

JURONG WEST SECONDARY SCHOOL  
SECONDARY FOUR – SCIENCE (BIOLOGY)  
**Chapter 8: INFECTIOUS DISEASES**

**Learning Outcomes:**

Candidates should be able to:

- (a) **state** that **infectious** diseases can be spread from person to person whereas non-infectious diseases cannot and **identify examples** of each
- (b) **explain** that infectious diseases are caused by **pathogens** such as **bacteria** and **viruses** and can be spread from person to person through **body fluids, food and water** (knowledge of the structure of bacteria and viruses is **not** required)
- (c) **state** the **signs and symptoms** of:
  - **influenza** – caused by the influenza virus
  - **pneumococcal disease** – caused by the bacteria, pneumococcus
- (d) **describe** the **transmission** and **methods to reduce** the transmission of:
  - influenza virus
  - pneumococcus
- (e) **state** that **vaccines** contain an agent that resembles a pathogen and prevent infectious diseases by **stimulating white blood cells** to quickly **produce antibodies** when the pathogen invades (f) **state** that **antibiotics** kill **bacteria** and are ineffective against viruses
- (g) **explain** that the **misuse and overuse of antibiotics** may accelerate the emergence of **antibiotic resistant bacteria**

(a) State that infectious diseases can be spread from person to person whereas non-infectious diseases cannot and identify examples of each

**Infectious diseases** are transmissible diseases that can be spread from one person to another via various methods.

- Causes: Pathogens

What are Pathogens?

- They are disease-causing organisms
- Eg: Bacteria and Viruses
- Different types of pathogens give rise to different types of diseases, for

example SARS-CoV-2 Virus results in COVID-19, **Vibrio Cholerae bacteria** results in Cholera



The COVID-19 Outbreak resulted in approximately 2.6 million cases and 1800 deaths around the world. Today, 15 million



people have been vaccinated against the disease. Cholera is a water-borne disease caused by contaminated water that

contains the Vibrio Cholerae bacteria. Think about what countries or conditions is Cholera the most common?

#### 4G3 Science(Biology) Chapter 8 Notes

**Non-Infectious Diseases** are non-transmissible diseases that cannot be spread from one person to another and are not caused by pathogens.

- Causes: **Inherited**, **lifestyle** or environmental conditions
  - Eg. **Sickle-cell anemia** patients would have inherited 2 faulty haemoglobin genes from their parents
  - Eg. **Excessive alcohol consumption** may cause liver cirrhosis over time
  - Eg. **Air Pollution** may lead to pulmonary diseases

|                             | Infectious Diseases                                                                       | Non-infectious diseases                                                              |
|-----------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Transmissibility</b>     | Can be <b>transmitted</b> from person to person                                           | <b>Cannot</b> be transmitted from person to person                                   |
| <b>Mode of Transmission</b> | a) <b>Droplets of water in air</b><br>b) Direct Contact<br>c) Contaminated Food and Water | May be <b>inherited</b> or caused by <b>environmental factors</b> /lifestyle changes |
| <b>Pathogen-causing</b>     | Caused by <b>pathogens</b>                                                                | <b>Not</b> caused by pathogens                                                       |
| <b>Examples</b>             | COVID-19, Influenza, Chicken Pox, Herpes, Cholera                                         | Diabetes, coronary heart diseases, sickle-cell anaemia                               |

## Let's Think!

### What is the difference between infectious and contagious?

An infectious disease means that it can be spread from one person to another, however something that is contagious focuses more on the fact that it can be spread via contact with another person (as a mode of transmission). So, when something is contagious, it is also infectious as it would mean that one would have to be in contact with the infectious agent to get the disease. Something infectious however, may not always be contagious.

For example, *Sinusitis*, Sinus Infection is infectious but not contagious. Mosquito borne diseases are also infectious but not contagious. On the other hand, COVID-19 and stomach flu are both infectious and very contagious as well.

A **disease** is a condition in that causes the body to **function less effectively**. Diseases produce specific **signs or symptoms**.

A sign of a disease can be **observed** or **measured**. E.g., Rashes, fever, coughing or vomiting. A symptom of a disease can be described or felt by the patient. E.g., Headache, fatigue, and nausea

(b) Explain that infectious diseases are caused by pathogens such as bacteria and viruses and can be spread from person to person through

body fluids, food and water

## How are Infectious Diseases transmitted?

1. **Droplets of water in the Air** (bodily fluids)
2. Direct Contact (bodily fluids)
3. Contaminated Food and water

2

### 4G3 Science(Biology) Chapter 8 Notes

#### 1. Droplets of water



- When a person sneezes or coughs, **many respiratory droplets are expelled** from the person's mouth or nose.
- These **respiratory droplets may contain pathogens**.
- Hence when someone **nearby inhales** these respiratory droplets, they also inhale these **pathogens** which can then **enter their respiratory system** and infect them.

**Think about how wearing a mask and practicing social distancing can help protect us against viruses.** A mask acts as a **protective layer** and **reduces the amount of pathogens** released from a person into the air. Hence, **reducing** the chance of someone nearby **inhaling** these pathogen-containing respiratory droplets and getting infected.

Respiratory droplets can usually travel 2-3m away from the infected person. By keeping a distance away from the infected person, the **likelihood of inhaling** these pathogen-containing respiratory droplets is **reduced**, thus protecting one from being infected.

the **lack of proper water supplied** and **sewage disposal**, resulting in the consumption of **Cholera bacteria**-containing water.

- **Salmonella** Infection – A food-borne disease that may occur when flies deposit salmonella onto our food.

#### • **Methods to prevent and control the spread:**

- Practice good personal hygiene
- Wearing of gloves when handling food
- Storing food properly
- Maintaining clean water supply and proper sewage disposal system

#### 2. Direct Contact

- An infected person may **exchange bodily fluids** or **blood** with another person via direct physical contact with them, for example during **sexual intercourse**.

#### • Examples:



- Sexually transmitted diseases (STIs) such as **Human deficiency Virus (HIV)** can be transmitted during sexual intercourse.
- **Hepatitis B and Syphilis** can be transmitted from mother to child during breastfeeding.
- HIV, Hepatitis B and C can also be transmitted via the **blood** of an infected person to someone uninfected.
- Through **open wounds/** break in the skin, **mucous membranes**, or even **infected needles**.

#### 3. Contaminated Food and Water

- When food and water are **not handled or stored properly**, they end up being **contaminated by pathogens**.
- The diseases that result from the transmission of contaminated food/water are called **food-borne/** **water-borne** diseases.
- **Examples:**
  - **Cholera** – A water-borne disease common in underdeveloped countries with



**Commented [NLYS1]:** Other questions to ponder about: 1. How does mask wearing protect that mask-wearer and those around him?  
2. Is mask wearing effective if worn improperly? 3. Why are there different kinds of masks being manufactured?  
4. What are the social impacts of mask wearing? 5. What are some downsides to the wearing of masks?

**Commented [NLYS2]:** Think about why a sterile needle has to be used each time a new injection is made?

- Someone that is **symptomatic** means that he/she has been infected and shows **symptoms** of the disease.
- Someone that is **asymptomatic** however does not show symptoms of the disease despite being



infected.

I'm not sick, not coughing, not sneezing, why should I still wear a mask?

This is so as you may be asymptomatic for the disease, hence even though you do not display symptoms, the **disease-causing pathogens are still present** in your **respiratory droplets** and **may infect** others when you exhale, talk or when they reach surfaces that others may come into contact with

(c) state the signs and symptoms of:

- influenza – caused by the influenza virus
- pneumococcal disease – caused by the bacteria, pneumococcus

(d) describe the transmission and methods to reduce the transmission of:

- influenza virus
- pneumococcus

## Influenza (virus)

HA)

Spike  
Protein

Membrane  
Envelope

NA)

Spike

M2

Single stranded RNA Protein Coat

Protein

**Spike proteins** found on the viral surface play a very important role in the virus's ability to infect their hosts. The influenza virus uses these spike proteins to **bind to specific complementary proteins** on their host cells, allowing it to gain entry into the host cell.

4

#### 4G3 Science(Biology) Chapter 8 Notes

##### What is Influenza?

- Disease that attacks the respiratory system
- People usually recover within 2 weeks, however it could lead to complications.

**Cause:** Influenza Virus

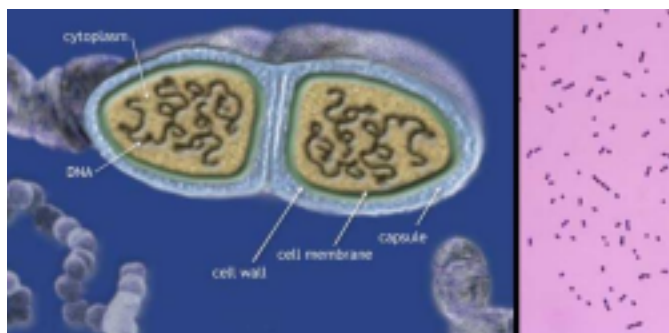
##### Mode of Transmission:

- Transmitted via droplets of water  
(Uninfected person may touch contaminated surfaces and then touch their mouth, nose or ears/ infected person may cough or sneeze and infect the uninfected that inhale these droplets)

##### Signs and Symptoms:

- High fever, headache, stuffy nose, cough, sore throat

## Pneumococcal Disease (bacteria)



Left: Close up image of *Streptococcus pneumoniae*; Right: How *Streptococcus pneumoniae* looks under a microscope

##### What is Pneumococcal Disease?

- It is one of the major causes of death worldwide that involves the *Streptococcus pneumoniae* bacteria attacking different parts of the body resulting in an infection

**Cause:** Pneumococcus bacteria known as *Streptococcus pneumoniae*

**Mode of Transmission:**

- Transmitted via droplets of water and contaminated surfaces (similar to influenza)

**Signs and Symptoms:**

- Fever, headache, vomiting, cough, chest pain, rapid breathing

5

4G3 Science(Biology) Chapter 8 Notes

## Methods to Reduce Transmission of pathogens

### 1. Get vaccinated

- Annual vaccinations are recommended.

- Why?

Upon exposure to different environmental conditions, the influenza virus's structure is bound to change to adapt to the new conditions. As such, a new vaccine will be developed each year to adapt to the virus's changing structure. Hence, one should get vaccinated with the latest vaccine to get immunized against the most recent viral structure.

### 2. Avoid coming into contact with infected persons/ Keep a distance from others if you are infected

### 3. Take daily preventive measures

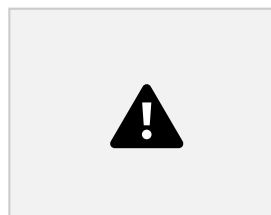
- Wash hands with soap and water
- Use disinfectant (e.g. Alcohol)
- Avoid touching eyes, nose and mouth
- If you are sick, wear a mask/ cover your nose and mouth when you sneeze or cough and dispose the tissue properly.

### 4. Take prescribed antiviral drugs (for virus) and antibiotics (for bacteria) to treat disease

(e) state that vaccines contain an agent that resembles a pathogen and prevent infectious diseases by stimulating white blood cells to quickly produce antibodies when the pathogen invades

A **vaccine** contains an agent that resembles a pathogen and prevents infectious diseases by stimulating white blood cells to quickly produce antibodies when the pathogen invades.

The process of receiving a vaccine is known as **vaccination**.



**Fun Fact!** Smallpox was a deadly disease in the 1600s and those who suffered from it developed small unsightly bumps on their skin. In 1796, Edward Jenner noticed that those who had been previously infected with cowpox did not get smallpox. He

injected the fluid from a cowpox patient's sore into a young boy and then exposed this young boy to smallpox. Despite suffering a slight initial reaction, the young boy never developed smallpox.

## Vaccines (TB pages 159 – 160)

**Commented [NLYS3]:** Discuss why the young boy may have suffered from an initial reaction?  
Do you think Edward Jenner's actions were justifiable/ ethical?

### How do vaccines work?

- When a pathogen enters our bloodstream, it stimulates our **white blood cells (lymphocytes) to produce antibodies** to fight against it.
- These antibodies are specific to the type of pathogen as different pathogens have different **antigens**.
- **Antigens are the proteins found on the surfaces of viruses and bacteria.** • A vaccine against a specific disease will hence **contain an agent that resembles the pathogen causing that specific disease**. This agent has antigens unique to the pathogen causing the disease, thus stimulating the white blood cells in the body to produce antibodies which destroy the pathogen directly or indirectly.
- Some of these white blood cells will remain in the bloodstream for a long time, they are called **memory cells**. They give **long term protection against this specific pathogen**.
- When encountering the actual live pathogen in the future, these memory cells would have already recognized them and hence **quickly divide to produce large number of antibodies to destroy the pathogens** before they can infect our cells.



After we have recovered from an influenza infection, we are protected from another

infection. Why? However, in a few months, we may get infected by the same virus again. Why?

(f) state that antibiotics kill bacteria and are ineffective against viruses

## Antibiotics (TB pages 161 – 162)

**Antibiotics** are drugs used to treat bacterial infections. They are made of microorganisms that can kill or inhibit the growth of bacteria or inhibit the growth of bacteria or fungi but interfering with their growth and metabolic activities.

Antibiotics are ineffective against viruses.

### How do Antibiotics work?

#### 1) Weakening bacterial cell wall

- Eg. Penicillin
- When water enters the weakened bacterial cell wall via osmosis, the cell cannot maintain its shape, swells, bursts and dies.

#### 2) breaking up bacterial cell membrane

- E.g. Polymyxin
- Without the cell membrane, the bacterial cell is no longer protected from its environment as any substance can move in and out of the cell

#### 3) Inhibits protein synthesis by ribosomes

- E.g. Tetracycline
- Binds to the bacterial ribosomes and prevent them from making proteins and enzymes, thus killing the bacteria

#### 4) Inhibits enzyme action

- E.g. Sulfa antibiotics
- By inhibiting some enzymes, the bacteria cannot grow



Why do antibiotics only work against bacteria and not viruses? (Hint: Recall the differences between the structures of bacteria and viruses)

Antibiotics kill bacteria by inhibiting cell wall synthesis, cell membrane function and ribosomal activities. However, in the first place, viruses do not have cell walls, cell membranes or ribosomes. Hence, rendering the actions of antibiotics obsolete when dealing against viruses.

What someone with a viral infection needs is rest. With rest, the body will be given time to fight against the infection and recover. Antivirals can also be administered to help this process.

## Antibiotic Resistance

all bacteria are killed.

- Using antibiotics only when necessary



'Superbugs' are pathogens that are resistant to medicines such as antibiotics. Have you wondered HOW they are **resistant** and why "antibiotics [may] drive bacteria toward[s] drug resistance"?

1. Within a population of bacterial cells, there are many different phenotypes. Most bacterial cells will be killed by antibiotics. However, there may be a small handful with mutations that make them resistant to antibiotics.
2. When exposed to antibiotics, these bacteria cells survive while those without the antibiotic resistant mutation are killed.
3. The antibiotic-resistant bacterial cells will hence continue to survive, divide and increase in numbers in the body.

**How does the misuse/ overuse of antibiotics drive **resistance**?**

**How can antibiotic resistance be reduced?**

- Not misuse or overuse antibiotics
- Complete the full course of antibiotics prescribed by physicians so that

**Commented [NLYS4]:** Textbook states that the bacteria "develops" the resistance but I'm afraid this might cause students to think that the bacteria mutated WHEN and BECAUSE it was exposed to the antibiotics rather than the mutation was ALD PRESENT and hence just so happen allowed it to thrive under antibiotic conditions

**Commented [NLYS5R4]:** Its like the evolution example of how the giraffe does not grow a longer neck to feed on the leaves of a tree, its just so happens that those with longer necks could feed on the leaves on the trees more than those w shorter necks, hence those w longer necks survive and reproduce while those with shorter necks die and don't have a chance to reproduce.

**Commented [NLYS6]:** When antibiotics are administered, they put pressure on the bacteria to adapt. Those with the mutations that can alter cellular targets of antibiotics or acquired dedicated resistance genes from other bacteria will hence naturally be selected for to survive (evolution), divide in large numbers and thrive, giving rise to a colony of antibiotic resistant bacteria.

## Reflection on the Chapter:

| LEARNING OBJECTIVES                                                                                                                                                                                              | HAVE I LEARNT THEM? HOW DO I KNOW I HAVE LEARNT? TRY TO ANSWER THE FOLLOWING LO. WHICH ARE THE ONES I AM STILL NOT SURE OF? |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| (a) <b>state</b> that infectious diseases can be spread from person to person whereas non-infectious diseases cannot and identify examples of each                                                               |                                                                                                                             |
| (b) <b>explain</b> that infectious diseases are caused by pathogens such as bacteria and viruses and can be spread from person to person through body fluids, food and water                                     |                                                                                                                             |
| (c) <b>state</b> the signs and symptoms of: <ul style="list-style-type: none"> <li>• influenza – caused by the influenza virus</li> <li>• pneumococcal disease – caused by the bacteria, pneumococcus</li> </ul> |                                                                                                                             |
| (d) <b>describe</b> the transmission and methods to reduce the transmission of: <ul style="list-style-type: none"> <li>• influenza virus</li> <li>• pneumococcus</li> </ul>                                      |                                                                                                                             |
| (e) <b>state</b> that vaccines contain an agent that resembles a pathogen and prevent infectious diseases by stimulating white blood cells to quickly produce antibodies when the pathogen invades               |                                                                                                                             |
| (f) <b>state</b> that antibiotics kill bacteria and are ineffective against viruses                                                                                                                              |                                                                                                                             |
| (g) <b>explain</b> that the misuse and overuse of antibiotics may accelerate the emergence of antibiotic-resistant bacteria                                                                                      |                                                                                                                             |

*The End*