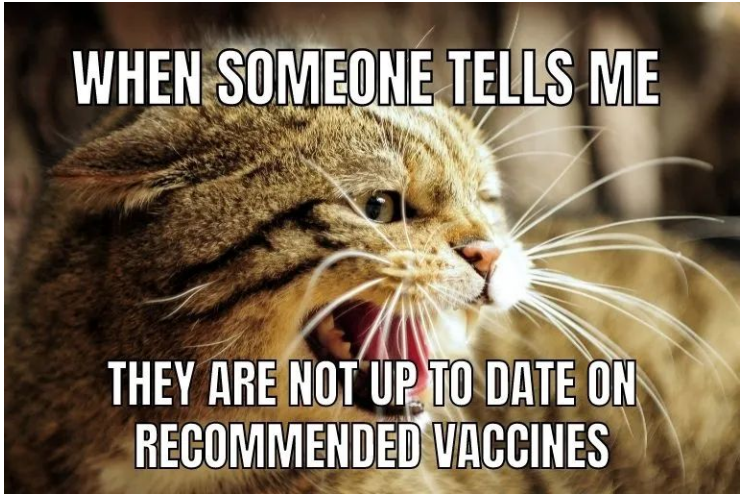
Learning Intention:

- To understand strategies used for identifying pathogens.
- To explain the transmission and control of infectious diseases
- To describe scientific and social strategies to identify and control the spread of pathogens

Success Criteria:

- I can explain the transmission and control of infectious diseases
- I can describe scientific and social strategies to identify and control the spread of pathogens
- I can explain how correct identification of the pathogen and isolation of the host is critical to controlling the spread of an infectious disease



Study design dot point
- scientific and social strategies employed to identify and control the spread of pathogens, including identification of the pathogen and host, modes of transmission, and measures to control transmission

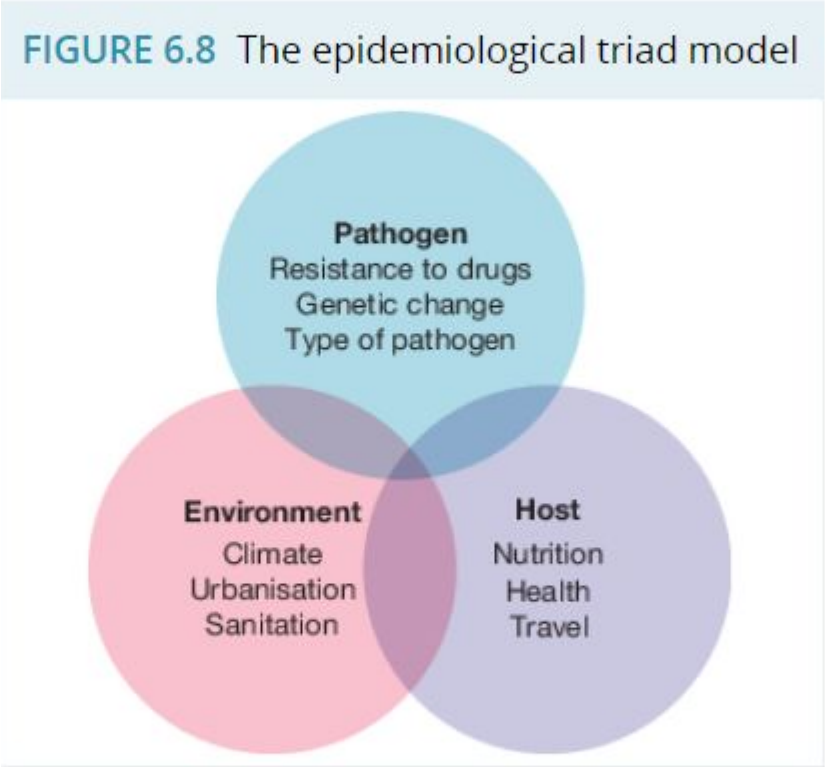
Warm up

Think-pair-share

During the COVID-19 pandemic, people were asked to wear masks, sanitise their hands and remain socially distanced at all times.

- **Thin**k – Individually make some notes about why you think these measures were necessary.
- **Pair** – Talk with your partner and come up with an agreed answer to the question.
- **Share** – Discuss with the class your answer the question.

Three main components of disease causation



Methods for Identifying pathogens

Some methods that scientists use to identify pathogens are:

Method	Description
Physical	Visualising pathogens using microscopes to determine their structure (Figure 1)
Phenotypic	Selective media – an agar plate designed to allow certain pathogens to grow and multiply to test for their presence in a sample (Figure 2). For example, an agar of buffered charcoal yeast extract is highly selective for *Legionella pneumophila*, the bacteria that causes Legionnaires' disease. If this bacteria is present in a sample and combined with buffered charcoal yeast it will grow and multiply, allowing scientists to identify it and determine the appropriate course of treatment.
	Biochemical test panels – a series of tests designed to specify a sample's genus and species. For example, scientists can run a Gram stain to determine if bacteria are Gram-positive or negative, then test if they are aerobic or anaerobic, then run more tests until they can identify the species of bacteria present in a sample (Figure 3).
Immunological	**Serology** – the diagnosis of disease based on the presence of antibodies or antigens in a person's **serum**. One example used to detect the presence of pathogenic antigens in a sample is the **enzyme-linked immunosorbent assay (ELISA)**. There are four main types of ELISA tests – direct, indirect, sandwich, and competitive.
	The sandwich method of ELISA involves: (1) antibodies specific to a certain pathogen are attached to a plate; (2) the serum sample to be tested is then applied to the plate, resulting in any pathogen antigens present attaching to the antibodies; (3) a second detection antibody, linked to a colour-changing enzyme, is added to the plate, binding to any antibody-antigen complexes present; (4) a substrate is then added, reacting with the enzyme on the second antibody and changing colour/emitting a signal to reveal whether any pathogenic antigens were present in the sample (Figure 4).
Molecular	Hybridisation-based detection – labelled segments of genetic material that are complementary to a pathogen's genetic material are added to a sample. If a signal is generated, it means a pathogen is present.
	Whole-genome sequencing – provides detailed information about the pathogen.

Identifying Virus

Knowing the identity of the pathogen guides decisions about treatment of the disease and preventing it from spreading.

Physical methods can assist in identifying viruses based on size and shape. These methods include:

1. x-ray crystallography, which has determined the structure of many viruses
2. electron microscopy, which has given us images that distinguish various kinds of virus.

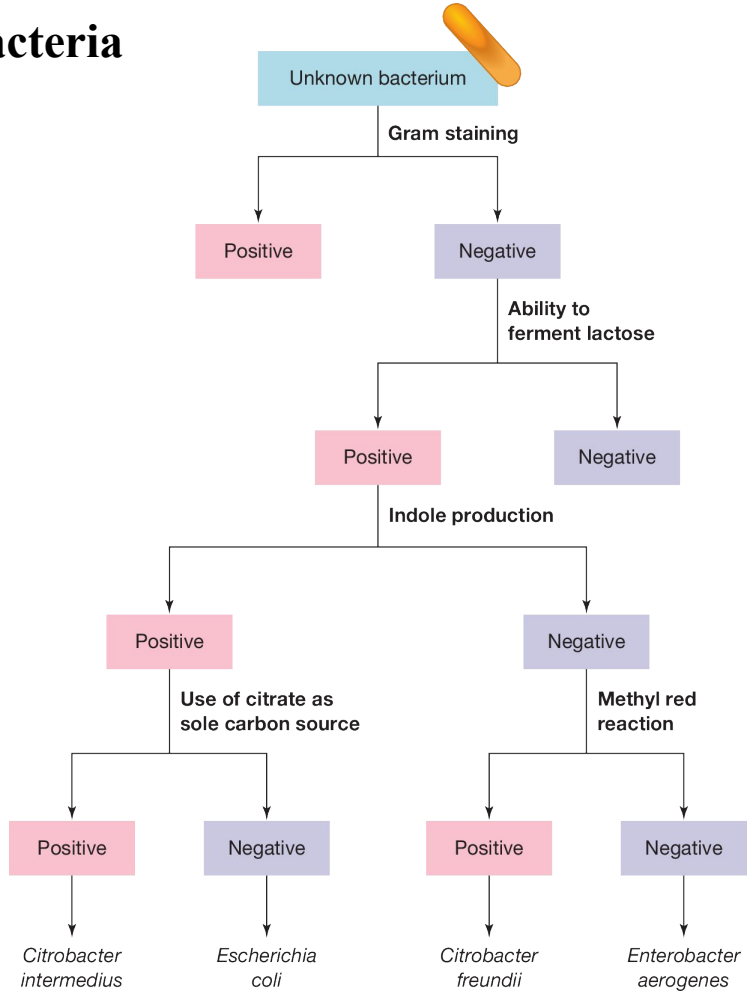
Immunological methods detect specific viral antigens or antibodies. One of the main techniques used is the enzyme-linked immunosorbent assay (**ELISA**) technique which allows for the diagnosis of diseases (including viral diseases).

Molecular techniques include the use of in situ hybridisation with **probes** to detect and locate specific genetic sequences that are diagnostic of particular viruses. This involves using a short radioactively labelled strand of nucleic acid (a probe) to bind to a specific sequence in tissue (in situ) through complementary base pairing. If the specific sequence is present, this can be easily located through the radioactive label on the probe.

Identifying Bacteria

Phenotypic methods use techniques that involve identifying particular traits or features in bacteria:

- **use of microscopy** to differentiate bacteria on the basis of differences in cell shape, size and response to Gram stain, and physical features such as the presence or absence of a capsule.
- use of a **range of biochemical tests** eliciting different bacterial responses
- use of different media to differentiate bacteria on the basis of variation in growth patterns.



Genotypic and molecular methods involve the examination of the genetic material of bacteria and use techniques such as gene probes, sequence analyses and plasmid fingerprinting to identify bacteria.

Immunological methods use techniques including monoclonal antibodies, ELISA and immunofluorescence to identify bacteria.

Modes of disease transmission

Five key methods of transmission to move from an infected host to a non-infected host:

1. Airborne transmission
2. Droplet transmission
3. Direct physical contact
4. Indirect physical contact
5. Faecal-oral transmission

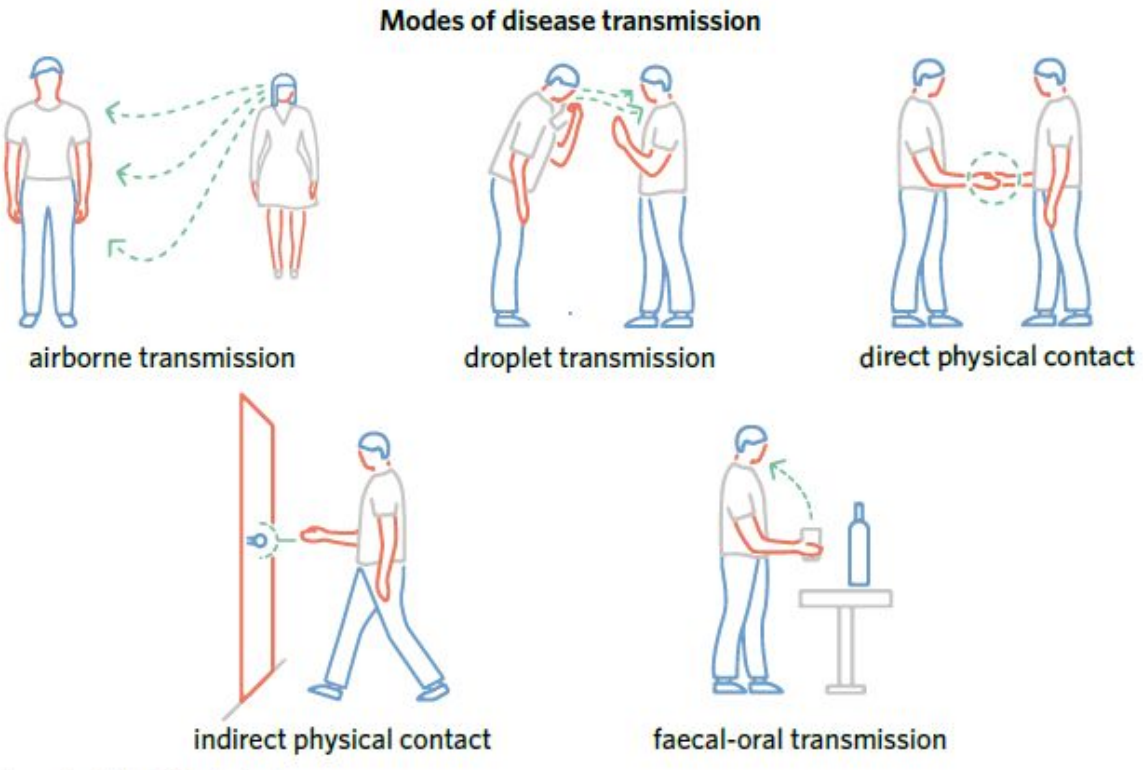


Table 2 Modes of pathogen transmission

Transmission route	Description	Examples
Airborne transmission	Pathogens spread via very small particles (traditionally <5 μm) that stay in the air for prolonged periods of time after a person sneezes, coughs, exhales, or talks. A person can inhale these particles and become sick even after the original host has left the vicinity.	Influenza virus – the causative agent of the flu SARS-CoV-2 – the causative agent of COVID-19 Rhinovirus – the causative agent of the common cold
Droplet transmission	**Respiratory droplets** containing pathogens can remain suspended in the air for a short period of time, before falling to the ground/onto a surface. If a person touches a surface containing droplets and then touches a mucosal surface (such as their eyes, mouth, or nose) the pathogen from the droplet may enter their system and infect them.	
Direct physical contact transmission	Pathogens can spread when a host physically touches another individual. This contact can occur either via skin-to-skin touch, sharing of bodily fluids, sexual contact, oral contact (kissing), from mother to baby *in utero* or post-birth (**vertical transmission**), or contact with a contaminated material during some medical procedures (**iatrogenic**).	*Tinea pedis* – the causative organism of athlete's foot Human immunodeficiency virus (HIV) – the causative agent of acquired immunodeficiency syndrome (AIDS) Epstein-Barr virus (EBV) – the causative agent of infectious mononucleosis (glandular fever)
Indirect physical contact transmission	Indirect transmission occurs when there is no direct host-to-host contact. Instead, pathogens are spread between hosts via **fomites** (e.g. food, water, tissues, needles) or a **vector** (e.g. mosquitoes).	*Plasmodium* – the causative agent of malaria, spread by mosquitoes
Faecal-oral transmission	Pathogens excreted in faeces can end up being consumed by another person indirectly via contamination of food or water by infected faeces. Additionally, faecal-oral transmission can also occur via airborne or droplet routes through the aerosilisation of pathogens when faeces is flushed.	*Vibrio cholerae* – the causative organism of cholera Rotavirus – the causative agent of diarrhoea, typically in young children

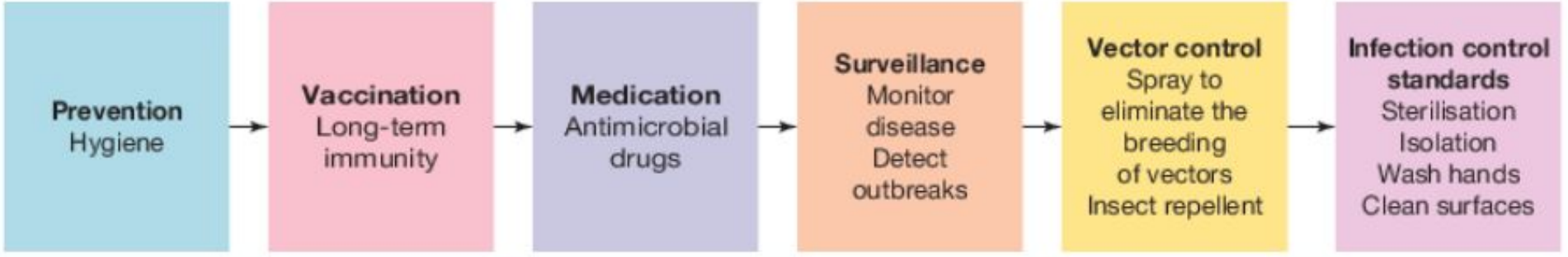
Controlling disease transmission

Strategy	Explanation
Prevention	• Improving hygiene and sanitation via handwashing • Sterilising hands and surfaces/tools using **antiseptics** and **disinfectants** • Ensuring access to clean water and food • Using personal protective equipment (PPE) such as gloves and masks when dealing with sick people (Figure 6a) • Vaccination, if a vaccine exists for the disease in question • Lockdown of areas/restrictions to reduce people's movement and the chance of spreading a disease
Screening	• Routine testing for the presence of disease in a population allows public health workers to quickly see who in a population is affected so they can target their response • Officials may observe medication sales at pharmacies and look for changes that might indicate that the prevalence of certain symptoms or illnesses has increased

Note: Due to antibiotics specificity to bacteria, they will have no therapeutic effect in someone infected with a virus. Inappropriate use of antibiotics can lead to **antimicrobial resistance** in which bacteria are no longer affected by antibiotics.

Strategy	Explanation
Quarantine and isolation	• Once a person becomes ill or has the potential to become ill (e.g. is returning home from visiting an affected area overseas), they may be separated from healthy people to ensure they don't spread their disease to the community (Figure 6b)
Identification of the pathogen	• Using the methods outlined in Table 1, scientists will attempt to identify which pathogen is present in an individual so they can initiate the appropriate responses
Identify and control mode/s of transmission	• Once officials know which pathogen is present, they can take appropriate steps to mitigate its transmission • For example, if a respiratory pathogen is threatening to cause an outbreak, measures that reduce the risk of airborne and droplet transmission (e.g. wearing of surgical masks, social distancing) will be taken to control transmission
Treating infected individuals	• Specific curative treatment, including the use of medications such as **antibiotics** and **antivirals** to target the pathogen - Antibiotics are medicines that can be used to treat diseases caused by bacteria. They selectively affect bacterial cells by targeting specific biochemical pathways or components unique to bacteria, without damaging the patient's cells - Antivirals are medicines that can be used to treat diseases caused by viruses. Similar to antibiotics, antivirals are designed to specifically target viruses, interfering with their ability to attach to, replicate in, and exit from a host cell

FIGURE 6.23 Mechanisms of controlling the spread of disease



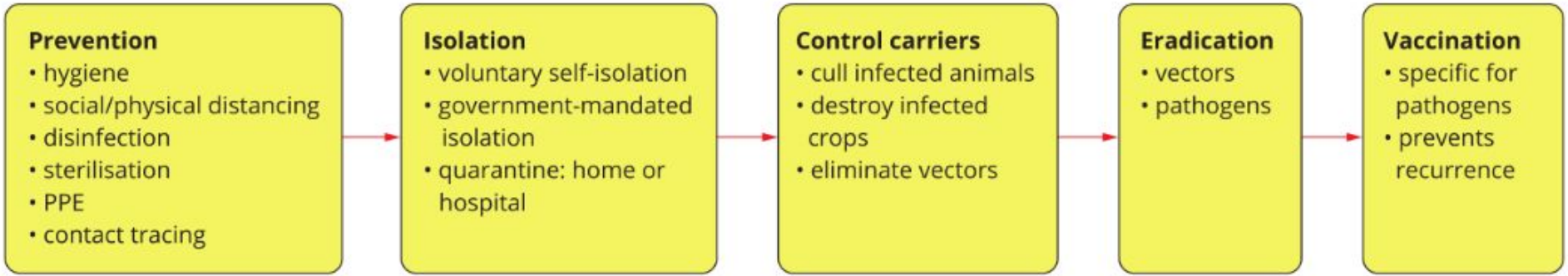


FIGURE 10.2.16 Key steps in the containment and control of infectious diseases

Worked example

Q. Discuss how vaccinations can be considered a prevention and control measure.

Answer: Vaccinations prevent the re-emergence of an infectious disease by providing immunity to the individuals who are vaccinated. Vaccinations are also considered a control measure, as they can provide herd immunity to minimise the spread of an infectious disease in a population.

Summary

- Identification of pathogens is important for both treatment and prevention.
- Methods to identify viruses include physical, immunological and molecular methods.
- Methods to identify bacteria include phenotypic, immunological and genotypic methods.
- It is also important to identify the host and/or the reservoir of a pathogenic agent to help prevent the spread of disease.
- The incubation period of a disease is the interval between a person's exposure to a pathogen and the onset of disease symptoms in that person.
- Asymptomatic carriers of a disease show no symptoms of a disease but can spread it.
- Infectious diseases may be spread directly (by person-to-person contact) or they may be spread indirectly.
- Methods to control the spread of disease includes prevention, vaccination, surveillance, modification of environment, infection control measures and medications.
- Antibiotics are agents that kill or inhibit bacteria using different bacterial targets.
- Antiviral drugs have been developed that target key viral enzymes involved in the viral replication cycle.

Reflection

Edrolo 8C Q1 -4, 12, 13, 15,