

- Triple Science Content only in purple
- Triple Science and Higher Content Only in blue

Topic 3 AQA GCSE Chemistry: Infection and Response

Communicable Diseases

- **Communicable diseases** are caused by **pathogens**, such as **viruses**, **bacteria**, **protists**, and **fungi**.
- These diseases can spread through:
 - **Direct contact**
 - **Water**
 - **Air**

Pathogens:

- **Viruses:** Reproduce inside host cells, damaging them. The infected cells eventually burst, releasing the virus into the bloodstream.
- **Bacteria:** Multiply quickly through binary fission, and produce **toxins** that damage cells and tissues.
- **Protists:** Often parasitic, living inside a host and causing harm.
- **Fungi:** Can grow as single cells or have structures like **hyphae**, which spread and release spores.

Reducing the Spread of Communicable Diseases:

- Improve **hygiene**.
- **Isolate** infected individuals.
- Remove **vectors** (e.g., use insecticides).
- Use **vaccinations**.

Viral Diseases

Disease	Symptoms	Spread	Prevention
Measles	Fever, red skin rash	Inhalation of droplets from sneezes/coughs	Vaccination of young children.

HIV	Flu-like symptoms, leading to AIDS (weakened immune system)	Spread by sexual contact or exchange of bodily fluids	Condoms, not sharing needles; antiretroviral drugs.
Tobacco Mosaic Virus (plants)	Discoloration of leaves, stunting photosynthesis	Contact between infected and healthy plants, or insect vectors	Good field hygiene, pest control.

Bacterial Diseases

Disease	Symptoms	Spread	Prevention
Salmonella	Fever, stomach cramps, vomiting, diarrhoea	Contaminated food (raw meat, eggs)	Cook food thoroughly, vaccinate poultry.
Gonorrhoea	Thick yellow/green discharge from the genitals, pain when urinating	Unprotected sexual contact	Use contraception (e.g., condoms); treat with antibiotics.

Fungal Diseases

Disease	Symptoms	Spread	Prevention
Rose Black Spot	Purple/black spots on rose leaves, causing leaves to yellow and drop	Spores spread through water or wind	Use fungicides, remove infected leaves.

Protist Diseases

Disease	Symptoms	Spread	Prevention
Malaria	Fever, shaking	Spread by mosquito vector (Anopheles)	Use insecticide-treated nets, antimalarial drugs.

Human Defence Systems

Non-specific defences include:

First line of defence (non-specific):

- **Skin** → physical barrier, secretes antimicrobial substances to kill pathogens
- **Nose** → hairs + mucus trap pathogens.
- **Trachea & bronchi** → mucus traps pathogens; cilia waft mucus to throat.
- **Stomach** → hydrochloric acid kills most microbes.

Second line of defence (immune response):

- White blood cells:
 - **Phagocytosis** → engulf and destroy pathogens.
 - **Antibodies** →
 - Specific antigens on pathogens which complementary antibodies can bind to.
 - Antigens then clump together, and then are engulfed and destroyed by white blood cells.
 - **Antitoxins** → neutralise toxins made by bacteria.

Vaccination

- **Vaccination** involves introducing small amounts of **dead** or **inactive pathogens** to stimulate the production of **antibodies**.
- If the pathogen infects the body again, **memory cells** quickly produce antibodies to destroy it, preventing illness.

Benefits of Vaccination:

- **Prevents epidemics** by creating **herd immunity**.

- Can **eradicate** diseases (e.g., smallpox).

Downsides:

- Vaccines may not always be effective.
- Some people might experience mild side effects.

Antibiotics and Painkillers

- **Antibiotics** kill **bacterial pathogens** without harming body cells.
 - Antibiotics do **not** work on **viruses** because viruses reproduce inside body cells.
- **Painkillers** relieve symptoms but do not tackle the cause of the disease.

Antibiotic Resistance:

- Bacteria can develop **mutations** that make them resistant to antibiotics.
- To reduce antibiotic resistance:
 - **Do not overuse** antibiotics.
 - **Complete the full course** of antibiotics even if you feel better.

Discovery and Development of Drugs

- In the past, drugs were often extracted from **plants** or **microorganisms**:
 - **Digitalis** (for heart problems) comes from **foxgloves**.
 - **Aspirin** (pain relief) comes from **willow**.
 - **Penicillin** was discovered by **Alexander Fleming** from **Penicillium mould** that was killing the bacteria.

Drug Testing:

1. **Preclinical testing** is done on cells, tissues, and animals to test for toxicity and efficacy.
2. **Clinical testing** uses healthy volunteers and patients to find the correct **dose** and check for side effects.

Clinical Trials:

- Trials involve:
 - Giving patients either the drug or a **placebo**.
 - Trials can be **single-blind** (only the doctor knows who gets the drug) or **double-blind** (neither the patient nor the doctor knows).

3.2 Monoclonal Antibodies

Producing Monoclonal Antibodies

- **Monoclonal antibodies** are made from a single **clone** of cells and can bind to one specific **protein**.
- They are produced by:
 1. Injecting **mice** with the desired antigen to stimulate **lymphocytes** to produce antibodies.
 2. Combining lymphocytes with **tumour cells** to create a **hybridoma**.
 3. The **hybridoma** cells divide and produce **identical antibodies**.

Uses of Monoclonal Antibodies

Use	Explanation
Pregnancy Tests	Detects the presence of hormone HCG in urine. <ul style="list-style-type: none"> - Done by urinating on a section that contains mobile antibodies complementary to the HCG hormone, if HCG is present, then the individual is pregnant due to colour change.
Cancer Treatment	<ul style="list-style-type: none"> - Monoclonal antibodies can carry toxic drugs or radioactive substances directly to cancer cells binding onto their antigens called tumour markers, reducing damage to healthy cells. - OR, monoclonal antibodies bind onto cancer cells stimulating an immune system response to the cancer cells. - OR, monoclonal antibodies can inhibit the stimulation of the growth of the cancer cells by binding onto their receptor sites.
Laboratory Testing	Used to detect hormones or diseases in blood samples, where the antibodies (bound to a fluorescent dye) will bind to the molecule you are looking for.

Advantages of Monoclonal Antibodies

- **Target specific cells** → they only bind to the particular antigen, e.g. cancer cells, so healthy cells are less affected.
- **Versatile uses** → can be used for diagnosis (pregnancy tests, detecting pathogens), treatment (targeting cancer), and research.

- **Reduced side effects compared to other treatments like chemotherapy, since they don't damage as many normal cells.**

Disadvantages of Monoclonal Antibodies

- **Expensive and time-consuming to develop and produce.**
- **Side effects can still occur (e.g. fever, low blood pressure, allergic reactions).**
- **Not always as effective as hoped — some treatments using monoclonal antibodies haven't worked well in clinical trials.**

Plant Disease

Identification of the plant disease

- **Symptoms of plant disease include: spots, stunted growth (lack of nitrate ions), decay, discolouration(magnesium deficiency), malformed stems (aphid infestation)**
- **Methods of detecting which plant disease it is:**
 - Gardening manuals/websites.
 - Laboratory tests.
 - Testing kits using monoclonal antibodies.

Examples (required by spec):

- **TMV (Tobacco Mosaic Virus) → discoloured leaves.**
- **Rose black spot → spotted leaves.**
- **Ion deficiencies:**
 - Nitrate deficiency → poor growth (due to no proteins, as they convert sugars to proteins).

- Magnesium deficiency → chlorosis (yellow leaves, less chlorophyll as magnesium is needed to make chlorophyll).

Plant Defence

- **Physical barriers** → cell walls, waxy cuticles to prevent entry in leaves, bark (a layer of dead cells) which stops pathogens from entering.
- **Mechanical defences** → thorns, hairs to prevent them from being eaten, curling leaves to move away from predators.
- **Chemical defences** → antibacterial chemicals, poisons to deter herbivores.