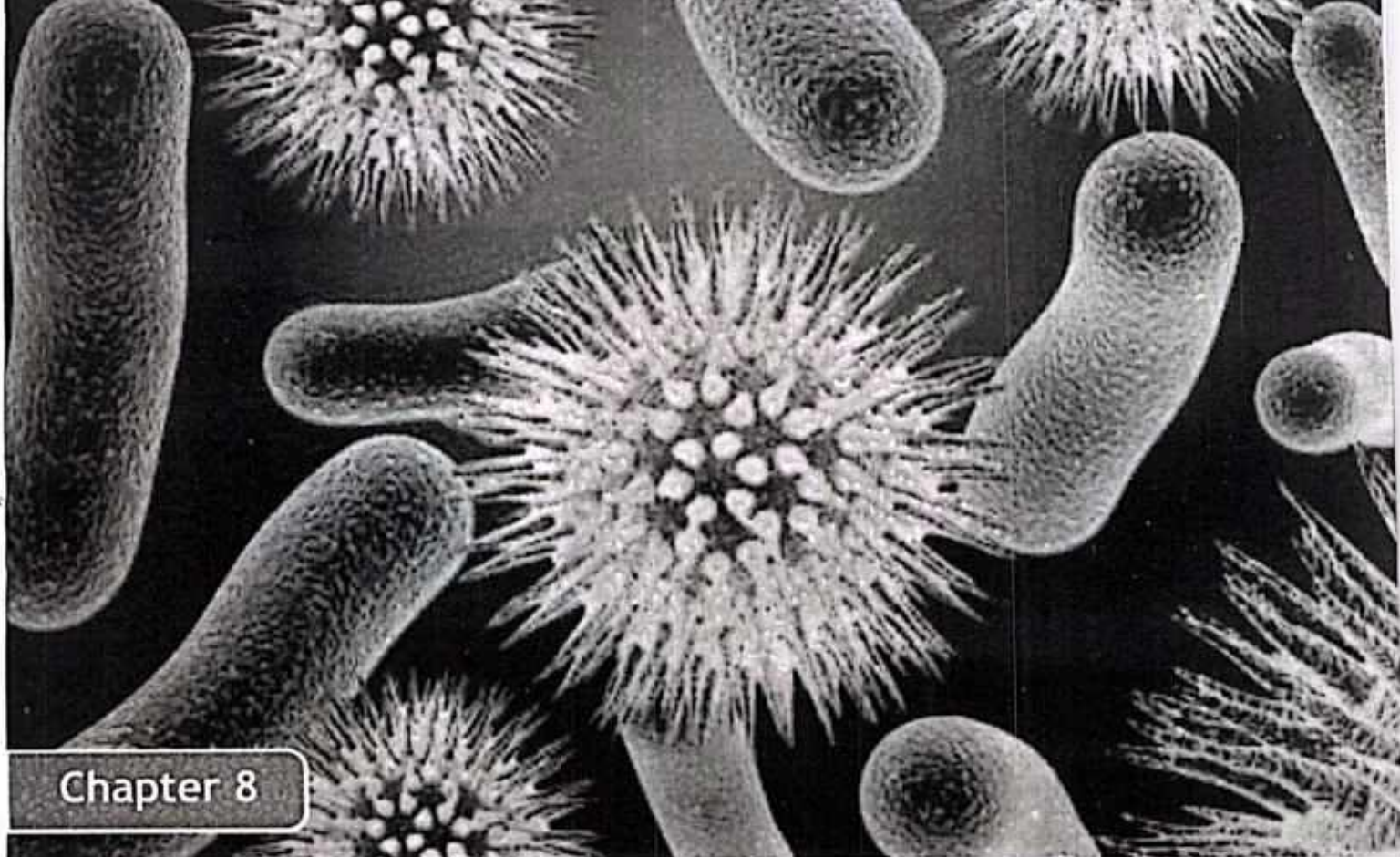




Chapter 8

DISEASES

SLOs: After completing this lesson, the student will be able to:

1. [B-10-1-01] Define disease, illness and infection and pathogen.
2. [B-10-1-02] List the 4 different types of pathogens (Viruses, Bacteria, Plasmodium, Fungi). and list their common diseases.
3. [B-10-1-03] Discuss antibiotics.
4. [B-10-1-04] Discuss the development of resistance in bacteria.
5. [B-10-1-10] Describe discovery of penicillin.
5. [B-10-1-11] Define Diabetes and its subtypes explain the effects on the human body.
6. [B-10-1-12] Discuss cancer and its effects on the human body.
7. [B-10-1-13] Narrate Covid 19 and list the harmful effects on the human body.
8. [B-10-1-14] Discuss that HIV compromises the Immune system and over times leads to development Acquired Immune Deficiency Syndrome (AIDS)
9. [B-10-1-15] Explain plant diseases commonly present in Pakistan, in terms of their effect on plant health and yield and their treatment. (Rust, smut, red rot of sugarcane)
10. [B-10-R-28] Describe infectious and non-infectious diseases and their types with examples
11. [B-10-R-29] Define zoonotic diseases and give their types.
12. [B-10-R-30] Describe vector borne diseases with examples

You are quite familiar with the name of the diseases like dengue, COVID-19, hepatitis B, and typhoid. Now, let us explore the topic of diseases.

8.1 DISEASES

A **disease** is a condition that affects the normal functioning of an organism, causing harm or discomfort. It can be caused by genetics, environment, lifestyle, or infection. A disease has a more objective, biological, or pathological basis. While often used interchangeably, "disease" and "illness" have distinct meanings. An illness is a person's subjective experience of feeling unwell. It may or may not be related to a specific disease. While disease focuses on the medical aspect, illness includes personal, social, and cultural factors.

According to duration, diseases are of two types:

1. **Acute Diseases:** Short-term diseases that resolve on their own or with treatment (e.g., pneumonia).
2. **Chronic Diseases:** Long-term diseases that persist or worsen over time (e.g., diabetes).

According to causes, diseases are either infectious or non-infectious.

8.2 INFECTIOUS DISEASES

Infectious diseases can spread from person to person or from animals to people. An infection occurs when a pathogen enters and multiplies inside a person's body, causing disease. A pathogen is an agent that causes disease or infection. Types of pathogens include viruses, bacteria, fungi, protozoans and parasitic worms.

They can spread in several different ways, through: skin contact, the transfer of bodily fluids, with faeces, ingesting contaminated food or water, inhaling airborne particles or droplets, touching an object that a person carrying the pathogen has also touched.

8.2.1 Types of Infectious Diseases

The types of infections are viral infection, bacterial infection, fungal infection, protozoan infection and parasitic infection.

Table 8.1: Types of pathogens, their description, examples and diseases

Pathogen	Description	Example	Disease
Bacteria 	Unicellular organisms without nucleus	<i>Salmonella typhi</i>	Typhoid
Viruses 	Non-living particles that reproduce by taking over living cells	<i>Coronavirus SARS-CoV-2</i>	COVID-19 disease
Fungi 	Simple organisms that grow as thread like filaments	Dermatophytes (skin fungi)	Ringworm
Protozoa 	Unicellular organisms, animal like Protista	<i>Plasmodium</i>	Malaria
Parasites 	Multicellular organisms that live as ectoparasites or endoparasites	<i>Ascaris</i>	Ascariasis

8.3 ZOONOTIC DISEASES

A zoonotic disease or zoonosis is an infectious disease that is directly transmitted from animal to humans, such as rabies and bird flu. Almost any animal can carry zoonotic disease e.g., mammals, birds etc.

Causes zoonotic diseases: Many different pathogens can cause zoonosis. These are viruses, bacteria, Parasites (protozoa and parasitic worms), fungi.

Symptoms of zoonotic diseases: Symptoms of zoonotic diseases vary depending on the specific illness. For example, symptoms of bird flu are fever, cough, tiredness, muscle aches, sore throat, shortness of breath, runny nose and headache.

8.3.1 Types of Zoonotic Diseases

Viral zoonoses: The examples of diseases caused by zoonotic viruses are rabies which can be transmitted from all mammals and bird flu which is transmitted from birds.

Bacterial zoonoses: Examples of bacterial zoonoses are anthrax which is transmitted from cattle and plague which is transmitted from rat fleas.

Fungal zoonoses: The example of zoonoses caused by fungus is ring worm which is transmitted from cats and cattle.

Protozoan zoonoses: Examples of protozoan zoonoses are African sleeping sickness which is transmitted from an African fly and beaver fever which is transmitted from beavers.

Parasitic worm zoonoses: Examples of parasitic worm zoonoses are snail fever which is transmitted from snails and tape worm which is transmitted from pig.

8.3.2 Transmission of Zoonotic Diseases

Zoonotic illness can spread through bites, scratches, inhalation, ingestion, or contact with contaminated animal waste or products.

Do you know?

Do you know that over 60% of human pathogens are zoonotic in origin?

8.4 VECTOR BORNE DISEASES

A vector is a living organism that transmits an infectious agent from an infected animal to a human or another animal. Vectors are common insects that carry and transmit diseases causing bacteria, viruses and parasite. The examples of vector are mosquitoes, ticks, flies, fleas and lice etc. Vectors may be biological vectors are mechanical vectors.

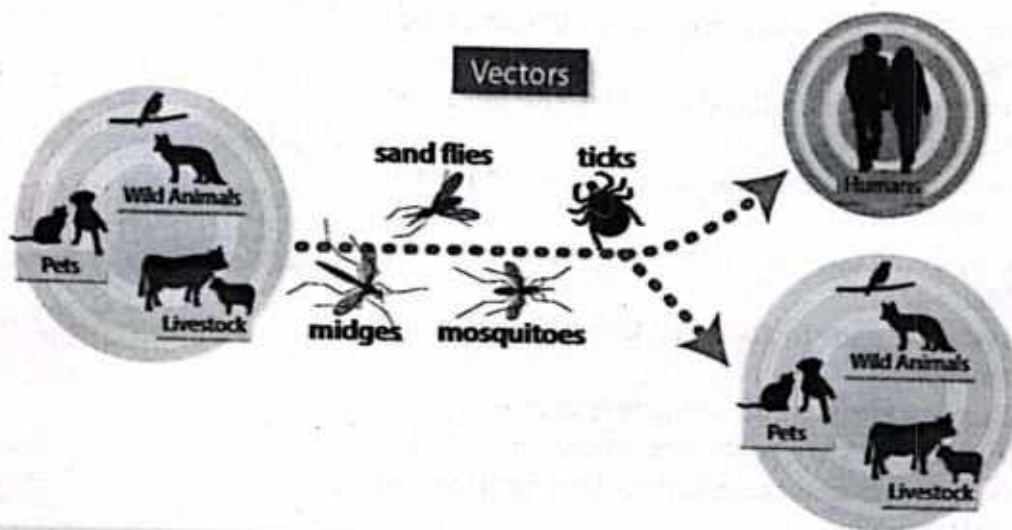


Fig. 8.1: Spread of Vector-borne diseases

- a. **Biting vectors:** The examples are mosquito, mite, flea and tick. They may carry pathogens that can multiply within their bodies and be delivered to new hosts, usually by biting.
- b. **Carrier vectors:** The example is flies that can pick up infectious agents on the outside of their bodies. Then they and transmit infectious agents through physical contact.
- Examples of vector-borne diseases include Dengue fever, Lyme disease, and malaria etc.
- Vector-Borne Diseases** are transmitted through vectors like insects. For example, malaria and dengue are spread by mosquitoes. A vector is an organism that acts as an intermediate host for a pathogen. Most importantly the vector transfers the pathogen from one host to the next host.

8.5 NON-INFECTIOUS DISEASES

Non-infectious diseases are not caused by pathogens and cannot spread from person to person. These include:

1. Physiological diseases (e.g., type 2 diabetes, cancer)
2. Genetic disorders (e.g., sickle cell anaemia, colour blindness)
3. Autoimmune diseases (e.g., type 1 diabetes, rheumatoid arthritis)
4. Nutritional deficiency diseases (e.g., scurvy, rickets)
5. Environmental diseases (e.g., lung cancer from smoking, skin cancer from UV rays)
6. Degenerative diseases (e.g., osteoarthritis, Alzheimer's disease)
7. Psychological disorders (e.g., anxiety disorders, depression)

8.6 COVID-19

You all are familiar with Covid-19. It was a global pandemic during 2020-2022. COVID-19 is caused by the coronavirus SARS-CoV-2. It is an acute disease. It affects the body in many ways:

1. **Respiratory System:** Causes breathing difficulties and pneumonia.
2. **Cardiovascular System:** Increases the risk of heart attacks and strokes.
3. **Nervous System:** Leads to headaches, fatigue, and loss of taste and smell.
4. **Digestive System:** Causes diarrhoea, nausea, vomiting and liver damage.
5. **Urinary system:** Leads to abnormal kidney function and kidney damage.
6. **Immune System:** Weakens the immune response.
7. **Mental Health:** Leads to anxiety, depression, and stress.
8. **Long-term Effects:** May cause lasting lung damage and other health problems.

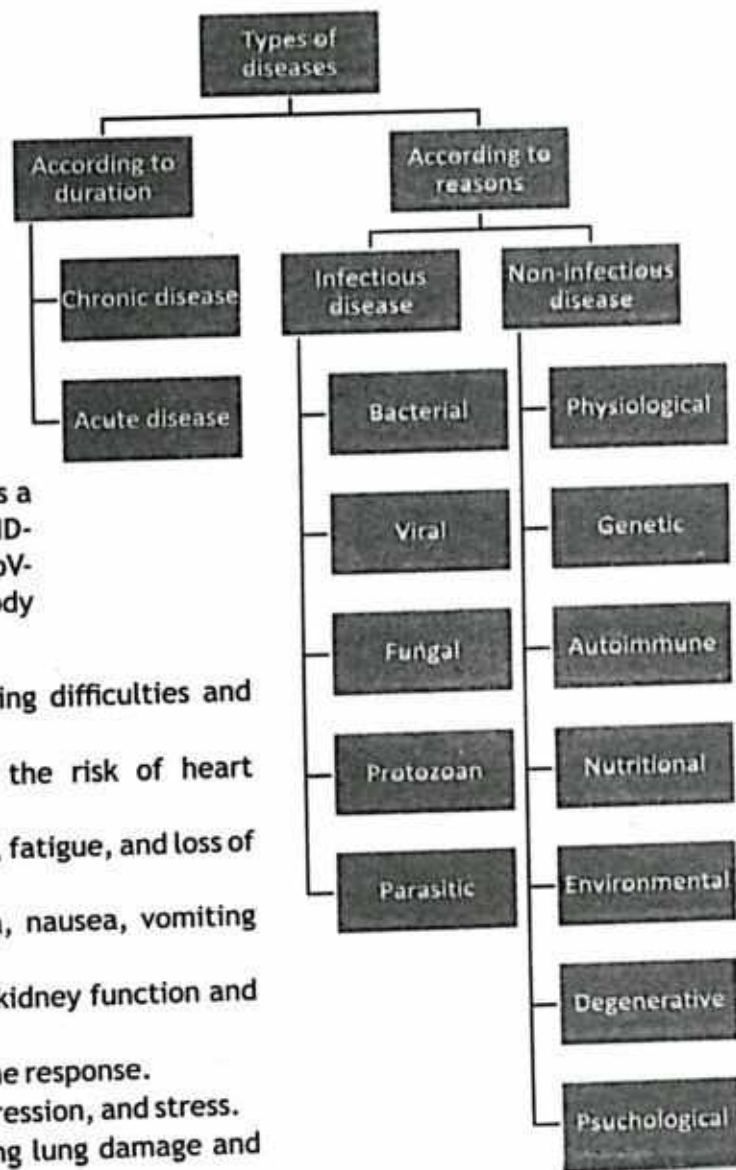


Fig. 8.2: Types of diseases

Prevention: COVID-19 can be prevented by following practices:

1. Washing hands frequently
2. Wearing masks
3. Social distancing
4. Staying home if symptomatic
5. Vaccination

Do you know?

COVID-19 has led to the rapid development of mRNA vaccines, a technology that could revolutionize vaccine production for other diseases!

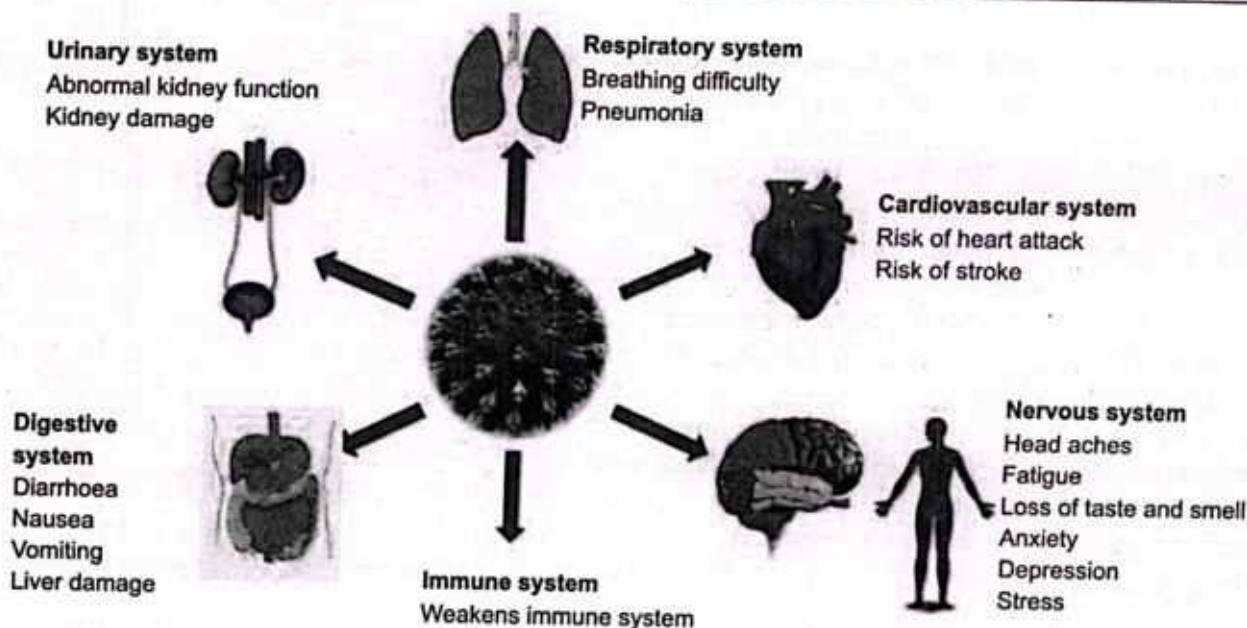


Fig. 8.3: COVID-19 effects on different body systems

8.7 AIDS

HIV (Human Immunodeficiency Virus) attacks the immune system, specifically helper T cells (CD4 T cells). It weakens the body's ability to fight infections. Without treatment, HIV can lead to AIDS (Acquired Immune Deficiency Syndrome) which is a chronic disease. The symptoms of AIDS include fever, headache, muscle aches, joint pain, swollen lymph nodes, diarrhoea, weight loss and severe immune dysfunction. In the final stages due to immune dysfunction lots of opportunistic infections attack the patient.

HIV is transmitted through patient's blood and body fluids. Infected needles, blood and instruments are mainly responsible for the spread of this disease. After infection there are four clinical stages showing the progression from HIV to AIDS. Stage 1 is without any symptoms and it lasts for few weeks. Stage 2 has mild symptoms and it can last up to 10 years. In stage 3 the immune system weakens and opportunistic infections start to appear.

Stage 1	Stage 2	Stage 3	Stage 4
Asymptomatic (No symptoms of HIV disease)	Mild symptoms	Advanced symptoms	Severe symptoms AIDS
Short, flu-like illness occurs 1-6 weeks after infection Infected person can infect other people	Average- 10 years Mild symptoms HIV in blood drops to very low levels Antibodies are detectable in the blood	The immune system deteriorates Opportunistic infections (OI) start to appear	Rapid decline in the number of CD4 ⁺ T cells Opportunistic infections become severe and cancer may develop

Fig. 8.4: Clinical stages showing the progression from HIV to AIDS

After that severe symptoms of AIDS start when infections become severe and cancer may develop. Infected persons of all stages can infect other people. Antiretroviral therapy (ART) can manage HIV and prevent AIDS progression. Early detection and treatment are crucial.

8.8 DIABETES

Diabetes is a group of metabolic disorders characterized by high blood sugar levels. It is a chronic disease. Its main types include:

1. **Type 1 Diabetes (T1D):** It is a chronic disease. An autoimmune disease destroying insulin-producing cells in the pancreas. It can be treated by taking regular injections of insulin.
2. **Type 2 Diabetes (T2D):** It is a chronic disease. A metabolic disorder from insulin resistance and impaired insulin secretion.
3. **Gestational Diabetes (GDM):** Develops during pregnancy. Most cases of gestational diabetes will reverse shortly after delivery. Proper management includes medication, diet, and lifestyle changes.

Effects of unmanaged diabetes include:

1. **Short-term effects:** Increased thirst, urination, fatigue, blurred vision, slow-healing wounds.
2. **Long-term effects:** Heart diseases, high blood pressure, irregular heartbeat, kidney damage, nerve damage, retina damage, high cholesterol level, high lipid level, high uric acid level, high risk of COVID-19, ketoacidosis, foot ulcers and memory loss.

Do you know?

The Berlin Patient is the only person in the world to have been cured of HIV after receiving a bone marrow transplant!



Fig. 8.5: Key steps for Type 2 Diabetes prevention and management

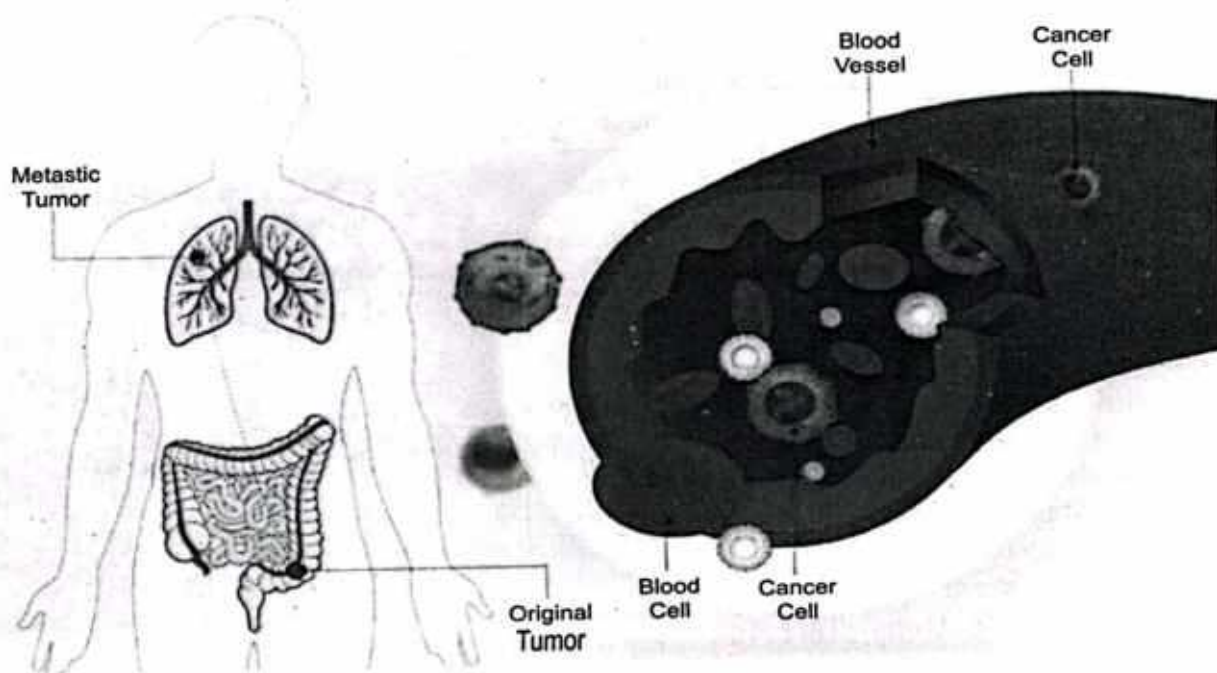


Fig. 8.6: Spread of cancer in the body

8.9 PLANT DISEASES IN PAKISTAN

Pakistan is an agricultural country. Crops and their yields are the back bone of our economy. Some common plant diseases caused by fungi in Pakistan are following.

Rust: Wheat leaf rust is a fungal disease caused by *Puccinia* rust fungus. It infects plants such as wheat, barley, rye. It gets transmitted from one plant to another through spores or air. Rust infections can lead up to 20% yield loss.

Smut: Smut is also a fungus that affects wheat crops and some grasses. Smut gets its name from the sooty, black appearance of infected wheat plants. The fungus produces spores in the leaves, grains or ears. These fungi are damaging pathogens of cereal crops, reducing yield and quality of harvested grain. It is caused by fungi *Ustilago tritici*.

Red rot of Sugarcane: Red rot is a very serious disease of sugarcane. The main symptom of the disease is the reddening of the internal tissues and reduced sugar content. It is caused by fungi *Colletotrichum falcatum*.

Effective disease management includes resistant varieties, crop rotation, and fungicides, along with proper diagnosis and monitoring.

Do you know?

Plants can get sick too, just like humans! Some plant diseases have been around for centuries.

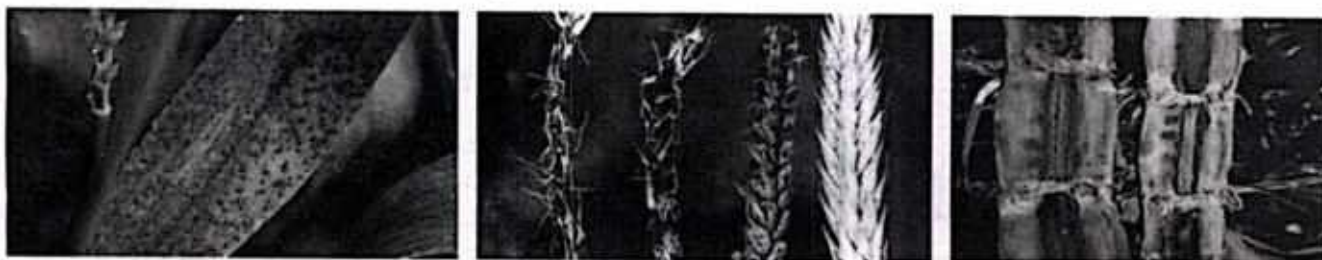


Fig. 8.7: Fungal plant diseases in Pakistan a. Rust on wheat leaves b. Smut on wheat kernels c. Red rot in sugarcane

8.10 ANTIBIOTICS

Antibiotics are chemicals produced by microorganisms which are capable of destroying or inhibiting the growth of another microorganism. The microorganisms that produce antibiotics are mostly bacteria and a few fungi. Now synthetic antibiotics are also available. Antibiotics are effective against bacterial infections but are of no use against viruses.

8.10.1 Discovery of Penicillin

The discovery of penicillin is attributed to Alexander Fleming in 1928. He was studying bacteria in his lab. He left a dish with bacteria uncovered. When he returned to his laboratory after a holiday, he noticed a mold, *Penicillium notatum*, growing on that bacterial culture. To his surprise, the mold killed the bacteria around it. He realized the mold was producing a special substance that could kill a wide range of harmful bacteria. He isolated the substance and named it penicillin.

Fleming thought penicillin could be used to treat bacterial infections, but he needed help to develop it. He worked with two other scientists, Florey and Chain, to purify and mass-produce penicillin.



Fig. 8.8: Alexander Fleming

Finally, penicillin was ready to use, and it revolutionized the treatment of bacterial infections. It saved many lives and became a widely used medicine. In short, Fleming's discovery of penicillin was an accident that led to a breakthrough in medicine. It has been estimated that Penicillin has saved over 500 million lives.

Penicillin was the first successful antibiotic used in medicine. From 1940s to 1960s it was widely used throughout the world against bacterial infections. But afterwards many bacteria get resistant against penicillin. Penicillin is still used to treat some bacterial infections.

8.10.2 Sources of Antibiotics

Antibiotics are derived from various natural sources, including:

1. **Bacteria:** Many antibiotics are produced by bacteria, e.g., streptomycin, tetracycline and erythromycin.
2. **Fungi:** Fungi like *Penicillium* (penicillin) and *Cephalosporium* (cephalosporins) produce antibiotics.
3. **Plants:** Some plants produce antibiotics e.g., garlic.
4. **Animals:** Some animals, like frogs and insects, produce antibiotics as a defense mechanism.

8.10.3 Mode of Action of Antibiotics

Antibiotics work by targeting specific biochemical processes in bacteria, ultimately leading to their death or inhibition of growth by inhibiting cell wall synthesis, protein synthesis, DNA, replication and metabolism.

1. **Cell Wall Inhibition:** Antibiotics like penicillins and cephalosporins inhibit the synthesis of the bacterial cell wall, causing it to weaken and eventually burst.
2. **Protein Synthesis Inhibition:** Antibiotics like tetracyclines and erythromycin bind to the bacterial ribosome, preventing protein synthesis and essential cellular functions.
3. **DNA Replication Inhibition:** Antibiotics like gentamicin bind to the bacterial DNA, inhibiting replication and repair.
4. **Membrane Disruption:** Antibiotics like polymyxins interact with the bacterial cell membrane, disrupting its structure and function.
5. **Metabolic Inhibition:** Antibiotics like sulfonamides inhibit specific metabolic pathways, depriving bacteria of essential nutrients.

By targeting these critical processes, antibiotics effectively prevent bacterial growth and proliferation, helping to clear infections.

8.10.4 Antibiotics Classification

Antibiotics that inhibit bacterial growth are called **bacteriostatic** and those that kill bacteria are **bactericidal**. The antibiotics that act against limited variety of bacteria are called **narrow spectrum antibiotics** e.g., penicillin. The antibiotics that act against a wide range of bacteria are called **broad spectrum antibiotics** e.g., tetracyclines. Some major groups of antibiotics are: sulphonamides, tetracycline and cephalosporin.

8.10.5 Antibiotic Resistance

Antibiotics are essential in medicine, but their overuse and misuse have contributed to antibiotic resistance. Antibiotic resistance in bacteria refers to the ability of bacteria to survive and grow in the presence of antibiotics, which are designed to kill or inhibit their growth. This occurs when bacteria develop mechanisms to avoid the effects of antibiotics, making these life-saving drugs less effective. It leads to untreatable infections that result in increased mortality. Resistant infections require longer treatment, increasing healthcare costs and make certain medical procedures risky. For example, drug resistant typhoid, drug resistant TB etc.

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The development of resistance in bacteria is a natural process that occurs through various

For your information

Mechanisms of resistance

Antibiotic resistant bacteria utilize following mechanisms:

1. **Enzyme production:** Bacteria produce enzymes that degrade antibiotics.
2. **Altered target site:** Bacteria modify their target sites, making antibiotics less effective.
3. **Active outflow:** Bacteria pump antibiotics out of their cells.
4. **Biofilm formation:** Bacteria form protective biofilms, reducing antibiotic effectiveness.

Factors contributing to resistance

There are many factors which are responsible for increasing antibiotics resistance in pathogenic bacteria. These include excessive use of antibiotics for humans, agricultural use in animal feed and lack of new antibiotic development.

Prevention

To combat resistance, it's essential to:

1. **Use antibiotics judiciously:** Only use antibiotics when necessary.
2. **Develop new antibiotics:** Invest in research and development.
3. **Improve infection control:** Enhance sterilization and hygiene practices.
4. **Monitor and track resistance:** Surveillance and data collection to inform strategies.

SUMMARY

1. A disease is a condition that affects the normal functioning of an organism, causing harm or discomfort.
2. An illness is a person's subjective experience of feeling unwell or sick.
3. Infectious diseases are illnesses caused by pathogens that get into body. The most common causes are viruses, bacteria, fungi and parasites. Infectious diseases usually spread from person to person, through contaminated food or water and through bug bites.
4. Zoonotic diseases are infections that are spread between people and animals. These infections are caused by germs, such as viruses, bacteria, parasites, and fungi.
5. Vector may be any organism (vertebrate or invertebrate) that functions as a carrier of an infectious agent between organisms of a different species.
6. Vector-borne diseases are infectious diseases caused by parasites, bacteria, or viruses such as malaria, dengue.
7. Non-infectious diseases include all diseases that are not caused by pathogens.
8. COVID-19 is a disease caused by a coronavirus that affects the human body in many ways.
9. HIV (Human Immunodeficiency Virus) attacks and compromises the immune system,

- specifically targeting helper T cells, which are crucial for fighting off infections and diseases.
10. Diabetes is a group of metabolic disorders characterized by high blood sugar levels, which can lead to a variety of complications if left unmanaged.
 11. Cancer is a group of diseases that can affect any part of the body and can lead to death. Cancer is caused by the rapid creation of abnormal cells that grow and spread to other organs.
 12. Some common plant diseases caused by fungi in Pakistan are rust, smut and red rot of sugar cane.
 13. Alexander Fleming in 1928 discovered penicillin accidentally.
 14. Antibiotics are chemicals produced by microorganisms which are capable of destroying or inhibiting the growth of another microorganism. The microorganisms that produce antibiotics are mostly bacteria and a few fungi.
 15. When bacteria are exposed to the same antibiotic for a long time, they acquire resistance against that antibiotic. Antibiotic resistance is accelerated by the misuse and overuse of antibiotics.

EXERCISE

Section I: Multiple Choice Questions

Select the correct answer:

1. What the patient feels when he goes to the doctor is:
 A) disease B) illness C) acute infection D) diagnosis
2. Bone fracture is a/an:
 A) acute disease B) chronic disease C) infectious disease D) zoonotic disease
3. Virus and bacteria are examples of:
 A) vectors B) pathogens C) disease D) illness
4. Mosquito is the deadliest animals on earth because:
 A) it has poison glands B) it can cause infection
 C) it can spread pathogens D) it sucks blood
5. The non-infectious diseases that run in the family are:
 A) physiological disorders B) genetic disorders
 C) autoimmune disorders D) nutritional disorders
6. COVID-19 is a/an:
 A) acute bacterial infection B) chronic bacterial infection
 C) acute viral infection D) chronic viral infection
7. COVID-19 spread as global pandemic was reduced after:
 A) lockdowns B) social distancing C) sanitization D) vaccination

8. HIV positive person can stay up to 10 years in stage:

- A) 1 B) 2 C) 3 D) 4

9. According to the International Diabetes Federation, in 2022, 26.7% of adults in Pakistan are affected by diabetes. This number is alarmingly high and is also increasing with each passing year. We can:

- A) do nothing about it B) make prayers to stop it
C) make life style changes to prevent it D) use vaccination to cure it

10. The rapid creation of abnormal cells that grow beyond their usual boundaries and spread to other organs is due to:

- A) AIDS B) diabetes C) cancer D) COVID-19

11. Which of the following CORRECTLY matches the antibiotic with its source?

	Antibiotics	Source
A)	Streptomycin	Fungi
B)	Cephalosporin	Animal
C)	Penicillin	Plant
D)	Tetracycline	Bacteria

12. First antibiotic discovered by Alexander Fleming in 1928 was:

- A) Streptomycin B) Cephalosporin C) Penicillin D) Tetracycline

13. Drug resistant typhoid is lethal due to:

- A) highly toxic bacteria B) antibiotics resistance
C) severe complications D) allergic reactions

14. If all pathogenic bacteria develop antibiotic resistance then health issues will increase regarding:

- A) all infectious diseases B) non infectious diseases
C) viral diseases D) bacterial diseases

15. Membrane disruption antibiotics can be grouped as:

- A) bacteriostatic B) bactericidal C) pesticide D) antiviral

Section II: Short Answer Questions

- What are zoonotic diseases?
- Enlist types of pathogens with examples.
- What are different types of non-infectious diseases?
- What are the effects of diabetes on human body?
- What are different types of diabetes?
- How diabetes can be prevented and managed?
- How cancer develops and spreads in the body?
- How cancer can be treated?
- Which systems of the body are affected by COVID-19? 10. What are the clinical stages of AIDS?
- What are the sources of antibiotics?
- What are different ways in which antibiotics act on bacteria?

12. Which factors contribute to the resistance of antibiotics and how it can be prevented?
13. Write the differences between:
 - a. Disease and illness
 - b. Infectious and non-infectious diseases
 - c. Vector and pathogen
 - d. Acute and chronic diseases

Section III: Extensive Answer Questions

1. Describe infectious and non-infectious diseases and their types with examples.
2. Describe diabetes and its subtypes. Explain the effects of diabetes on the human body.
3. Discuss cancer and its effects on the human body.
4. Explain Covid-19 and its harmful effects on the human body.
5. Discuss that HIV compromises the Immune system and over times leads to development Acquired Immune Deficiency Syndrome (AIDS)
6. Explain plant diseases commonly present in Pakistan, in terms of their effect on plant health and yield and their treatment.
7. Narrate the discovery of first antibiotic.
8. Discuss antibiotics in detail.
9. Describe antibiotic resistance and its effects.