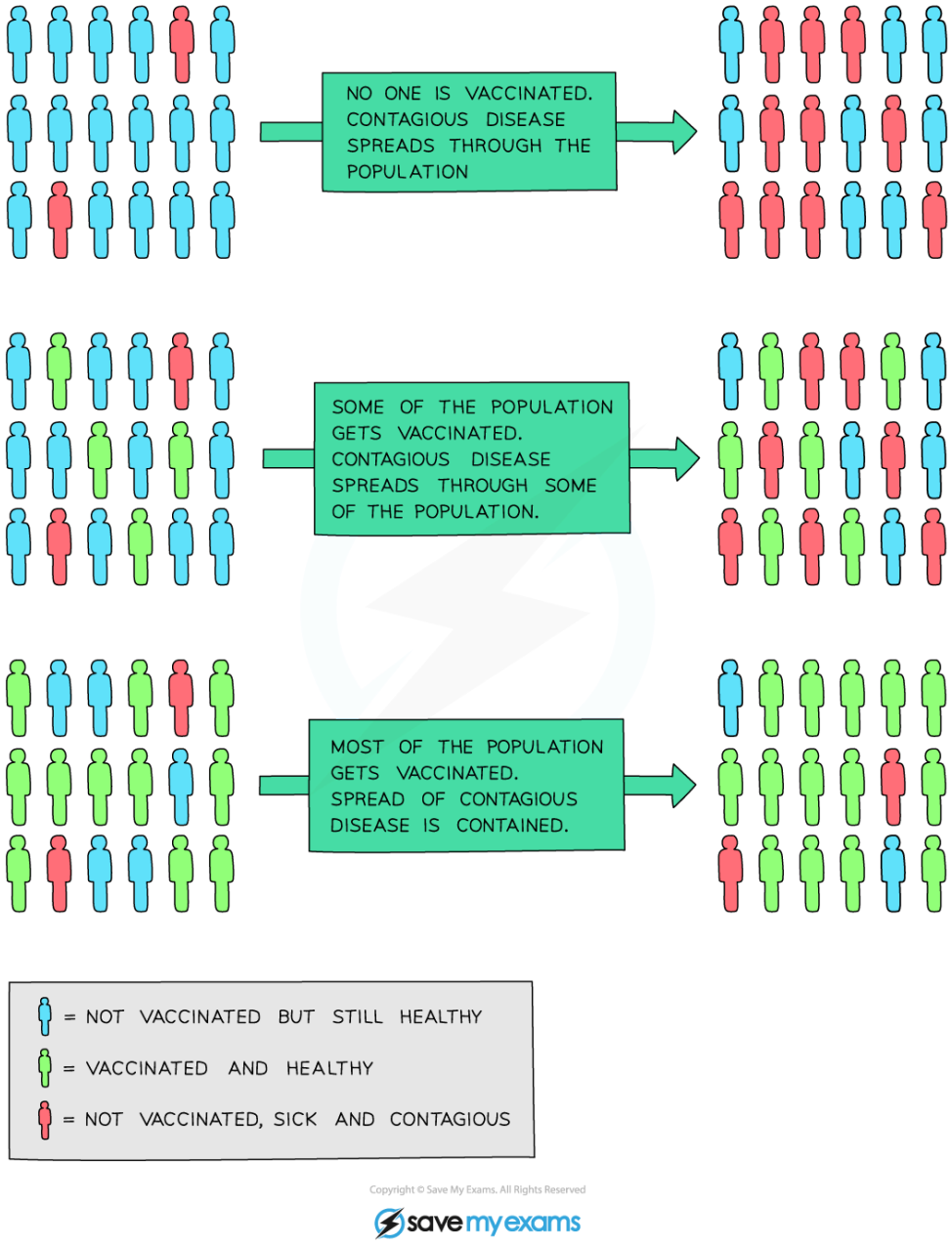
Preventing the Spread of Disease: Extended

Extended Tier Only

- If **a large enough percentage** of the population is vaccinated, it **provides protection for the entire population** because there are **very few places for the pathogen to breed** - it can only do so if it enters the body of an unvaccinated person
- This is known as **herd immunity**
- If the number of people vaccinated against a specific disease **drops** in a population, it leaves the rest of the population at risk of **mass infection**, as they are more likely to come across people who are infected and contagious This **increases the number of infections**, as well as the number of people who could die from a specific infectious disease



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Herd immunity

- **Herd immunity prevents epidemics and pandemics from occurring in populations**
- This is the reason that many vaccinations are given to **children**, as they are regularly seen by medical practitioners and can be vaccinated early to ensure the entire vaccinated population remains at a high level
- In certain instances, vaccination programmes are run with the aim of **eradicating** certain dangerous diseases, as opposed to controlling them at low levels
- An example of a disease which has been eradicated as a result of a successful vaccination programme is **smallpox**, which was officially eradicated in 1980 after a

vaccination programme run by the World Health Organisation since the mid-1950s

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Passive Immunity & Breastfeeding

- Passive immunity is a **fast-acting, short-term defence** against a pathogen by antibodies acquired from another individual
- Antibodies pass from **mother to infant** via **breast milk** - this is important as it helps the very young to fight off infections until they are **older and stronger** and their immune system is more responsive
- The body **does not make its own antibodies or memory cells** in passive immunity, hence the name

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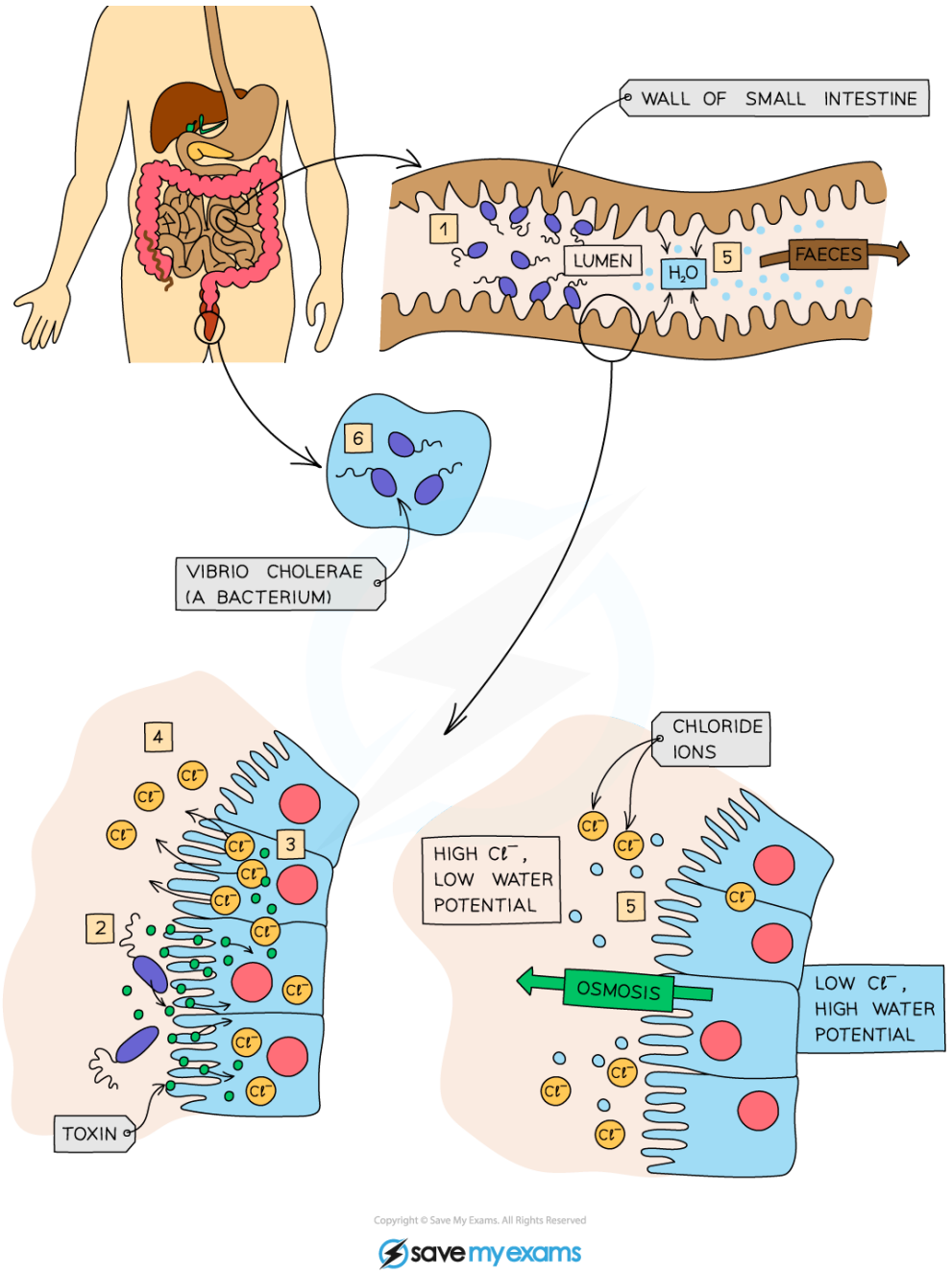
Cholera

Cholera causes diarrhoea

- Diarrhoea is the **loss of watery faeces from the anus**
- If it is severe and continues for a long time, it **can lead to death**
- Severe diarrhoea can cause the **loss of significant amounts of water and ions** from the body, causing the tissues and organs to stop working properly
- It can be effectively treated by **oral rehydration therapy**
- This is a **drink with a small amount of salt and sugar** dissolved in it
- There are many causes of diarrhoea, one of which is infection with **Vibrio cholerae bacteria**, which causes the disease **cholera**

How does Vibrio cholerae cause diarrhoea?



How cholera leads to diarrhoea

- Ingested via **infected water or food**, if it enters the small intestine it can cause illness in the following way:

1. Bacteria attach to the wall of the **small intestine**
2. They produce a **toxin**
3. The toxin stimulates the cells lining the intestine to **release chloride ions** from inside the cells into the lumen of the intestine

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4. The chloride ions accumulate in the lumen of the small intestine and **lower the water potential** there
5. Once the water potential is lower than that of the cells lining the intestine, **water starts to move out of the cells** into the intestine (by **osmosis**)
6. Large quantities of water are lost from the body in **watery faeces**
7. The blood contains **too little chloride ions and water**

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