

Wizz World of **SCIENCE**

GRADE

7



Aligned with Single National Curriculum

PREFACE

Wizz World of Science for grades I to 7 has been conceptualized, penned, composed and designed by professionals and educators who have vast experience of dealing with subject of science in the past. Our books lie well within the frameworks defined by National Curriculum. The newly introduced National Assessment Framework (NAF), that is now an integral part of National Curriculum Framework (NCF) has been particularly incorporated in Wizz World of Science Series to make sure that basic purpose of this initiative regarding policy and practice level to improve quality of education is actually met. The quality of education has been further made sure with holistic and cognitive approach that identifies specific areas of learning and development that a today's student requires. The series:

- Guides students in a very simple way how to solve the cognitive tasks by creating a comfortable zone.
- Encourages students to practice and apply concepts.
- Involves students in interactive exercise and activities.
- Help students to create a natural space for thinking through well-planned activities.

WHY WIZZ PUBLISHERS?

Wizz Publishers is the best choice for students because it is:

- Backed by practical experience and critical analysis for over 30 years.
- Developed, designed and printed with the latest and modern techniques.
- Available at economical prices keeping in view the recent economic melt down domestically.
- Based on well-planned activities and systematically developed exercises.
- Helpful for students to develop the 21st century life skills for a bright future.

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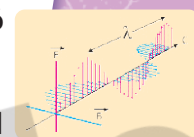
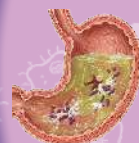
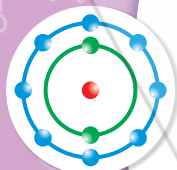
Wizz World of SCIENCE

GRADE

7

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Students' Learning Outcomes

All students will be able to:

- Explain the root and shoot system in plants. Label different parts of leaf, stem, and root (external and internal structure).
- Predict the role of xylem and phloem in transport of water and food in plants by observing the cross section of the stem.
- Define the process of photosynthesis and derive the word equation for it.
- Know that plants require minerals to maintain healthy growth and life processes (limited to magnesium to make chlorophyll and nitrates to make proteins).
- Explain that the structure of leaves is adapted to the process of photosynthesis.
- Describe the process of respiration and write the word equation for it. Compare and contrast the process of photosynthesis and respiration.
- Investigate the phenomenon of transpiration and its importance in a plant (wind, temperature, light, humidity affecting rate of transpiration in plants).
- Explore and apply natural raise of water based on the principle of transpiration.

Let's Start!

- What are the two main systems of a plant, and how do they work together?
- Why are xylem, phloem, and chloroplasts important for a plant's survival?



THINK-PAIR-SHARE!

- Take 1–2 minutes to think about the two main systems of a plant: roots and shoots.
- Consider how water, nutrients, and food move within a plant and why chloroplasts are important.

Pair up with a classmate and discuss:

- How do the root system and shoot system help each other?
- Why are xylem, phloem, and chloroplasts crucial for a plant's survival?

- Each pair shares one key idea with the class.
- Discuss real-life examples, like how cutting a plant affects its water and food movement.

The Story of Plant Discovery

Over 300 years ago, a scientist named Nehemiah Grew carefully studied plants under the microscope. He was amazed to see that plants were not just green things growing from the ground, but living organisms made up of tiny structures and tubes. These structures worked together to take in water, make food, and transport it around the plant.

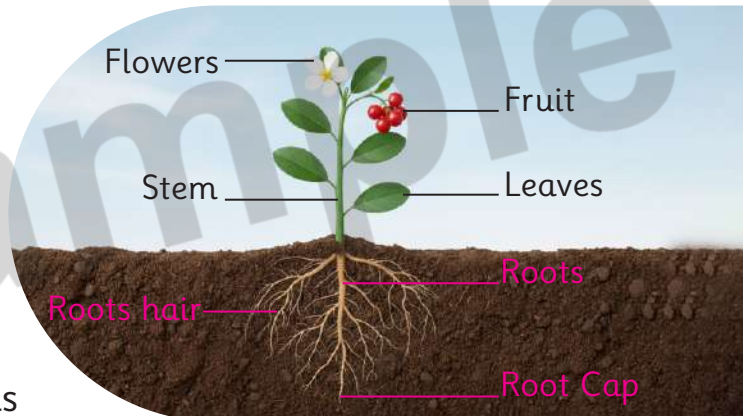
Many years later, other scientists built on Grew's work, discovering the processes of **photosynthesis**, **respiration**, and **transpiration**, which keep plants alive and healthy. Today, we know plants are complex systems with specialized parts and every part has a role to play.



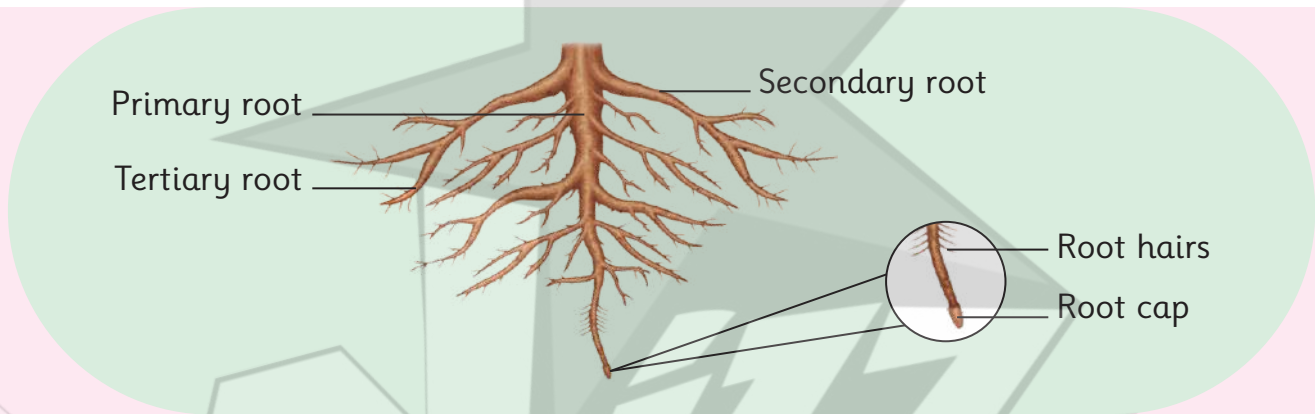
1.1 The Root and Shoot Systems

Have you ever observed that a plant has two main halves, upper half and a lower half?

The upper half comprises the shoot system of a plant, whereas, the lower half comprises the root system of a plant. The root system is



found underground. Roots fix the plant in the soil, preventing it from being blown away or washed away. They also absorb water and dissolved minerals from the soil, which are essential for the plant's survival. At the tip of each root is a root cap, which protects it as it pushes through the soil. It also helps the root sense the direction of growth, guiding it to grow downwards. Tiny root hairs grow from the roots, making a bigger surface area to soak up more water and minerals.



The shoot system is found above the ground, which includes the stem, leaves, flowers, and fruits. The stem supports the leaves and flowers, holding them up to the sunlight. It also acts as a highway, carrying water, minerals, and food to different parts of the plant.



Let's

Think Aloud

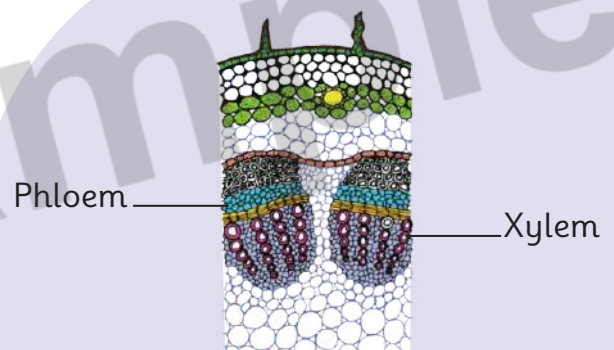
Why do you think a plant with damaged roots cannot survive even if its leaves are healthy?

1.1.1 Inside the Stem (Xylem and Phloem)

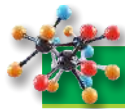
If you could look at a cross section of a stem under a microscope, what do you think you would see?

You would be able to see two important transport tissues:

- Xylem carries water and minerals upward from the roots to the leaves.



- Phloem carries the food made in the leaves to the rest of the plant. Together, they form a transport network that keeps the plant alive and healthy.



SciByte

Some trees can transport water more than 100 meters from the roots to the topmost leaves without any pump! This is possible because of transpiration pull and capillary action.



Activity Time!

Investigating Water Transport in Plants

Objective: To observe the movement of water through the xylem.

Resources:

- Celery stalk with leaves
- Jar
- Coloured water (food colouring)
- Knife (for teacher use)

Instructions:

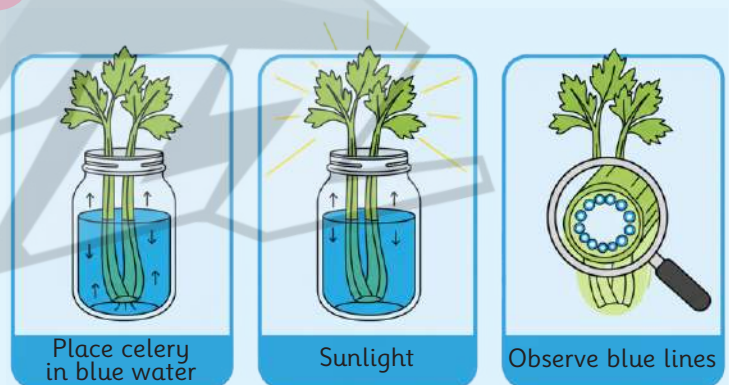
- Fill a jar halfway with water and add a few drops of food colouring.
- Place a fresh celery stalk with leaves into the jar.
- Leave it in a sunny place for a few hours.
- After several hours, cut the celery stalk across the stem and look for coloured lines inside.

Answer the following questions:

a. What do you observe in the celery stalk?

b. Which plant tissue is responsible for this movement of water?

c. How does this help the plant survive?



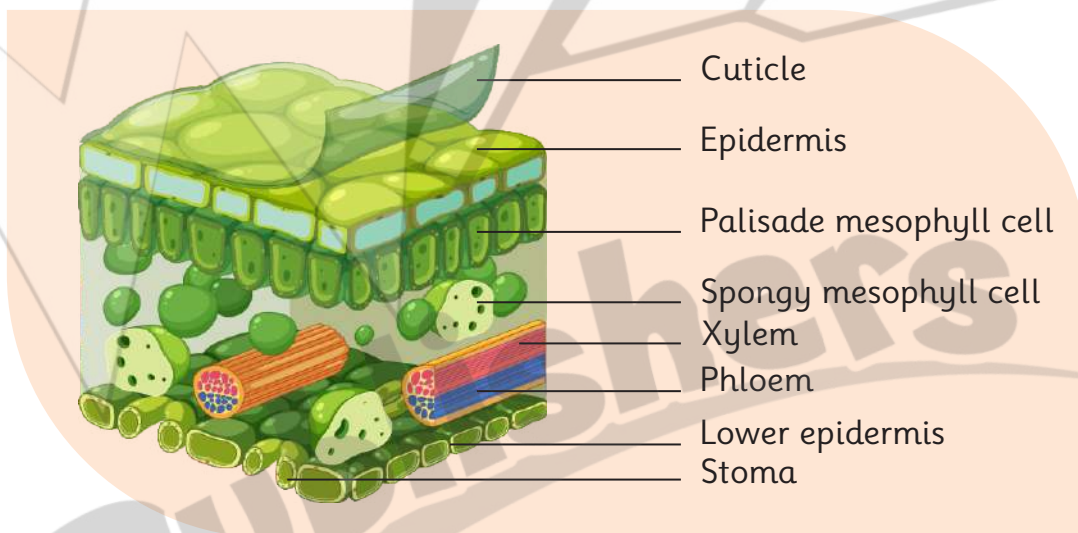
1.1.2 The Leaf

Why do you think leaves are called the “food factories” of a plant?

Leaves are specially designed to make food through the process called photosynthesis. That's why they are called the “food factories” of a plant.

If you look at the leaf, you will see that leaves are flat and broad to capture maximum sunlight. Leaves are covered with a thin waxy layer which helps to reduce water loss. There are tiny openings on the underside of the leaf called stomata, which open and close to control gas exchange and water loss.

If we look inside the leaf, the upper part contains tightly packed cells full of chloroplasts, i.e., tiny structures that contain chlorophyll. Chlorophyll is the green pigment that traps sunlight and is responsible for making food. Below this is the spongy layer with air spaces that allow gases to move in and out.



Let's

Think *Cloud*

Why are most stomata found on the underside of leaves rather than the upper surface?



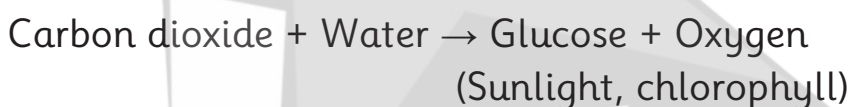
Teacher's Note:

Explain students the phenomenon of transpiration pull and capillary action.

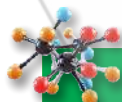
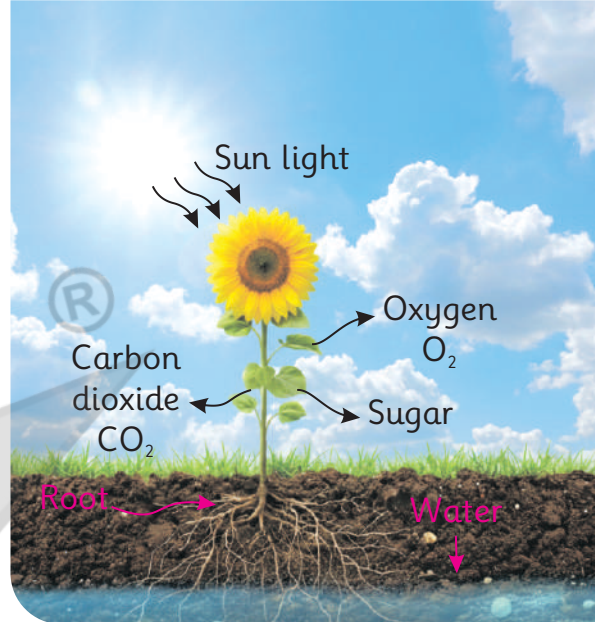
1.2 Photosynthesis

It is the process by which plants make their own food using sunlight, water, and carbon dioxide. It takes place in the chloroplasts of leaf cells. During photosynthesis, plants use sunlight energy to change carbon dioxide from the air and water from the soil into glucose, a type of sugar that serves as food. Oxygen is released as a by-product.

The word equation for photosynthesis is:



Leaves are perfectly adapted for photosynthesis. Their broad surface area collects more sunlight. The thin structure allows sunlight to reach all cells quickly. The presence of many chloroplasts ensures that light energy is efficiently captured. Stomata allow carbon dioxide to enter and oxygen to exit, while veins in the leaf carry water from the roots and transport food to other parts of the plant.



SciByte

The Amazon rainforest produces about 20% of the world's oxygen through photosynthesis.



Activity Time!

Objective: To show that sunlight is necessary for photosynthesis and starch production.

Resources:

- Two healthy potted plants
- Cupboard or dark room
- Sunlight
- Iodine solution



- Dropper
- Beaker
- Hot plate/stove (for boiling leaves)
- Ethanol (alcohol)
- Forceps

Instructions:

- Place one plant in a sunny place and another in a dark cupboard for three days.
- Take one leaf from each plant.
- Boil each leaf in water for 2–3 minutes.
- Place each leaf in a test tube or beaker containing ethanol. Then heat this container in a hot water bath until the leaf loses its green colour and turns pale.
- Rinse the leaves in warm water to soften them.
- Add a few drops of iodine solution to each leaf and observe.

Answer the following questions:

a. Which leaf turned blue-black with iodine?

b. What does this indicate about starch production in the leaf?

c. Why did the leaf from the dark cupboard show a different result?

Minerals for Healthy Growth

To carry out photosynthesis, plants need minerals from the soil.

Magnesium is required to make chlorophyll, without which photosynthesis cannot occur.

Nitrates are needed to make proteins, which help in growth and repair of the plant.



Adequate
magnesium



Magnesium
deficiency



Let's

Think Aloud

What do you think would happen to a plant's leaves if it lacked magnesium?

1.3 Respiration in Plants

Plants and animals both need energy to stay alive. They get this energy through respiration, which happens in all living cells, even in plants.

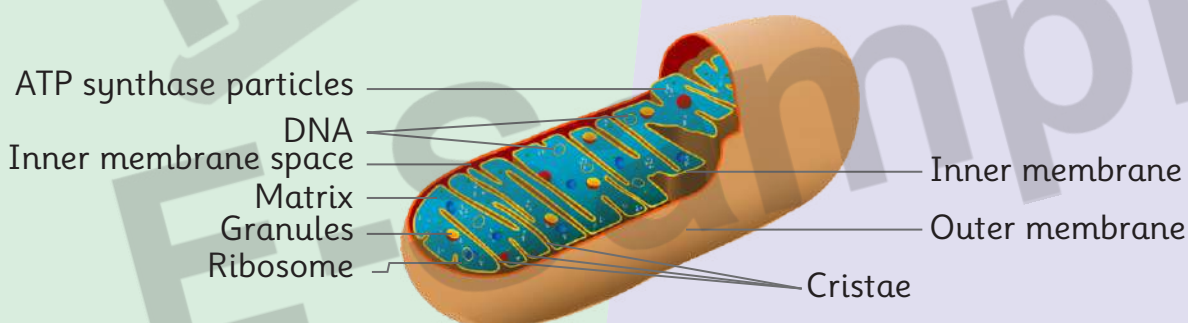
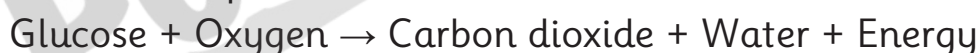
Respiration mainly takes place inside special parts of the cell called mitochondria. These are often called the "powerhouses of the cell" because they release energy for the cell to use.

In respiration:

- Glucose (sugar made during photosynthesis or taken from food) is the fuel.
- Oxygen is used by the mitochondria to break down this glucose.
- This process releases energy that cells need for growth, repair, movement, and other life activities.
- Along with energy, two waste products are made:
 - ✓ **Carbon dioxide (CO₂)**: released back into the air.
 - ✓ **Water (H₂O)**: either used by the plant again or given off.

Think of mitochondria like tiny stoves inside cells: glucose is the fuel, oxygen is the air that helps it burn, energy is the heat, and smoke/ash are like the carbon dioxide and water left behind.

The word equation for respiration is:



Mitochondrion inner structure



Let's

Think Aloud

Why do plants still need oxygen at night, even though they make oxygen during the day?

Comparing Photosynthesis and Respiration

Photosynthesis and respiration are almost opposite processes. Here's the proper Venn diagram comparing **Photosynthesis** and **Respiration**, showing their differences in each circle and their similarities in the overlapping section.

-
- Happens in chloroplasts
 - Needs sunlight
 - Uses CO_2 and water
 - Produces glucose and oxygen
 - Stores energy
- Both are vital for plants
 - Involve energy transformation
 - Occur in cells
 - Use and produce glucose / energy
- Happens in mitochondria
 - Does not need sunlight
 - Uses glucose and oxygen
 - Produces CO_2 and water
 - Releases energy (ATP)

Photosynthesis

Respiration

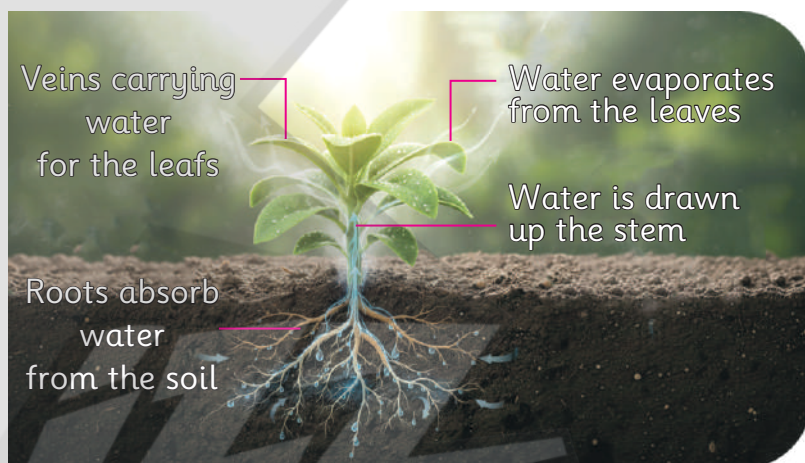
1.4 Transpiration

Have you ever noticed tiny drops of water on a plant's leaves in the morning or felt the air near plants feel cooler? Do you ever wonder why?

That is because of transpiration, a process where plants lose water as vapours through stomata in their leaves. It is like the plant is "breathing out" water, which helps it stay cool.

This loss of water creates a pull that draws more water upward from the roots through the xylem, a process called the transpiration pull. Transpiration helps in cooling the plant and transporting minerals.

The upward movement of water in plants happens naturally due to the combination of root pressure, capillary action, and transpiration pull. As water evaporates from the leaves, more is drawn upward, keeping a constant supply available for photosynthesis and other life processes.



Factors Affecting the Rate of Transpiration

Transpiration is the process by which plants lose water as water vapor through tiny openings in their leaves called **stomata**. The rate at which this happens is not always the same. It depends on different environmental factors:

- **Temperature**
 - ✓ On a hot day, water molecules gain more energy and evaporate quickly from the leaf surface. This makes transpiration faster.
 - ✓ On a cold day, evaporation slows down, so transpiration decreases.
- **Humidity (Moisture in Air)**
 - ✓ If the air is dry, water vapor easily escapes from the leaf into the atmosphere, so transpiration increases.
 - ✓ If the air is humid (full of water vapor), the air already contains a lot of moisture. This makes it harder for water to leave the leaf, so transpiration slows down.
- **Wind Speed**
 - ✓ A strong wind blows away the water vapor around the leaf surface. This keeps the concentration of water vapor low outside the leaf, so more water keeps evaporating.

- ✓ If the air is still (no wind), water vapor builds up around the leaf, reducing the rate of transpiration.

- **Light Intensity**

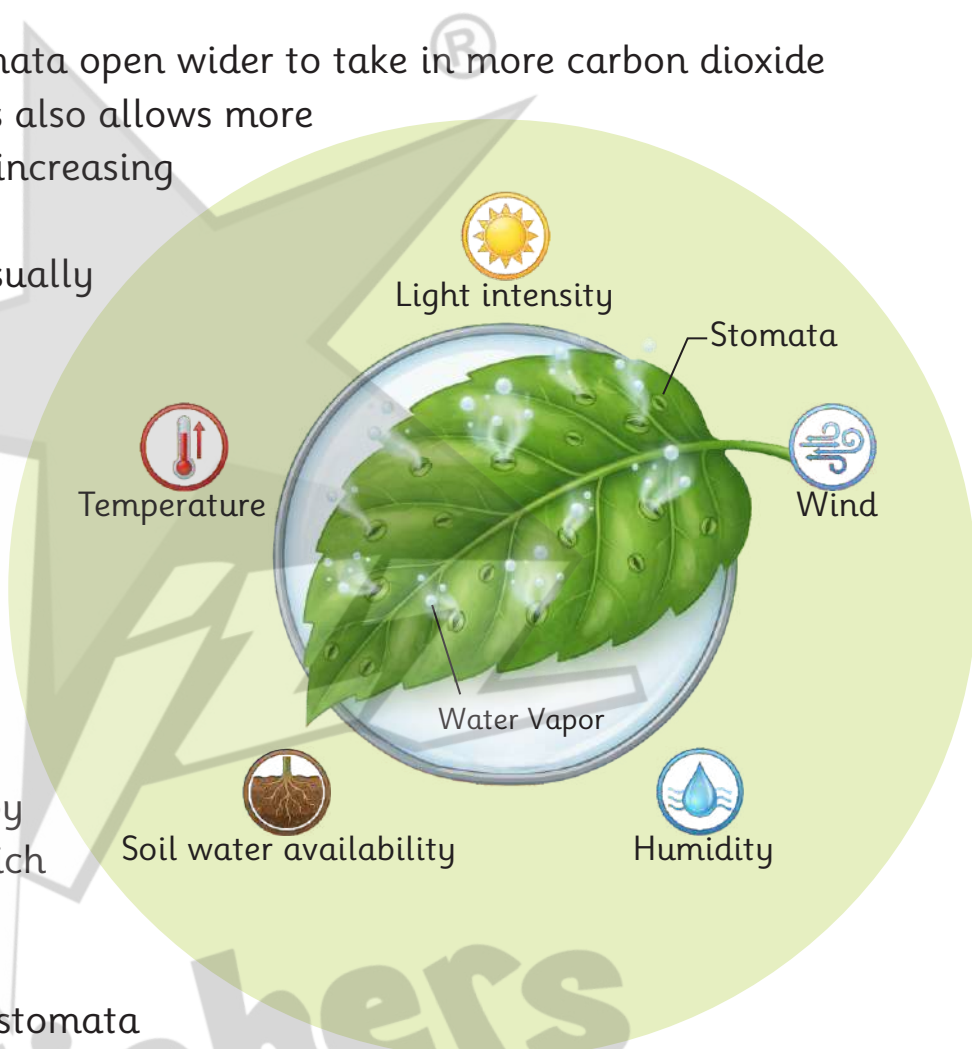
- ✓ In bright light, the stomata open wider to take in more carbon dioxide for photosynthesis. This also allows more water vapor to escape, increasing transpiration.
- ✓ In darkness, stomata usually close, reducing transpiration.

- **Availability of Soil Water**

- ✓ If the soil has plenty of water, plants can absorb it easily and maintain a high rate of transpiration.
- ✓ If the soil is dry, the plant conserves water by closing its stomata, which reduces transpiration.

- **Leaf Characteristics**

- ✓ Thin leaves with many stomata lose water faster.
- ✓ Leaves with a thick cuticle (waxy layer) or smaller surface area reduce water loss.



Activity Time!

Investigating Transpiration in Plants

Objective: To show that water is lost from leaves through transpiration.

Resources:

- Healthy leafy plant
- Transparent plastic bag

- String
- Sunny location

Instructions:

- Choose a healthy leafy branch of a plant.
- Cover it completely with a transparent plastic bag.
- Tie the bag tightly around the stem using string.
- Leave the plant in the sun for a few hours.
- Observe the inside of the bag.



Answer the following questions:

- What do you observe inside the bag after a few hours?

- Where did the droplets come from?

- How does this process help in the upward movement of water in plants?



What have you learnt?

- Plants have two main systems: **Root system** (below ground) and **Shoot system** (above ground).
- Roots fix plants in soil, absorb water and minerals, and have root hairs and root caps for protection and absorption.
- The **stem** supports leaves and flowers, and acts as a transport highway.
- Inside the stem, **xylem** carries water/minerals upward and **phloem** carries food to all parts of the plant.
- Leaves are called **food factories** because they make food by photosynthesis. They are flat, broad, and have stomata for gas exchange.

- **Photosynthesis** takes place in chloroplasts using sunlight, carbon dioxide, and water to make glucose (food) and oxygen.
- Plants need **minerals**: Magnesium (for chlorophyll) and Nitrates (for proteins).
- **Respiration** takes place in mitochondria, the "powerhouse of the cell," where glucose + oxygen → carbon dioxide + water + energy.
- Photosynthesis and respiration are **opposite processes** but both are necessary for plant survival.
- **Transpiration** is the loss of water vapor from leaves through stomata. It cools plants and pulls water upward.
- Upward water movement happens due to **root pressure, capillary action, and transpiration pull**.
- Transpiration is affected by temperature, humidity, wind, light, soil water, and leaf structure.

Exercise

1 Choose the correct option.

- Which process in plants makes their own food using sunlight?
 - Photosynthesis
 - Transpiration
 - Respiration
 - Germination
- Which part of the plant anchors it in the soil and absorbs water?
 - Stem
 - Leaf
 - Root
 - Flower
- The green pigment in leaves that traps sunlight is called _____.
 - xylem
 - guard cells
 - chlorophyll
 - phloem

- iv. What is the main function of the stem?
- a To absorb sunlight
 - b To transport water and food
 - c To make seeds
 - d To open and close stomata
- v. Which factor will reduce the rate of transpiration?
- a High temperature
 - b Strong wind
 - c High humidity
 - d Bright sunlight
- vi. If a plant is kept in complete darkness for several days, what will most likely happen?
- a It will grow faster
 - b It will stop making food
 - c It will make more oxygen
 - d Its stomata will stay closed
- vii. Farmers cover the soil around plants with straw in hot summers. This helps the plants because_____.
- a it increases transpiration
 - b it reduces water loss
 - c it makes stomata open wider
 - d it increases photosynthesis
- viii. Imagine two plants: one with broad leaves and one with needle-like leaves. Which will transpire more and why?
- a Broad-leaved plant, because larger surface area
 - b Needle-leaved plant, because less water loss
 - c Both equally, because all leaves transpire
 - d Neither, because only roots lose water
- ix. How are photosynthesis and transpiration connected?
- a Both use oxygen
 - b Both take place in roots
 - c Both involve stomata in leaves
 - d Both make glucose
- x. Which statement best explains why transpiration is important for plants?
- a It helps produce seeds
 - b It helps move water and minerals upward
 - c It stores food in leaves
 - d It opens guard cells

2 Crossword Challenge!

Read the clues and solve the fun crossword puzzle. The clues are given from key terms in the unit.

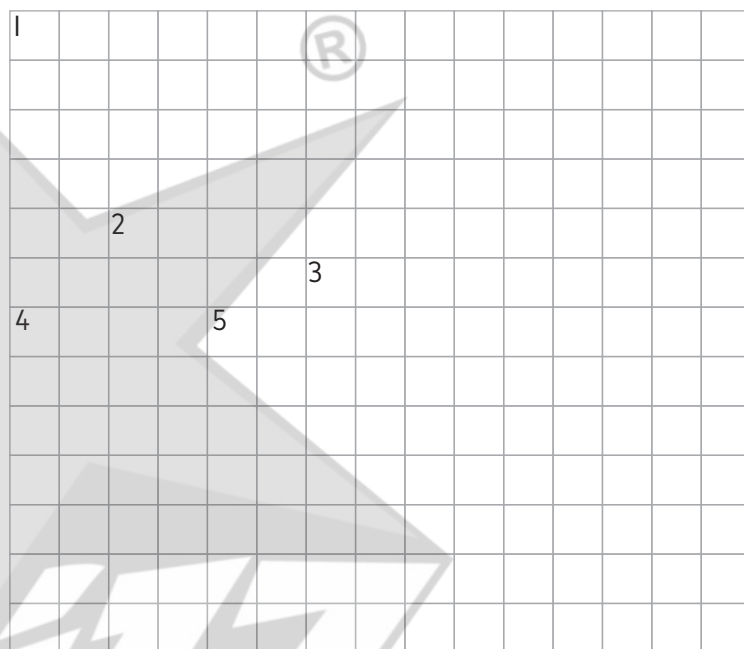
Clues

Across

- i. The process by which plants make their own food

Down

- i. The green pigment in plants
- ii. Tiny openings in leaves
- iii. Tube-like structures that carry water in plants
- iv. Gas released during photosynthesis



3 Show Photosynthesis in Steps (with a Diagram)

Instructions:

- i. Open your notebook and draw a step-by-step diagram of photosynthesis.
- ii. Start with sunlight, water, and carbon dioxide going into the plant.
- iii. Show arrows to explain how:
 - Sunlight gives energy.
 - Roots take water and minerals from the soil.
 - Leaves take in carbon dioxide from the air.
- iv. Draw the plant making glucose (sugar) and releasing oxygen.
- v. Use arrows for the flow of each step.
- vi. Label each part clearly (sun, roots, soil, leaves, oxygen, glucose).

4 Read each scenario carefully and answer the questions given.

- a. **Scenario 1:** It's a bright summer afternoon. The sun is strong, and the wind is blowing steadily.
 - Do you think the plant will lose water faster or slower? Why?
- b. **Scenario 2:** The air feels damp, and the sky is cloudy after a night of rain. How will the amount of water lost from the plant's leaves change?

- c. **Scenario 3:** A small plant is growing under the shade of tall trees where little sunlight reaches.
- What happens to its transpiration rate compared to a plant in full sunlight?
- d. **Scenario 4:** A plant is placed inside a warm room, right next to an open window where a gentle breeze comes in.
- How might temperature and wind together affect its water loss?
- e. **Scenario 5:** A cactus is in the cool desert night with almost no wind.
- Will transpiration be high or low? Why do you think so?

5 Answer the following questions briefly.

- Name the two main systems in plants.
- Why are root hairs important?
- State two functions of stomata.
- Give the word equation for photosynthesis.
- List two factors affecting the rate of transpiration.

6 Answer these questions in detail.

- Explain how the structure of a leaf is adapted for photosynthesis.
- Compare and contrast photosynthesis and respiration.



Constructed Response Questions

- Farmers sometimes use green shade nets to protect plants from intense sunlight. Based on the process of photosynthesis, predict how this might affect the plant's growth and justify your answer with the word equation.
- A plant in your school garden shows yellowing leaves but is otherwise healthy. Using your knowledge of magnesium and nitrates, explain what might be causing this and suggest how to fix the problem.

Shoebox Plant Model – Photosynthesis and Transpiration

Objective: To demonstrate how plants make food through photosynthesis and lose water through transpiration using a 3D model.

Resources:

- Shoebox (medium size, as base and background)
- Green, blue, yellow, and white chart papers
- Clay or green paper (for plant parts: stem, leaves, roots)
- Straws (for stem and arrows)
- Cotton balls (to show water vapor)
- Glue, tape, scissors
- Markers or crayons (for labeling)
- Small pebbles or brown paper (for soil)

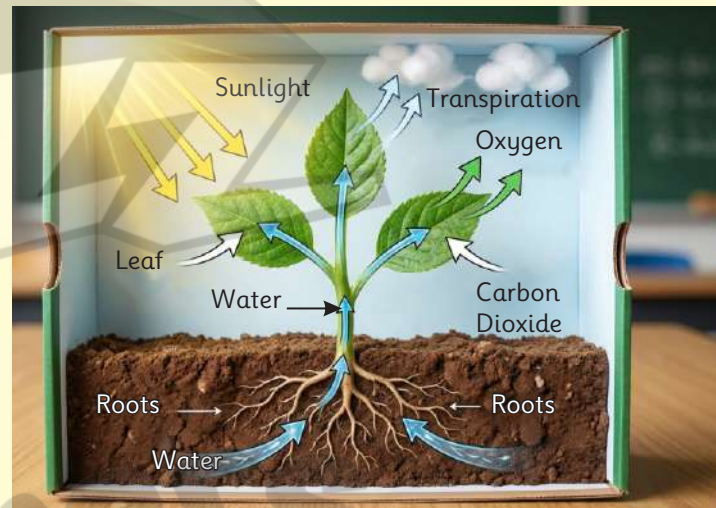
Instructions:

- Line the base of the shoebox with brown paper or pebbles to represent soil.
- Make a stem from chart paper or clay, add leaves, and attach clay roots at the bottom.
- Show water movement with blue arrows from roots to leaves.
- Add yellow arrows from the top for sunlight.
- Paste white arrows into leaves for carbon dioxide and green arrows out for oxygen.
- Place cotton balls above leaves with upward arrows to show transpiration.
- Label all parts clearly.

Expected Outcome:

A 3D shoebox model showing how plants:

- Absorb and transport water from roots to leaves.
- Use sunlight and carbon dioxide to make food.
- Release oxygen into the air.
- Lose water vapor through transpiration.



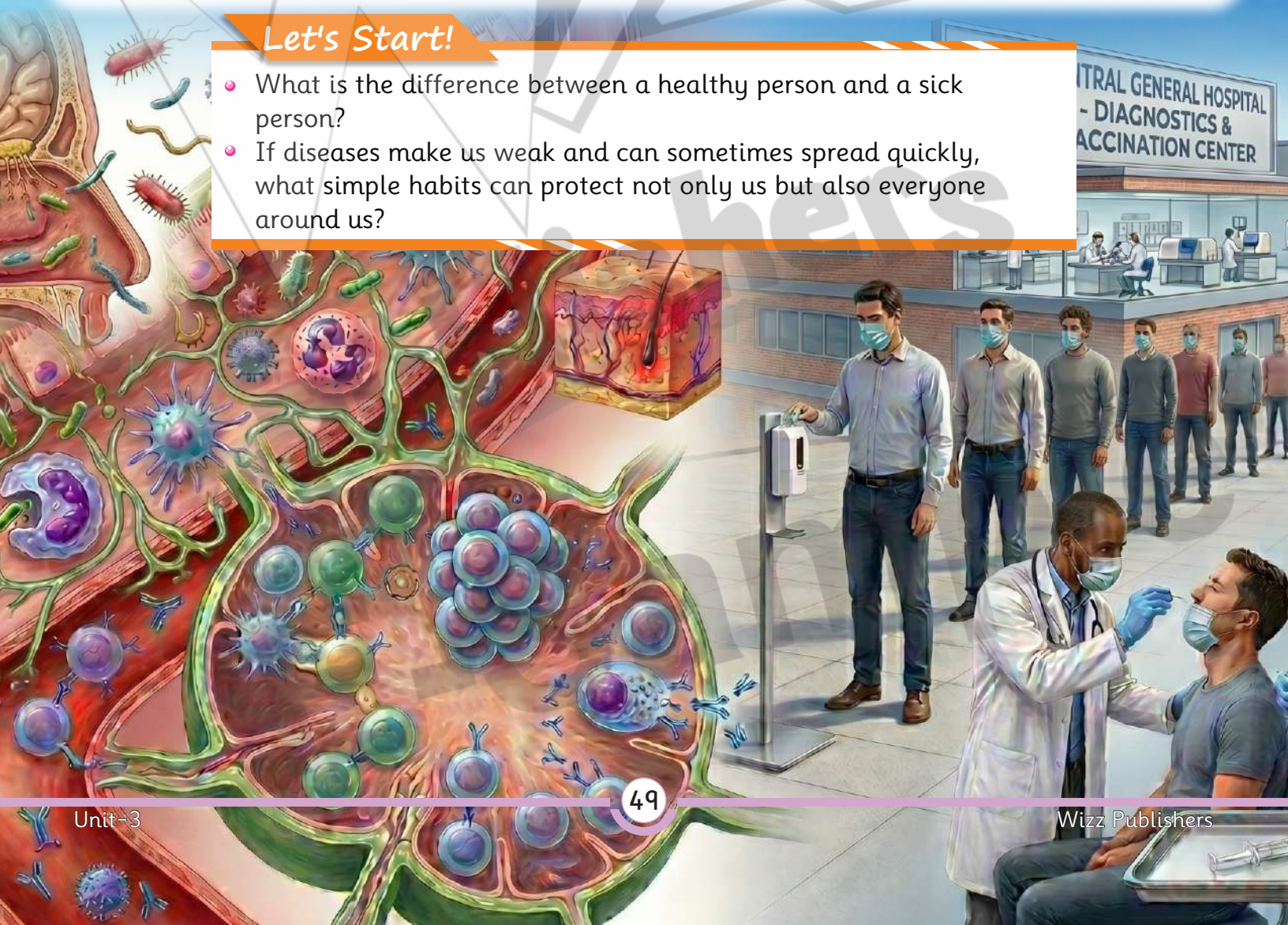
Students' Learning Outcomes

All students will be able to:

- Explain various lines of defences that the body has against pathogens.
- Describe the three types of immunity in humans: innate, adaptive, and passive.
- Identify the various types of pathogens that cause infectious diseases.
- Describe the parts of the immunity system and how they function to produce an immune response.
- Illustrate how adaptive immunity develops over time.
- Visualize the ways to add additional layers of defence (such as wearing masks, using sanitizers, etc.).
- Propose some common strategies for strengthening their immune system.
- Explain how infectious diseases such as hepatitis, COVID-19, typhoid, and dengue are caused, how they are tested and diagnosed, and how they can be prevented.
- Suggest ways in which communities of people can safeguard against the spread of infectious diseases.

Let's Start!

- What is the difference between a healthy person and a sick person?
- If diseases make us weak and can sometimes spread quickly, what simple habits can protect not only us but also everyone around us?



THINK-PAIR-SHARE!

- Have you had any illness before (like chickenpox)?
- Do you know which diseases spread from person to person and which don't?
- How often do you wash your hands or eat fruits and vegetables?
- What can you do to avoid infections?

Pair up with a classmate and share your answers to the questions above. Discuss examples from your own lives and compare habits.

Each pair shares one interesting point with the class:

- A disease you know that spreads or doesn't spread.
- A healthy habit you follow.
- A tip to prevent infections.

3.1 LINES OF DEFENCE AGAINST PATHOGENS

Have you ever wondered why, despite living in an environment full of germs, we don't get sick all the time?

This is because our body has built-in defence systems that protect us from harmful microorganisms.

Microorganisms that cause diseases are called **pathogens**. When pathogens enter and multiply inside the body, it results in an infection. These harmful organisms are present all around us; in the air we breathe, the food we eat, the things we touch, and even through wounds. To keep us safe, our body uses two strong shields: physical barriers and immunity.

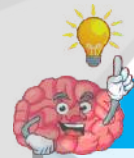
3.1.1 Physical Barriers

Our body's **first line of defence** consists of the skin, mucous membranes, hairs, cilia, saliva, and other protective features. They act as guards that stop pathogens from entering body cells.

- The skin has a tough outer layer called the **epidermis**, made mostly of dead cells that keep shedding and removing pathogens. The pigment **melanin**,

present in the epidermis, protects us from the harmful rays of sunlight.

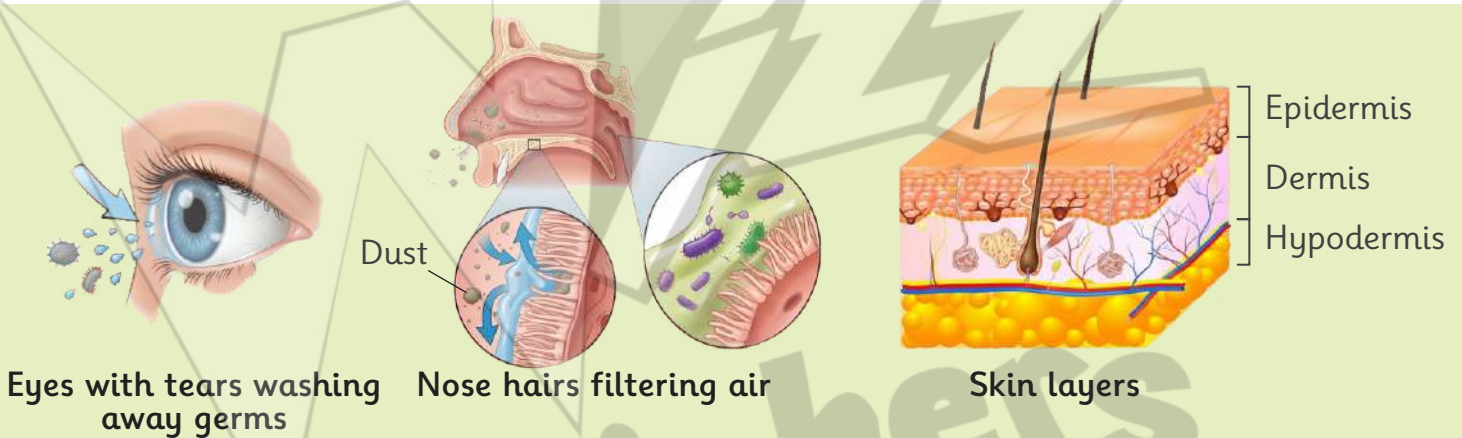
- The moist linings of organs such as the mouth, nose, lungs, and stomach are called **mucous membranes**. These secrete mucus, a sticky fluid that traps germs and prevents them from entering deeper tissues.
- The hairs in the nose filter dust, microbes, and pollutants from the air. The **cilia** (tiny hair-like structures) move these trapped particles toward the digestive system, where they are destroyed.
- **Saliva** in the mouth has antiseptic properties, killing germs in food and cleaning the teeth and oral cavity.
- Constant blinking of eyes and tears wash away pathogens, keeping our eyes safe.



Let's

Think *Aloud*

If our skin were not shedding dead cells, what would happen to the germs that land on it?



3.1.2 Chemical Barriers

The second protective layer comes from chemical substances in the body.

- The skin secretes acidic fluids that prevent bacterial growth.
- The stomach produces gastric juice containing hydrochloric acid, which destroys germs in food.
- An enzyme called lysozyme, present in tears, sweat, and saliva, breaks bacterial cell walls, killing them.
- Sebum, a fatty substance in sweat, forms a thin protective film on the skin that prevents microbes from multiplying.



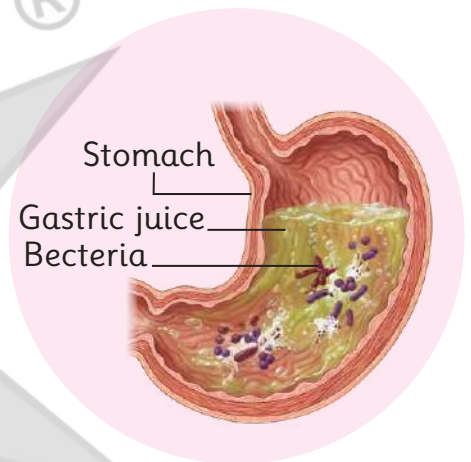
SciByte

Did you know? The hydrochloric acid in your stomach is so strong that if placed on metal, it could corrode it, yet it safely protects you by killing pathogens in food.

3.1.3 Nonspecific Defence

Sometimes pathogens manage to cross the first two barriers. In such cases, the body activates nonspecific defences like phagocytosis, inflammation, fever, and other immune responses.

- **Phagocytosis:** Special white blood cells called phagocytes surround and digest harmful microorganisms, removing them from the body.
- **Inflammatory response:** When tissues are damaged, the body responds with heat, redness, swelling, and pain. This is due to inflammatory cells rushing to the affected area. They destroy the pathogens and begin the healing process.



Activity Time!

Observing Body's Response to a Scratch

Objective: To understand how the body's nonspecific defences, such as inflammation, respond to minor injuries.

Resources:

- Magnifying glass
- Optional: notebook and pen to record observations

Instructions:

- Find a small scratch or minor cut on your hand (if you don't have one, ask your teacher for guidance on a safe alternative, like observing a healing scratch).
- Using a magnifying glass, observe the area carefully. Note any redness, swelling, or warmth.
- Continue to observe the scratch over a few hours and record any changes..
- Discuss with your classmates or teacher why your body reacts in this way when the skin is injured.

Answer the following questions:

- a. What changes did you notice in the scratch over time?

b. Why does the body cause redness, swelling, or warmth at the injury site?

c. How do these changes help protect the body from infections?

3.2 Immunity or Specific Defence

How does our body know exactly which germ is making us sick and how to fight only that one?

Our body has a highly advanced protection system called **immunity**, also known as specific defence. Unlike the general barriers that block all germs, immunity targets particular invaders with great precision.

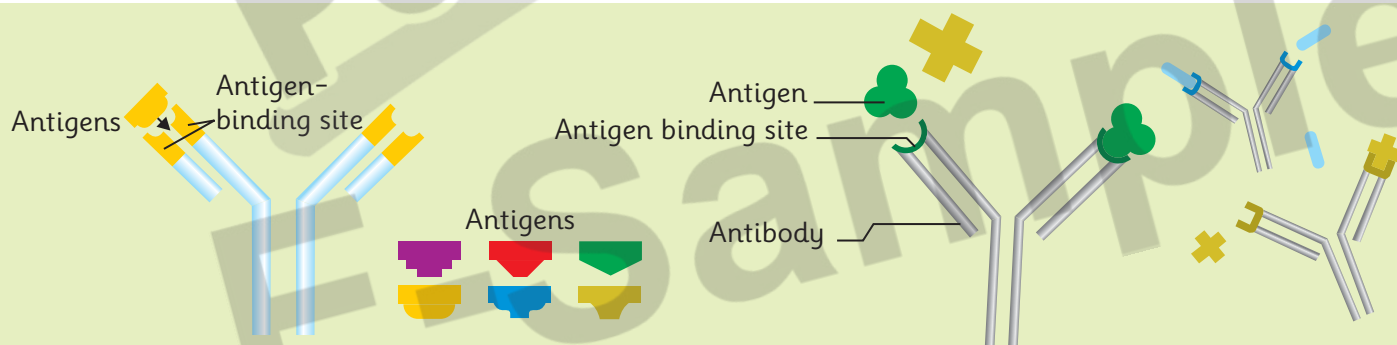
Pathogens such as viruses, bacteria, fungi, or toxins trigger our body to produce special proteins called antibodies. These antibodies are made by **lymphocytes** in response to unique markers on pathogens called antigens. Each antibody fits its antigen like a lock and key, neutralizing it. Because this defence acts only against specific antigens, it is called specific defence.

Two types of white blood cells; B-lymphocytes and T-lymphocytes play a central role in immunity.

- **B-lymphocytes** defend by producing antibodies and antitoxins. This action is known as the **humoral response**.
- **T-lymphocytes** attack pathogens directly. This is called the **cell-mediated response**.

 **Let's Think Aloud**

"Isn't it amazing that our body creates a special weapon (antibody) for every germ it meets—like having a tailor-made key for each lock?"

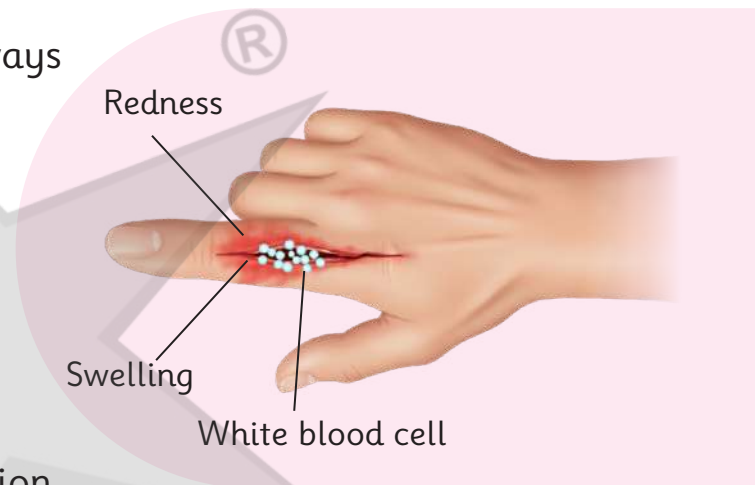


Antibodies match their specific antigens

3.2.1 Types of Immunity

Innate Immunity

This type of immunity is inherited from our parents and protects us from birth. It is always present in the body and responds very quickly, though less powerfully. Innate immunity gives a non-specific response, meaning it fights off invaders in general, not one particular germ. For example, redness and swelling around a wound happens when white blood cells rush to the injured site. This is an innate immune reaction.



SciByte

Did you know? Your innate immunity is like a security guard that never takes a break. It doesn't check "who" the invader is—it simply attacks anything harmful!

Adaptive Immunity

This is the immunity that develops after birth in response to exposure to specific germs or vaccines. Adaptive immunity is **slower to respond** (5–6 days) but much stronger and more precise. It creates a memory so the body can fight the same germ more quickly in the future.

Adaptive immunity has two types: **active** and **passive**.

Active Immunity

In active immunity, the body produces its own antibodies when exposed to pathogens. Although it takes time, the response is **stronger and long-lasting**. Vaccination is a good example: a weak or dead form of the pathogen is injected into the body so the immune system learns how to fight it.



Vaccines train the immune system.



Let's

Think Cloud

"Why do we get vaccinated as children? Because it's like giving our body a training session, so it remembers the germ and can fight it faster next time!"

Passive Immunity

Passive immunity occurs when ready-made antibodies are transferred into the body. This works quickly but does not last long, since the body did not make the antibodies itself. An example is the protection a baby gets from antibodies present in mother's milk.



SciByte

A mother's milk doesn't just provide food. It also passes immunity, giving babies a natural shield against many diseases!

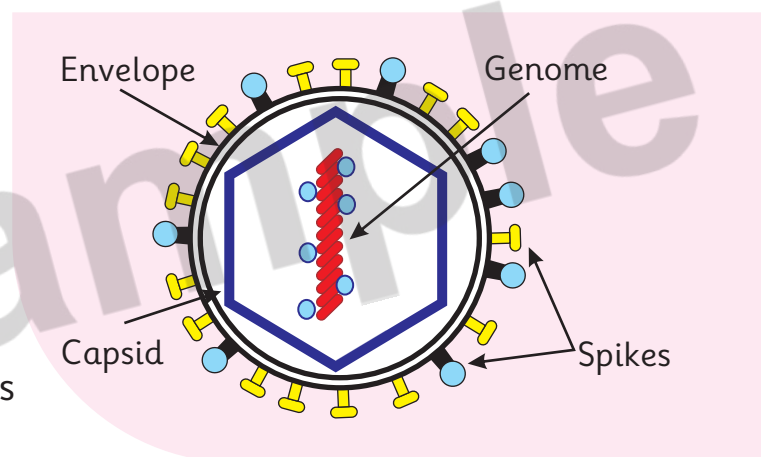
3.3 Pathogens Causing Infectious Diseases

Why don't all illnesses come from the same germ?

Different microorganisms, such as viruses, bacteria, fungi, and parasites, can enter our body and cause diseases. These harmful microbes are called pathogens, and the illnesses they cause are known as infectious diseases.

3.3.1 Viruses

Viruses are extremely tiny particles that cause many infectious diseases. A complete virus consists of its genetic material (genome) covered by a protein coat (capsid). In some viruses, there is an extra covering called the envelope, which may carry spikes. These spikes help the virus recognize and attach to a host cell.



Once inside a host cell, the virus takes over the cell's machinery and makes many copies of itself. After completing its replication cycle, the new viruses burst out, damaging and destroying the host cell. They then spread to infect other cells.

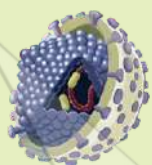
Some common viral diseases in humans are AIDS, COVID-19, hepatitis, polio, common cold, and measles.



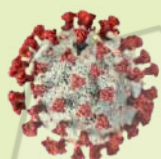
Let's

Think *Aloud*

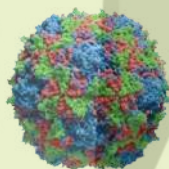
If antibiotics cure bacterial diseases, why don't they work on viruses like flu or COVID-19? This is because antibiotics cannot kill viruses!



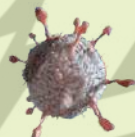
Hepatitis



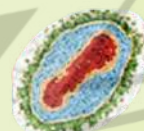
COVID-19



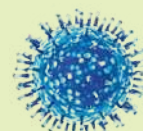
Polio



Measles



Smallpox



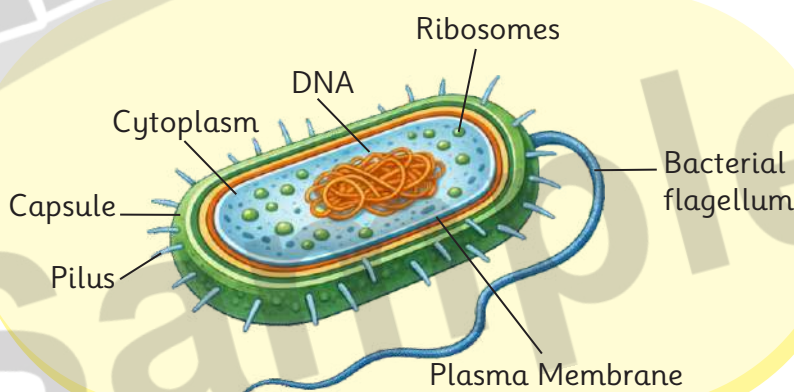
Common cold

Different viruses causing diseases.

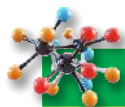
3.3.2 Bacteria

Bacteria are single-celled microorganisms found in all types of environments. A bacterial cell has:

- DNA (nucleoid) floating freely in the cytoplasm (not in a nucleus).
- A plasma membrane surrounded by a cell wall.
- In some cases, a protective capsule around the cell wall.
- Ribosomes for protein synthesis.
- Flagella for movement and pili for attachment to host cells



Diseases caused by bacteria include cholera, diarrhea, typhoid, tuberculosis, and tetanus.

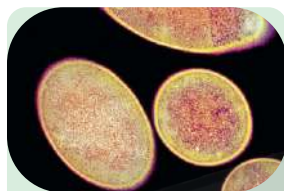


SciByte

Did you know? Not all bacteria are harmful, some live in our gut and actually help us digest food!



Cholera



Diarrhea



Typhoid



Tuberculosis



Tetanus

Bacteria causing diseases.

3.3.3 Fungi

Fungi can be single-celled (like yeast) or multicellular (like moulds and mushrooms). They do not make their own food since they lack chlorophyll. Instead, they often grow on decaying matter.

A fungal cell contains a true nucleus, mitochondria, endoplasmic reticulum, and golgi apparatus. They also have thick cell walls. The body of multicellular fungi is made up of filaments called hyphae, and they reproduce through spores.

Examples include yeast, mould, and mushrooms. Common fungal diseases in humans are athlete's foot, jock itch, and ringworm.



Yeast



Mould



Mushroom



Athlete's foot



Tetanus

Fungi causing diseases.



Let's

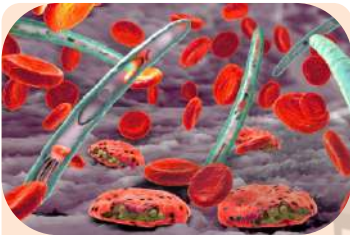
Think Aloud

Why does athlete's foot often spread in public showers or swimming pools? Because fungi grow well in warm, moist places!

3.3.4 Parasites

Parasites are organisms that live in or on another organism (the host) to obtain food. They can cause serious infections in humans.

- Endoparasites live inside the body, usually in the bloodstream or intestines. Examples: malarial parasite, tapeworm, roundworms.
- Ectoparasites live on the outside of the host. Examples: ticks, lice, mosquitoes.
- Larger worms are multicellular parasites that may live inside or outside the body.



Malaria parasite in blood cells



Tapeworm in intestines



Roundworm

Endoparasites



Tick on skin



Lice in hair



Roundworm

Bacteria causing diseases.



SciByte

Did you know? The malarial parasite is spread by female Anopheles mosquitoes. A single mosquito bite can inject these parasites directly into your blood!



Activity Time!

Pathogen Detective!

Objective: To identify different types of pathogens (virus, bacteria, fungi, parasites) and the diseases they cause.

Resources:

- Chart paper or worksheet with pictures/names of pathogens and diseases.
- Scissors (for cutting cards if using printed material).
- Glue or markers.

Instructions:

- Students will use/create cards/pictures of pathogens (virus, bacteria, fungi, parasite) and another set of cards with disease names.
- Their task is to match each pathogen with the disease(s) it causes.
 - ✓ Example: Match Virus → COVID-19.
 - ✓ Match Bacteria → Tuberculosis.
 - ✓ Match Fungi → Ringworm.
 - ✓ Match Parasite → Malaria.
- Once completed, groups will present their answers and explain why they matched them.

Answer the following questions:

a. Which pathogen causes malaria?

b. Which pathogen causes athlete's foot?

c. Can antibiotics cure viral diseases? Why?

d. How are fungi different from bacteria?

Avoiding Infections

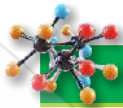
Have you ever wondered why washing your hands can stop you from getting sick?

Our bodies are constantly exposed to germs, which are tiny organisms that can cause diseases. Infections happen when these germs enter your body and multiply. You can protect yourself by following simple hygiene habits and safety measures:

- **Wash your hands regularly** with soap and water, especially before eating and after using the toilet.
- **Cover your mouth and nose** with a tissue or your elbow when sneezing or coughing.
- **Keep your surroundings clean** to reduce the number of germs around you.
- **Avoid close contact** with people who are sick.
- **Eat a healthy diet and get enough sleep** to strengthen your immune system.



By practicing these habits, you can reduce your risk of catching or spreading infections.



SciByte

Did you know? Handwashing with soap can reduce respiratory illnesses by up to 21% and diarrhea-related sickness by nearly 50%!



Activity Time!

Activity

Objective: Students will identify common ways germs spread and practice hygiene habits that prevent infections.

Resources:

- Soap and water
- Tissue papers
- Small bowls of coloured water or glitter (to represent germs)
- Paper towels

Instructions:

- Dip your hands into the "germ water" (coloured water or sprinkle glitter).

- Try to rub your hands together and notice how the “germs” spread.
- Wash your hands thoroughly with soap and water. Observe how the “germs” disappear.
- Discuss other ways germs can spread and how to stop them (covering sneezes, keeping surfaces clean).

Answer the following questions:

- What happened to the “germs” when you rubbed your hands together?

- How effective was washing hands in removing the “germs”?

- What other habits can prevent germs from spreading in your home or school?



What have you learnt?

- Our bodies are constantly exposed to **pathogens**, which are microorganisms that can cause infections.
- The body has two main defence systems: **physical barriers** and **immunity**.
- **Physical barriers** include skin, mucous membranes, nose hairs, cilia, saliva, and tears, which prevent pathogens from entering the body.
- **Chemical barriers**, such as stomach acid, lysozyme, and sebum, destroy germs and prevent their multiplication.
- **Nonspecific defences** like phagocytosis, inflammation, and fever attack pathogens that bypass the first two barriers.
- **Immunity** is the body’s specific defence system, targeting particular pathogens using antibodies produced by B-lymphocytes and T-lymphocytes.
- There are two types of immunity: **innate** (present at birth, non-specific) and **adaptive** (develops after exposure, specific and has memory).

- **Adaptive immunity** can be active (body produces antibodies, e.g., vaccination) or passive (antibodies received from another source, e.g., mother's milk).
- **Pathogens** that cause infectious diseases include viruses, bacteria, fungi, and parasites.

Good hygiene practices; like washing hands, covering sneezes, cleaning surroundings, avoiding sick people, eating healthy, and sleeping well help prevent infections.

Exercise

1 Choose the correct option.

- What is a pathogen?
 - A helpful microorganism
 - A disease-causing microorganism
 - A body cell
 - A nutrient
- Which of the following is the first line of defence in the human body?
 - Antibodies
 - Skin and mucous membranes
 - White blood cells
 - Vaccines
- What is the main function of mucous membranes?
 - Produce energy
 - Trap and stop germs from entering the body
 - Produce hormones
 - Digest food
- Which chemical in the stomach kills harmful germs?
 - Oxygen
 - Hydrochloric acid
 - Glucose
 - Enzymes only
- Which cells engulf and destroy pathogens?
 - Red blood cells
 - Phagocytes
 - Platelets
 - Nerve cells

- vi. What is the main function of antibodies?
- a To digest food
 - b To produce energy
 - c To neutralize specific pathogens
 - d To carry oxygen
- vii. Which type of immunity is present from birth?
- a Adaptive immunity
 - b Passive immunity
 - c Innate immunity
 - d Artificial immunity
- viii. What is the main purpose of vaccines?
- a To cure diseases instantly
 - b To replace white blood cells
 - c To train the immune system to recognize pathogens
 - d To kill all bacteria in the body
- ix. Which of the following is a viral disease?
- a Typhoid
 - b Tuberculosis
 - c COVID-19
 - d Cholera
- x. Which of the following is an ectoparasite?
- a Tapeworm
 - b Lice
 - c Malaria parasite
 - d Roundworm

2 Answer the following questions briefly.

- i. What are pathogens?
- ii. Name two physical barriers of the human body.
- iii. What is the role of phagocytes?
- iv. Differentiate between innate and adaptive immunity.
- v. Give two examples of viral diseases.

3 Answer the following questions in detail.

- i. Explain the three lines of defence in the human body with examples.
- ii. Describe how adaptive immunity develops over time.
- iii. Differentiate between viruses, bacteria, fungi, and parasites with one example each.
- iv. Explain how vaccination helps the immune system protect the body.

4 Match each term with its correct function. Write the correct number next to each function.

Skin

Phagocytes

Antibodies

Mucous membranes

Vaccination

Stomach acid

Kills germs in food entering the stomach

Engulfs and destroys harmful microorganisms

Produces specific proteins to neutralize pathogens

Traps germs in sticky mucus

Provides a physical barrier against pathogens

Trains the immune system to fight specific diseases



Constructed Response Questions

- i. Zara frequently falls ill because she does not follow proper hygiene practices such as handwashing and covering her mouth when sneezing.
 - How can poor hygiene increase the risk of infections?
 - Which line of defence is most affected when germs easily enter the body?
 - Suggest three ways Sara can protect herself from infectious diseases
- ii. There is an outbreak of dengue fever in Ahmed's community, and many people are getting sick. Ahmed is unsure how the disease spreads and how it can be controlled.
 - Explain how dengue is transmitted from one person to another. Also, suggest three effective preventive measures that Ahmed and his community can adopt to reduce the spread of the disease.



Disease Prevention Awareness Campaign

Objective: To understand infectious diseases and promote awareness of prevention methods.

Resources:

- Chart paper
- Colours and markers
- Pictures or drawings

Instructions:

- Choose one infectious disease (e.g., dengue, typhoid, COVID-19, hepatitis).
- Write how the disease is caused and how it spreads.
- Describe its symptoms.
- Explain methods of prevention.
- Create an awareness poster for school or community.
- Present your poster to the class and explain your message.

Expected Outcome:

Students will understand how infectious diseases spread and how hygiene, immunity, and awareness help prevent them.

Extension Question:

Why is it important for communities to follow hygiene practices together to prevent the spread of infectious diseases?

Students' Learning Outcomes

All students will be able to:

- Differentiate between physical and chemical changes using daily life examples.
- Explain the role of oxygen in processes such as combustion, rusting, and tarnishing.
- Identify and explore methods to prevent rusting of metals.
- Relate the uses of materials to their chemical properties, such as tendency to rust or flammability.
- Assess the impact of combustion reactions on the environment.
- Relate the uses of materials to their physical properties, such as melting point, boiling point, solubility, and thermal conductivity.
- Distinguish between physical and chemical properties of matter.

Let's Start!

- Can you name some changes you see at home every day like boiling water, burning paper, or melting ice?
- Do you think all changes are the same, or are some permanent while others are temporary?



THINK-PAIR-SHARE!

Take a moment to think about:

- The changes you see at home, such as boiling water, burning paper, or melting ice.
- Decide: are all these changes the same, or are some reversible while others are not?

Pair up with a classmate and share your examples.

Discuss: Which changes can be reversed (like melting ice) and which cannot (like burning paper)?

Each pair shares one key point with the class.



Activity Time!

Exploring Water in Different Forms

Objective: To help students distinguish between physical and chemical changes by observing changes in water.

Resources:

- A kettle (for steam)
- Freezer ice cubes
- Simple diagram cards of H_2O , H_2 , and O_2 molecules.

Instructions:

- Show students liquid water. Ask: What will happen if we heat this water?
- Boil the water and let students observe the steam. Discuss: Did the structure of water change? (H_2O stays H_2O) → Physical Change.
- Show ice cubes and ask: What is the structure of ice? (H_2O in solid form). Did the structure change when water froze? → Physical Change.
- Ask students: What happens if we pass electric current through water?

- (Demonstrate or explain: water splits into hydrogen (H_2) and oxygen (O_2)). → Chemical Change.

Answer these questions:

- a. What makes melting ice and boiling water physical changes?

- b. Why is passing electricity through water a chemical change?

- c. Can you think of other changes around you that are physical? What about chemical?



Let's

Think *Aloud*

"If some changes can be easily reversed, like ice melting back into water, why do others, like burning paper, seem impossible to undo?"

5.1 PHYSICAL AND CHEMICAL CHANGES

Have you ever noticed how ice melts into water but water turning into steam cannot be caught in the same cup? Why do you think this happens?

All changes in matter can be grouped into two main types:

- Physical changes
- Chemical changes

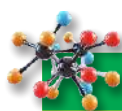
5.1.1 Physical Changes

A physical change is a change that affects the appearance or state of a substance but does not alter its chemical composition. These changes are usually reversible.

For example, when water freezes to form ice, it can melt back into water. Similarly, heating water to produce steam does not change the water chemically; cooling steam gives water again.

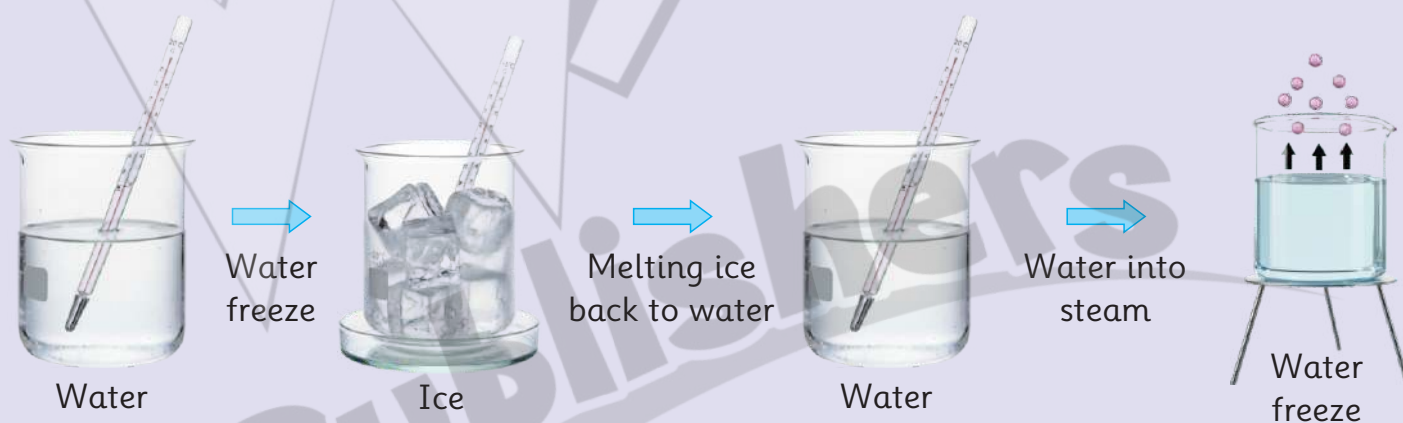
Other examples of physical changes include:

- **Melting of chocolate:** Solid chocolate melts into liquid chocolate when heated and solidifies again when cooled.
- **Dissolving sugar in water:** Sugar dissolves in water, forming a sweet solution, but can be recovered by evaporating the water.
- **Heating of metals:** Aluminum foil glows red when heated but returns to its original silver colour after cooling (as long as it doesn't melt).



SciByte

Did you know? Physical changes involve energy changes too, like heating or cooling, but the substance itself remains chemically unchanged!



5.1.2 Chemical Changes or Chemical Reactions

Why do you think burning wood cannot be turned back into the same wood?

A chemical change occurs when a substance changes its chemical composition and forms a new substance with different properties. These changes are generally irreversible by simple physical means. Examples include:

- **Rusting of iron:** Iron reacts with oxygen and moisture to form rust (iron oxide), which cannot revert to iron by simple methods.

- Digestion of food: Food is broken down into new chemicals for the body to use.
- Burning of paper or wood: The substance turns into ash, carbon dioxide, and other gases.



Let's

Think *Aloud*

What would happen if we tried to reverse a chemical reaction like burning a candle? Could it go back to the wax?

Terms:

- Reactants: Substances that take part in a chemical reaction.
- Products: New substances formed after the chemical reaction.

Heat and light

Ash



Carbon dioxide

Burning wood

Chemical changes produce new substances with different properties

5.1.3 Role of Oxygen in Natural Chemical Reactions

Combustion

Why does rubbing a matchstick make it ignite?

When a matchstick is struck, combustion occurs. Combustion is a chemical reaction where a substance reacts with oxygen, releasing heat and light.

Example: Burning charcoal in air: $C + O_2 \rightarrow CO_2 + \text{Heat}$

Rusting

Rusting is the slow chemical process in which iron reacts with oxygen and moisture (water or air containing water vapour) to form a reddish-brown flaky substance called rust (iron oxide). This weakens the iron and causes damage to objects made from it.

Iron exposed to air and moisture reacts with oxygen to form rust:

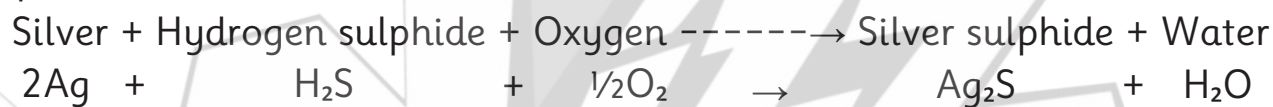


Tarnishing

When oxygen reacts chemically with other substances, the process is called **oxidation**. Combustion and rusting are common examples of oxidation. Another example is tarnishing. Tarnish is a thin layer of corrosion that forms on the surface of metals like silver, copper, brass, aluminium, and magnesium. This layer is usually dull, blackish, or gray in colour. Tarnishing occurs when oxygen in the air reacts with the surface of these metals. It can also happen when non-metals such as sulphur react with the outer layer of metal objects. Unlike rusting, which affects deeper parts, tarnish remains only on the surface.

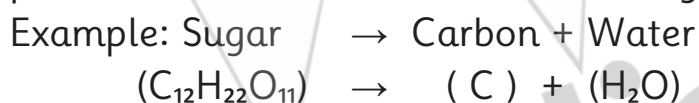
Tarnishing may also result from reactions with gases like hydrogen sulphide or sulphur dioxide. For instance, silver tarnishes quickly when exposed to hydrogen sulphide, but it can also tarnish slowly when exposed to oxygen over time.

Examples:



Heating sugar

When sugar is heated strongly, it breaks down into black carbon and water. The water escapes as steam. Since sugar turns into entirely new substances; carbon and water, that cannot be changed back into sugar by any physical means, this process is considered a chemical change.



Metals are often mixed with other elements to form alloys that resist rusting. This formation of alloys is also a chemical change.

Heating Potassium Chlorate

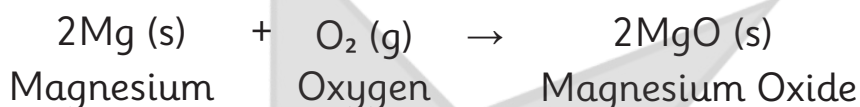
When potassium chlorate is heated in a test tube, it first melts into a transparent liquid. Upon further heating, bubbles of a gas are released, leaving behind a white solid, potassium chloride. The gas produced is oxygen.



Here, potassium chloride and oxygen are entirely different substances compared to potassium chlorate, proving it is a chemical change.

Burning Magnesium in Air

When a strip of magnesium ribbon is heated, it burns with a bright white flame and forms a white ash. This ash is magnesium oxide, a new compound with properties different from both magnesium and oxygen.



Original substances (Before reaction)		Reaction products (After reaction)	
Steel iron nails (Fe)			Rusted Oxide $\text{Fe}_2\text{O}_3 \cdot n\text{H}_2\text{O}$
British Crown, 1953 (Ag)			Silver Sulfide Ag_2S
Magnesium Metal (Mg)			Magnesium Oxide (MgO)
Sucrose (sugar) ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$)			Amorphous Carbon (C) and Water Vapor



Activity Time!

Observing Physical Vs Chemical Changes

Objective: Identify and compare physical and chemical changes in everyday materials.

Resources:

- Ice cubes
- Sugar
- Salt
- Candle
- Matches
- Small metal nail
- Glass of water
- Notebook.

Instructions:

- Show students liquid water. Ask: What will happen if we heat this water?



- Boil the water and let students observe the steam. Discuss: Did the structure of water change? (H_2O stays H_2O) → Physical Change.
- Show ice cubes and ask: What is the structure of ice? (H_2O in solid form). Did the structure change when water froze? → Physical Change.
- Ask students: What happens if we pass electric current through water?

Observation Table:

Material/Process	What Happened?	Physical or Chemical Change?
Water → Ice → Water		
Sugar in Water		
Candle Melting		
Candle Burning		
Rusting of Nail		

Answer the following questions:

- a. Which of the changes you observed could be reversed?

- b. Which changes created new substances?

- c. Why do you think some changes are reversible while others are not?

Comparison of Physical and Chemical Changes

Have you ever noticed how ice melts into water and then freezes back into ice again? Now think about how wood burns to form ash, can we turn that ash back into wood?

These everyday examples show us that some changes are easy to reverse while others are not. Let's compare physical changes and chemical changes to understand the difference more clearly.

Aspect	Physical Change	Chemical Change
Nature of Change	Only the physical properties (such as shape, size, or state) are altered.	The chemical properties change, resulting in entirely new substances.
Composition	The chemical composition remains the same.	The chemical composition changes, forming substances with new properties.
Reversibility	Usually reversible by simple physical methods.	Generally not reversible by physical means.

5.1.4 Impact of Combustion on Environment

Have you ever seen smoke rising from vehicles or chimneys and wondered what's actually in it?

When fuels are burned to meet our energy needs, they release different gases into the air. While combustion gives us useful energy, it also creates emissions that harm the environment. Let's look at the major products of combustion and how they affect our surroundings.

Products of Combustion

Carbon dioxide (CO_2), nitrous oxide (N_2O), water vapour (H_2O), methane (CH_4)

Carbon monoxide (CO), particulates (dust, soot, fumes)

Sulphur dioxide (SO_2), nitric oxide (NO), volatile organic compounds (VOCs)

Lead, sulphur (trace elements)

Effects on the Environment

Increase the greenhouse effect, leading to global warming.

CO is poisonous; both CO and particulates contribute to smog.

Cause smog and acid rain.

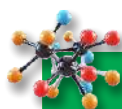
Potential carcinogens; linked to fatal diseases such as cancer.

Compounds of hydrogen with fluorine, chlorine, bromine, iodine

Potential carcinogens and contributors to global warming.



Combustion affects both the environment and human health



SciByte

Even though combustion gives us energy, the gases released can stay in the atmosphere and disrupt natural systems.



Activity Time!

Investigating Combustion Effects

Objective: Explore the effects of combustion on the environment and suggest possible solutions.

Resources:

- Chart paper

Instructions:

- Research common sources of combustion in daily life (e.g., vehicles, factories, burning wood).
- Create a table showing the pollutants released and their environmental effects.
- Present your findings to the class and discuss solutions such as cleaner fuels, renewable energy, and planting more trees.

Observation Table:

Source of Combustion	Pollutant Produced	Environmental Effect
Cars / Trucks		®
Factories		
Burning Wood / Forests		

Answer the following questions:

- Which pollutant is mainly responsible for global warming?

- How can smog formation be reduced in big cities?

- Suggest one renewable energy source that can replace fossil fuels.

5.2 Chemical Equation

Have you ever wondered what really happens when a candle burns, or when vinegar is mixed with baking soda? How can we record such changes in a simple, scientific way?

To make it easier to study and understand chemical reactions, scientists don't just describe them in words, they use special symbols and formulae. This way of writing is called a chemical equation, and it shows us exactly which substances take part in the reaction and what new substances are formed.

A chemical equation is the symbolic representation of a chemical reaction using symbols, formulae, and signs. It is a simple way to show what happens during a chemical reaction.

In a chemical equation:

- The substances that take part in the reaction are called reactants. They are always written on the left-hand side.
- The new substances formed are called products. They are written on the right-hand side.

- An arrow ($\rightarrow$) separates the reactants from the products and points toward the products, showing the direction of the reaction.

Example 1:

When **sulphur** reacts with **oxygen**, it produces **sulphur dioxide**.

Word equation: Sulphur + Oxygen $\rightarrow$ Sulphur dioxide

Symbol equation: $S(s) + O_2(g) \rightarrow SO_2(g)$

Here, (s) shows sulphur is in solid form, and (g) shows that oxygen and sulphur dioxide are gases.



Example 2:

When **zinc** reacts with **hydrochloric acid**, **zinc chloride** and **hydrogen** gas are formed.

Word equation: Zinc + Hydrochloric acid $\rightarrow$ Zinc chloride + Hydrogen

Symbol equation: $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

In this reaction:

- Zinc (Zn) is solid,
- Hydrochloric acid (HCl) is aqueous (dissolved in water),
- Hydrogen (H_2) is a gas.



Let's

Think Aloud

What would happen if we changed the amount of one reactant? How would that affect the products?

The equation also shows the ratio of substances: 1 mole of zinc reacts with 2 moles of hydrochloric acid to produce 1 mole of zinc chloride and 1 mole of hydrogen gas.



Activity Time!

Writing Simple Chemical Equations

Objective: Learn how to represent everyday reactions as chemical equations using symbols and formulas.

Resources:

- Coloured pens/pencils

- Baking soda
- Vinegar
- Small candle
- Matches (with supervision).

Instructions:

- Perform or observe simple reactions such as:
 - ✓ Mixing baking soda and vinegar (lots of fizz!)
 - ✓ Burning a candle (watch the flame carefully)
 - ✓ Rust forming on a nail (long-term observation)
- Identify the reactants (starting substances) and products (new substances formed).
- Use coloured pens to write chemical equations. (Reactants = blue, Products = red, Arrows = green).
- Fill in the templates below with correct formulas.
- Share your work with a partner and compare your results.

Fun Twist: Create a "Before and After" comic strip. Draw one box for the reactants and one for the products, then write the chemical equation underneath!

Equation Templates:

- Baking Soda + Vinegar → _____ + _____ + _____
- Wax (Candle) + Oxygen → _____ + _____
- Iron + Oxygen + Water → _____ + _____

Answer the following questions:

- In the baking soda + vinegar reaction, which substances are reactants and which are products?

- When a candle burns, what new substances are formed?

- How can you tell whether a substance is solid, liquid, or gas in your equations?

5.3 PHYSICAL AND CHEMICAL PROPERTIES

Why does ice feel cold, but sugar tastes sweet? How are these related to the substance itself?

Physical properties describe how a substance behaves without changing its chemical composition. Examples include:

- State of matter: solid, liquid, or gas
- Colour, taste, and odor
- Density, hardness, solubility, melting point, boiling point

(i) Hardness

Hardness is a measure of a material's ability to resist scratches. A harder substance can scratch softer ones.

For example:

- **Diamond** is extremely hard and can only be scratched by another diamond.
- **Graphite** is soft and can be scratched easily.



(ii) Solubility

Solubility is the maximum amount of a substance that can dissolve in 100 g of a solvent at a specific temperature.

- **Solute:** substance that dissolves (e.g., sugar)
- **Solvent:** substance that does the dissolving (e.g., water)

(iii) Melting Point

Have you ever watched an ice cube slowly turn into water on a warm day? At what temperature do you think this change happens?

The melting point is the specific temperature at which a solid begins to melt and turn into liquid. It is the temperature at which the solid and liquid states of a substance exist in equilibrium at standard pressure. For example, the melting point of water is 0 °C.

(iv) Boiling Point

Have you ever noticed how water starts bubbling and turning into steam when it is heated on the stove? At what point does this change happen?

The boiling point is the specific temperature at which a liquid begins to boil and changes from the liquid state to the gaseous state. At this temperature, the vapor pressure of the liquid becomes equal to the atmospheric pressure. For example, the boiling point of water is 100 °C under normal atmospheric pressure.



Melting and boiling points are physical properties of substances.

5.3.1 Chemical Properties

Chemical properties describe how a substance reacts with other substances, changing its chemical composition. These changes are chemical reactions.

Examples:

- Burning fuel
- Rusting of iron
- Reaction of acids with metals



Chemical properties involve the formation of new substances.



Let's

Think Aloud

Why can't we reverse burning or rusting by just cooling or drying? What has changed chemically?



Activity Time!

The Property Detectives

Objective: Solve the mystery of whether everyday observations belong to physical or chemical properties.

Resources:

- Detective notebook

- Magnifying glass (optional, fun prop)
- Items (sugar, iron nail, candle, vinegar)
- Coloured pens.

Instructions:

- Imagine you are a detective investigating clues left by substances.
- Observe the "clues" (melting, dissolving, rusting, burning, sour smell, shiny surface).
- Decide if each clue is a Physical Property (appearance, state, easy to reverse) or a Chemical Property (new substance formed, irreversible).
- Record your findings in your detective notebook under the right column.
- At the end, share your "case report" with the class.

Answer these questions:

- Which "clues" tell you that a new substance has been formed?

- Which "clues" only describe how the substance looks or behaves without changing its identity?

- If you had to give one golden rule to spot a chemical property, what would it be?

5.4 USING CHEMICAL PROPERTIES OF MATERIALS

Have you noticed that some substances burn easily while others do not, or that bleach removes stains so effectively?

These everyday observations are linked to chemical properties of materials. Let's explore how reactivity, acidity, and flammability make materials useful in daily life.

Reactivity

Reactivity is the tendency of a substance to undergo chemical changes. For instance, baking powder releases carbon dioxide when heated, which makes cakes and bread soft and fluffy. Similarly, chlorine reacts with stains,



Reactivity – substances changing when they react

giving it its bleaching ability, which is why it is widely used in detergents.

Acidity

Acidity refers to the ability of a substance to react as an acid. Hydrochloric acid in our stomach helps digest food. Acidity regulators in packaged foods preserve flavor and colour while preventing harmful microbial growth.



Reactivity: substances changing when they react



Flammability: ability of a substance to burn.

Flammability

Flammability is a material's ability to catch fire. Acetylene burns with oxygen to produce a high-temperature flame, which is used for welding and metal cutting.



Let's

Think Aloud

If we didn't know a substance's chemical properties, could we safely use it in baking, cleaning, or industrial work?



Activity Time!

Observing Chemical Properties

Objective: Identify and understand chemical properties in everyday materials.

Resources:

- Baking powder
- Vinegar
- Small flame source (teacher-supervised)
- Cloth with a stain

- Small amount of bleach (teacher-handled)
- Gloves and safety goggles

Instructions:

- Reactivity Test – Mix baking powder with water, then add a little vinegar. Watch the bubbles form (carbon dioxide gas is released).
- Bleaching Test – With gloves on, apply a small drop of bleach on a stained cloth and observe how the stain fades.
- Flammability Test – Teacher demonstrates by carefully lighting a small piece of paper or candle wick to show burning.
- After each observation, students record what property was shown: reactivity, bleaching (oxidation), or flammability.
- Discuss in groups: Why are these properties useful in our daily lives (e.g., cleaning, cooking, fuel use)?

Answer these questions:

a. Which substances showed reactivity?

b. Which substance was flammable?

c. How are these chemical properties useful in real life?

5.5 USING PHYSICAL PROPERTIES OF MATERIALS

Why does copper carry electricity while plastic does not?

Why does sugar dissolve in water but sand does not? These differences are examples of physical properties, which determine how substances are used in daily life.

Conductivity

Metals like copper conduct electricity and are used in household and industrial wiring.





Solubility

Have you ever added sugar to a glass of water or tea and noticed how it disappears, even though you can still taste it?

Solubility is a substance's ability to dissolve in a solvent. Water dissolves nutrients from food for absorption into the bloodstream and dissolves fertilizers for plant roots. Medicines are often dissolved in water for easy administration.

Freezing Point

Freezing preserves food and medicines. For example, ice cream and vaccines are stored at freezing temperatures to extend shelf life.



Boiling Point

Boiling points are used to separate components of crude oil in fractional distillation, natural gas, petrol, diesel, and other products are separated based on their boiling points.



SciByte

"Did you know that rocks heated deep in the Earth's crust melt to form lava, showing how extreme heat changes physical state?"



Activity Time!

Testing Physical Properties

Objective: Explore solubility and conductivity of everyday materials.

Resources:

- A glass of water
- Sugar
- Salt
- Copper wire
- Plastic strip
- Battery
- Small bulb
- Connecting wires



Instructions:

- Solubility Test – Add sugar to water and stir. Observe whether it disappears or remains visible. Repeat with salt.
- Conductivity Test – Set up a simple circuit using a battery and bulb. Connect the copper wire in the circuit and note if the bulb lights up. Then replace the copper wire with the plastic strip and observe.
- Record your results in two columns: "Soluble / Insoluble" and "Conducts / Does not Conduct."
- Share your findings with the class and discuss why these physical properties are useful in real life (e.g., sugar dissolves in tea, copper wires in electricity).

Answer these questions:

a. Which material allowed electricity to pass?

b. Which substances dissolved in water?

c. Why are solubility and conductivity important in daily life?

5.6 PREVENTION OF RUSTING

Have you ever wondered why metal tools, bikes, or gates start corroding over time? This happens because iron reacts with oxygen and moisture, forming rust. Let's learn how to protect metals from rusting using their chemical and physical properties.

Methods to Prevent Rusting

- **Applying oil** – Creates a barrier to keep air and moisture away.
- **Applying paint** – Protects the metal surface from contact with air and water.
- **Forming alloys** – Stainless steel is an alloy of iron resistant to rust.
- **Dry coatings** – Quick-drying coatings prevent moisture from reaching the metal.
- **Proper storage** – Storing metals in dry or low-moisture conditions slows rusting.
- **Galvanizing** – Coating iron with zinc forms a strong rust-resistant layer.
- **Coat powder** – Acrylic, vinyl, or epoxy powder protects metals from moisture.



Let's

Think Cloud

Why do you think we use stainless steel in kitchen sinks instead of ordinary iron?



Activity Time!

Testing Rust Prevention Techniques

Objective: To investigate and compare different methods of preventing rust on iron objects.

Resources:

- 3–4 clean iron nails (same size)
- Small beakers or plastic cups (one for each nail)

- Water (enough to half-fill each beaker)
- Cooking oil
- Paint (any quick-dry paint or nail polish works)
- Tissue or cloth
- Labels or sticky notes
- Notebook and pencil for recording observations

Instructions:

- Take three iron nails. Wipe them clean with a tissue or cloth to remove any dirt or grease.
- Coat one nail with oil, coat another with paint, and leave the third nail uncoated.
- Label each beaker (Oil-coated, Painted, Uncoated).
- Fill each beaker halfway with water and place one nail in each beaker.
- Leave the setup in the classroom or near a window where it can be observed daily.
- Over the course of one week, check the nails every day. Record any changes in colour, texture, or rust formation.
- At the end of the week, compare the three nails and discuss which protection method worked best.

Answer these questions:

a. Which nail rusted the most?

b. Which nail stayed protected for the longest time?

c. Why does coating with oil or paint prevent rusting?



What have you learnt?

- Substances have certain characteristics that distinguish them from each other; these are called their properties.
- **Physical properties** include state, colour, odour, taste, hardness, melting point, boiling point, solubility, and conductivity.

- **Chemical properties** include reactivity, flammability, acidity, burning of fuel, rusting of iron, and digestion of food.
- A change in the physical properties of a substance is called a physical change.
- **Physical changes** are usually reversible and do not alter the chemical composition of the substance.
- A change in the chemical properties of a substance is called a **chemical change** or chemical reaction.
- Chemical changes produce new substances with different properties and are generally irreversible by simple physical methods.
- The representation of a chemical reaction using symbols, formulas, and signs is called a chemical equation.
- Substances that take part in a chemical reaction are called reactants.
- Substances formed in a chemical reaction are called products.
- A **chemical reaction** of oxygen with some other substance is called oxidation.
- **Combustion**, rusting, and tarnishing are examples of oxidation.
- Both oxygen and moisture are needed for rusting to occur.
- **Measures to prevent rusting** of metals include applying oil or paint, using dry coatings, forming alloys such as stainless steel, galvanizing, and proper storage in dry conditions.

Exercise

1 Choose the correct option.

- i. Which of the following is a physical property of a substance?
- | | |
|--------------|----------------|
| a Reactivity | b Flammability |
| c Solubility | d Rusting |

- ii. Which change is an example of a chemical change?
- a Ice melting
 - b Water boiling
 - c Salt dissolving
 - d Iron rusting
- iii. In a chemical equation, the substances present before the reaction are called:
- a Products
 - b Reactants
 - c Catalysts
 - d Solvents
- iv. Which pair of conditions is necessary for rusting to occur?
- a Oxygen and heat
 - b Oxygen and moisture
 - c Moisture and darkness
 - d Heat and light
- v. Which of these is an oxidation reaction?
- a Mixing sugar in water
 - b Burning of wood
 - c Melting of ice
 - d Cutting of paper
- vi. Which property helps us separate sand from sugar when mixed?
- a Colour
 - b Solubility
 - c Odour
 - d Hardness
- vii. Which method prevents rusting by forming a protective zinc layer?
- a Painting
 - b Oiling
 - c Galvanizing
 - d Alloying
- viii. Why are physical changes usually reversible?
- a Because new substances are formed
 - b Because no new substances are formed
 - c Because energy is absorbed
 - d Because oxygen is not involved
- ix. When wood burns, it produces ash, carbon dioxide, and water vapour. What does this indicate?
- a It is a physical change
 - b It is a chemical change
 - c It is a reversible change
 - d It does not involve oxygen

- x. A student notices that milk turns sour if left outside. This is an example of:
- a Physical change due to cooling
 - b Chemical change due to bacteria
 - c Physical property of taste
 - d Physical change due to evaporation

2 Answer the following questions briefly.

- i. How would you explain the difference between **physical properties** and **chemical properties** with one example each?
- ii. Why is rusting considered a chemical change, while melting of ice is not?
- iii. If a student dissolves salt in water, what kind of change has taken place?
- iv. Justify your answer.
- v. Suggest two methods to prevent rusting of iron gates placed outside in rainy weather.
- vi. Why is it important to use chemical equations instead of long word statements in chemistry?

3 Answer the following questions in detail.

- i. Compare **physical changes** and **chemical changes** in terms of:
 - Effect on chemical composition
 - Reversibility
 - Examples from daily life
- ii. Imagine you are designing a science experiment for your classmates:
 - Show one physical change and one chemical change using simple household items.
 - Explain how the properties of substances help identify the type of change.
 - Suggest one real-life application of understanding chemical changes (e.g., in cooking, industry, or environment).

4 Complete the Equations

- i. $\text{Zn (s)} + \text{HCl (aq)} \rightarrow \text{-----} + \text{H}_2 \text{ (g)}$
- ii. $2\text{Mg (s)} + \text{O}_2 \text{ (g)} \rightarrow \text{-----}$
- iii. $\text{C (s)} + \text{O}_2 \text{ (g)} \rightarrow \text{-----}$
- iv. $2\text{KClO}_3 \text{ (s)} \rightarrow \text{-----} + 3\text{O}_2 \text{ (g)}$

5 What Went Wrong?

- i. Ali saw his mother boiling water in a kettle. He said, "Look! The water is changing into another substance."

What went wrong in Ali's statement?

- Boiling water is a chemical change.
- Boiling water is only a physical change.
- Water becomes a new substance after boiling.
- The steam formed has a different chemical composition than water.

- ii. Sana left her bicycle outside in the rain. After a few weeks, she noticed reddish-brown flakes on the metal and said, "My cycle just changed its colour physically."

What went wrong in Sana's explanation?

- Rusting is only a physical change.
- Rusting is both a physical and chemical change.
- Rusting is both a physical and chemical change.
- Rusting is a chemical change.
- Colour change in rusting has no link to chemical properties.

- iii. During a science activity, Hamza burned a strip of magnesium ribbon. It gave a bright white flame and turned into ash. He told his teacher, "The ash can be changed back into magnesium by cooling."

- What went wrong in Hamza's statement?
- Burning magnesium is a physical change.
- The ash is a different substance formed by a chemical change.
- Cooling can reverse a chemical reaction.
- Fire does not cause new substances to form.



Constructed Response Questions

- i. You left an iron gate outside during the rainy season and noticed rust forming. Which method would you use to prevent rusting next time and why?
- ii. Your friend spilled bleach on a coloured shirt. Explain what happened chemically and why bleach is used in cleaning.
- iii. You want to make a soft, fluffy cake at home. Which chemical property of baking powder helps in this?



Science Detectives: Uncovering Physical and Chemical Mysteries

Objective: To explore and investigate everyday changes, identify whether they are physical or chemical, and explain the science behind them in a creative way.

Resources:

- Notebook
- Pen/pencil
- Camera/phone (optional)
- Chart paper or computer for poster/slideshow.

Instructions:

- Walk around your home, school, or neighborhood and observe at least five changes (e.g., candle burning, chocolate melting, rust on a bicycle, fruit rotting, boiling water).
- For each change, record:
 - ✓ What happened?
 - ✓ Was it reversible or irreversible?
 - ✓ Did new substances form?
 - ✓ Is it physical or chemical? Why?
- Collect evidence by taking photos, drawing sketches, or recording short videos.
- Write detective-style "case reports" for each change (e.g., Case I: The Mystery of the Melting Ice).
- Present findings by creating either:
 - ✓ A Detective File Poster with case numbers, pictures/sketches, and explanations, OR
 - ✓ A short slide show / video report like a detective solving mysteries.
- Bonus: Suggest how each change could be useful in daily life.

Expected Outcome: Students will classify real-life changes as physical or chemical, justify their reasoning, and creatively present their findings in a detective-style format.

Students' Learning Outcomes

All students will be able to:

- Demonstrate how a solution is formed (using water as a universal solvent).
- Distinguish among solute, solvent, and solution; and between saturated and unsaturated solutions.
- Define solubility.
- Recognize that the amount of solute which can dissolve in a given solvent has an upper limit.
- Identify the factors which affect the solubility of a solute in a solvent and recognize the importance
- Explain what is meant by a concentrated and dilute solution.
- Identify ways of accelerating the process of dissolving materials in a given amount of water and provide reasoning (i.e., increasing the temperature, stirring, and breaking the solid into smaller pieces increases the process of dissolving).
- Explore the effectiveness of various cleaning solutions in cleaning tarnished and oxidized coins (STEAM)
- Make a rock candy with sugar using crystal seeding technique (STEAM).

Let's Start!

- When you mix sugar in water, why does it disappear even though you cannot see the particles anymore?
- How can you tell the difference between a dilute solution and a concentrated solution just by tasting or observing it?



THINK-PAIR-SHARE!

Individually, think about the sugar-water example. Why is the solution in one glass sweeter than the other when the amount of sugar is different? What does this tell you about dilute and concentrated solutions?

Turn to your partner and discuss:
Why do solute particles spread evenly in a solvent?
How does this explain why solutions look uniform everywhere?
Share one example from daily life of a dilute solution and a concentrated solution.

Pairs share their ideas with the class. Possible responses:
"Solutions are homogeneous because solute particles are too tiny to see and spread out evenly."
"A glass of juice with little sugar is dilute, but the same juice with extra sugar is concentrated."

7.1 UNSATURATED AND SATURATED SOLUTIONS

When you make lemonade, have you noticed that sugar sometimes keeps disappearing, but at other times it just sits at the bottom? Why does this happen?

This difference happens because not all solutions can hold the same amount of solute. Sometimes the water can still take in more sugar, and sometimes it has already reached its limit. To understand this, we need to learn about the types of solutions.

Solutions are mixtures where a solute (like sugar or salt) dissolves in a solvent (like water). Depending on how much solute is present, a solution can be unsaturated or saturated.

Unsaturated Solution

If 5g of salt is added to 500 ml of water and stirred, the salt dissolves completely. If more salt is added, it still dissolves. This type of solution is called unsaturated because it can still dissolve more solute at that temperature.



Unsaturated Solution

Saturated Solution

If salt keeps being added to the same water, a point will come where no more salt dissolves. The excess salt stays at the bottom. This solution is called saturated. At this stage, the solvent has reached its maximum capacity for holding solute at that temperature.

Example: Hot tea can hold more sugar than iced tea, which is why sweetening cold drinks is harder.



Adding sugar to hot and cold tea.



Let's

Think Aloud

If we heat a saturated solution, will it be able to dissolve more solute? Why or why not?

7.2 SOLUBILITY

Why does salt disappear in water but not in oil?

This difference happens because not all substances behave the same way in different solvents. Some substances mix well, while others do not.

A substance that dissolves in a solvent is called soluble. A substance that does not dissolve is called insoluble. For example, sugar is soluble in water but insoluble in oil.

But every solvent has a limit. Once that limit is reached, the solution becomes saturated. The exact amount of solute that can dissolve at a particular temperature is called its **solubility**.

Examples:

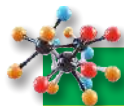
- Sodium nitrate dissolves better in water than silver chloride.



Salt settling in a glass of oil

- Sulphur dioxide dissolves better in water than carbon dioxide.
- Naphthalene dissolves in benzene but not in water.

Solubility is the maximum amount of solute that can dissolve in 100g of solvent at a specific temperature.



SciByte

Do you know why the ocean is salty? Rivers dissolve minerals like sodium chloride from rocks and carry them to the sea, where the salts remain dissolved. Over millions of years, the oceans became salty!



Activity Time!

Which Dissolves, Which Doesn't?

Objective: To test how sugar dissolves in different solvents and compare their effectiveness.

Resources:

- Four cups (with water, oil, vinegar, and soda)
- Sugar
- Spoon

Instructions:

- Fill four separate cups: one with water, one with oil, one with vinegar, and one with soda.
- Add one spoonful of sugar into each cup.
- Stir well and observe what happens.
- Record your observations about which solutions dissolved the sugar fully, partially, or not at all.



Answer the following questions:

- In which liquids did sugar dissolve completely?

- In which liquids did sugar not dissolve at all?

- What does this tell you about the solubility of sugar in different solvents?

- Why do you think sugar dissolves better in some liquids than in others?

7.2.1 Factors Affecting Solubility

Why do soda bottles fizz more when left in the sun than when chilled?

To answer this, we need to look at the factors that affect how substances dissolve. Solubility isn't the same for all materials, it depends on the nature of the solute and solvent, the temperature, and the pressure.



- **Nature of Solute and Solvent:** The principle is "like dissolves like." Ionic solutes (like table salt) dissolve in ionic solvents (like water). Covalent solutes (like oils or wax) dissolve in covalent solvents (like alcohol or kerosene).
- **Temperature:** Most solids dissolve better in hot liquids. For gases, it's the opposite. Their solubility decreases with heat. That's why soda goes flat when it warms up.
- **Pressure:** Gases dissolve more when pressure is high. This is why soda is bottled under high pressure to keep the gas in.



Let's

Think Aloud

Why do you think deep-sea creatures need special adaptations?
(Hint: gases behave differently under high pressure in the ocean.)



Activity Time!

Soda Showdown

Objective: To observe how temperature affects the solubility of gases in liquids.

Resources:

- Two soda bottles (one chilled, one kept outside in the sun)

Instructions:

- Take one soda bottle from the fridge (chilled) and one that has been kept outside in the sun (warm).
- Open both bottles at the same time.
- Carefully observe the fizzing in each bottle.
- Compare the amount of gas released from each.



Temperature affects gas solubility in liquids.

Answer the following questions:

- Which soda bottle fizzed more when opened?

- What does this tell you about the solubility of gases at higher and lower temperatures?

- How is this observation related to real-life situations, like keeping drinks cold?

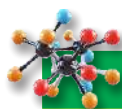
- Why do you think sugar dissolves better in some liquids than in others?

Everyday Applications of Solubility

Solubility is not just science; it is part of daily life and industries.

- **Carbonated drinks:** Carbon dioxide stays dissolved in cold soda due to solubility.
- **Paints:** Solvents like alcohol and turpentine dissolve paints and help them dry quickly.

- **Textiles:** Dyes dissolve in water to color fabrics.
- **Medicine:** Drugs must be soluble to reach the right concentration in the body.
- **Petroleum:** Solubility rules help in refining fuels.



SciByte

Ever wondered why doctors say to take some medicines with water? Many tablets won't dissolve in your stomach unless water helps break them down!



Activity Time!

Colour It!

Objective: To observe how solubility is used in the dyeing process and understand its importance in industries.

Resources:

- Two small pieces of white cloth
- Two cups
- Plain water
- Fabric dye (mixed with water)

Instructions:

- Place one piece of cloth into the cup with plain water.
- Place the other piece of cloth into the cup with dyed water.
- Leave both pieces for a few minutes.
- Take them out and compare how they look.

Answer the following questions:

a. What difference do you see between the two pieces of cloth?

b. How does the solubility of dye in water help in changing the cloth's color?



- c. Why is solubility an important factor for textile industries?

7.3 WAYS OF ACCELERATING THE PROCESS OF DISSOLVING MATERIALS

Why do you stir sugar in tea instead of waiting for it to dissolve on its own?

The process of dissolving can be made faster by:

- Reducing the particle size of the solute
- Stirring the solution
- Increasing temperature

Particle Size

Have you ever noticed that powdered sugar disappears almost instantly in your tea, while a sugar cube takes much longer? This happens because of the size of the solute particles.

Smaller particles have a larger surface area in contact with the solvent. The greater the surface area, the more quickly the solvent molecules can interact with and pull apart the solute particles. This makes the dissolving process faster.

For example:

- **Powdered sugar** has many tiny particles, giving it a huge surface area. That's why it dissolves quickly in water.
- **Sugar cubes**, on the other hand, have fewer exposed surfaces. The water can only act on the outside layer first, so it takes more time for the cube to dissolve completely.



This principle is used in real life:

- In the **pharmaceutical industry**, medicines are often ground into fine powders to make them dissolve faster in the body.
- In **cooking**, powdered spices spread and dissolve more quickly than whole ones, giving stronger flavor in less time.



Activity Time!

Cube vs Powder

Objective: To investigate how particle size affects the rate of dissolving.

Resources:

- One cup of water with powdered sugar
- One cup of water with a sugar cube
- Two spoons

Instructions:

- Drop a spoon of powdered sugar into one cup of water.
- Drop a sugar cube into the other cup of water.
- Observe both cups carefully.
- Note which one disappears faster.

Answer the following questions:

- a. Which dissolved faster: the powdered sugar or the cube?
-
- b. Why do smaller particles dissolve more quickly than larger ones?
-
- c. Can you think of other examples where particle size matters in daily life (e.g., cooking, medicine)?
-



Smaller particles dissolve more quickly.

Stirring

When you stir a mixture, you're not just moving the spoon, you're also moving the solute and solvent particles around. This constant movement spreads the solute more evenly throughout the solvent, so fresh solvent particles can reach the solute faster. As a result, the dissolving process speeds up.



Without stirring, solute particles may just settle at the bottom, and only the surrounding solvent does the dissolving. Stirring prevents this by keeping both

the solute and solvent in motion, allowing them to interact more effectively.

For example:

- When you add sugar to tea or coffee, stirring helps it dissolve quickly and evenly.
- In cooking, stirring soups or sauces helps salt, sugar, or spices spread out evenly instead of staying concentrated in one spot.
- In medicine, stirring a powdered oral solution ensures the patient receives the correct dose, instead of the drug collecting at the bottom.



Activity Time!

Stir and Wait

Objective: To explore the effect of stirring on the rate of dissolving.

Resources:

- Two cups of water
- Equal amounts of sugar
- One spoon

Instructions:

- Add the same amount of sugar to both cups of water.
- Stir one cup continuously while leaving the other cup still.
- Observe the time taken for sugar to dissolve in both.
- Record your observations.

Answer the following questions:

a. In which cup did the sugar dissolve faster?

b. How did stirring affect the dissolving process?

c. Why do we usually stir when making drinks like tea, coffee, or lemonade?

Temperature

Hot liquids dissolve solids faster because molecules move quickly. For gases, however, higher temperatures reduce solubility.



Activity Time!

Ice Tea vs Hot Tea

Objective: To investigate how temperature affects the solubility of solids in liquids.

Resources:

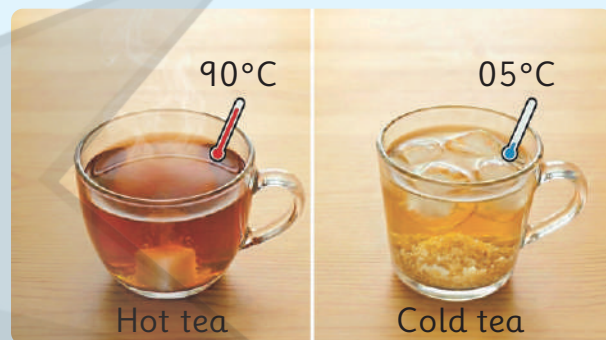
- One cup of hot tea
- One cup of iced tea
- Equal amounts of sugar
- Spoon

Instructions:

- Add the same amount of sugar to both cups of tea.
- Stir each cup for the same duration.
- Observe how easily sugar dissolves in hot tea compared to iced tea.
- Record your findings.

Answer the following questions:

- a. In which cup did the sugar dissolve more easily?
-
- b. What does this experiment show about the effect of temperature on solubility?
-
- c. Can you give other real-life examples where hot liquids dissolve substances faster than cold ones?
-



What have you learnt?

- Unsaturated solutions can dissolve more solute, while saturated ones cannot.
- Solubility is the maximum amount of solute that can dissolve in 100 g of solvent at a specific temperature.
- Factors affecting solubility: solute-solvent nature, temperature, and pressure.

- Dissolving can be accelerated by reducing particle size, stirring, and heating.
- Solubility has practical applications in food, medicine, industry, and daily life.

Exercise

1 Choose the correct option.

- When more salt can still dissolve in water at a given temperature, the solution is _____.
 - saturated
 - unsaturated
 - concentrated
 - supersaturated
- A solution that has reached its maximum capacity to dissolve solute at a particular temperature is _____.
 - Dilute solution
 - Saturated solution
 - Weak solution
 - Unsaturated solution
- Which of the following substances is insoluble in water?
 - Sugar
 - Salt
 - Oil
 - Baking soda
- Which factor decreases the solubility of gases in liquids?
 - Decreasing pressure
 - Increasing temperature
 - Decreasing temperature
 - Increasing pressure
- A student opens a soda bottle. Why do bubbles appear?
 - Solubility of CO_2 increases when pressure is reduced
 - Solubility of CO_2 decreases when pressure is reduced
 - Temperature inside the bottle drops suddenly
 - The soda becomes saturated with sugar

- vi. Which best explains why sugar dissolves faster in hot tea compared to cold water?
- a Increased stirring
 - b Reduced solubility at higher temperatures
 - c Solubility of solids increases with temperature
 - d Size of sugar particles is bigger in hot tea
- vii. Imagine you are preparing medicine in liquid form. Why is solubility important?
- a To make it taste sweet
 - b To ensure the right concentration of drug dissolves in the solution
 - c To make the medicine look colorful
 - d To prevent the drug from dissolving
- viii. "Like dissolves like" means:
- a Ionic solutes dissolve best in ionic solvents, and covalent solutes in covalent solvents
 - b All solutes dissolve equally in any solvent
 - c Water dissolves only ionic compounds
 - d Temperature does not affect solubility
- ix. In the textile industry, dyes must be soluble in water because:
- a They evaporate easily
 - b They need to stick evenly to fabric
 - c They are insoluble in solvents
 - d They react with fibers
- x. If you wanted to dissolve rock salt faster in water, which method would be most effective?
- a Using cold water and no stirring
 - b Crushing the salt, stirring, and using warm water
 - c Adding more salt than needed
 - d Leaving the solution undisturbed

2 Draw Venn diagrams to compare the following:

- i. Saturated solution and Unsaturated solution.
- ii. Effect of temperature on solubility of solids and of gases.

3 Answer these questions briefly.

- Define solubility in your own words.
- Give one daily life example of the importance of solubility in medicines.
- Does sugar dissolve faster in hot tea than in cold water? Why?
- Write one difference between soluble and insoluble substances.

4 Answer these questions in detail.

- Explain how the nature of solute and solvent affects solubility with examples.
- Describe three practical uses of solubility in industries.
- Discuss how pressure affects the solubility of gases in liquids, using soda water as an example.
- How do size of particles and stirring influence the process of dissolving?



Constructed Response Questions

- Sana added salt to her lemonade, and it dissolved completely. Later, she added more salt but it stayed at the bottom. What type of solution did she form in each case? Explain.
- A factory uses dyes to colour fabrics. Explain why solubility is important in the textile industry.
- Ahmed opened a soda bottle at a party, and bubbles appeared immediately. Explain the scientific reason for this observation.
- You are asked to prepare a concentrated sugar syrup for sweets. Which factors will you use to dissolve sugar faster?

5 Real-Life Triggers

- If you were asked to design a drink that always keeps its fizz, what scientific changes would you suggest?
- Imagine a new solvent is discovered that can dissolve both ionic and covalent compounds. How could this impact industries?





Solubility in Daily Life

Objective: To investigate how different substances dissolve in various solvents and how temperature affects solubility, linking it to everyday situations like cooking, medicine, and cleaning.

Resources:

- Sugar, salt, sand, water (room temperature and hot), cooking oil, 6 glasses, spoons, and chart paper for recording results.

Instructions:

- Collect three solids (sugar, salt, sand) and two solvents (water and cooking oil). Keep one set of water at room temperature and another heated.
- Test solubility in room temperature water: stir sugar, salt, and sand separately and observe if they dissolve fully, partially, or not at all.
- Test solubility in oil: stir sugar, salt, and sand separately and record your observations.
- Test solubility in hot water: stir sugar, salt, and sand separately and compare with room temperature water.
- Record findings in a table:

Substance	Water (Room Temp)	Water (Hot)	Oil
Sugar	Dissolved fully	Dissolved faster & more	Did not dissolve
Salt			
Sand			

- Prepare a colourful poster or chart with observations, drawings, and explanations.

Expected Outcome: Students will demonstrate that sugar and salt dissolve in water but not in oil, and that higher temperature increases solubility. They will relate solubility to real-life examples like making tea, medicine absorption, and cleaning.

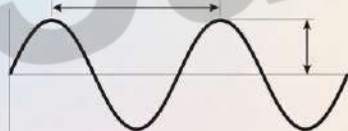
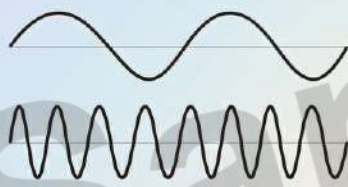
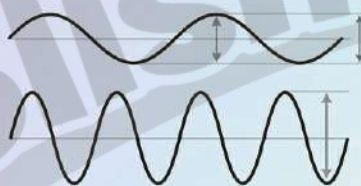
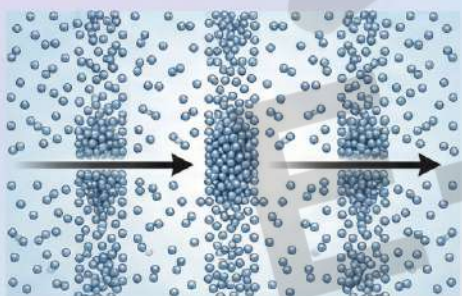
Students' Learning Outcomes

All students will be able to:

- Define a wave.
- Compare the types of waves (mechanical and electromagnetic) with daily life examples.
- Distinguish between Longitudinal and Transverse waves.
- Identify: water wave and sound wave as mechanical wave; light wave as electromagnetic wave.
- Define the terms: Wavelength, frequency, and time period of wave.
- Define and relate: Pitch and frequency, Amplitude and frequency.
- Explain the factors affecting pitch and loudness of sound.
- Compare and interpret waveforms in terms of pitch and loudness.
- Construct the inverse relation between time period and frequency.
- Relate common phenomenon (e.g., echo, hearing thunder after seeing lightning) to the properties of sound.

Let's Start!

- Have you ever felt the vibration of a mobile phone on a table or the strings of a guitar when plucked? What did you notice?
- Why do you think astronauts in space cannot talk to each other without special equipment, even if they shout loudly?



THINK-PAIR-SHARE!

Individually, read each statement about sound. Decide if you think it is correct (C) or incorrect (I).

- The speed of sound in air is about 300 m/s.
- The speed of sound in glass is about 4,500 m/s.
- Sound cannot pass through liquids.
- Sound travels faster in steel than in air.

Discuss your answers with your partner. For the incorrect statements, work together to rewrite them correctly.

Share your corrected versions with the class. The teacher will confirm and explain why the correct answer is true.

9.1 Waves

Have you ever seen a flag fluttering on a windy day? What do you notice; does the air itself rush across the field with the flag, or is something else happening?

When the wind blows across the flag, it makes the cloth flap back and forth. The air particles vibrate and transfer energy, creating waves of motion in the fabric. The flag itself doesn't move across the field; instead, the energy of the wind travels through it.

In the same way, think about dropping a pebble onto the surface of a drum. The drumhead shakes, and the vibrations travel through the air as sound waves. The air particles don't travel all the way to your ears; they just pass the energy along, one to the next, until the sound reaches you.



- Waves are therefore carriers of energy.
- They can travel in different forms, depending on the medium.

Types of Waves:

- **Mechanical waves:** These need a medium (solid, liquid, or gas) to travel.
Example: sound waves.
- **Electromagnetic waves:** These do not need a medium and can travel through space. Example: light waves.

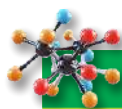


Let's

Think *Cloud*



If sunlight travels through empty space, what would happen if light waves also needed air to move? Would Earth receive sunlight?



SciByte

Did you know the same kind of waves that travel on water also occur deep underground during earthquakes? Scientists call them seismic waves, and they help detect the strength of earthquakes.

9.2 Mechanical Waves

Mechanical waves are further divided into two main types:

- Transverse waves
- Longitudinal waves

9.2.1 Transverse Waves

Have you ever played with a rope, shaking one end up and down? What did you see traveling along it?

A transverse wave is a wave in which the particles of the medium vibrate perpendicular to the direction of wave motion.

- The highest point of the wave is called the **crest**.
- The lowest point of the wave is called the **trough**.
- A complete cycle consists of one crest and one trough.

Transverse waves can be produced in solids (like a stretched string) or on the surface of liquids. They do not form in gases.

Rope/Slinky Demo

Take a slinky or rope. Fix one end and move the other up and down. Notice how the disturbance moves forward while each coil only moves up and down. These are transverse waves.



Let's

Think *Aloud*



If the rope particles only move up and down, how does the wave still carry energy forward?

9.2.2 Longitudinal Waves

What happens when you push and pull a slinky spring placed on a table?

In a longitudinal wave, particles of the medium vibrate parallel to the direction of wave travel. As waves travel, the medium experiences two key changes in particle arrangement.

- Compression: When particles are close together (high pressure region).
- Rarefaction: When particles are far apart (low pressure region).



Activity Time!

Making Waves with a Rope

Objective: To observe how compressions and rarefactions (or disturbances) travel through a medium.

Resources:

- A long rope or skipping rope
- A fixed support (hook, door handle, or a friend holding one end).

Instructions:

- Tie or hold one end of the rope firmly to a support.
- Hold the free end of the rope and quickly push and pull it forward and backward in a straight line.
- Watch how sections of the rope move closer together (compressions) and spread apart (rarefactions) as the disturbance travels along the rope.

- Repeat the motion several times to see the pattern clearly.

Answer the following questions:

- What do you notice moving along the rope — the rope itself or the disturbance?

- How can you identify compressions and rarefactions in the rope's motion?

- What does this experiment tell us about how sound waves travel through air?

Example: Sound waves are also longitudinal waves.



Activity Time!

Watching Sound Move Air

Objective: To observe how sound waves make air particles vibrate.

Resources:

- Small candle
- Matchbox/lighter (teacher use only)
- Loudspeaker/mobile phone with loud music.

Instructions:

- Place a lit candle on a safe surface (teacher-supervised).
- Put a loudspeaker or mobile phone playing music close to the candle.
- Watch the flame carefully as the sound plays.
- Notice how the flame flickers back and forth when the sound is louder.

Answer the following questions:

- What did you notice happening to the candle flame when the sound played?

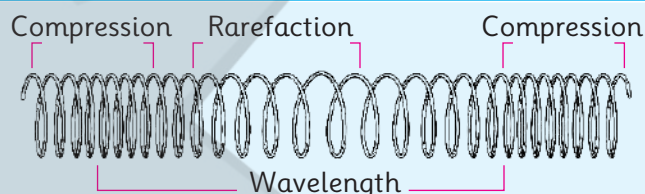
- What does the flickering flame tell us about how air particles move when sound travels?

- c. How is the flame's motion similar to the vibration of air particles in sound waves?



Let's Think Aloud

If air particles only vibrate back and forth, why do we hear sound far away instead of just at the source?



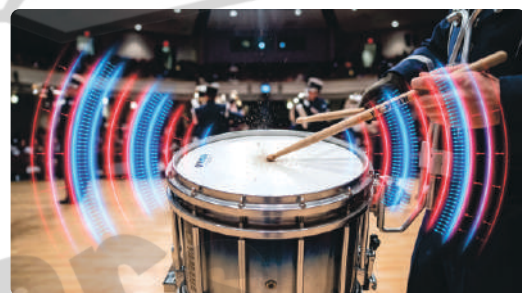
9.3 Sound as a Compressional Wave

When someone beats a drum, how does its sound reach your ears?

When the diaphragm of a drum vibrates, it pushes and pulls air particles:

- Moving outward creates a compression (high pressure zone).
- Moving inward creates a rarefaction (low pressure zone).

As the diaphragm continues vibrating, a series of compressions and rarefactions travel outward. This chain reaction is what we call a sound wave.



Sound waves as compressional waves

Thus, sound travels as a longitudinal compressional wave in air.

9.4 BASIC TERMS RELATED TO WAVES

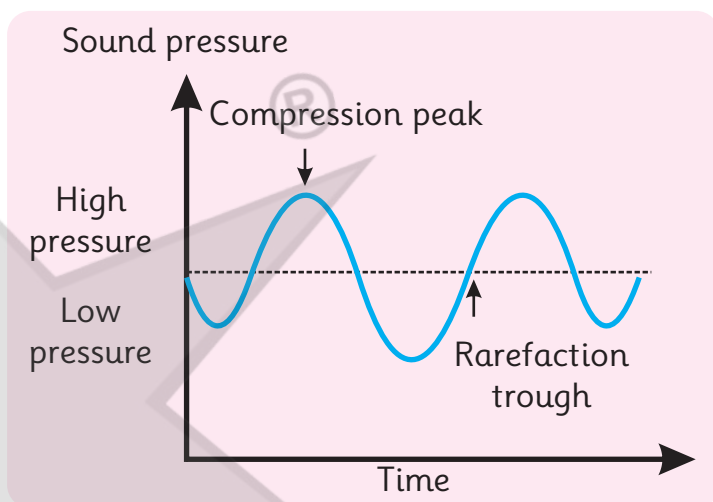
When you hear a drum or see ripples in a pond, what different features of the wave can you notice; how high it is, how far apart the ripples are, or how quickly they repeat?

To describe and compare waves we use a small set of key words; amplitude, wavelength, frequency and time period. These tell us about the size, spacing and timing of waves so we can predict how they behave.

Sound pressure vs time

If you plot sound pressure on the vertical axis and time on the horizontal axis, the trace moves above and below the normal atmospheric pressure as compressions and rarefactions pass by.

- The pressure is highest in the middle of a compression and lowest in the middle of a rarefaction.
- That up-and-down swing is what our ears detect as sound.



Amplitude

The amplitude of a wave is the maximum displacement of the vibrating particles from their mean (rest) position.

- Unit: metre (m).
- For sound: larger amplitude → louder sound; smaller amplitude → quieter sound.



Let's

Think Cloud

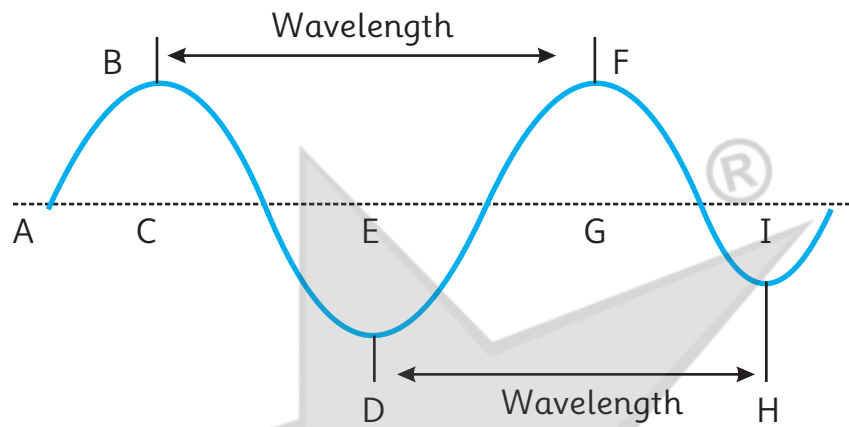
If you clap softly then clap loudly, which clap has the larger amplitude? Why do you think our ears register the loud clap as "bigger"?

Wavelength (λ)

Wavelength (λ) is the distance between centers of two consecutive compressions (or two consecutive rarefactions) in a longitudinal wave, or crest to crest / trough to trough in a transverse wave.

- Unit: metre (m).
- Symbol: λ (lambda).

Wavelength tells us about the spatial size of one wave cycle; how "far" a single wave extends in space.

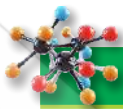
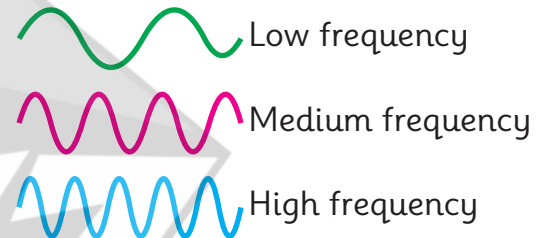


Frequency (f)

Frequency is the number of complete waves (or vibrations) produced in one second.

- Symbol: f .
- Unit: Hertz (Hz) (1 Hz = 1 cycle per second).

Example: $f = 4$ Hz means 4 vibrations every second.



SciByte

Bats use ultrasonic frequencies (well above human hearing) to "see" by echo — some bats emit calls above 100 kHz.

Time period (T)

Time period (T) is the time taken to complete one full cycle (one vibration). It is the reciprocal of frequency:

$$T = \frac{1}{f} \quad \text{and} \quad f = \frac{1}{T}$$

- Unit: second (s).

Wavelength and frequency are related for a wave that travels at speed v : $v = f\lambda$. So, for a given wave speed, increasing f causes λ to decrease, and vice versa.



Let's

Think Aloud

If a sound wave in air has a fixed speed, how does its wavelength change when you whistle faster (higher frequency)?



Activity Time!

Making Ripples in Water

Objective: To observe how frequency, amplitude, and wavelength affect water waves.

Resources:

- Shallow tub or bowl of water
- Pencil or finger.

Instructions:

- Fill the tub halfway with water.
- Dip the tip of a pencil straight up and down near the edge of the tub at a steady pace.
- Watch the circular ripples spreading outward.
- Try dipping faster and then harder to notice the changes in the ripples.

Answer the following questions:

a. What happens to the number of ripples when you dip faster? (frequency)

b. What happens to the height of ripples when you dip harder? (amplitude)

c. Does dipping faster change the spacing between ripples? (wavelength)



Problem 9.1:

An object produces a sound with frequency 60 Hz. Find its time period.

Solution (step by step):

Given: $f = 60 \text{ Hz}$

Use $T = 1/f$

$$T = \frac{1}{60} = 0.016666\dots \text{s} \approx 0.0167 \text{ s.}$$

Answer: $T \approx 0.0167 \text{ s.}$

Problem 9.2:

A pendulum oscillates 48 times in 6 seconds. Find its frequency and time period.

Solution (step by step):

- Frequency $f = \frac{N}{t} = \frac{48}{6} = 8 \text{ Hz.}$
- Time period $T = \frac{1}{f} = \frac{1}{8} = 0.125 \text{ s.}$

Answer: $T = 8 \text{ Hz, } T = 0.125 \text{ s.}$

Audible frequency range

Can humans hear every sound animals make? Why not?

Human hearing is limited. Sounds we can hear are audible; others are not.

- Human audible range: $\sim 20 \text{ Hz to } 20,000 \text{ Hz (20 kHz).}$
 - ✓ Below 20 Hz $\rightarrow$ infrasound (inaudible to humans).
 - ✓ Above 20 kHz $\rightarrow$ ultrasound (inaudible to humans).

Let's explore available frequency range of some more living things

Subject	Lower Limit (Hz)	Upper Limit (Hz)
Dog	40 Hz	50 kHz
Cat	45 Hz	65 kHz
Cow	23 Hz	35 kHz
Rabbit	360 Hz	42 kHz
Mouse	1 kHz	91 kHz
Bat	2 kHz	120 kHz

Elephant	16 Hz	12 kHz
Goldfish	20 Hz	3 kHz
Dolphin	2 kHz	150 kHz
Owl	200 Hz	12 kHz



Activity Time!

Counting Vibrations

Objective: To measure frequency of vibrations and explore limits of human hearing.

Resources:

- Small eraser 25 cm string
- Stopwatch
- Stretched rubber band

Instructions:

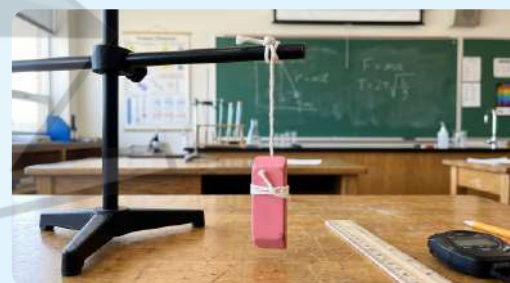
- Tie the eraser securely to one end of the string to make a simple pendulum.
- Set the pendulum swinging and count the number of oscillations in 60 seconds.
- Divide the total oscillations by 60 to calculate frequency (oscillations per second).
- Now pluck a stretched rubber band and try to detect how fast it vibrates.
- Listen carefully: can you hear the vibrations? Can you actually count them per second?

Answer the following questions:

a. How many oscillations did your pendulum make in one minute?

b. What was the frequency of your pendulum's motion?

c. Why is it difficult to count the vibrations of the rubber band?



d. What does this tell us about the limits of human hearing?



SciByte

Bats and dolphins use ultrasonic signals (well above 20 kHz) for navigation and hunting. Dogs hear higher-pitched whistles humans cannot.

9.5 CHARACTERISTICS OF SOUND

Two instruments play the same note; one sounds “high” and thin, the other “deep” and booming. What makes them different?

Sound differs in pitch, loudness and quality (timbre). We’ll explore pitch and loudness in the next sections.

9.4.1 Pitch of Sound

The feature of sound that helps us tell apart a **sharp sound** from a **deep** one is called the pitch of sound. For example, compare the sound of a flute and a drum. The flute produces a sharp, high-pitched sound, while the drum makes a deep, low-pitched one.

Let us try an activity to understand pitch. Take a ruler and place one end firmly on the edge of a table while the other end sticks out. Pluck the free end of the ruler gently, it will start vibrating and produce a sound. Now press the ruler further inside the table so that only a short length is left outside, then pluck it again. Notice the difference: the shorter length vibrates faster and produces a higher-pitched sound. The longer length vibrates slower and produces a lower-pitched sound.

In the same way, the pitch of sound depends on how fast or slow vibrations are. Faster vibrations mean higher frequency, and therefore, higher pitch. Slower vibrations mean lower frequency and a deeper pitch.

This is why the whistle of a bird sounds sharper than the moo of a cow.

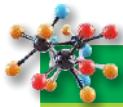
Similarly, children usually have high-pitched voices compared to adults, and women's voices are generally higher in pitch than men's.



Let's

Think *Cloud*

If two identical cords vibrate at different frequencies, which will sound higher? How can musicians use string length and tension to control pitch?



SciByte

Human male voices average around 85–180 Hz, female voices 165–255 Hz.

9.4.2 Loudness of Sound

What happens if you blow gently into a whistle and then blow with full force?

The loudness of a sound mainly depends on its amplitude (how far the vibrating object moves back and forth).

- Stronger vibrations → larger amplitude → louder sound.

We can make the same sound source louder or softer by changing the force used.



Activity Time!

Blowing Across a Bottle

Objective: To explore how blowing strength changes loudness while pitch depends on air vibrations.

Resources:

- Empty glass bottle.

Instructions:

- Hold an empty glass bottle upright.
- Blow gently across its mouth and listen to the soft sound produced.
- Now blow harder across the bottle mouth and notice the change in loudness.
- Compare the pitch (highness or lowness) of the sound when blowing gently and when blowing strongly.

Answer the following questions:

- a. What difference do you notice between gentle blowing and strong blowing?
-
- b. Did the pitch of the sound change when you blew harder, or did it remain the same?
-
- c. How do you think the shape and air inside the bottle affect the pitch of the sound?
-



Activity Time!

Design Your Own Rubber Band Guitar

Objective: To explore how sound is produced and how its pitch and loudness change with thickness, tightness, and force of vibration.

Resources:

- A sturdy shoebox
- Three rubber bands of different thickness
- Tape (if needed)
- A pencil/pen for plucking.

Instructions:

- Stretch three rubber bands of different thickness around the shoebox. Keep some tight and some loose.
- Pluck each band one by one and carefully listen to the sound produced.

- Compare the sounds by investigating:
 - ✓ **Thick vs. thin bands:** Thicker bands produce deeper sounds.
 - ✓ **Loose vs. tight stretch:** Tighter bands produce higher-pitched sounds.
 - ✓ **Plucking gently vs. strongly:** Stronger plucks produce louder sounds, though pitch remains the same.
- Record your observations in a simple table.



Expected Outcome: Students will understand that sound is caused by vibrations and that its pitch depends on the thickness and tightness of the vibrating band, while loudness depends on how strongly it is plucked.



Let's Think Aloud

Why does tightening a guitar string raise its pitch? (tension increases frequency)



SciByte

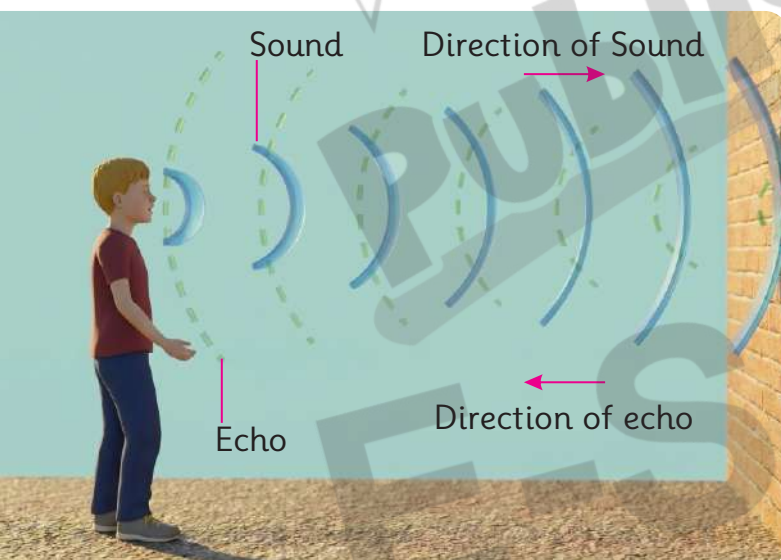
Doubling the amplitude of a sound does not double the perceived loudness. Loudness is a complex logarithmic sensation measured in decibels.

9.4.3 Echo

Have you ever shouted in an empty room and heard your voice come back?

An echo is a reflected sound wave heard after the original sound because the wave bounced off a surface and returned.

For a distinct echo, the reflecting surface should be at least about 17 m away (gives a sufficient time delay for human ears to separate original and reflection).





Activity Time!

Talking Through a Toy Telephone

Objective: To demonstrate how sound can travel through solids.

Resources:

- Two empty tin cans or paper cups
- Long piece of string
- Nail (for making holes)
- Tape.

Instructions:

- Use a nail to make a small hole in the base of each can (teacher-supervised if using tin cans).
- Thread the string through both holes and tie a knot at each end so it doesn't slip out.
- Pull the string tight and keep it stretched.
- One student talks into one can while another listens at the other end.
- Switch roles and observe how sound travels.

Answer the following questions:

a. What happened when you spoke into the can?

b. How did the sound travel from one can to the other?

c. What does this experiment show about sound traveling through solids?

Thunder and lightning:

Lightning is seen immediately (light travels $\sim 300,000$ km/s). Thunder is heard later because sound travels much slower (~ 340 m/s in air). The time gap helps estimate distance to the lightning.



Do you know?

- Dolphins detect echoes underwater and can "see" with sound pulses hundreds of metres away.
- Sound travels faster in solids and liquids than in gases, which is why miners can hear machinery through rock before they hear it through air.

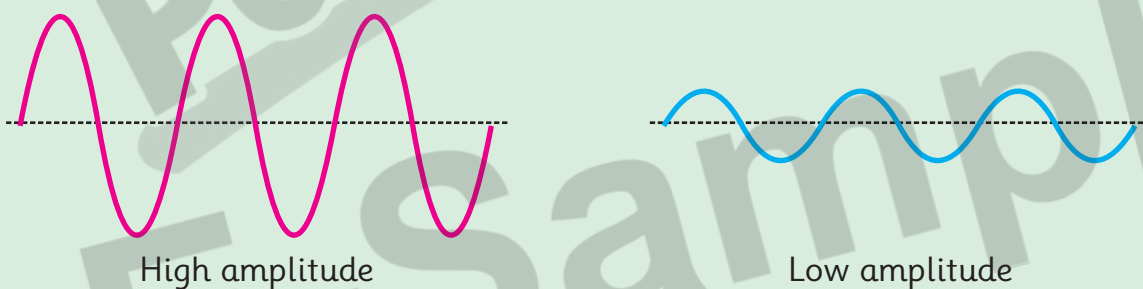
Relationship of amplitude and frequency

Which wave carries more energy; one with higher amplitude or one with higher frequency?

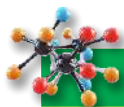
Amplitude and energy: The amplitude of a wave is like the "height" of the wave's vibration. Larger amplitude means each vibration is stronger, so every single wave carries more energy. For example, if you hit a drum softly, the sound wave has small amplitude (low energy), but if you strike it hard, the wave has large amplitude (high energy).

Frequency and energy transfer: Frequency tells how many waves pass a point in one second. If the amplitude is the same, a higher frequency wave delivers more energy per second because more waves are passing through. For example, a mosquito's wings flap very quickly, creating a high-frequency buzzing sound that transfers energy rapidly compared to the slow wing beats of a butterfly.

Combined effect: So, both matter. A wave with large amplitude and high frequency is the most powerful. Imagine ocean waves: a tall wave (high amplitude) carries huge force, but when many such waves crash one after another in quick succession (high frequency), the energy hitting the shore is much greater than a single big wave arriving slowly.



More energy per wave" and "more waves per second



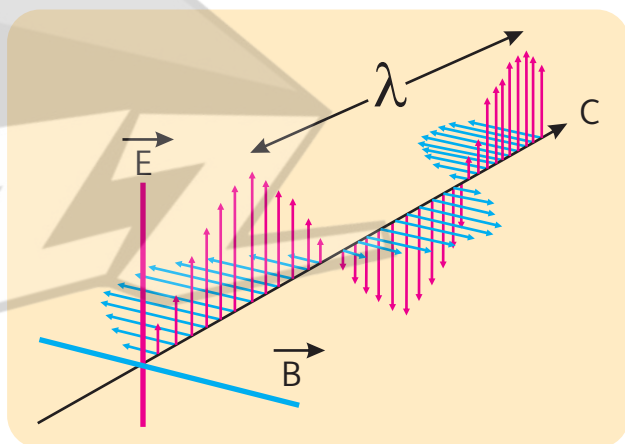
SciByte

In medical ultrasound, high-frequency sound waves carry energy into tissues; adjusting amplitude and frequency changes imaging resolution and penetration.

9.6 ELECTROMAGNETIC WAVE

Have you ever thought about how your TV, mobile phone, or even a microwave oven can work without any visible connection — almost like magic?

The secret lies in something we cannot see: electromagnetic (EM) waves. These waves are created when electric fields and magnetic fields vibrate together. Unlike sound, which needs air to travel, EM waves can move through the vacuum of space, carrying energy from one place to another. In fact, the sunlight we see with our eyes is only a tiny portion of the vast electromagnetic spectrum.



Let's

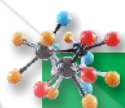
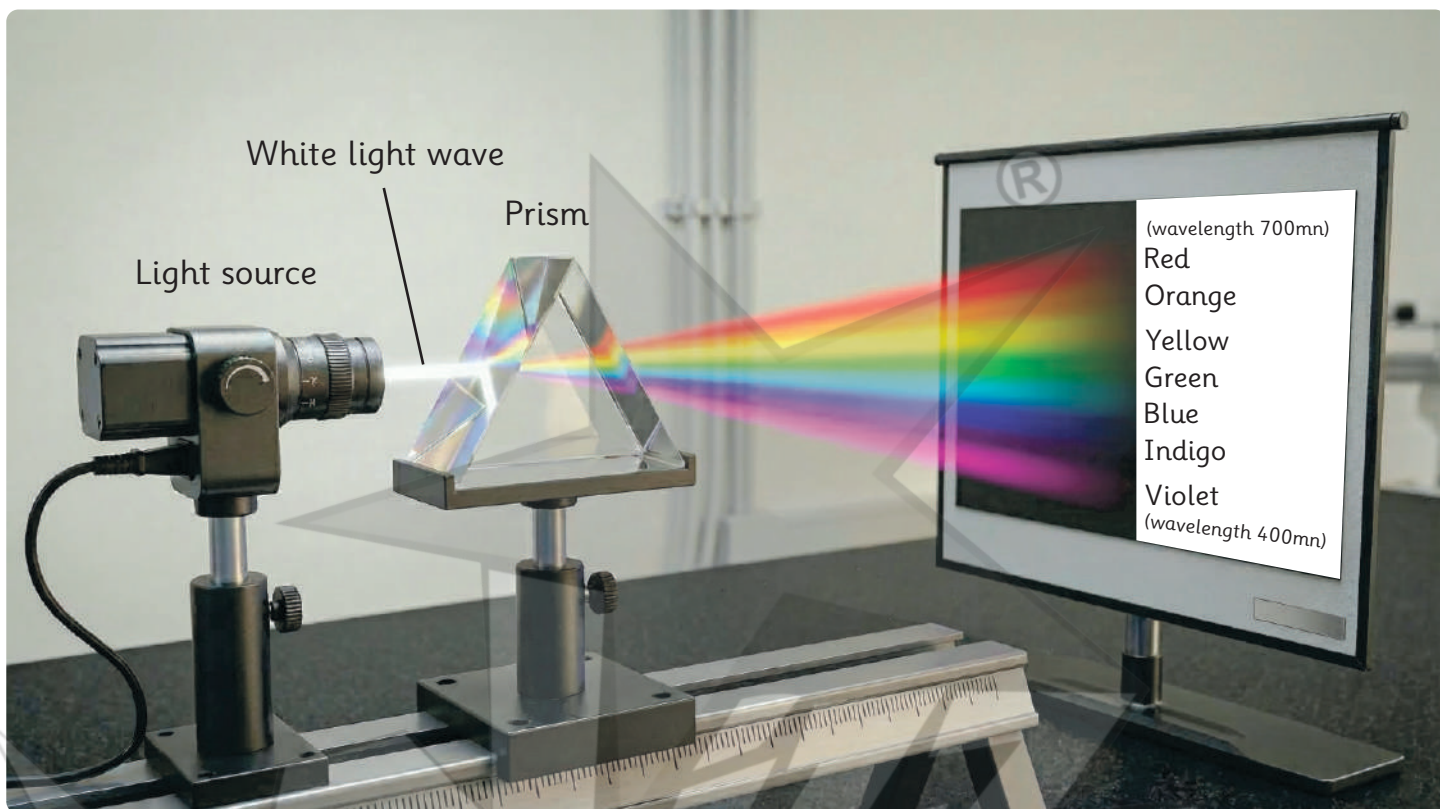
Think Aloud

Why do you think electromagnetic waves are so special compared to sound waves? (Hint: Think about how sunlight reaches Earth through the vacuum of space!)

The Visible Spectrum

Our eyes can detect only a small part of EM waves, called visible light. Its wavelength ranges from **400 nm (violet)** to **700 nm (red)**.

When white light from the Sun passes through a glass prism, it bends and splits into seven colors: **Violet, Indigo, Blue, Green, Yellow, Orange, and Red (VIBGYOR)**



SciByte

Did you know that bees can see ultraviolet (UV) light? That's why flowers often have UV patterns to attract them, which humans cannot see with the naked eye!

Properties of Light Waves

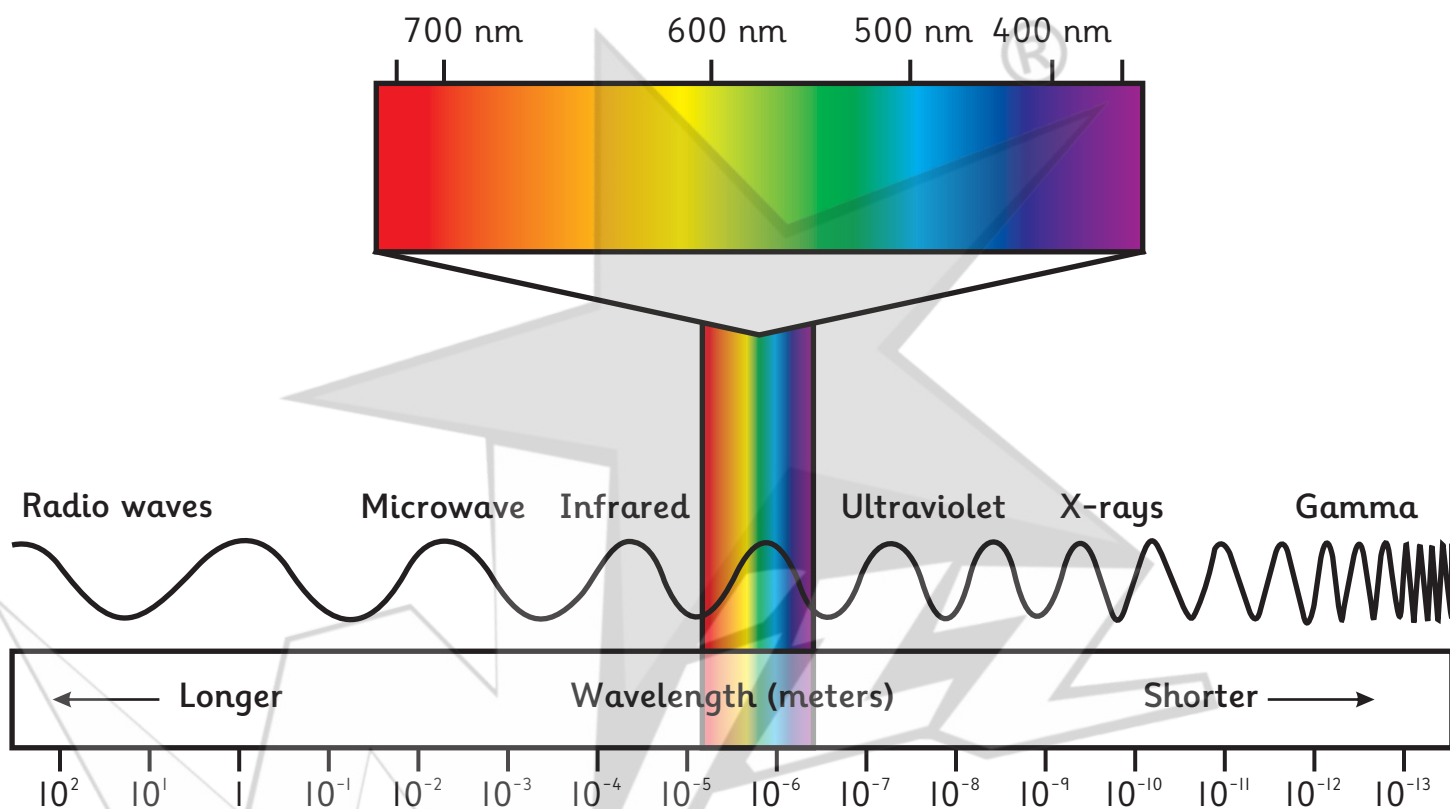
Unlike sound waves, light waves don't need a medium to travel. This is why sunlight reaches us through the vacuum of space. Light can be classified based on its frequency or wavelength.

Applications of Electromagnetic Waves

Electromagnetic waves are everywhere in our daily life! Here are some of their uses:

- **Radio Waves:** Used in communication systems, radios, telephones, and television.
- **Microwaves:** Used for cooking, since they heat up water and fat in food.
- **Infrared Waves:** Used in remote controls and short-range communication.
- **Visible Light:** Allows us to see the world around us.
- **Ultraviolet (UV) Rays:** Used for sterilization because they kill bacteria.

- **X-rays:** Used in hospitals to look at bones inside the body.
- **Gamma Rays:** Used in radiotherapy to destroy cancer cells.



Activity Time!

Exploring the Invisible Spectrum

Objective: To investigate different parts of the electromagnetic spectrum around us.

Resources:

- TV remote control
- Mobile phone with camera
- Sunny day (or rainbow photo)
- Internet or textbook for research.

Instructions:

- Point a TV remote at your phone's camera and press any button. Notice the flashing light on the screen, this is infrared radiation, which our eyes cannot see directly.

- On a sunny day, look for a rainbow in the sky. Compare it to how a prism splits white light into many colours.
- Research or discuss in class: Which types of electromagnetic waves are used for Wi-Fi and Bluetooth signals?

Answer the following questions:

- What did you observe on your phone screen when pressing the remote button?

- How is a rainbow similar to light passing through a prism?

- Which electromagnetic waves are used in Wi-Fi and Bluetooth communication?



What have you learnt?

- **Waves** transfer energy without transferring matter.
- **Mechanical waves** need a medium (air, water, solid) to travel.
- **Electromagnetic waves** can travel even in empty space.
- **Transverse waves:** vibrations are at right angles to the wave's direction.
- **Longitudinal waves:** vibrations are in the same direction as the wave's travel.
- **Sound waves** are longitudinal, while **light waves** are electromagnetic.

Wavelength is the distance between two compressions or rarefactions.

- **Frequency** is the number of waves passing a point per second.
- **Amplitude** determines the loudness of sound.
- **Echo** is heard when sound reflects back from a hard surface.
- Louder sound depends on **amplitude, surface area of vibration,** and distance from the source.

Exercise

1 Choose the correct option.

- i. Which type of electromagnetic wave has the longest wavelength?
- a Gamma rays
 - b X-rays
 - c Microwaves
 - d Ultraviolet
- ii. The human eye can detect only a small portion of the electromagnetic spectrum. This portion is known as _____.
- a infrared light
 - b visible light
 - c ultraviolet light
 - d x-rays
- iii. A student places food in a microwave oven. The food becomes hot mainly because microwaves _____.
- a heat the air inside the oven
 - b heat the oven's walls
 - c vibrate the water molecules in the food
 - d reflect off the metal surface
- iv. Which of the following correctly matches an electromagnetic wave with its application?
- a Radio waves – sterilization
 - b Infrared waves – remote control
 - c Gamma rays – sending TV signals
 - d X-rays – cooking
- v. Light from the Sun is passed through a glass prism. The colours appear in a sequence because _____.
- a the prism changes their frequency
 - b each colour bends at a different angle
 - c the prism increases their wavelength
 - d colours are absorbed differently

- vi. A doctor wants to check a patient's bones without surgery. Which electromagnetic wave will be most useful?
- a Infrared waves
 - b Gamma rays
 - c Ultraviolet rays
 - d X-rays
- vii. Which statement is true about electromagnetic waves?
- a They need air to travel
 - b They cannot move through a vacuum
 - c They consist of both electric and magnetic fields
 - d They are always visible to the human eye
- viii. A factory uses UV lamps to sterilize its equipment. Why are UV rays effective for this purpose?
- a They carry very low energy
 - b They have high energy that can kill bacteria
 - c They can pass through metal surfaces
 - d They produce heat quickly
- ix. Imagine scientists discover a new type of wave with a wavelength of 1000 meters. Compared to visible light, this wave would be _____.
- a higher in frequency and energy
 - b lower in frequency and energy
 - c exactly the same as violet light
 - d invisible but in the ultraviolet region
- ix. Which of the following best explains why gamma rays can be dangerous to humans?
- a They are part of the visible spectrum
 - b They have very long wavelengths
 - c Their high energy can damage cells and DNA
 - d They only heat up the skin

2 Answer these questions briefly.

- i. Define electromagnetic waves in your own words.
- ii. What is the visible light spectrum and its wavelength range?
- iii. Name two electromagnetic waves with higher frequency than visible light.
- iv. Name two electromagnetic waves with longer wavelength than visible light.
- v. Why is violet light bent more than red light in a prism?

3 Read the problem statements carefully and solve.

- i. A student shines white light into a prism. The violet light emerges at 400 nm and the red at 700 nm. Explain why these colours separate.
- ii. Suppose a microwave oven operates at a wavelength of 0.12 m. What type of electromagnetic wave is this, and why is it suitable for heating food?
- iii. An X-ray machine emits radiation with a wavelength of 1×10^{-10} m.
- iv. Compare its energy with visible light and explain why safety precautions are necessary.
- v. If the frequency of a radio wave is 100 MHz (100×10^6 Hz), calculate its wavelength. (Use $c = 3 \times 10^8$ m/s)
- vi. A hospital uses gamma rays for cancer treatment. Explain the advantage and risk of using gamma rays in medicine.

4 Higher-Order Thinking Questions

- i. Why are gamma rays used in cancer treatment but dangerous for healthy tissue? Suggest one way to minimize risks.
- ii. Imagine humans could see beyond 700nm into infrared. How might daily life or technology be different?
- iii. If you were to invent a new device using any part of the EM spectrum, which wave would you choose and why?

Students' Learning Outcomes

All students will be able to:

- Design a model to demonstrate drip and sprinkler irrigation system for conservation of water.
- Use different techniques of preserving foods like orange juice, apple jam and pickles.
- Make a simple Stethoscope.
- Make a sanitizer using suitable substances.

Let's Start!

- Why do some plants and vegetables grow only in certain seasons?
- How can milk be turned into different products like yogurt, butter, or cheese?



THINK-PAIR-SHARE!

- Take a minute to think about which vegetables or fruits you see only during certain seasons.
- Think about your experience with milk at home – have you seen it turned into yogurt, butter, or cheese?

Pair up with a classmate and share your thoughts.

Discuss:

- Why some plants grow only in certain seasons.
- How milk changes when it is made into different products.

- Each pair shares one interesting point with the whole class.
- Discuss how seasonal planning and milk processing help in daily life.

11.1 Drip and Sprinkler Irrigation

Have you ever seen gardeners watering plants in different ways? Which method do you think saves the most water?

Plants, like humans, need water to grow. But if we pour too much water, it is wasted. Farmers and gardeners have invented smart methods to water plants without wasting water. Two of these methods are drip irrigation and sprinkler irrigation.

Drip Irrigation

In drip irrigation, water slowly drips to the roots of plants through pipes and small openings called valves or stoppers. This method makes sure that plants get enough water and nutrients right where they need it, without wasting a drop.

Sprinkler Irrigation

Sprinkler irrigation works like artificial rain. Water is sprayed from pipes using spray heads or sprinklers, covering the whole soil surface evenly.



Let's

Think Aloud

Why do you think farmers in hot and dry areas prefer drip irrigation instead of sprinklers?



Activity Time!

Making a Simple Drip Irrigation System

Objective: To observe how water can be delivered slowly and efficiently to plants using a drip irrigation system.

Resources:

- Plastic bottles
- Drip pipes with needles and valves
- Glue gun
- Thread
- Screwdriver
- Potted plants

Instructions:

- Take clean plastic bottles and cut off their bottoms.
- Make holes in the bottle lids using a hot screwdriver.
- Hang the bottles above the potted plants using thread.
- Fix drip pipes into the holes of the lids with glue.
- Position the needle ends near the roots of the plants.
- Fill the bottles with water and watch as it slowly drips into the soil.
- Use the valves to stop or control the dripping as needed.



Answer the following questions:

- a. How does the drip irrigation system help water reach the plant roots efficiently?
-
- b. Why is it better to deliver water slowly rather than all at once?
-
- c. How can controlling the drip help save water?
-



Activity Time!

Making a Simple Sprinkler System

Objective: To observe how water can be distributed to plants like rainfall using a simple sprinkler system.

Resources:

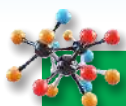
- Plastic water tank
- Plastic pipe
- Plastic bottle
- Glue gun
- Hot iron nail

Instructions:

- Place a water tank at a height and fix a pipe to its bottom outlet.
- Connect the other end of the pipe to a plastic bottle.
- Use a hot iron nail to make small holes at the bottom of the bottle.
- Fill the water tank and watch as water sprinkles out through the holes, simulating rainfall.

Answer the following questions:

- a. How does this sprinkler system help water reach the plants evenly?
-
- b. Why is it important to make small holes instead of one large hole?
-
- c. How does placing the water tank at a height help the sprinkler work effectively?
-



SciByte

Did you know? Drip irrigation was first used in Israel to grow crops in deserts! It helps save up to 50% more water compared to other methods.

11.2 Techniques of Preserving Foods

What happens if you leave cooked food outside for a day? How can we make food last longer?

Food spoils because tiny microorganisms grow in it. To stop them, people use food preservation methods. These include drying, adding preservatives like vinegar or salt, and sealing food in jars.



Let's
Think Aloud

Why do you think vinegar and salt help in preserving food?



Activity Time!

Making Pickles at Home

Objective: To learn how to preserve fruits and vegetables using salt, vinegar, and spices.

Resources:

- Raw mangoes, onions, lemons
- Salt, vinegar, sugar, spices (mustard seeds, cinnamon, cloves, chili flakes)
- Glass jars
- Knife and cutting board

Instructions:

- **Mango Pickle:** Cut raw mangoes into pieces and dry in sunlight. Soak in salt water overnight. Place in a jar and pour vinegar solution. Seal the jar tightly. Wait 15 days before tasting.
- **Onion Pickle:** Pour boiling water over sliced onions for one minute, then drain. Place onions in a jar. Heat cinnamon, cloves, and chili flakes with vinegar, lime juice, sugar, and salt to make a brine. Pour over onions and seal.



Answer the following questions:

- a. Why do we soak or boil the vegetables before adding the vinegar and spices?

b. How does vinegar help preserve these foods?

c. What would happen if the jars were not sealed properly?



Activity Time!

Making Sweet Preserves and Juices

Objective: To learn how to preserve fruits as jams and make fresh juice at home.

Resources:

- Apples, oranges, lemons
- Sugar, cinnamon, orange zest, lemon juice, honey
- Glass jars or bottles
- Knife, cutting board, grinder, stove or pan



Instructions:

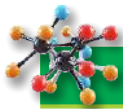
- Apple Jam: Mix apple slices with sugar, cinnamon, orange zest, and lemon juice. Cook until soft and jam-like. Store in a clean jar.
- Lemon Pickle: Boil lemon slices in their juice until soft. Add sugar and acetic acid. Keep outside for 15 days, then store in the refrigerator.
- Orange Juice: Peel and slice oranges. Grind with sugar/honey and ice. Strain and store in glass bottles.

Answer the following questions:

a. How does cooking the apples help turn them into jam?

b. Why do some preserved foods need to stay in sunlight while others are refrigerated?

c. What is the purpose of straining the orange juice before storing it?



Preserving food is not new! Ancient Egyptians dried fish and meat under the hot sun to store food for months.

11.3 Simple Stethoscope

Have you ever seen a doctor using a stethoscope? What do you think it helps them hear?

A stethoscope is an instrument used by doctors to listen to the heartbeat and breathing sounds. You can make a simple one at home!



Activity Time!

Making a Homemade Stethoscope

Objective: To observe how sound travels through tubes and how we can listen to heartbeats.

Resources:

- Y-shaped tube
- Thin plastic tubes
- Cotton
- Balloon
- Funnel
- Scissors

Instructions:

- Attach two plastic tubes to the two arms of the Y-shaped tube.
- Place cotton swabs at the free ends of these tubes.
- Connect a longer tube to the third arm of the Y-shaped tube.
- Fix the other end of this tube to a funnel.
- Stretch a balloon over the mouth of the funnel.
- Place the funnel on someone's chest and listen through the tubes for heartbeats.

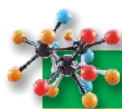


Answer the following questions:

a. How does cooking the apples help turn them into jam?

b. Why do some preserved foods need to stay in sunlight while others are refrigerated?

c. What is the purpose of straining the orange juice before storing it?



SciByte

Your heart beats about 100,000 times every day. That's more than 2.5 billion times in an average lifetime!

11.4 Hand Sanitizer

Why do we use sanitizer instead of just water to clean our hands sometimes?

Sanitizers kill germs that can make us sick. They are made of alcohol, aloe vera, glycerin, or essential oils.



Activity Time!

Making Alcohol-Based Hand Sanitizer

Objective: To prepare a simple hand sanitizer that can help kill germs.

Resources:

- Isopropyl alcohol (4 cups)
- Hydrogen peroxide (1/4 cup)
- Glycerin (1 teaspoon)
- Distilled water (1 cup)
- Container or bottle for storing



Instructions:

- Pour 4 cups of alcohol into a clean container.
- Add $\frac{1}{4}$ cup of hydrogen peroxide.
- Stir in 1 teaspoon of glycerin.
- Add 1 cup of distilled water and mix well.
- Pour the mixture into bottles for use as sanitizer.

Answer the following questions:

a. Why is alcohol important in this sanitizer?

b. What is the role of glycerin in the mixture?

c. How does this sanitizer help in daily hygiene?



Activity Time!

Making Aloe Vera Hand Sanitizer

Objective: To prepare a gentle hand sanitizer using aloe vera gel for moisturizing along with germ protection.

Resources:

- Isopropyl alcohol
- Aloe vera gel
- Lemon juice or essential oil (few drops)
- Bottle for storing

Resources:

- Mix alcohol and aloe vera gel in a 2:1 ratio.
- Add a few drops of lemon juice or essential oil.
- Stir well and store in a clean bottle.
- Use the sanitizer as needed to clean hands.

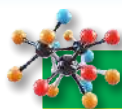


Answer the following questions:

a. How does aloe vera make this sanitizer different from a regular alcohol-based one?

b. Why is adding a few drops of essential oil or lemon juice helpful?

c. How does this sanitizer help prevent the spread of germs?



SciByte

The first microscope was invented over 400 years ago. It allowed scientists to discover microscope life forms for the very first time.



What have you learnt?

- Drip irrigation delivers water drop by drop directly to plant roots, saving water.
- Sprinkler irrigation works like artificial rain, spreading water evenly across fields.
- Food preservation methods (like pickling, drying, and making jams) stop food from spoiling.
- A stethoscope helps doctors hear heartbeats and breathing sounds.
- Hand sanitizers kill germs when soap and water are not available.
- Science helps us in everyday life — from growing crops to staying healthy.

Exercise



1 Choose the correct option.

- i. Drip irrigation saves water by _____.
- a flooding the field
 - b delivering water drop by drop to roots
 - c spraying water everywhere
 - d storing water in a tank
- ii. Which irrigation method works like artificial rain?
- a Canal irrigation
 - b Drip irrigation
 - c Sprinkler irrigation
 - d Tube well irrigation
- iii. Why do we add salt and vinegar to pickles?
- a To add color
 - b To preserve food and stop germs
 - c To make food soft
 - d To make food hot
- iv. A stethoscope is mainly used to listen to _____.
- a temperature
 - b heartbeats and breathing
 - c blood pressure
 - d digestion sounds
- v. Which ingredient makes sanitizers effective against germs?
- a Sugar
 - b Alcohol
 - c Salt
 - d Vinegar
- vi. Drip irrigation is especially useful in _____.
- a rainy areas
 - b dry regions with little water
 - c flooded fields
 - d riversides
- vii. Why do we dry mangoes before making pickle?
- a To change their color
 - b To remove water that can spoil them
 - c To make them sweet
 - d To make them hard

viii. What would happen if a stethoscope had no funnel?

- a It would still work the same
- b It would be unable to collect sound properly
- c It would make louder sounds
- d It would measure temperature

xi. Which of these shows how science helps us daily?

- a Only in big laboratories
- b Only in space research
- c In our kitchens, farms, and hospitals
- d Only for making machines

x. Why do some people prefer aloe vera sanitizer?

- a It smells bad
- b It keeps hands soft and moisturized
- c It has no germs
- d It lasts forever

2 Answer these questions briefly.

- i. Define drip irrigation in one line.
- ii. How does a sprinkler irrigation system work?
- iii. Name two ways food can be preserved.
- iv. Why do doctors use a stethoscope?
- v. What are the main ingredients in alcohol-based sanitizer?

3 Answer these questions in detail.

- i. Compare drip irrigation and sprinkler irrigation. Which one saves more water and why?
- ii. Explain three food preservation methods with examples.
- iii. Describe step by step how to make a simple stethoscope at home.
- iv. Write the process of making aloe vera hand sanitizer and explain why it is helpful.



Constructed Response Questions ||

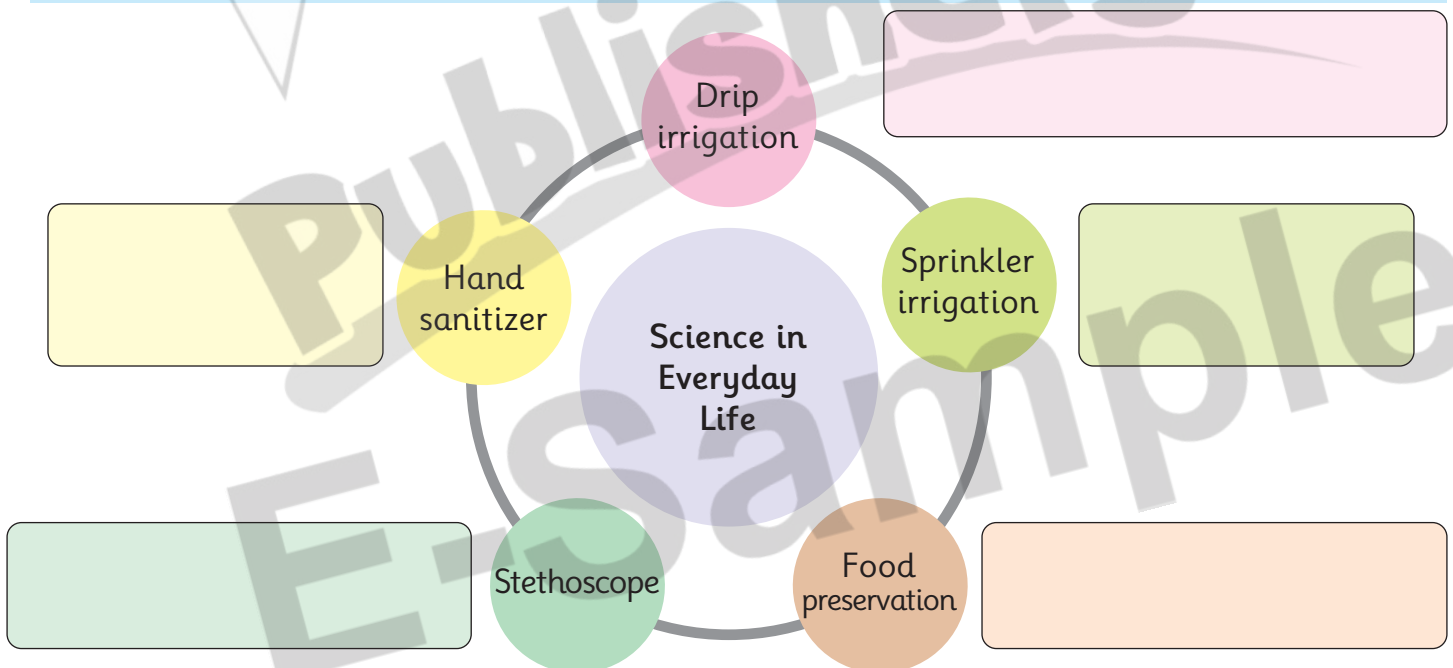
- i. Imagine your family has a small garden. Which irrigation system would you choose and why? Support your answer with two reasons.
- ii. Your school canteen sells food that often spoils quickly. Suggest one preservation method the canteen can use, and explain how it will keep the food fresh.
- iii. A doctor forgets to bring a stethoscope. What simple materials could you use to make one at home?

A doctor forgets to bring a stethoscope. What simple materials could you use to make one at home?

4 Investigate

- i. Leave one slice of bread uncovered for two days and another slice sealed in a plastic bag. What do you observe? Why does one spoil faster?
- ii. Visit a local farm (or watch a video). Find out which irrigation system the farmer uses and why.
- iii. Ask a doctor how many times they use a stethoscope in a day. Record your findings.

5 Complete the Cause-and-Effect Wheel below. In the center write: "Science in Everyday Life". Around it, fill the outer boxes with the effect each application has:



My Science Helpers in Daily Life

Objective: To explore how different science-based tools and methods make our daily lives easier and healthier.

Resources:

- Scrapbook or chart paper (for poster)
- Colored pencils, markers, or crayons
- Pictures (drawn, printed, or cutouts) of irrigation, food preservation, stethoscope, and hand sanitizer
- Glue, tape, scissors



Instructions:

- Divide your scrapbook page or poster into four equal sections.
- Label the sections:
 - ✓ Irrigation (Drip/Sprinkler)
 - ✓ Food Preservation (Pickle/Jam)
 - ✓ Stethoscope
 - ✓ Hand Sanitizer
- In each section:
 - ✓ Draw or paste a picture of the item.
 - ✓ Write 3–4 sentences on how it helps us in daily life.
- Decorate your scrapbook/poster with borders, colors, or small doodles to make it attractive.
- Present your completed work in class and explain each part.

Expected Outcome:

Students will be able to recognize and explain how science supports everyday life in farming, food storage, health check-ups, and hygiene.