

9

DISEASES AND IMMUNITY



Students Learning Outcomes

After studying this chapter, students will be able to:

- Describe infectious and non-infectious diseases and their types with examples.
- Define zoonotic diseases and give their types.
- Describe vector borne diseases with examples.
- Enlist allergies with some common types.

The human body is a complex system designed to maintain health and function despite constant exposure to potential threats. These threats come in various forms including microorganisms, genetic disorders, environmental influences and

According to the World Health Organization (WHO), "health is a state of complete physical, mental, and social well-being and not merely the absence of disease or illness".

lifestyle choices. In this chapter, we will explore the nature of diseases and various types of disease vectors.

9.1 DISEASE

Disease is defined as a specific condition that affects the normal functioning of the body or mind. It covers a wide range of conditions which affect various body systems. Examples of diseases include infections, metabolic disorders, autoimmune diseases, and genetic disorders. The term “illness” means the subjective experience of being unwell due to disease. This includes individual's perception and response towards their health condition.

Basic Types of Diseases

1. Infectious Diseases (Infections)

These are the communicable diseases (can spread from person to person or from the environment to person). Infectious diseases result

Infections can be localized (e.g., skin infection) and systemic (affecting multiple organs).

from harmful organisms (pathogens) entering the body. Common pathogens include viruses, bacteria, fungi, parasitic protozoans (e.g., *Plasmodium*) and worms (e.g., tapeworm). Infectious diseases spread from person to person, through contaminated food, water, or bug bites. Examples include:

- **Viral Infections:** Hepatitis, flu, dengue, measles, HIV, and COVID-19.
- **Bacterial Infections:** Typhoid, strep throat, cholera, tuberculosis.
- **Fungal Infections:** Candidiasis (yeast infection).
- **Infections by Parasitic Protozoan:** Malaria, Amoebiasis.
- **Infections by Parasitic Worms:** Roundworm, tapeworm infections.

Overuse of antibiotics by people has caused resistance in many bacteria. It is a major health risk.

2. Non-Infectious Diseases

These are non-communicable diseases (do not transmit from one person to others). Such diseases result from heredity, unhealthy lifestyles, environmental factors, aging etc. Examples include:

Diabetes and cancers are not solely due to lifestyle choices. These diseases also have genetic basis. Lifestyle choices can however, delay the onset of such diseases.

- Many non-infectious diseases develop due to unhealthy lifestyle. These include heart diseases, hypertension, diabetes, cancer, and stroke. Mental health diseases like depression are also included in this category.

- Genetic diseases are caused by abnormalities in genes or chromosomes. Examples include haemophilia, thalassemia, and muscular dystrophy.
- Some non-infectious diseases result from the gradual decline of body organs or tissues due to aging or other factors. Examples include Alzheimer's disease, Parkinson's disease, and arthritis.

Other Types of Diseases

1. Zoonotic Diseases

An infectious disease that is naturally transmitted from animals to humans is called zoonotic disease. Zoonotic pathogens may be bacteria, virus or other parasites. Humans can get zoonotic pathogens through direct contact with animals or through food, water or the environment. Examples of zoonosis include:

Some diseases, such as AIDS, began as a zoonosis but later became human-only diseases.

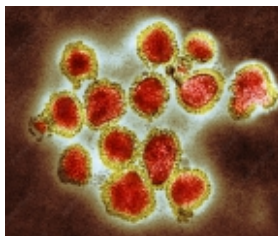
a- Anthrax: It is caused by the bacterium *Bacillus anthracis*. The infection site may be skin, lungs or digestive system. Anthrax is transmitted to humans through contact with contaminated animal products (e.g., hides, wool). Usually, anthrax bacteria enter the body through a wound in the skin, by eating contaminated meat or inhaling the spores of bacteria.

b- Bird Flu (Avian Influenza): It is caused by influenza A virus. The infection sites include nose, throat and lungs. Humans get bird flu through close contact with infected birds.

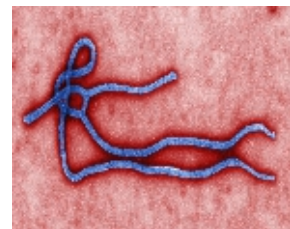
c- Ebola: It is caused by Ebola virus which targets sites in the body including liver, immune system, and blood vessels. The virus spreads through direct contact with body fluids, such as blood from infected humans or animals. It also spreads from contact with contaminated objects.



Bacillus anthracis



Influenza A virus



Ebola virus

FIGURE 9.1: Causative agents of Anthrax, Bird flu and Ebola

2. Vector-Borne Diseases

These are infections that are transmitted by vectors i.e., living organisms that carry pathogens from one host to another. These diseases can be caused by

bacteria, viruses or other parasites. Examples include:

1- Malaria: It is caused by a parasitic protozoan (*Plasmodium*). It primarily affects liver and then the RBCs. If untreated, it can lead to organ damage. It spreads from one human to other through *Anopheles* mosquito.



Anopheles mosquito

2. Dengue Fever: It is caused by Dengue virus that transmits through *Aedes* mosquito. Dengue fever affects multiple organs, including skin, blood vessels, and lymph nodes.



Aedes mosquito

3. Lyme Disease: It is caused by bacteria *Borrelia burgdorferi* which spread through ticks. The infection affects the skin, joints, and nervous system.



Ixodes ticks

4. Yellow Fever: It is an infection caused by yellow fever virus that spreads through *Aedes* or *Haemagogus* mosquitoes. The infection initially affects the liver, then involves the kidneys, heart, and nervous system.



Haemagogus mosquito

3- Allergies

An allergy is an abnormal immunological response of the body against a foreign substance that's typically not harmful to the body. Such foreign substances which cause allergies are called **allergens**. Common allergens include pollen, dust mites, certain foods, insect stings, and certain medicines.

FIGURE 9.2:
Some vectors that transmit diseases

The immune system's response to allergens involves the release of inflammatory chemicals such as **histamine**. It results in symptoms that affect the skin, respiratory system, digestive system, and cardiovascular system. The following are the major types of allergies.

Types of Allergies

1. Respiratory Allergies:

- **Allergic Rhinitis (Hay Fever)** - Caused by airborne allergens like pollen, dust mites etc. Symptoms include sneezing, itching, nasal congestion, and runny nose.

Anaphylactic shock is a severe, life-threatening allergic reaction. It can occur suddenly after exposure to an allergen such as certain foods, insect stings, or medicines. It causes difficulty in breathing and sudden drop in blood pressure. It requires immediate medical treatment.

- **Asthma** - A chronic condition where various allergens (ammonia, latex, pesticides, fumes, metal or wood dusts etc.) trigger inflammation and narrowing of the airways. It leads to wheezing, shortness of breath, chest tightness, and coughing.

2. Skin Allergies:

- **Eczema (Atopic Dermatitis)** – Chronic skin condition characterized by itchy, inflamed patches of skin. Several allergens can trigger eczema. For example, dust mites, pollen, pet skin flakes, mold spores, certain fabrics, metals etc.
- **Contact Dermatitis** – Skin reaction resulting from direct contact with allergens like nickel, latex, or certain plants. Symptoms include redness, itching, and blisters.

3. Food Allergies:

- **Common Food Allergies** – Range from mild (itching and swelling) to severe (difficult breathing, loss of consciousness etc.). Allergens may be peanuts, tree nuts, shellfish, fish, milk, eggs, soy, and wheat.

4. Insect Sting Allergies:

- **Venom Allergens** – Bee, wasp, and ant stings can trigger allergic reactions e.g., local pain and swelling, hives, and in severe cases, anaphylaxis.

5. Drug Allergies:

- **Common Drugs Allergies** – Range from mild rashes and itching to severe anaphylactic reactions. Allergens may be certain antibiotics, aspirin, and Non-Steroidal Anti-Inflammatory Drugs (NSAIDs).

9.2 PATHOGENS

A pathogen is a microorganism or agent that causes disease in its host. Pathogens include viruses, bacteria, fungi, and other parasites like plasmodium. Each type of pathogen interacts with the body in a unique way, leading to different types of diseases.

Pathogens can spread to humans through the five main ways i.e., air, food, water, person-to-person contact, and bites of animals. The following table lists the types of pathogens.

Table 9.1: Types of Pathogens

Type of Pathogen	Example	Disease Caused	Common Transmission Method
Virus	Influenza Virus	Influenza (Flu)	Airborne droplets Direct contact
	Human Immunodeficiency Virus (HIV)	AIDS	Sexual contact Blood transfusion Shared needles
	SARS-CoV-2	COVID-19	Airborne droplets Surface contact
Bacteria	<i>Streptococcus pyogenes</i>	Strep Throat	Respiratory droplets Direct contact
	<i>Mycobacterium tuberculosis</i>	Tuberculosis (TB)	Airborne droplets
	<i>Escherichia coli</i>	Food Poisoning	Contaminated food/ water
Fungi	<i>Candida albicans</i>	Candidiasis (Yeast Infection)	Fungal growth in warm, moist areas Direct contact
	<i>Tinea pedis</i>	Athlete's Foot	Contaminated surfaces
	<i>Aspergillus fumigatus</i>	Aspergillosis	Inhalation of fungal spores
Parasitic Protists	<i>Plasmodium falciparum</i>	Malaria	<i>Anopheles</i> mosquito
	<i>Giardia lamblia</i>	Giardiasis	Contaminated water Contaminated food
	<i>Entamoeba histolytica</i>	Amoebiasis	Contaminated food/water

Note: Many invertebrates also live as pathogens. For example; tapeworm and roundworm are invertebrates that live in human intestine and cause infections.

9.3 IMMUNITY

Immunity is the ability of the body to defend itself against disease-causing organisms. The following are the types of immunity:

- 1- Innate Immunity:** This type of immunity is present in body by birth. It includes the first line of defence and second line of defence.
- 2- Acquired Immunity:** It is acquired during life time. It includes the third line of defence.

First Line of Defence

It is nonspecific defence against any pathogen, regardless of the pathogen's identity. It includes the skin and mucous membranes.

1. Skin serves as a physical barrier to pathogens. In addition, the oil and sweat glands present in skin inhibit the growth of many microbes.
2. Mucous membranes are epithelial tissues that protect the interior surfaces of the body e.g., respiratory and digestive systems, the urethra. Mucous membranes secrete mucus that traps pathogens.

Second Line of Defence

The second line is also a non-specific defence. It includes:

- 1- Killer cells of blood move through the bloodstream to detect and destroy pathogens. For example:

- **Macrophages** develop from monocytes (a type of WBCs). They ingest bacteria and kill them.
- **Neutrophils** are a type of WBCs. They do phagocytosis (engulfing the pathogen and killing it). They also release killing chemicals on pathogens. They also release network of fibres which bind with pathogens and kill them.



FIGURE 9.3: A macrophage attacking microbes

- **Natural killer cells** are a type of T-lymphocytes. They kill the body cells that are infected by pathogens. They also detect and kill cancer cells.
- 2- Protective proteins also provide non-specific defences. For example:
 - Special proteins form a ring-shaped structure that punctures the membranes of infected cells, causing the cells to die.
 - **Interferon** is another protective protein. It is released by cells infected with viruses. Interferon causes nearby cells to make a protein that helps them resist viral infection.
 - 3- **Inflammation:** Infected or injured cells release chemicals called **histamines** which cause local expansion of blood vessels. It results in heat, redness and swelling. This condition is called inflammation. This response is often strong enough to stop the spread of microbes.
 - 4- **Fever:** Fever is also a second line of defence. When macrophages attack

the pathogens, they release chemicals called **pyrogens** in blood. When pyrogens reach the brain, the temperature regulating part of the brain raises the body's temperature above the normal value of 37 °C (98.6 °F). It results in the rise in body temperature. The higher than normal body temperature is known as fever. It increases the activity of phagocytes and slows bacterial and viral growth.

Third Line of Defence

The third line of defence or **acquired immunity** is of two types:

1. In **active immunity**, a type of lymphocytes called B-cells prepare antibodies to kill the pathogen. It may be natural or artificial (vaccination):
2. In **passive immunity**, the individual is given antibodies to combat specific microbes. Passive immunity is short-lived.

Blood Clotting

Blood clotting, or coagulation, is a process that prevents excessive bleeding when a blood vessel is injured. The following are the main steps:

1. When a blood vessel is injured, the exposed collagen fibres activate the blood platelets. Activated platelets adhere to the collagen and the damaged walls of blood vessel. In this way, a temporary "platelet plug" is formed.
2. Platelets release special proteins called clotting factors which convert prothrombin (a plasma protein), into thrombin.
3. Thrombin converts fibrinogen, another plasma protein, into fibrin strands. Fibrin strands weave through the platelet plug, forming a blood clot.

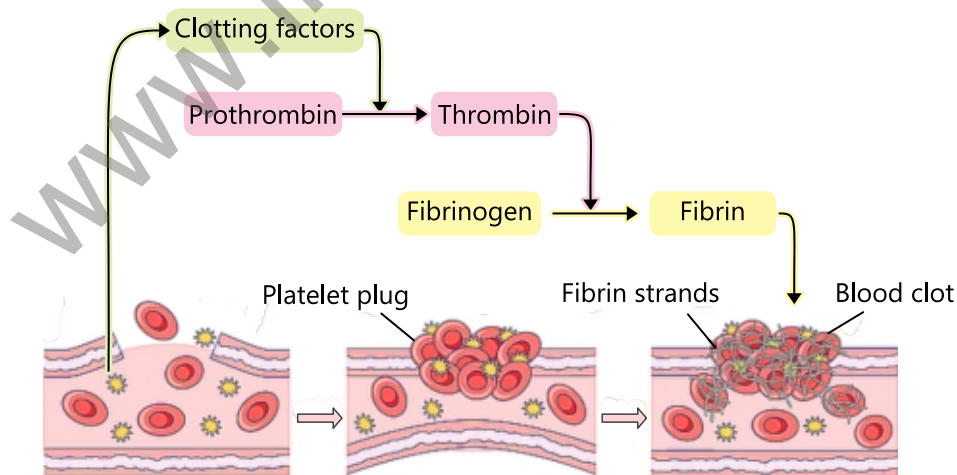


FIGURE 9.4: Formation of blood clot

4. Platelets within the clot contract and reduce the size of wound.
Once the vessel is repaired. A plasma protein breaks down the fibrin clot, dissolving the clot and restoring normal blood flow.



EXERCISE

A. Select the correct answers for the following questions.

- A doctor finds bacteria in a patient's blood sample. What type of disease is the patient suffering from?
 - Infectious disease
 - Non-infectious disease
 - Genetic disorder
 - Nutritional deficiency
- Which of the following is an example of an infectious disease?
 - Diabetes
 - Hypertension
 - Influenza
 - Osteoporosis
- A person develops rabies after being bitten by a dog. This is an example of:
 - Non-infectious disease
 - Food-borne illness
 - Zoonotic disease
 - Genetic disorder
- Which of the following is a vector-borne disease?
 - AIDS
 - Malaria
 - Tuberculosis
 - Diabetes
- A person develops dengue fever after a mosquito bite. In this case, the mosquito acts as:
 - Host
 - Pathogen
 - Vector
 - Reservoir
- Which of the following is the first line of defence against pathogens?
 - Antibodies
 - Skin and mucous membranes
 - T cells
 - B cells
- Skin is categorized as;
 - Non-specific defence
 - Specific defence
 - Acquired immunity
 - Passive Immunity

8. What triggers an allergic reaction?

- a) Pathogens
- b) Allergens
- c) Antigens
- d) Antibodies

B. Write short answers.

1. Define infectious diseases.
2. Define zoonotic diseases. Also give examples
3. Enlist allergies with some common types.
4. Differentiate between innate and acquired immunity.
5. Describe the role of skin as a component of defence system.
6. State the role of mucous membranes in defence.

C. Write answers in detail.

1. Describe infectious and non-infectious diseases and their types with examples.
2. Describe vector borne diseases with examples.
3. Describe the roles of T-cells and B-cells in immunity.
4. Write a note on blood clotting.

D. Inquisitive questions

1. Why do infectious diseases spread faster in crowded places?
2. How can genetics increase a person's risk of developing non-infectious diseases?
3. Why do some people develop allergies while others do not?