# Microorganisms

## Definition and Observation

Microorganisms, also known as microbes, are living organisms that are too small to be seen with the naked eye. They include bacteria, fungi, protozoa, and some algae. Some microbes, like the fungus growing on bread, can be seen with a magnifying glass, but most require a microscope for observation.

## Classification of Microorganisms

Microorganisms are classified into four major groups: bacteria, fungi, protozoa, and algae. Viruses are also microscopic but differ from other microorganisms as they reproduce only inside the cells of host organisms such as bacteria, plants, or animals.

## Examples and Importance

Common ailments like cold and flu are caused by viruses, while diseases like dysentery and malaria are caused by protozoa. Bacterial diseases include typhoid and tuberculosis. Microorganisms play significant roles in health, environment, and industry.

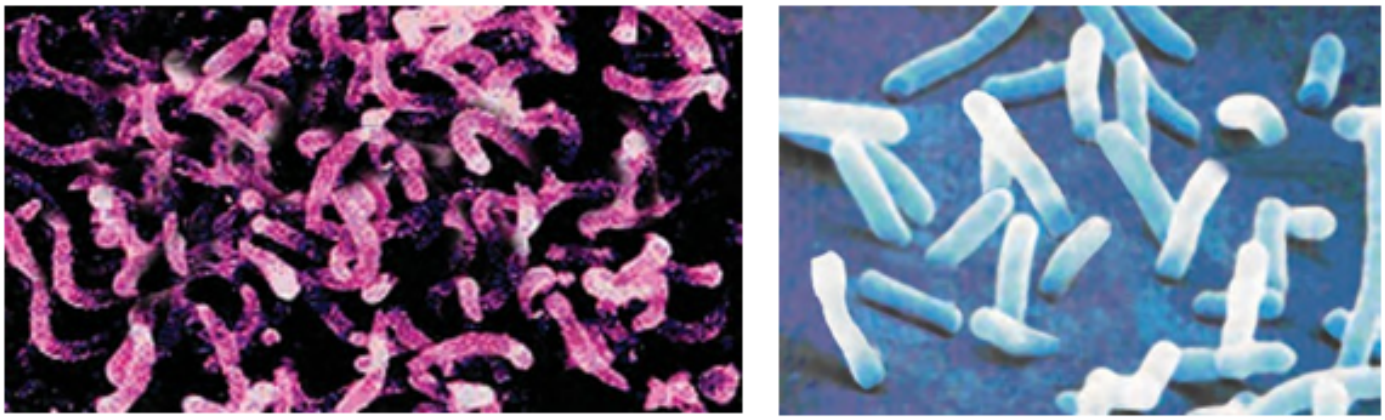

*Fig. 2.1: Bacteria*

Bacteria are tiny living organisms found everywhere. The left image shows curved Vibrio bacteria stained pink or purple, aiding movement in liquids. The right image shows rod-shaped Bacillus bacteria, found in soil and water, some used in antibiotic production.


**Fig. 2.2 : Algae**

Algae are simple plant-like organisms that perform photosynthesis. Chlamydomonas is a single-celled green alga with flagella for movement and an eyespot for sensing light. Spirogyra is a filamentous green alga with spiral chloroplasts inside its cells.

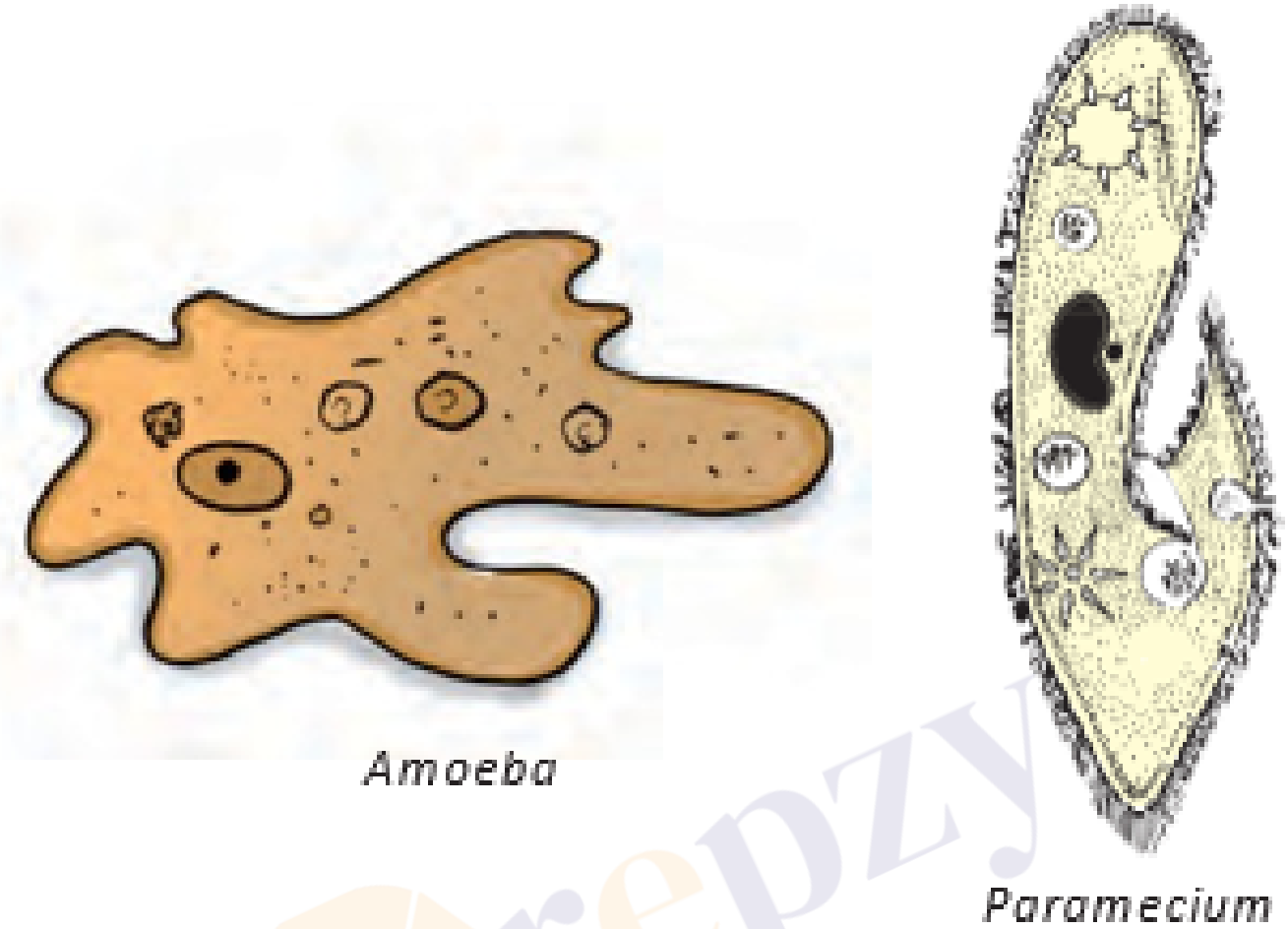


**Fig. 2.3 : Protozoa**

Protozoa are single-celled organisms. Amoeba moves using pseudopodia and engulfs food by phagocytosis. Paramecium moves using cilia and has a complex cell structure with macronucleus and micronuclei.

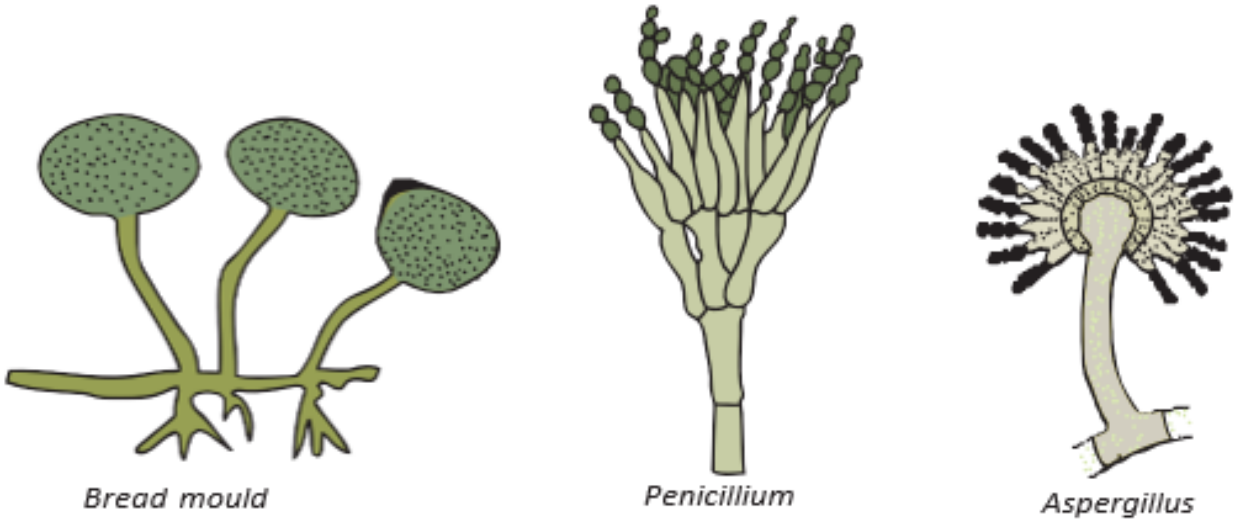


**Fig. 2.4 :** *Fungi*

Fungi include bread mould, Penicillium, and Aspergillus. They reproduce by spores and absorb nutrients from their surroundings. Penicillium is known for producing the antibiotic penicillin.

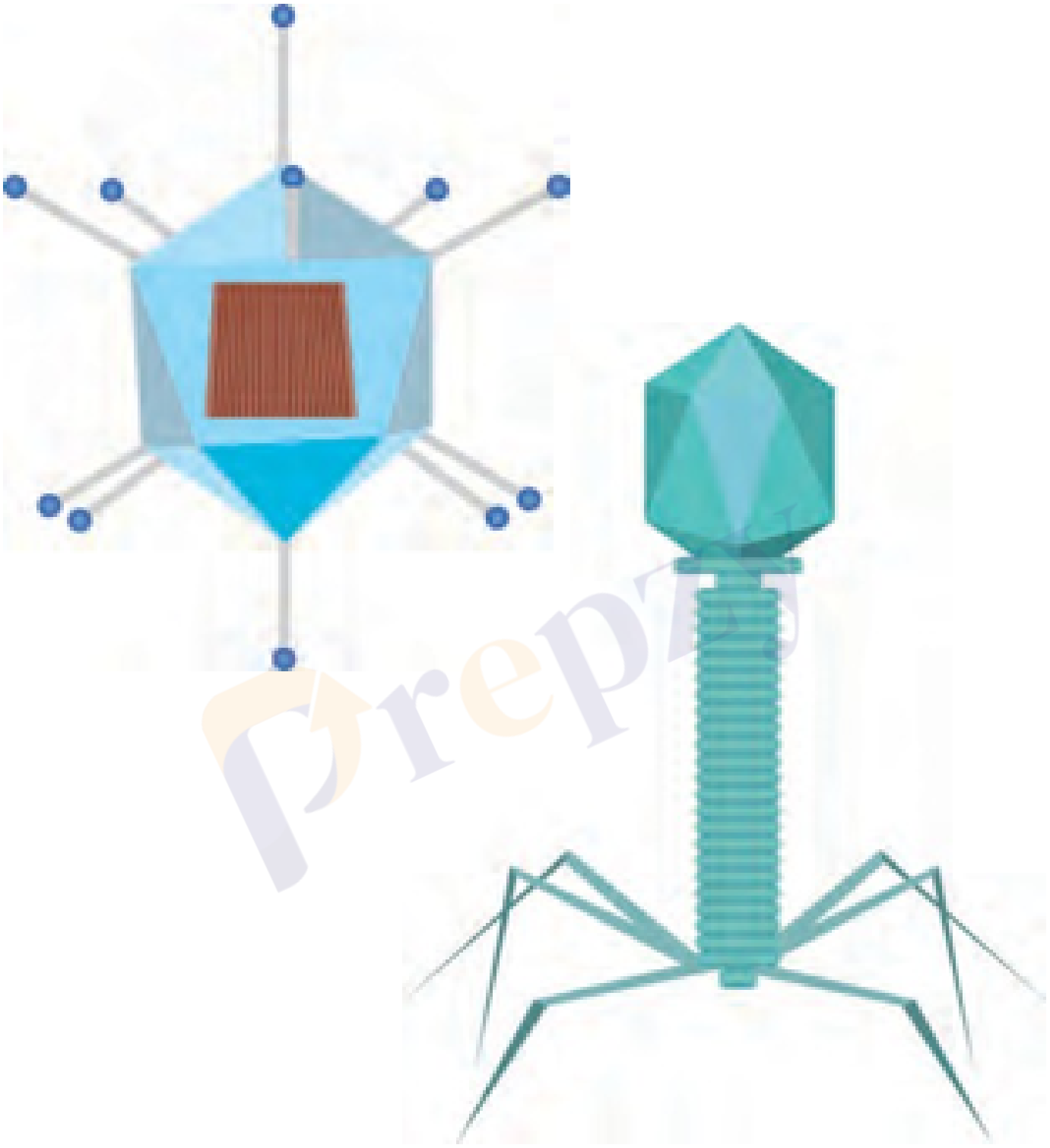

*Fig. 2.5 : Viruses*

Viruses are infectious agents composed of genetic material (DNA or RNA) enclosed in a protein coat called a capsid. The icosahedral virus has a 20-sided shape, while the bacteriophage has a complex structure with a head, neck, tail sheath, and tail fibers for infecting bacteria.

## Solved Examples

**Example 1:** Identify the type of microorganism responsible for causing malaria and explain its mode of transmission.

*Solution:* Malaria is caused by a protozoan parasite called *Plasmodium*. It is transmitted to humans through the bite of the female Anopheles mosquito, which acts as a carrier (vector) of the disease.

**Example 2:** Explain how yeast helps in the making of bread.

*Solution:* Yeast is a fungus that ferments sugars in the dough, producing carbon dioxide gas. The gas forms bubbles that get trapped in the dough, causing it to rise and become soft and fluffy. This process is called fermentation.

## Practice Set

- **Level 1 (Easy):** What are microorganisms? Name the four major groups of microorganisms.
- **Level 2 (Moderate):** Describe the role of bacteria in nitrogen fixation.
- **Level 3 (Challenging):** Explain the structure of a bacteriophage and its function in infecting bacteria.

## Answer Key

- **Level 1:** Microorganisms are tiny living organisms not visible to the naked eye. The four major groups are bacteria, fungi, protozoa, and algae.
- **Level 2:** Certain bacteria, such as Rhizobium, live in root nodules of leguminous plants and convert atmospheric nitrogen into ammonia, a form usable by plants. This process is called nitrogen fixation and increases soil fertility.

- **Level 3:** A bacteriophage has a head containing genetic material, a neck connecting the head to the tail sheath, a tail sheath that contracts to inject DNA into the host bacterium, and tail fibers that help attach to the bacterial surface. It infects bacteria by injecting its genetic material, taking over the bacterial machinery to reproduce.

# Microorganisms Living

## Habitats of Microorganisms

Microorganisms can be unicellular or multicellular and live in diverse environments including ice-cold climates, hot springs, deserts, marshy lands, and inside animals and humans. Some live freely, while others grow on other organisms.

## Role in Environment and Human Life

Microorganisms are involved in various processes such as decomposition, fermentation, and nitrogen fixation. They are used in food preparation like curd and bread, production of alcohol, and cleaning the environment by decomposing organic waste.

## Examples of Beneficial Microorganisms

Bacteria like Lactobacillus help in curd formation by converting milk into curd. Yeast is used in baking and alcohol production. Certain bacteria fix nitrogen in soil, enhancing fertility.

Maida with yeast powder

Raised maida

**Fig. 2.6**

Yeast mixed with flour ferments sugars producing carbon dioxide, causing the dough to rise. This process is essential in baking bread and other products.

## Solved Examples

**Example 1:** Describe the process of fermentation by yeast in bread making.

*Solution:* Yeast consumes sugars in the dough and produces carbon dioxide gas and alcohol. The gas forms bubbles that make the dough rise, resulting in soft bread.

**Example 2:** Explain how microorganisms help in cleaning the environment.

*Solution:* Microorganisms decompose dead plants and animals, breaking them down into simple substances that enrich the soil. This process helps in waste management and maintaining ecological balance.

## Practice Set

- **Level 1 (Easy):** Name two food products made using microorganisms.
- **Level 2 (Moderate):** How do microorganisms help in increasing soil fertility?
- **Level 3 (Challenging):** Explain the role of microorganisms in environmental cleaning.

## Answer Key

- **Level 1:** Curd and bread are made using microorganisms.
- **Level 2:** Certain bacteria fix atmospheric nitrogen into forms usable by plants, increasing soil fertility.
- **Level 3:** Microorganisms decompose organic waste, converting it into nutrients that enrich the soil and prevent accumulation of harmful substances.

## Harmful Microorganisms

### Pathogens and Diseases

Some microorganisms cause diseases in humans, animals, and plants. These disease-causing microbes are called pathogens. They spread through air, water, food, contact, or vectors like insects.

### Common Human Diseases

Diseases such as tuberculosis, measles, chicken pox, polio, cholera, typhoid, hepatitis A, and malaria are caused by bacteria, viruses, or protozoa. Preventive measures include

vaccination, hygiene, isolation, and vector control.

*Fig. 2.8 : Female Anopheles mosquito*

The female Anopheles mosquito transmits malaria by carrying the Plasmodium parasite. Preventing mosquito breeding and using mosquito nets help control malaria.

Table 2.1: Some Common Human Diseases caused by Microorganisms

| Human Disease | Causative Microorganism | Mode of Transmission | Preventive Measures (General) |
|---|---|---|---|
| Tuberculosis | Bacteria | Air | Keep the patient in complete isolation. Keep the personal belongings of the patient away from those of the others. Vaccination to be given at suitable age. |
| Measles | Virus | Air | |
| Chicken Pox | Virus | Air/Contact | |
| Polio | Virus | Air/Water | |
| Cholera | Bacteria | Water/Food | Maintain personal hygiene and good sanitary habits. Consume properly cooked food and boiled drinking water. Vaccination. |
| Typhoid | Bacteria | Water | |
| Hepatitis A | Virus | Water | Drink boiled drinking water. Vaccination. |
| Malaria | Protozoa | Mosquito | Use mosquito net and repellents. Spray insecticides and control breeding of mosquitoes by not allowing water to collect in the surroundings. |

Common human diseases caused by microorganisms include their causative agents, modes of transmission, and preventive measures as summarized in the table.

## Diseases in Animals and Plants

Microorganisms cause diseases like anthrax in animals and citrus canker, rust of wheat, and yellow vein mosaic in plants. These diseases reduce crop yield and can be controlled by chemicals.

Table 2.2: Some Common Plant Diseases caused by Microorganisms

| Plant Diseases | Micro-organism | Mode of Transmission |
|---|---|---|
| Citrus canker | Bacteria | Air |
| Rust of wheat | Fungi | Air, seeds |
| Yellow vein mosaic of *bhindi* (Okra) | Virus | Insect |

## Food Poisoning

Microorganisms growing on food can produce toxins causing food poisoning. Proper food preservation is essential to prevent spoilage and illness.

## Solved Examples

**Example 1:** How does the female Anopheles mosquito contribute to the spread of malaria?

*Solution:* The female Anopheles mosquito bites an infected person, picks up the Plasmodium parasite, and transmits it to healthy individuals through subsequent bites, spreading malaria.

**Example 2:** What are the common methods to prevent the spread of communicable diseases?

*Solution:* Methods include vaccination, maintaining hygiene, isolating infected individuals, using mosquito nets, and controlling vectors like mosquitoes and flies.

## Practice Set

- **Level 1 (Easy):** Define pathogens and give two examples of diseases caused by them.
- **Level 2 (Moderate):** Explain how mosquitoes act as carriers of diseases.
- **Level 3 (Challenging):** Describe the preventive measures to control plant diseases caused by microorganisms.

## Answer Key

- **Level 1:** Pathogens are disease-causing microorganisms. Examples: bacteria causing tuberculosis, viruses causing chicken pox.
- **Level 2:** Mosquitoes carry disease-causing parasites or viruses from infected to healthy individuals by biting, acting as vectors.
- **Level 3:** Preventive measures include using chemicals to kill microbes, removing infected plants, crop rotation, and maintaining field hygiene.

## Food Preservation

### Causes of Food Spoilage

Microorganisms grow on food, producing toxins and causing spoilage, which results in bad smell, taste, and color changes.

### Methods of Preservation

Chemical methods use preservatives like salt, sugar, sodium benzoate, and sodium metabisulphite to inhibit microbial growth. Heat treatment like boiling and pasteurization

kills microbes. Cold storage slows microbial growth. Proper storage and packing prevent contamination.

### Pasteurization

Pasteurization involves heating milk to about 70°C for 15-30 seconds and then cooling it rapidly to kill harmful microbes without affecting taste.

## Solved Examples

**Example 1:** Explain how salt preserves food.

*Solution:* Salt draws out moisture from food and microbes through osmosis, inhibiting their growth and preventing spoilage.

**Example 2:** What is the importance of pasteurization?

*Solution:* Pasteurization kills harmful microorganisms in milk, making it safe for consumption and extending shelf life.

## Practice Set

- **Level 1 (Easy):** Name two chemical preservatives used in food preservation.
- **Level 2 (Moderate):** How does refrigeration help in food preservation?
- **Level 3 (Challenging):** Describe the process and benefits of pasteurization.

## Answer Key

- **Level 1:** Sodium benzoate and sodium metabisulphite.
- **Level 2:** Refrigeration lowers temperature, slowing down microbial growth and enzyme activity, thus preserving food.
- **Level 3:** Pasteurization heats milk to about 70°C for a short time to kill harmful microbes without affecting taste, making milk safe and extending shelf life.

## Nitrogen Fixation

### Biological Nitrogen Fixation

Certain bacteria, such as Rhizobium, live in root nodules of leguminous plants and convert atmospheric nitrogen ($N_2$) into ammonia ($NH_3$), which plants can use for growth. This symbiotic relationship benefits both bacteria and plants.

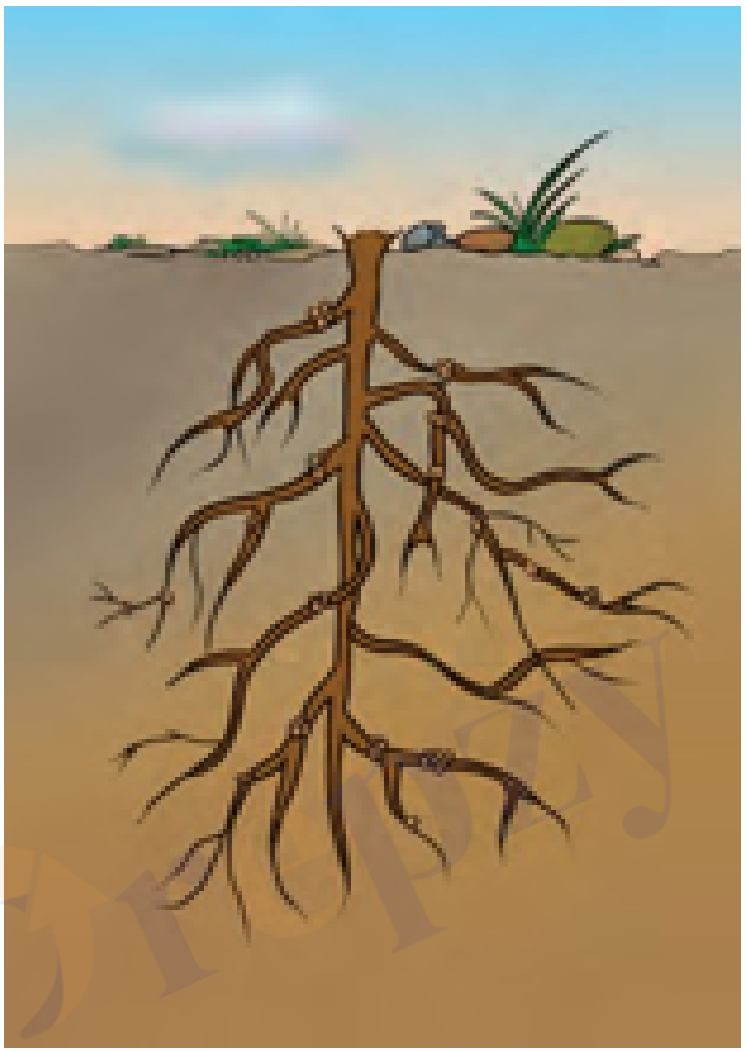

*Fig. 2.9 : Roots of a leguminous plant with root nodules*

## Nitrogen Cycle

The nitrogen cycle is the natural process of recycling nitrogen through the atmosphere, soil, plants, and animals. Nitrogen-fixing bacteria convert atmospheric nitrogen into usable forms. Plants absorb these compounds, animals consume plants, and decomposers return nitrogen to the soil. Denitrifying bacteria convert nitrogen compounds back to nitrogen gas, completing the cycle.

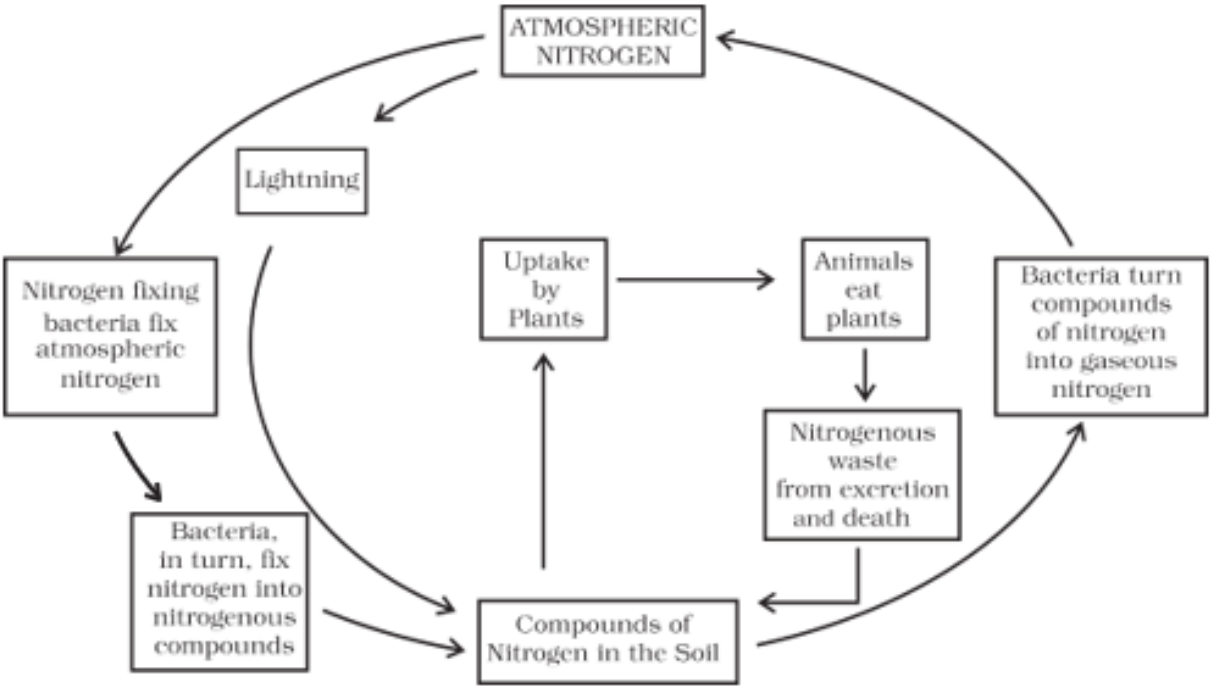


*Fig. 2.10 : Nitrogen cycle*

## Solved Examples

**Example 1:** What is the role of Rhizobium bacteria in nitrogen fixation?

*Solution:* Rhizobium bacteria live in root nodules of leguminous plants and convert atmospheric nitrogen into ammonia, providing nitrogen in a form plants can use.

**Example 2:** Explain the importance of the nitrogen cycle.

*Solution:* The nitrogen cycle recycles nitrogen, making it available to living organisms for protein and DNA synthesis, maintaining ecological balance.

## Practice Set

- **Level 1 (Easy):** What is nitrogen fixation?
- **Level 2 (Moderate):** Describe the symbiotic relationship between Rhizobium and leguminous plants.
- **Level 3 (Challenging):** Explain the steps involved in the nitrogen cycle.

## Answer Key

- **Level 1:** Nitrogen fixation is the process of converting atmospheric nitrogen into ammonia by certain bacteria.
- **Level 2:** Rhizobium bacteria live in root nodules, receive carbohydrates and protection from the plant, and provide usable nitrogen compounds in return.
- **Level 3:** Atmospheric nitrogen is fixed by bacteria and lightning, converted into nitrogenous compounds absorbed by plants, passed to animals, returned to soil by decomposers, and converted back to nitrogen gas by denitrifying bacteria.

## Quick Reference Table

## Common Mistakes and Misconceptions

## Glossary