2 Chapter

Microorganisms: Friend and Foe

We'll cover the following key points:

- Microorganisms
- Friendly Microorganisms
- Harmful Microorganism
- Food Preservation
- Nitrogen Fixation and its Cycle

Hi, I'm EeeBee

Do you Remember:

Fundamental concept in previous class.

In class 7th we learnt

- Replenishment of nutrients in the soil

Still curious? Talk to me by scanning the QR code.

Learning Outcomes

By the end of this chapter, students will be able to:

- Explore the amazing world of microorganisms, their unique traits, and diverse habitats.
- Identify microorganisms: bacteria, fungi, algae, protozoa, viruses; beneficial/harmful.
- Explore microorganisms' role in food, health, and environmental sustainability.
- Microorganisms: Nature's allies and adversaries, shaping ecosystems and health.

Guidelines for Teachers

The teacher can introduce this chapter by highlighting the characteristics, habitats, and ecological roles of microorganisms, offering students insights into the unique interactions between microorganisms and other living organisms. Through hands-on activities and engaging discussions, the teacher can encourage critical thinking and prompt students to consider the applications of microbiology in daily life. Additionally, the teacher can emphasize the importance of hygiene and sanitation, helping students make informed choices to prevent the spread of harmful microorganisms.

NCF Curricular Goals and Competencies

This chapter addresses the following curricular goals and competencies:

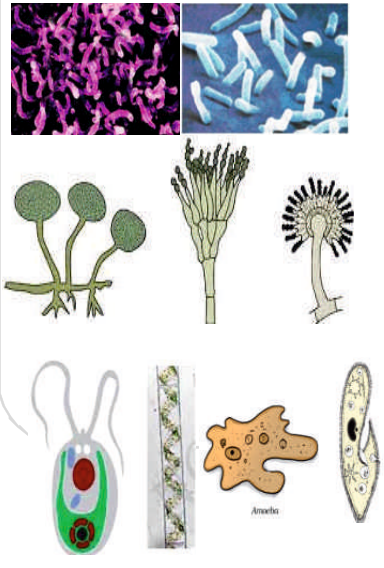
- CG-3 (C 3.1): Explores the living world around us and its interaction with the inanimate world from a scientific perspective.
- CG-6 (C 6.2): Engages with the nature and processes of science by exploring the evolution of scientific knowledge and conducting scientific inquiry.

MICROORGANISMS : FRIEND AND FOE

Mind Map

Microorganisms

Bacteria
Fungi
Protozoa
Algae



Microorganisms Live

They live in all types of environment, ranging from ice cold climate to hot springs; and deserts to marshy lands. They are also found inside the bodies of animals including humans.

Harmful Microorganisms

Disease causing Microorganisms

- In Humans
- In Animals
- In Plants

➢ Food Poisoning

Nitrogen Fixation

It is involved in the fixation of nitrogen in leguminous plants (pulses).

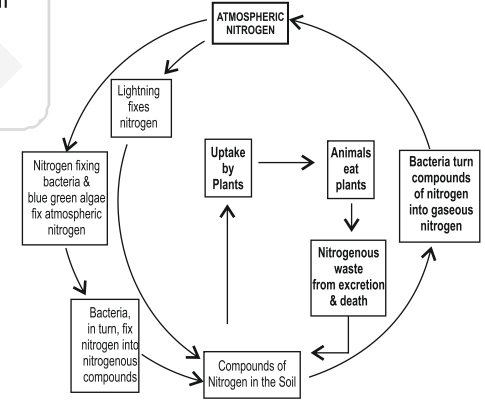
Friendly Microorganisms

- Making of Curd and Bread
- Commercial use of Microorganisms like production of alcohol, wine and a citric acid.
- Medicinal Use of Microorganisms
- Vaccine production
- Increasing Soil Fertility
- Cleaning the Environment

Food Preservation

- By Chemical Method
- Preservation by Common Salt
- Preservation by Sugar
- Preservation by Oil and Vinegar
- Heat and Cold Treatments
- Storage and Packing

Nitrogen cycle



Based on NCERT*

Microorganisms

One afternoon, Aarav feels hungry and grabs a piece of bread left on the kitchen counter. His mother Meera quickly intervenes.

Microorganisms, commonly known as microbes, are incredibly small living organisms, invisible to the naked eye and observable only with the aid of a microscope. They are found in every corner of the Earth, from deep ocean floors to high mountain peaks, and from frozen Arctic ice to scorching deserts. Microbiology, the scientific study of these microorganisms, has allowed us to understand the vast diversity, complexity, and impact that these tiny life forms have on human health, agriculture, and ecosystems.

Microorganisms can be classified into five major groups:

1. Bacteria
2. Fungi
3. Algae
4. Protozoa
5. Viruses

In History...

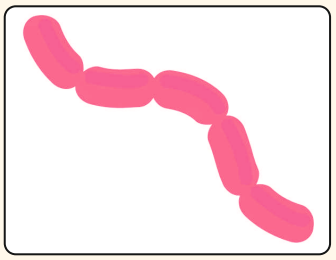
In the late 17th century, Dutch scientist **Antonie Van Leeuwenhoek** was the first to observe microorganisms through a microscope. He discovered "animalcules" (tiny living organisms) in water, dental plaque, and other substances, marking the beginning of microbiology.

However, in the late 19th century, **Louis Pasteur** and **Robert Koch** revolutionized the field by linking specific microorganisms to infectious diseases. Pasteur's work in pasteurization and vaccination demonstrated the power of microorganisms in fighting disease, marking them as "friends" when used in medical advancements.

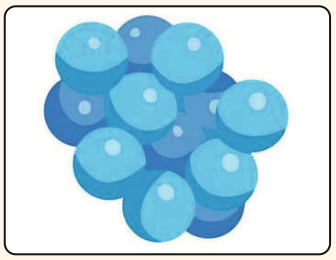
By the 20th century, the discovery of **antibiotics** like penicillin by **Alexander Fleming** proved that some microorganisms could indeed be lifesavers.

Bacteria

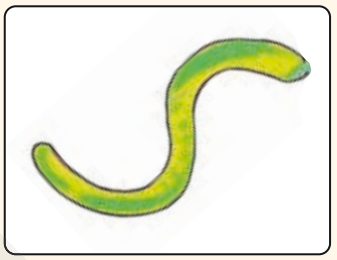
Bacteria are single-celled, or unicellular, organisms that are slightly larger than viruses and come in a range of shapes. They play diverse roles in ecosystems and human health. Bacteria are categorized into three main shapes:



Rod-shaped (Bacilli)



Spherical-shaped (Cocci)

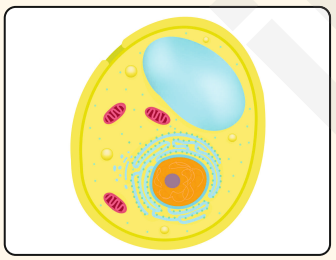


Spiral-shaped (Spirilla)

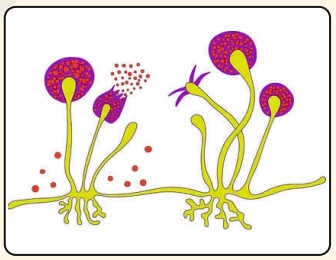
- **Rod-shaped (Bacilli):** These are elongated bacteria that resemble rods. An example is Lactobacillus, a bacterium used in the fermentation of milk to produce yogurt.
- **Spherical-shaped (Cocci):** These bacteria are round or spherical in shape. Streptococcus is an example, often associated with certain infections in humans.
- **Spiral-shaped (Spirilla):** These bacteria have a twisted, spiral shape. An example is Treponema, a bacterium linked to syphilis.

Fungi

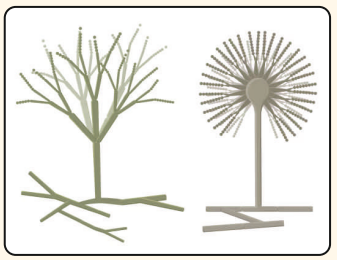
Fungi can be either unicellular (such as yeast) or multicellular (such as molds and mushrooms). Unlike plants, fungi do not perform photosynthesis; instead, they obtain nutrients by breaking down organic matter. They have a unique structure:



Yeast



Bread Mould

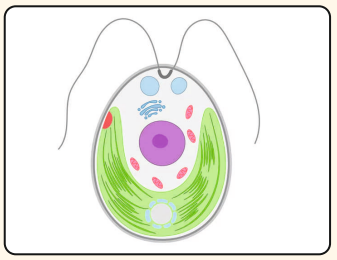


Penicillium and Aspergillus

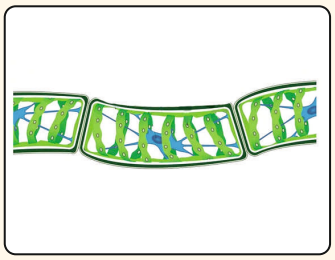
- **Yeast:** A single-celled fungus used in baking and brewing.
- **Bread Mould:** A multicellular fungus often found growing on stale bread.
- **Penicillium and Aspergillus:** Molds that can have both beneficial and harmful impacts; Penicillium produces the antibiotic penicillin, while Aspergillus includes species that can spoil food or cause infections.

Algae

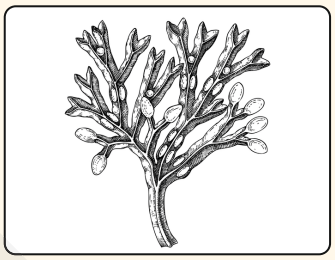
Algae are diverse organisms that can be either unicellular (like Chlamydomonas) or multicellular (like Spirogyra and Fucus). They contain chlorophyll, allowing them to perform photosynthesis, and are typically found in aquatic environments. Algae have the following characteristics:



Chlamydomonas



Spirogyra

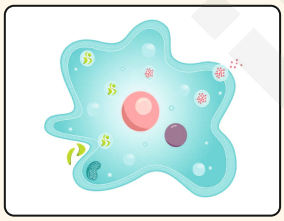


Fucus

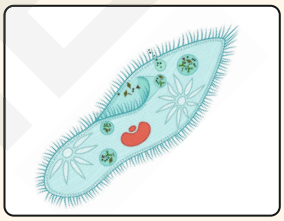
- **Chlamydomonas:** A single-celled green alga that moves with the help of flagella.
- **Spirogyra:** A filamentous green alga that forms long, thread-like strands.
- **Fucus:** A brown alga commonly found in marine environments

Protozoa (Singular: Protozoan)

Protozoa are a group of single-celled microorganisms found mostly in moist or aquatic environments. They exhibit a variety of shapes and structures, each adapted to their specific way of life. Protozoa can move using structures like cilia (tiny hair-like structures) or flagella (tail-like appendages), or by extending parts of their cell membrane to form temporary "feet," as in the case of Amoeba. While some protozoa capture and consume other small organisms or organic material for sustenance, others live as parasites, deriving nutrients from a host.

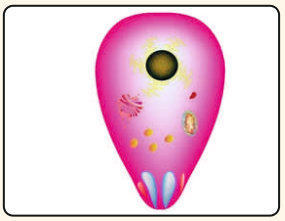


Amoeba



Paramecium

Trypanosoma

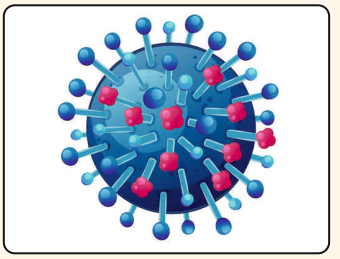


Plasmodium

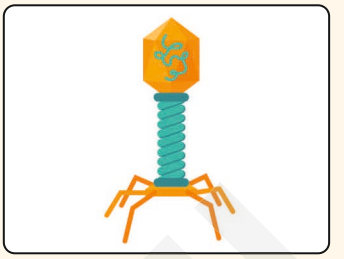
- **Amoeba:** Known for its irregular shape and ability to change form as it moves or engulfs food.
- **Paramecium:** Recognized for its elongated shape and covered with tiny hair-like cilia for movement.
- **Trypanosoma:** A parasitic protozoan responsible for causing African sleeping sickness, transmitted through tsetse flies.
- **Plasmodium:** A parasitic protozoan that causes malaria in humans, spread through the bite of infected Anopheles mosquitoes.

Viruses (Singular: Virus)

Viruses are tiny, non-living microorganisms that remain inactive outside a host. They rely entirely on a host cell to reproduce, lacking the ability to feed, grow, respire, or perform life processes on their own. Parasitic by nature, viruses inject their genetic material into host cells, hijacking them to produce more virus particles. Example of viruses given below:



Influenza Virus



Bacteriophage

- **Influenza Virus:** A virus that causes the flu in humans, leading to symptoms like fever, sore throat, and body aches.
- **Bacteriophage:** A type of virus that infects and replicates within bacteria, often used in research due to its unique structure and function.

Where Do Microorganisms Live?

Microorganisms are found everywhere in the air, water, soil, on living beings, and even on objects. They also thrive on dead matter, recycling nutrients back into the environment. Remarkably, they can survive extreme conditions, from icy climates and scorching springs to dry deserts and marshy areas, making them adaptable to nearly all environments on Earth.

Did you know

Microorganisms are the hidden superheroes of our planet!

Did you know that they help in making some of your favorite foods, like cheese, bread, and yogurt? Yeast, a tiny microorganism, makes bread rise by producing bubbles of carbon dioxide, while bacteria are responsible for the tangy taste of yogurt and cheese. But that's not all—they also clean up the environment by breaking down waste, fix nitrogen to help plants grow, and even produce half the oxygen we breathe! Without microorganisms, life as we know it wouldn't exist—they're everywhere, from deep oceans to your own body! In fact, your body has more microbial cells than human cells! Isn't that mind-blowing?

KEYWORDS

Genetic Material: The molecules, such as DNA or RNA, that carry hereditary information of an organism.

Host Cells: The living cells that provide an environment for the replication of viruses or other microorganisms.

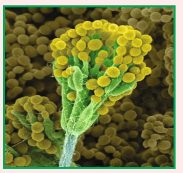
Let's recall what we know

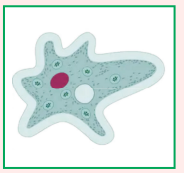
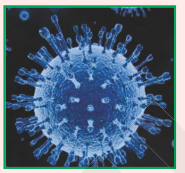
Apply Concept in Real-Life

Apply

Classify and Describe Microorganisms

Observe the images provided and identify each microorganism. Classify each one into the appropriate category from the five major groups: bacteria, fungi, algae, protozoa, and viruses. Write a detailed description of the characteristics of each group in your notebook.

Skills Practiced: Identification, Analytical and Logical Thinking, Application of Knowledge

Examine Further

Analyse

1. What are the potential consequences of nutrient pollution on aquatic ecosystems?
2. How can knowledge of pathogenic microorganisms help in detecting foodborne illnesses?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. Explain the role of bacteria and fungi in natural ecosystems.
2. Which microorganism is known as the smallest living organism on Earth?
3. Provide examples of multicellular algae.
4. What are the characteristics that distinguish bacteria from fungi?

Creative Task

Create

Perform this activity in your biology lab with your teacher's guidance.

1. Can air contain microorganisms?

   Perform the following activity to justify your answer.

   - Take a clean petri dish with agar, an inoculation loop, and a bell jar.
   - Expose the petri dish in an open area for a few hours.
   - After that, cover the dish and allow it to incubate for a few days.
   - Examine the dish for any microbial growth and observe under a microscope.
   - Write your observations and conclusions in your notebook.

Skills Practiced: Brainstorming, research, digital literacy, creativity

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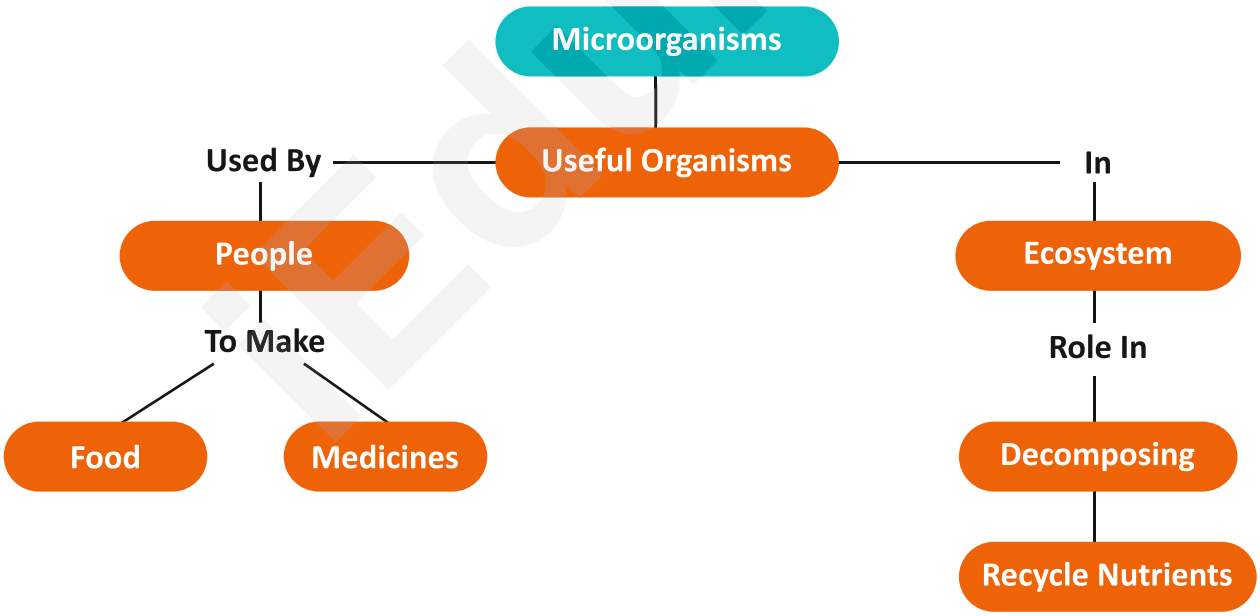
Take a Task

Watch Remedial

Bloom's Taxonomy

Friendly Microorganisms

Riya is curious about a poster in her classroom showing yogurt being made. She asks her teacher, Mr. Singh, about it.



Making of Curd and Bread

Curd Production

Microorganism Involved: Lactobacillus bacteria.

Process: Lactobacillus bacteria ferment lactose in milk into lactic acid, causing milk proteins to coagulate and form curd.

Bread Production

Microorganism Involved: Yeast (e.g., Saccharomyces cerevisiae).

Process: Yeast ferments sugars in the dough, releasing carbon dioxide, which makes the dough rise and bread soft and fluffy.

Commercial Use of Microorganisms

Food and Beverage Production

- Used for fermentation in the making of wine, beer, cheese, vinegar, and fermented foods like sauerkraut and kimchi.
- Yeast is essential in alcohol production and fermentation processes.

Biotechnology

- Microorganisms are used to produce enzymes, biofuels, antibiotics, vitamins, and other valuable chemicals.
- *Examples:* E. coli is used in gene cloning and production of recombinant proteins.

Waste Management

- Microorganisms break down organic waste in composting and biogas production, offering eco-friendly waste disposal solutions.

Medicinal Use of Microorganisms

Antibiotics Production

- Many antibiotics are derived from microorganisms.
- *Example:* Penicillium mold is the source of penicillin.
- Antibiotics are used to treat bacterial infections by killing or inhibiting bacterial growth.

Probiotics

- Beneficial bacteria used to restore gut health.
- Found in yogurt, fermented foods, and supplements.

Enzyme Production

- Microorganisms produce enzymes for medical use, such as in digestive enzyme therapy.

KEYWORDS

Digestive Enzyme Therapy: A treatment approach that uses specific enzymes to aid the breakdown and absorption of nutrients, addressing digestive disorders or enzyme deficiencies.

Vaccine Production

Microorganisms are used in creating vaccines by introducing weakened or inactivated pathogens into the body, which helps stimulate the immune system.

Example: Vaccines for diseases like polio, measles, and smallpox are produced using weakened forms of the virus.

Increasing Soil Fertility

- **Nitrogen Fixation** — Nitrogen-fixing bacteria like Rhizobium (found in root nodules of legumes) convert atmospheric nitrogen into ammonia, a form that plants can use.
- **Composting** — Microorganisms decompose organic matter in composting, turning waste into nutrient-rich humus that improves soil health.
- **Organic Fertilizers** — Microbes help break down organic material in manure and waste, turning them into nutrient-rich compost for crops.

Cleaning the Environment

- **Biodegradation** — Microorganisms decompose organic pollutants like oil spills, sewage, and toxins into harmless substances.
- **Bioremediation** — This process involves using microorganisms to clean up contaminated environments
- **Decomposition** — Microorganisms decompose dead plants and animals, recycling nutrients back into the ecosystem.

KEYWORDS

Immune system: The immune system is the body's defense network that protects against harmful invaders like bacteria, viruses, and other pathogens.

Activity

Take 1/2 kg flour (atta or maida), add some sugar and mix with warm water. Add a small amount of yeast powder and knead to make a soft dough. What do you observe after two hours? Did you find the dough rising?

Maida with yeast powder

Raised maida

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Let's recall what we know

Bloom's Taxonomy

Apply Concept in Real-Life Context

Apply

1. Identify some beverages or foods that rely on fermentation for their production, and describe the specific microorganisms responsible for each.
2. What are the by-products of fermentation, and how are they utilized in various industries?

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

1. Discuss the impact on community health if childhood vaccination rates drop significantly.
2. Explain why microorganisms in soil are essential for maintaining soil health and plant growth.

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. Outline the steps involved in the industrial production of yogurt.
2. Describe the role of bacteria in the production of antibiotics.
3. How do beneficial microorganisms help improve soil fertility?

Creative Task

Create

To understand the process of fermentation better, try the following activity:

1. Set up two beakers: one with a sugar solution and yeast, and another with only water and yeast.
2. Place both beakers in a warm environment and cover them.
3. After a few hours, compare the smells and appearances of the solutions in both beakers.

Record your observations and explain the differences between the two solutions in your notebook.

Skills Practiced: Brainstorming, research, digital literacy, creativity

Harmful Microorganism

Rahul and his brother, Mohit, are about to drink water from a roadside tap during a walk.

Disease causing Microorganisms in Humans

Pathogens enter our body through the air we breathe, the water we drink or the food we eat. They can also get transmitted by direct contact with an infected person or carried by an animal. Microbial diseases that can spread from an infected person to a healthy person through air, water, food or physical contact are called communicable diseases. Examples of such diseases include cholera, common cold, chicken pox and tuberculosis.

Female Anopheles mosquito

When a person suffering from common cold sneezes, fine droplets of moisture carrying thousands of viruses are spread in the air. The virus may enter the body of a healthy person while breathing and cause infection.

These are some insects and animals which act as carriers of disease-causing microbes. Housefly is one such carrier. The flies sit on the garbage and animal excreta. Pathogens stick to their bodies. When these flies sit on uncovered food they may transfer the pathogens. Whoever eats the contaminated food is likely to get sick. So, it is advisable to always keep food covered. Avoid consuming uncovered items of food. Another example of a carrier is the female Anopheles mosquito which carries the parasite of malaria (Plasmodium). Female of dengue mosquito acts as

KEYWORDS

Pathogens: Microorganisms , such as bacteria, viruses, or fungi, that cause disease in their hosts.

Parasite: An organism that lives on or inside another organism and benefits at the host's expense.

carrier of dengue virus. How can we control the spread of malaria or dengue?

All mosquitoes breed in water. Hence, one should not let water collect anywhere, in coolers, tyres, flower pot, etc. By keeping the surroundings clean and dry we can prevent mosquitoes from breeding. Try to make a list of measures which help to avoid the spread of malaria.

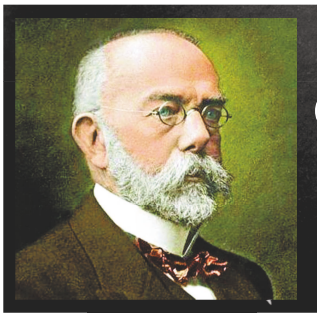
Some Common Human Diseases caused by Microorganisms

Human Disease	Causative Microorganism	Mode of Transmission	Preventive Measures (General)
Tuberculosis Measles Chicken Pox Polio	Bacteria Virus Virus Virus	Air Air Air/Contact Air/Water	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
Cholera Typhoid	Bacteria Bacteria	Water/Food Water	Maintain personal hygiene and good sanitary habits. Consume properly cooked food and boiled drinking water.
Hepatitis A	Virus	Water	Drink boiled drinking water. Vaccination
Malaria Dengue	Protozoa Virus	Mosquito Mosquito	Use mosquito net and repellents. Spray insecticides and control breeding of mosquitoes by not allowing water to collect in the surroundings.

Some of the common diseases affecting humans, their mode of transmission and few general methods of prevention are shown in table.

Disease causing Microorganisms in Animals

Several microorganisms not only cause diseases in humans and plants, but also in other animals. For example, anthrax is a dangerous human and cattle disease caused by a bacterium. Foot and mouth disease of cattle is caused by a virus.



Robert Koch. (1876) discovered the bacterium (Bacillus anthracis) which

Disease causing Microorganisms in plants

Several microorganisms cause diseases in plants like wheat, rice, potato. sugarcane, orange, apple and others. The diseases reduce the yield of crops. See above table for some such plant diseases. They can be controlled by the use of certain chemicals which kill the microbes.

Some Common Plant Diseases caused by Microorganisms

Plant Diseases	Microorganism	Mode of Transmission
Citrus canker	Bacteria	Air
Rust of wheat	Fungi	Air, seeds
Yellow vein Mosaic of bhindi (Okra)	Virus	Insect

Food Poisoning

Roby was invited by his friend to a party and he ate a variety of food stuff. On reaching home, he started vomiting and had to be taken to a hospital. The doctor said that this condition could be due to food poisoning.

Food poisoning could be due to the consumption of food spoilt by some microorganisms. Microorganisms that grow on our food sometimes produce toxic substances. These make the food poisonous causing serious illness and even death. So, it is very important that we preserve food to prevent it from being spoilt.

Let's recall what we know

Apply Concept in Real-Life Context

Apply

1. List two viral diseases and discuss how they spread. What preventive steps can individuals take to avoid contracting these diseases?
2. Why is personal and community hygiene crucial in preventing outbreaks of diseases like cholera and typhoid?

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

1. If someone you know plans to visit a region with a high risk of malaria, what precautions should they take to minimize their risk of infection?
2. What actions can you take to raise awareness and prevent the spread of contagious diseases within your local community or school?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. What steps should individuals take to protect themselves from waterborne diseases like cholera?
2. Identify common viral diseases that affect humans and describe their primary symptoms.
3. List diseases in animals caused by microorganisms, and explain how these diseases impact animal health and agriculture.

SCAN TO ACCESS

Take a Task

Watch Remedial

Bloom's Taxonomy

Creative Task

Create

Design an educational activity to demonstrate the impact of harmful microorganisms on health and hygiene.

Activity Instructions

1. Create two simulated "germ" environments using harmless substances like flour (to represent germs).
2. Divide students into two groups: one group should pretend they don't wash their hands after certain activities, while the other group practices proper hand hygiene.
3. Have the "non-washing" group touch various surfaces and items around the room, leaving traces of "germs."
4. Observe and discuss how the "germs" spread from one surface to another.

Reflect on the activity by discussing

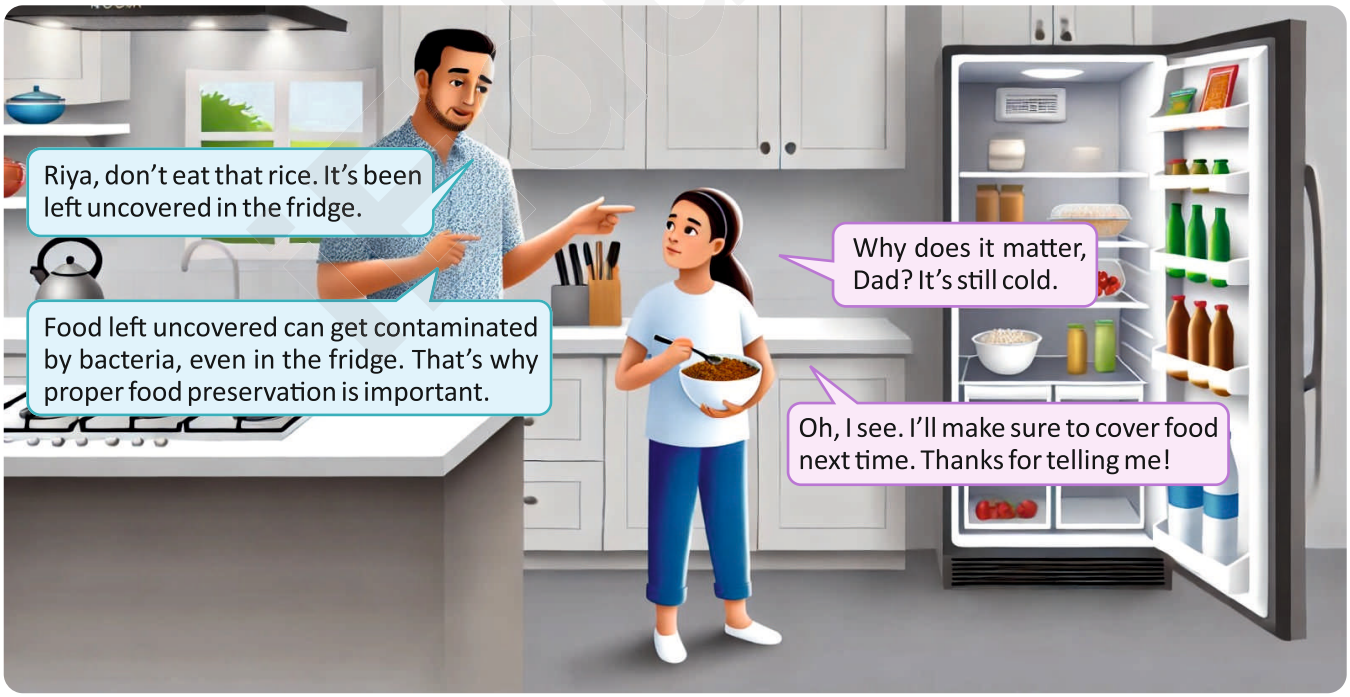
- How easily can harmful microorganisms spread?
- Why is proper hand hygiene essential in preventing the spread of infections?

Write your observations and conclusions in your notebook.

Skills Practiced: Brainstorming, research, digital literacy, creativity

Food Preservation

One evening, Riya opens the refrigerator and takes out a bowl of rice left uncovered. Her father, Raj, notices her.



Food Preservation: An Essential Practice for Health and Longevity

Food is an essential source of energy for all living organisms. However, when food is not stored properly, it can spoil or become contaminated with harmful microorganisms, leading to foodborne

illnesses commonly known as food poisoning. Food poisoning is a major cause of various diseases in humans, and it can have severe health consequences. To avoid such risks, food preservation is vital. By preserving food through various methods, we can extend its shelf life, prevent spoilage, and ensure that it remains safe for consumption.

Method of Food Preservation

Different food items need different methods of preservation. Some of these methods are :

Preserved by	
Sun Drying	The method is used for preserving and storing raw vegetables and certain fruits. Drying in the sun reduces the moisture content of food material. As micro-organisms do not grow in dry conditions, it becomes easy to store dried vegetables like cauliflower, fenugreek, and mint and fruits like mango, apple and peach in airtight containers.
Common Salt	Preservation of food by adding salt is called salting. The meat and fish are covered with salt to drain out water by osmosis. Raw mango, lemon, amla, tamarind and other fruits and vegetables are preserved by salting. This inhibits growth of bacteria.
Sugar	Sugar syrup containing 68% sugar is used for the preservation of fruits and vegetables. Such a high concentration of sugar reduces moisture contents and thus prevents growth of microbes. Carrots, plums, ripe mangoes, amla, apples, etc., are preserved by sugar in the form of jams, Jellies and squashes.
Pickling	Oil and vinegar are used to make pickles because bacteria cannot survive in high acid contents of the medium. Vegetables, fruits like raw mangoes, lemon, chillies, etc., are preserved as pickle. Salt or sugar is added to the pickle to enhance its taste.
Chemicals	Citric acid is added to pickles and some squashes, while sodium benzoate and sodium metabisulphite are used as preservation to preserve squashes, jams and jellies.
Freezing	Deep freezing prevents bacterial growth and inactivates the enzymes. Therefore, deep-frozen food retains flavour as well as freshness.

Pasteurisation

Pasteurisation is the process of heat and cold treatment to which milk is subjected to make it bacteria-free. The milk is heated to 62°C for 30 minutes or 70°C for about 15—30 seconds and them chilled suddenly. The process of pasteurisation was discovered by Louis Pasteur. The milk treated this way is called pasteurised milk and can be safely used without boiling.

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Apply Concept in Real-Life Context

Apply

How do temperature control methods (such as heating and refrigeration) help preserve food, and what effect do they have on microbial growth?

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

How would you ensure dried fruit packaging prevents contamination and extends shelf life?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. Describe the methods used to eliminate harmful microorganisms in food using high temperatures.
2. Explain how preservatives like benzoate and potassium extend food shelf life.

Creative Task

Create

Test Food Preservation Techniques

1. Collect small samples of perishable foods like fruits or vegetables.
2. Apply three methods: salting, refrigeration, and drying.
3. Store each sample in a sealed container and observe changes in appearance, texture, or smell over several days.
4. Note which method preserved the food best and why.

Discussion Points

- Which method worked best?
- How does each method prevent harmful microorganisms?

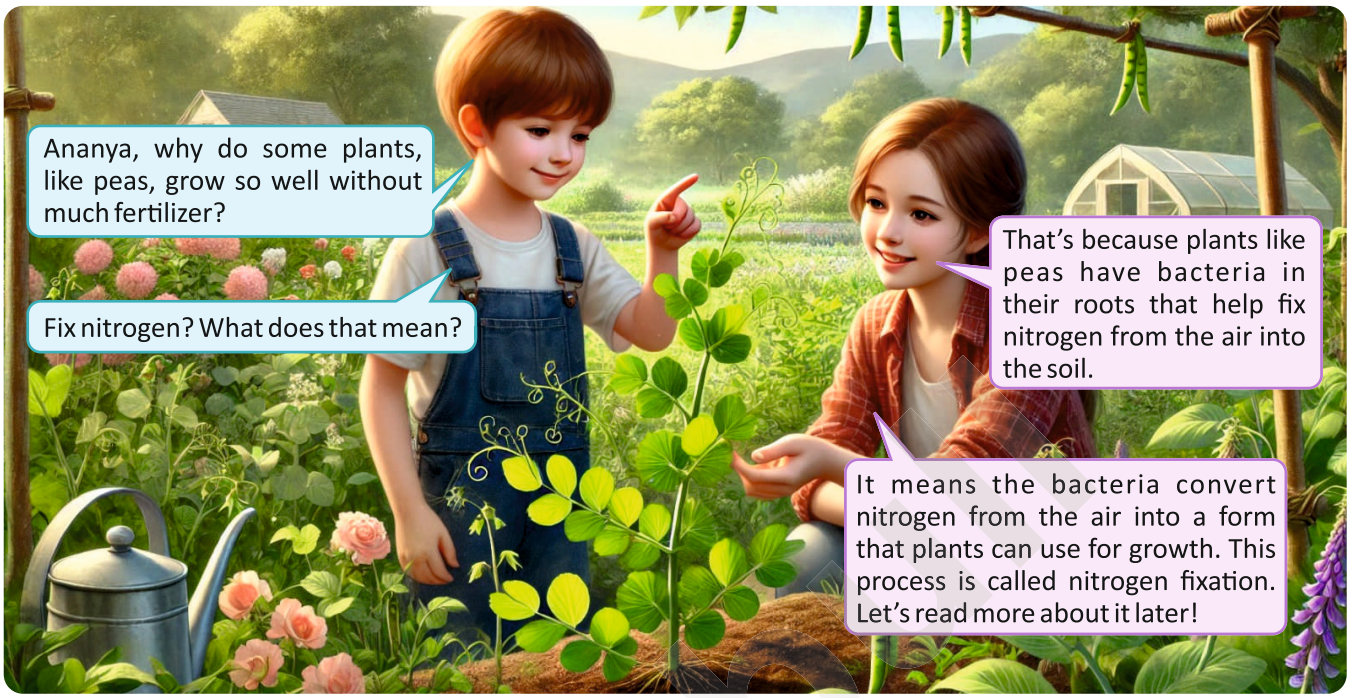
Document your findings in a report or presentation.

Skills Practiced: Brainstorming, research, digital literacy, creativity

Bloom's Taxonomy

Nitrogen Fixation

Ravi and his sister, Ananya, are in their garden observing the plants.



The conversion of atmospheric nitrogen into forms usable by plants is essential for plant growth and productivity. This process, known as nitrogen fixation, transforms nitrogen gas (N_2) in the atmosphere into compounds like nitrates (NO_3^-) and ammonium (NH_4^+), which plants can readily absorb. Nitrogen fixation occurs through two primary natural mechanisms: lightning and symbiotic bacteria.

During Lightning

During lightning, energy breaks nitrogen (N_2) bonds in the atmosphere, allowing it to combine with oxygen (O_2) to form nitrogen oxides (NO, No_2). These dissolve in rainwater as nitric acid (HNO_3), which reacts with soil minerals to form nitrates (NO_3^-). Nitrates enrich the soil and provide nutrients for plant growth.

Symbiotic Bacteria

Certain types of bacteria, particularly those associated with leguminous plants like peas, beans, and clovers, play a vital role in nitrogen fixation. These bacteria, such as the well-known Rhizobium, live in the root nodules of leguminous plants. They convert atmospheric nitrogen (N_2) into organic nitrates through a biological process. In return, the plants provide carbohydrates and a protected environment to these bacteria, establishing a mutually beneficial relationship. This symbiosis not only supports the nitrogen needs of the host plants but also enriches the soil for future crops.

The Nitrogen Cycle

Nitrogen is a critical component of many cellular molecules, including proteins, chlorophyll, vitamins, and nucleic acids. Despite making up approximately 78% of the Earth's atmosphere, atmospheric nitrogen (N_2) is inert and inaccessible directly to most plants and animals. The nitrogen cycle is the process that makes nitrogen available to plants and animals by converting nitrogen through various chemical forms in the environment.

1. **Nitrification**

   Nitrification is the two-step process by which certain soil bacteria convert ammonia (NH_3) first into nitrites (NO_2^-) and then into nitrates (NO_3^-). This is accomplished by two types of nitrifying bacteria:

   - The first group of bacteria oxidizes ammonia into nitrites.
   - A second group further oxidizes nitrites into nitrates. These nitrates are then available in the soil for plants to absorb through their roots, providing them with the nitrogen they need for essential biological processes.

2. **Assimilation**

   During assimilation, plants absorb the nitrates and ammonium ions present in the soil and incorporate them into organic compounds, such as amino acids, proteins, and nucleic acids, which are critical for their growth and development. Animals obtain these organic nitrogen compounds by consuming plants or other animals.

3. **Ammonification**

   When plants and animals die, or when animals excrete waste, nitrogen returns to the soil in organic forms. Through the process of ammonification, decomposers like bacteria and fungi break down these organic nitrogen compounds into ammonia (NH_3). This ammonia can then either be reused by plants or further processed in the nitrogen cycle.

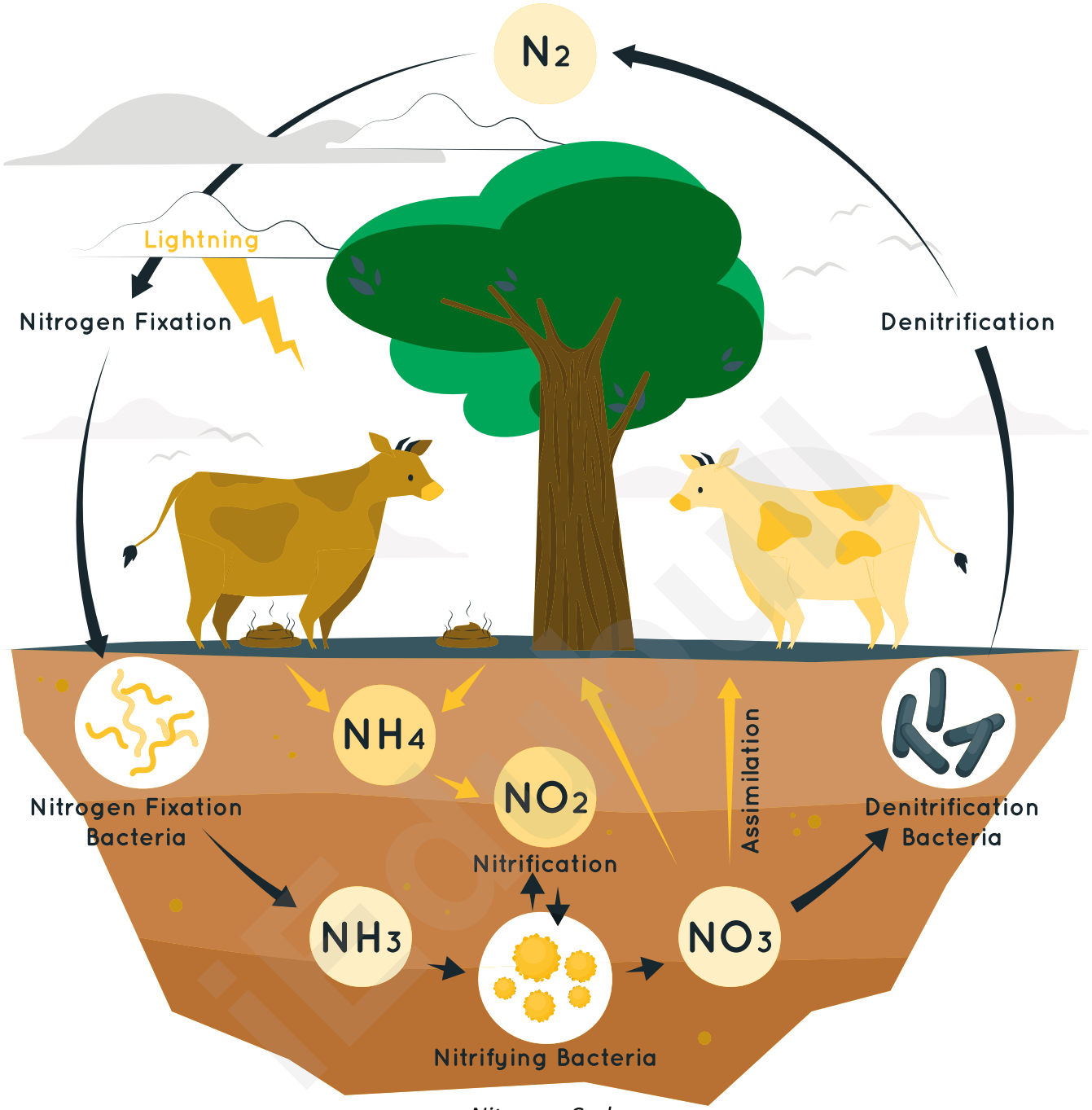
4. **Denitrification**

   Denitrification is the final step in the nitrogen cycle, where certain bacteria in anaerobic conditions (such as waterlogged soils) convert nitrates back into nitrogen gas (N_2) or nitrous oxide (N_2O), releasing it back into the atmosphere. This step completes the nitrogen cycle by returning nitrogen to its gaseous state, helping to maintain the balance of nitrogen in the environment.

The nitrogen cycle is a complex yet balanced system that transforms nitrogen through different chemical forms, making it accessible to living organisms and then recycling it back into the atmosphere.

KEYWORDS

Nitrifying bacteria: Nitrifying bacteria are microorganisms that convert ammonia into nitrites and then into nitrates in the nitrogen cycle.



Nitrogen Cycle

Did you know

Some plants hire tiny "microbial workers" to help them fix nitrogen? Legumes, like peas and beans, form partnerships with bacteria called Rhizobia. These bacteria live in little root nodules and convert atmospheric nitrogen into a form plants can use—ammonia! In return, the plants give the bacteria a cozy home and some sugary snacks. It's like a nitrogen factory with free room and board!

Let's recall what we know

SCAN TO ACCESS

Take a Task

Watch Remedial

Bloom's Taxonomy

Apply Concept in Real-Life Context

Apply

1. How would you explain the roles of nitrification and denitrification in the nitrogen cycle, and why are these processes important for soil health?

Skills Practiced: Critical and logical thinking, Identification, Application thinking

Further Analysis

Analyse

1. Investigate the role of denitrifying bacteria in the nitrogen cycle. How does their activity lead to nitrogen loss in ecosystems, and what are the potential impacts on soil health and agricultural yields?

Skills Practiced: Critical analysis, logical reasoning, brainstorming

Self-Assessment Questions

Evaluate

1. What is nitrogen fixation, and why is it vital for plants?
2. How does nitrification occur, and which organisms are involved?
3. What is the role of denitrification in the nitrogen cycle?
4. Name two natural ways nitrogen fixation happens in nature.

Creative Task

Create

Build Models

- Use clay and craft materials to create models of nitrogen-fixing bacteria and root nodules.
- Construct a mini root system with soil and legume seeds to demonstrate where bacteria interact with plant roots.
- Create a visual representation of nitrogen fixation by lightning.

Present Findings

- Share models and diagrams with the class, explaining each method's role in making nitrogen available to plants.
- Discuss the environmental impact of nitrogen fixation and its importance in the nitrogen cycle.

Reflection Questions

1. Why is nitrogen fixation vital for plant growth?
2. How do these processes support biodiversity and soil fertility?
3. What environmental changes (e.g., pollution or climate change) could affect nitrogen fixation?

Skills Practiced: Brainstorming, research, digital literacy, creativity

SUMMARY

1. Microorganisms

Microorganisms are tiny living organisms, including bacteria, fungi, viruses, and protozoa, visible only under a microscope. They are found everywhere—air, water, soil, and even inside living organisms. While they play crucial roles in nature, their impact on human life can be both beneficial and harmful.

2. Friendly Microorganisms

Beneficial microorganisms contribute to several essential processes:

- **Food Production:** Used in making products like yogurt, bread, and cheese.
- **Medicines:** Certain bacteria (e.g., Penicillium) are used to produce antibiotics.
- **Decomposition:** Break down organic matter, enriching the soil.
- **Nitrogen Fixation:** Convert atmospheric nitrogen into usable forms for plants.
- **Biotechnology:** Aid in producing vaccines and genetically engineered products.

3. Harmful Microorganisms

Some microorganisms cause harm by:

- **Diseases:** Responsible for illnesses in humans (e.g., tuberculosis, cholera), plants (e.g., blights), and animals (e.g., anthrax).
- **Food Spoilage:** Leads to contamination and wastage of food.
- **Toxins:** Produce harmful substances that can cause poisoning or allergic reactions.

4. Food Preservation

Techniques to prevent spoilage by harmful microorganisms include:

- **Methods:** Refrigeration, drying, salting, sugaring, and vacuum sealing.
- **Chemical Additives:** Use of preservatives like vinegar or citric acid to inhibit microbial growth.
- **Sterilization and Pasteurization:** Heat treatments to kill harmful microbes in food and beverages.

5. Nitrogen Fixation and Its Cycle

Microorganisms like Rhizobium bacteria and cyanobacteria fix atmospheric nitrogen into nitrates and ammonia, essential for plant growth. These compounds are absorbed by plants and passed through the food chain. Decomposers return nitrogen to the soil, while denitrifying bacteria release it back into the atmosphere, completing the nitrogen cycle.

Microorganisms are indispensable to life, serving as both allies in sustaining ecosystems and adversaries when mismanaged or uncontrolled.

Gap Analyzer™
Take a Test

EXERCISE

That turn curiosity into confidence—let's begin!

A. Choose the correct answer.

1. Which of the following microorganisms helps in the production of antibiotics?
   (a) Bacteria ☐ (b) Virus ☐
   (c) Protozoa ☐ (d) Algae ☐
2. Which of the following microorganisms causes cholera?
   (a) Lactobacillus ☐ (b) Vibrio cholerae ☐
   (c) Rhizobium ☐ (d) Plasmodium ☐
3. Which microorganism is used in baking and brewing industries?
   (a) Yeast ☐ (b) Amoeba ☐
   (c) Penicillium ☐ (d) Algae ☐
4. Nitrogen fixation is carried out by:
   (a) Fungi ☐ (b) Protozoa ☐
   (c) Rhizobium ☐ (d) Virus ☐
5. Which of the following is not a method of food preservation?
   (a) Pasteurisation ☐ (b) Adding sugar ☐
   (c) Adding antibiotics ☐ (d) Refrigeration ☐

B. Fill in the blanks.

1. Microorganisms that are beneficial to humans are called _____.
2. _____ is the process used to kill harmful microbes in milk by heating and rapidly cooling it.
3. _____ bacteria convert atmospheric nitrogen into a usable form for plants.
4. _____ is a disease caused by fungi that affects the skin.

C. Write True or False.

1. Lactobacillus is a harmful microorganism. _____
2. Nitrogen fixation helps improve soil fertility. _____
3. Adding salt or sugar to food encourages microbial growth. _____
4. Viruses can reproduce only inside a living host cell. _____

D. Define the following terms.

1. Microorganisms
2. Food Preservation
3. Nitrogen Fixation
4. Pathogen
5. Fermentation

E. Match the columns.

Column A	Column B
1. Malaria	(a) Milk preservation
2. Penicillium	(b) Disease-causing microbe
3. Curd making	(C) Antibiotics
4. Pathogen	(d) Rhizobium
5. Nitrogen Cycle	(e) Mosquito

F. Give Reasons

1. Friendly microorganisms are used in agriculture.
2. Adding sugar to food preserves it.
3. Viruses are not classified as living organisms.
4. Rhizobium bacteria are important for farming.
5. Proper food storage prevents microbial growth.

G. Answer in brief.

1. How do microorganisms help in making medicines?
2. What role do bacteria play in nitrogen fixation?
3. Explain how salt and sugar act as food preservatives.
4. What measures can be taken to prevent diseases caused by harmful microorganisms?
5. Why is pasteurisation important for preserving milk?

H. Answer in detail.

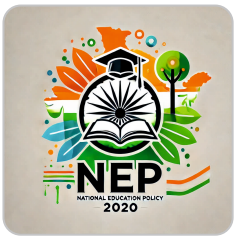
1. Explain the different groups of microorganisms with examples.
2. Discuss the benefits of friendly microorganisms in our lives.
3. Describe the harmful effects of microorganisms on food, health, and agriculture.
4. Explain the nitrogen cycle and its importance in maintaining soil fertility.
5. Write in detail about the various methods of food preservation and how they prevent microbial growth.

NEP Corner

Know about NEP 2020

Study What You Love!

You can now choose subjects across streams. Like Math and Music together? It's possible under NEP 2020!



Skill-based Activity

Activity Time

STEM

Experiment: Yeast in Action

Conduct the following experiment at home:

1. Collect water, sugar, yeast, a beaker, and a spoon.
2. Fill the beaker with water.
3. Stir in 2-3 teaspoons of sugar until it dissolves.
4. Add half a teaspoon of yeast and mix thoroughly.
5. Cover the beaker and leave it in a warm place for about four hours.

Now, answer these questions:

1. Write down what changes you observe in the beaker and conclude what these changes indicate.
2. What is the biological process that happens when yeast interacts with sugar and water?
3. Mention three industries that use this process and explain its significance in each.
4. How does the temperature of the environment affect the results of this experiment?

Skills Covered: Creativity, Observation, Critical Thinking, Data Analysis, Responsibility, Research

Exploring Microbial Diversity

Art

Create a detailed chart to explore the diversity of microorganisms.

1. Categorize microorganisms into beneficial and harmful groups.
2. Provide two examples from each category and explain their roles in daily life or the environment.
3. Highlight the role of microorganisms in food production and give examples.

Skills Covered: Creativity, Imagination, Problem-solving, Environmental Awareness

Healthcare Milestone: The Pulse Polio Campaign

Group Activity

India's Pulse Polio Programme, launched on October 2, 1994, played a crucial role in eradicating polio from the country, which once accounted for 60% of global cases.

1. Form groups to research the challenges India faced during the polio eradication campaign.
2. Identify the key strategies used in the campaign to reach rural and remote areas.
3. Compare India's polio eradication program with similar campaigns in other countries.
4. Present your findings in a creative format, such as a role-play, infographic, or video presentation.

Skills Covered: Critical thinking, Planning, Collaboration, Communication, Creativity, Teamwork, Problem-solving, Responsibility

Understanding Antibiotic Resistance

Case to Investigate

Antibiotic overuse has led to the alarming rise of antibiotic-resistant bacteria, posing a global health threat.

1. Conduct research or consult a healthcare professional about how antibiotics work to fight infections.
2. Identify the primary causes of antibiotic resistance and their consequences on human health.
3. Suggest strategies individuals and communities can adopt to use antibiotics responsibly.
4. Design a public awareness poster or digital campaign to educate people about the dangers of overusing antibiotics.

Skills Covered: Observation, Critical thinking, Research, Analytical skills, Communication

Biotechnology Innovations

Aligning with SDGs

Biotechnology has transformed medicine, agriculture, and environmental sustainability through groundbreaking innovations.

1. Investigate how genetic engineering is being used to produce crops resistant to pests and diseases.
2. Explore the role of biotechnology in creating eco-friendly alternatives to plastics.
3. Discuss how biotechnological advances have improved vaccine development, focusing on mRNA technology.
4. Evaluate the ethical dilemmas associated with genetic modification and its societal impact.

SDG 2: Zero Hunger, SDG 3: Good Health and Well-being, SDG 9: Industry, Innovation, and Infrastructure, SDG 15: Life on Land

Skills Covered: Research, Brainstorming, Problem-solving, Presentation skills