

BIOLOGY

Practical Notebook



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General Instructions

1. Wear your complete school uniform or lab coat properly.
2. If you have long hair, make sure it is tied back securely.
3. Keep your hands clean and your fingernails trimmed.
4. Always bring your practical notebook, pen, and any other required items.
5. Be punctual and always come to the lab on time.
6. Listen carefully to your teacher's instructions before starting any activity.
7. Handle all models, mannequins, and lab equipment with great care.
8. Never eat or drink anything inside the lab.
9. Be gentle and respectful with your lab partner during all activities.
10. Work together as a team and help your classmates.
11. Respect the opinions of others, even if you disagree.
12. Do not take photos or videos of anyone without permission from the teacher and the student.
13. Never taste or smell any chemicals used in the experiments.
14. Wear safety goggles when your teacher tells you to.
15. Report any accident, spill, or broken equipment to your teacher immediately.
16. Tell your teacher right away if you feel unwell, uncomfortable, or do not understand something.
17. Clean your work area and put all equipment back in its proper place after you finish.
18. Wash your hands thoroughly with soap and water at the end of every lab session.

Student Learning Outcomes

Students are required to carry out practical work as an integral part of the course. They are advised to maintain a laboratory practical in which they record, experimental arrangements used, the observations made, the analysis of these observations and the conclusions. Through experimental work the students are expected to develop the following skills:

1. Techniques

- Cutting of longitudinal and cross sections parts of plant.
- Making slides from fresh cultures (stain/glycerin).



2. Information Handling

- Search, select and interpret scientific information from a variety of sources. Display of results in tabular forms.
- Analyze, interpret and draw inferences from a variety of forms of information including the results of experiments.
- Demonstrate knowledge and understanding of biological facts and principles, practical techniques and safety precautions.

3. Experimental and investigative skills

- Use of microscope and other tools for accurate biological investigations.
- Observe gross features and fine details and find similarities and differences.
- Become acquainted with the use of scientific instruments and equipment.

4. Attitudes

- Display respect for evidence, rationality and intellectual honesty during investigation tasks.
- Support for collaborative activity, active inquiry, problem solving and decision making.
- Demonstrate knowledge and understanding of the personal, social, economic and technological applications of biology in modern society.

Follow-up Tasks/Assessment Questions

Follow-up tasks/assessment questions have been included in the student laboratory manual. If students do not have their manuals, please provide the questions to them by writing on the board. Do not give the answers. Responses can be handled in many ways:

- Brain storm with the class.
- Divide students into groups of 3-4 and have them work out the responses.



General Safety Procedures

Before you begin.....

1. Keep your work table neat and clean. Make sure that it is not full of unnecessary things such as school bag, files, clothes and books etc.
2. Read all the instructions in your practical manual / book before you do anything.
3. Look out for possible safety precautions.
4. Be sure that equipment and glassware are clean before use.
5. Know locations of laboratory safety showers, eyewash stations, and fire extinguishers. The safety equipment may be located near the laboratory entrance.

While you are doing the experiment.....

1. Follow the directions in the practical manual / book closely.
2. Do not wander around and do not endanger people around you.
3. Wear or use protective devices that are provided for you. These protective devices include goggles, gloves, apron and safety tongs.
4. Use wire gauge or sand bath for heating. Never leave heating apparatus unattended. Turn off Bunsen burners or spirit lamp when you have to leave your work table for a while or when you have finished your experiment.
5. Handle the apparatus and other instruments particularly sharp objects to avoid damage and loss.
6. If you have broken any glassware (beakers, test-tubes and thermometers etc.) or spilt anything, report to your teacher at once. You may have to help in cleaning up.
7. Be aware of where fire extinguishers, fire blankets and first aid box are located in the laboratory.
8. Do not eat or drink in the laboratory.
9. All containers must have appropriate labels. Unlabeled chemicals should never be used.

After you have finished....

1. Turn off the water and gas, disconnect electrical connections and return your apparatus to Lab Staff.
2. Clean your equipment and glassware.
3. Do not dispose of material in the sink unless you are instructed to do so.
4. Wash your hands thoroughly.

The best preventive measure is to always be careful and alert. Take care of yourself and your neighbours.



Notes on Biology Drawing

The following are the guidelines for students about drawing and labelling.

1. The drawings should be large. The more details you need to include, the larger your drawing should be.
2. Draw what you see. Do not copy a textbook diagram.
3. The different parts of the specimen should be drawn in the correct proportions.
4. All drawings and labelling (in capital letters) should be done in pencil. Use a sharp 2B pencil for clear outlines. Faint outlines would make it difficult for the examiner to assess your drawing.
5. Do not shade with the side of your pencil. Do not use crayons or coloured pencils.
6. Leave sufficient space on either side of your drawing for labels. Write a title at the bottom of each drawing.
7. Label neatly and legibly. Write horizontally and space out your labels neatly.
8. Take care of your singulars and plurals, e.g. a line pointing to one seed should not be labelled as 'seeds'.
9. Labelling lines should not cross each other. Avoid long labelling lines that cut across the whole drawing.



Description of Dissection Box

Dissection box is used for dissection of animals and plants for the laboratory. It contains the following items:

No.	Name of Article	Number in Dissection Box
1	Scalpel	Two
2	Forceps	Two
3	Hooks	Three
4	Dropper	One
5	Blow pipe	One
6	Razor	One
7	Seeker	One
8	Pair of scissors	Two
9	Retractor	One
10	Needle	One
11	Lancet	One

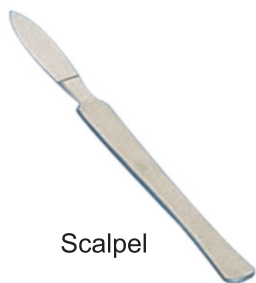


Dissection Box

The uses of items are given below.

- **Scalpel:** It is used to cut different parts of the animal and section of a plant.
- **Forceps:** It is used to hold small tissues or skin of animals.
- **Hooks:** A set of three hooks is used to stretch the tissues of animals during dissection.
- **Scissors:** These small and large scissors are used for cutting purpose.
- **Retractor (lifter):** It is used to retract or lift tissues or other materials.
- **Lancet:** It is used for removing membranes.
- **Needles:** It is used to make holes in certain part of animal or plant. It is also used to separate stretched tissues and blood vessels.
- **Seeker:** It is used to search or trace the hidden parts of dissected animal.
- **Razor:** It is used for sharp cutting, various cross sections of plants and for the preparation of slides.
- **Blow pipe:** It is a hollow curved tipped pipe. It is used for blowing purpose.
- **Dropper:** It is used to put drop of liquid material.





Scalpel



Forceps



Hooks



Scissors



Retractor (Lifter)



Lancet



Needles



Seeker



Razor



Blow pipe



Dropper



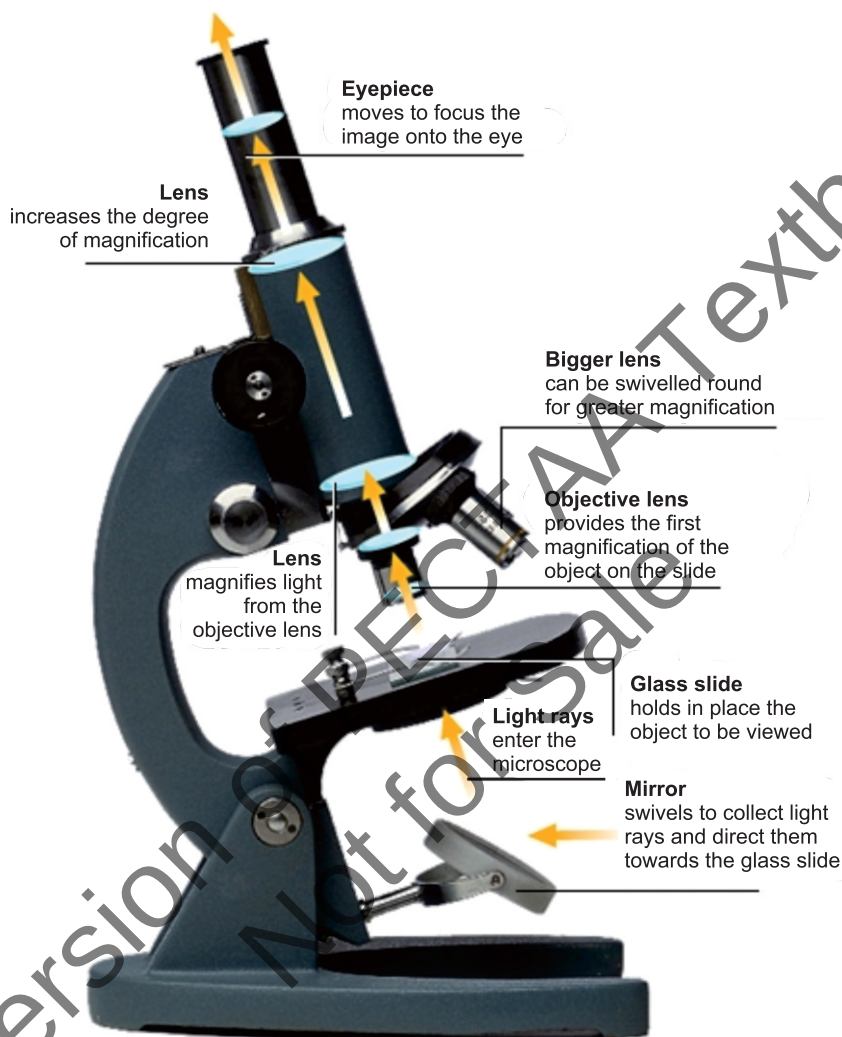
Magnifying lens



Glass slide



Uses of Microscope



Compound microscope

Microscope is an expensive instrument that must be given proper care. The following suggestions should be kept in mind.

1. If it is necessary to carry your microscope, always carry it in an upright position. Grasp it firmly with one hand, while supporting the base with the arms towards you. Do not tilt or jar the microscope during transit. Never keep microscope near edge of table.
2. The ocular and objective lenses often require cleaning. These glass lenses are easily scratched and should be cleaned only with lens paper.
3. Learn to keep one hand on the fine focus knob and focus continually up and down while



- studying a given object.
4. Do not tilt the microscope while observing any kind of preparation. The microscope is less likely to be knocked off the table when in a vertical position.
 5. Adjust the mirror (if present) and iris diaphragm to give a clear but not too bright view through the eye piece.
 6. Place the specimen slide on the stage and secure it in place with clips.
 7. Using the coarse adjustment, lower the body tube until the objective lens is close to but not touching the slide.
 8. Now look through eye piece and use the fine adjustment to raise the body tube until the object on the slide is brought into focus.
 9. Always start with low power objective lens to locate the parts of the specimen and then switch to higher power objective lens to observe the details.
 10. Always use a cover slip on wet mount preparation.
 11. Do not remove any part from the microscope.
 12. Clean the microscope and put it back at its proper place after use and be sure that low power objective has been turned in position, the body tube has been moved down, the microscope has been restored to upright position and the clips do not extend beyond the stage.
 13. If you find that your instrument is not working properly report it to your teacher.



Dissecting microscope



GUIDELINES FOR TEACHERS ON PRACTICAL WORK

Teachers are encouraged to teach various concepts through learner-centered activities that promote curiosity, inquiry, creativity and critical discussions through group work and collaboration. The purpose of lab work is to enhance critical thinking skills, experimental design and instrument handling. Students should learn the skills to use tools, devices and apparatus with care and while noting observations and taking readings, they should strive for accuracy and precision. Students should not demonstrate a casual attitude toward practical work but should be active, careful and prioritize safety for themselves and their peers in the lab.

Preparation for Practical Work in the Lab

To optimize the use of limited lab equipment in a school setting, teachers should organize students into groups of 4 to 5 and encourage individual participation in handling apparatus and taking readings. A group-wise practical schedule chart should be prominently displayed in the lab, assigning multiple experiments to keep all groups engaged. The chart should track progress and indicate which group is assigned to each experiment. The lab incharge should prepare apparatus in advance with teacher assistance, if needed. Teachers should supervise and provide support during lab work, keeping records of students' progress and providing feedback in their practical notebooks.

Bimonthly Practical Based Assessment / Evaluation

Some bimonthly practical-based assessment papers are provided in the practical manual. The teacher may prepare additional papers following the same pattern if the need arises to overcome the shortage of available apparatus for each group. The teacher should move around to monitor and assess the students' performance by asking prompt questions about their practical work. The teacher should also conduct a Viva-Voce on the experiment they are performing and ask questions that enhance their critical thinking skills. If a student is stuck somewhere, the teacher may address the issue or provide hints to guide him / her back on the right track. Based on the performance record, the teacher can identify students with below-average performance and provide them with extra care and personal attention to help them overcome their shortcomings.





Observation of the Apparent Distinguishing Taxonomic Characters from the Fresh and Preserved Specimens.

Students' Learning Outcome

After performing this activity, students will be able:

- To observe, identify, and compare the distinguishing morphological and anatomical taxonomic characters of organisms by using both fresh and preserved specimens.
- To understand the significance of these characters in classification, identification, and taxonomic placement.

Background Information

Kingdom Animalia

The kingdom Animalia is further divided into two main groups, namely invertebrates (without a backbone) and vertebrates (with a backbone).

Invertebrates

The characteristics of some important invertebrates are as follows.

Jellyfish

- Jellyfish are found in oceans (some species are also found in freshwater).
- The body is made of two germ layers i.e., ectoderm and endoderm.
- The digestive cavity has only one opening.
- There is no respiratory and circulatory system.
- There is no central nervous system.

DO YOU KNOW?

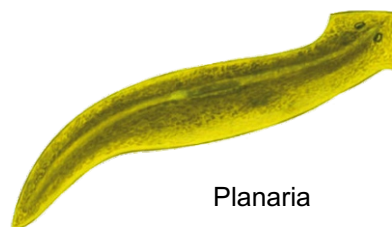
There are more insects in a single square mile of fertile soil than there are people on the entire earth.



Jellyfish

Planaria

- Planaria are found in oceans and fresh waters.
- The body is made up of three germ layers, i.e., ectoderm, mesoderm and endoderm.
- The digestive cavity has only one opening.
- There is no respiratory and circulatory system.
- They possess a definite head with sense organs.



Planaria



Ascaris

- It is a human parasite with tubular body form.
- Its digestive tract has two openings i.e., mouth and anus.
- The body is made of three germ layers, i.e., ectoderm, mesoderm and endoderm.



Ascaris

Tapeworm

- Tapeworms are parasitic worms that live inside the bodies of vertebrate hosts.
- It has a long, flat, ribbon-like body.
- Body is divided into segments.
- They lack a mouth and digestive tract.
- Anterior end bears suckers, hooks, or both for attachment to the host's intestine.



Tapeworm

Earthworm

- It lives as a free-living animal and is found in soil.
- It possesses a segmented body.
- There is a closed blood circulatory system.
- It respire through skin.



Earthworm

Leech

- Leeches are mostly aquatic or moist-environment animals.
- Leech has an elongated and segmented body.
- The body wall is covered with a cuticle.
- The circulatory system is a closed type.
- Respiration is through the body surface.



Leech

Snail

- Snails are found on land, fresh water and in the seas.
- Its body possesses a muscular foot.
- Its body is enclosed in a coiled shell.
- Head has two tentacles.
- Eyes are located on tentacles.



Snail



Aedes aegypti

- It belongs to the major group of invertebrates i.e., “insects”.
- The body is divided into head, thorax and abdomen.
- They use wings for flight.
- They possess blood circulatory system and respire through special air tubes (tracheal tubes).
- It lives as free-living but the female transmits the virus of dengue fever from one human to the other.



Aedes aegypti

Starfish (Sea Star)

- It is found only in oceans.
- Its body is star shaped and consists of central round disc and five arms.
- Arms have number of tube feet on ventral side.
- The water vascular system in a starfish is a unique system that helps in movement, feeding, gas exchange, and excretion.



Starfish (Sea Star)

Vertebrates

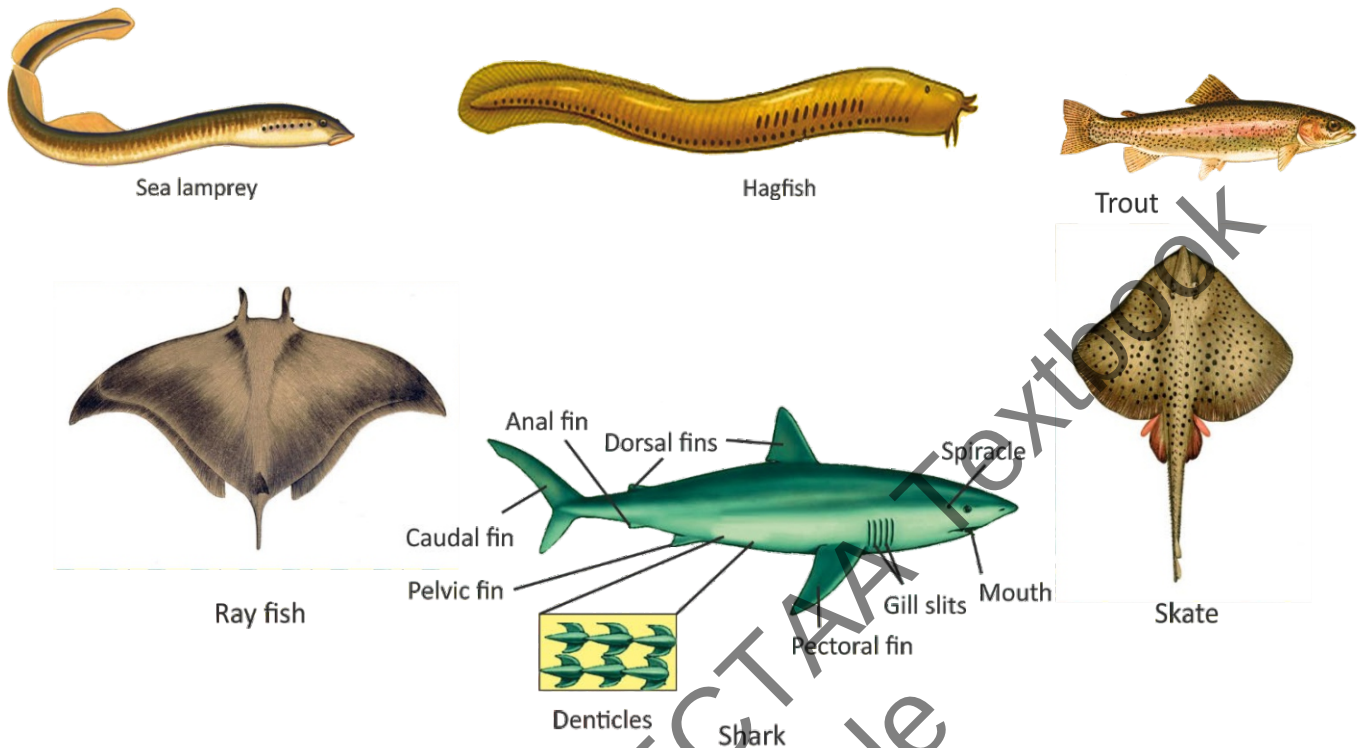
The vertebrates are divided into five classes.

1. Class Pisces (Fishes)

Fish are found in water and are cold-blooded (they cannot maintain their body temperature). There are three main groups of fishes.

Feature	Jawless Fishes	Cartilaginous Fishes	Bony Fishes
Skeleton	Made of cartilage only (no jaws, no true bones)	Entirely cartilaginous	Bony skeleton made of calcium
Jaws	Absent	Present (cartilage jaws)	Present (bony jaws)
Mouth	Round, sucker-like	Ventrally placed, with sharp teeth	Terminal or varied, with movable jaws
Scales	Absent	Placoid scales (tooth-like)	Cycloid, ctenoid, or ganoid scales
Gill Cover (Operculum)	Absent	Absent	Present
Buoyancy Organ (Swim Bladder)	Absent	Absent (must swim constantly to avoid sinking)	Present (helps in floating)
Reproduction	External fertilization	Internal fertilization	Mostly external fertilization
Circulation	2-chambered heart	2-chambered heart	2-chambered heart
Examples	Lamprey, Hagfish	Shark, Ray, Skates	Rohu, , Tuna, Salmon





Sharks are covered with **denticles**, which are tiny, tooth-like structures embedded in their skin.

Class Amphibia

- i. They live in both habitats, i.e. water and land.
 - ii. They have glandular skin that lack scales.
 - iii. They have bony skeleton.
 - iv. Adult members have lungs. During their developmental stages they have gills (some adults retain gills throughout life).
 - v. They breathe through lungs, gills and skin.
 - vi. They have two pairs of limbs.
 - vii. They mostly reproduce in water.
 - viii. They are cold blooded animals (they cannot regulate their body temperature internally).
- Examples: Frog, toad, salamander and newt



Newt



Salamander



Frog



Class Reptilia

- Most are terrestrial and a few live in water.
- Their skin is hard with scales and scutes and bony plates.
- They have a bony skeleton.
- They have two pair of limbs (absent in snake).
- They have eggs with leathery shell.
- Respiration takes place through lungs.
- They are cold blooded animals.

Examples: Lizard, snake, turtle, crocodile, alligator



Fascinating Fact

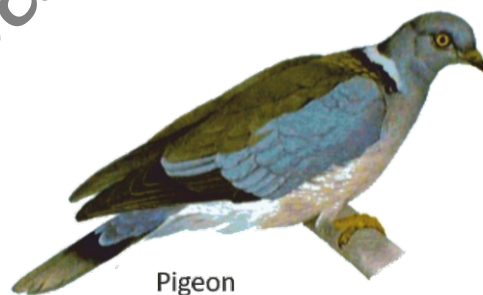
A crocodile's tongue is attached to the roof of its mouth.



Class Aves

- The body is covered with feathers.
- Their forelimbs are modified into wings.
- All the birds have horny beaks and lay eggs.
- They have hollow and light bones.
- They have air sacs, which assist the lungs for respiration, by supplying continuous oxygen during flight.
- They are warm blooded (they can maintain their body temperature).

Examples: Crow, sparrow, pigeon, parrot



DO YOU KNOW?

The giraffe is one of the quietest animals: it has no vocal cords to make any noise.

Class Mammalia

- Body is covered with hairs.
- Their skin has sweat glands, scent glands, sebaceous glands and mammary glands.
- All the mammals have external ear and moveable eye lid.
- They have mammary glands that secrete milk for nourishing the young.
- They are warm blooded.



Examples: Cat, cow, goat, rat, human, whale

Kingdom Plantae

Kingdom plantae is divided into two main groups

1. Non-vascular Plants

- They do not have vascular bundles.
- In their bodies, transportation of water, minerals and food is carried out by diffusion.

Examples: Mosses and liverwort.

DO YOU KNOW?

Non-vascular plants are the amphibians of plant world, because they require water for reproduction and cannot live away from water.



Mosses



Liverwort

2. Vascular Plants

Vascular plants are more advanced group of plants. Vascular plants have efficient conducting tissues known as vascular tissues i.e., xylem and phloem.

They are further divided into two groups, i.e., seedless plants and seed plants.

a. Seedless plants: They do not produce seeds during their life cycle. *Pteris* and *Adiantum* are common examples of seedless vascular plants.

b. Seed plants: They produce seeds during their life cycle.

Gymnosperms: Some seed plants do not produce flowers, and their seeds are naked (not covered with fruits). Such seed plants are called non-flowering plants or gymnosperms (e.g., *Cycas*, *Pinus*, etc.).

Angiosperms: These seed plants produce flowers, and their seeds are covered with fruits. Such plants are called flowering plants or angiosperms (e.g., rose, mango, wheat, *Brassica*, etc.).

Angiosperms are of two types, i.e. monocots (have one cotyledon in seeds, e.g. garlic, onion, rice, wheat, grasses) and dicots (have two cotyledons in seeds, e.g. potato, tomato, beans, apple, *Brassica*).



Adiantum



Pine





Rice



Wheat

Monocots



Onion

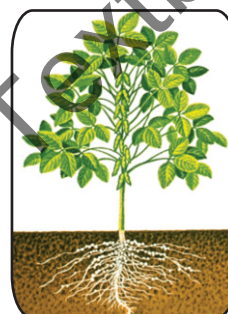


Potato



Apples

Dicots



Soybeans



Materials / Apparatus Required

Preserved and live animals and plants, charts, photographs, hand lens, magnifying glass, forceps, safety gears



Precautions

- Handle specimens carefully, avoiding damaging delicate structures such as leaves or wings while observing.
- Use forceps or brushes gently for small specimens.
- Wear gloves if required, especially for preserved specimens stored in formalin or alcohol, to avoid skin irritation.
- Do not directly smell preserved specimens; formalin and alcohol fumes can be harmful.
- After handling any biological specimen, whether fresh or preserved, wash hands thoroughly.
- Do not taste or ingest any specimen parts or solutions used.



Procedure

- Collect the specimens (both fresh and preserved) provided to you.
- Use a hand lens or magnifying glass to examine external structures.



- Note important taxonomic characteristics.
- Record observations in a table with specimen name vs distinguishing characters.

Specimen	Distinguishing characters
A	
B	
C	
D	
E	
F	



Conclusions

Based on the observations, conclude to which taxonomic group each organism belongs.

Specimen	Taxonomic group
A	
B	
C	
D	
E	
F	



FOLLOW-UP TASKS

Assessment Questions

1. List the ways by which birds are adapted for flight.

Ans. Adaptations of birds for flight

- Hollow bones
- Wings with feathers
- Streamlined body
- Strong chest muscles
- Air sacs for more oxygen.

2. What type of skeleton is present in amphibian, reptiles, birds and mammals?

Ans. Amphibians, reptiles, birds, and mammals have an endoskeleton.

3. In which group of vertebrates, the cartilaginous skeleton is present?

Ans. Cartilaginous skeleton is present in cartilaginous fishes (like sharks and rays).

4. If fish lack lungs, how are they adapted to live in water?

Ans. They use gills to absorb oxygen dissolved in water.

5. Identify any two flowering plants present in your surroundings.

Ans. Two flowering plants: Examples: Rose, Hibiscus (or any local flowering plants around you).

6. Draw a table to mention the main differences among the five main classes of vertebrates.

Ans.

Feature	Pisces (Fishes)	Amphibians	Reptiles	Birds (Aves)	Mammals
Body covering	Scales	Moist skin (no scales)	Dry skin with scales	Feathers	Hair or fur
Body temperature	Cold-blooded	Cold-blooded	Cold-blooded	Warm-blooded	Warm-blooded
Respiration	Gills	Gills (larva), lungs & skin (adult)	Lungs	Lungs with air sacs	Lungs with diaphragm
Heart chambers	2 chambers	3 chambers	4 chambers	4 chambers	4 chambers
Reproduction	External fertilization, lays eggs in water	External fertilization (mostly), lays eggs in water	Internal fertilization, lays eggs on land (shelled)	Internal fertilization, lays hard-shelled eggs	Internal fertilization, gives birth to young (mostly)
Habitat	Aquatic	Both aquatic & terrestrial	Mostly terrestrial	Terrestrial (adapted for flight)	Terrestrial (some aquatic)
Examples	Fish (salmon, shark)	Frog, salamander	Snake, lizard, turtle	Pigeon, crow, eagle	Human, dog, whale



Brain Benders

1. Another possible way to classify organisms would be to separate them into unicellular and multicellular organisms. Explain why this is not a useful classification system.

Ans. This is not a useful system because it only tells us how many cells the organism has, but not how they are related to each other. Many very different organisms (like bacteria, protists, and yeast) are unicellular, while plants, animals, and fungi are multicellular. Grouping them only by cell number does not show their evolutionary relationships or similarities in structure, function, or genetics. Scientists prefer classification systems that show how organisms are related.

2. Why are the ventral muscles of the belly more developed in amphibians than they are in fishes?

Ans. Amphibians have more developed belly (ventral) muscles because they need them for movement on land. These muscles help support their body against gravity and allow them to crawl or hop. Fishes, on the other hand, live in water where the body is supported by buoyancy, so they do not need strong ventral muscles for support or movement.

REAL-LIFE APPLICATIONS

Students learn to identify and differentiate organisms correctly in the field and laboratory. This is essential for careers in Botany, Zoology, Environmental Science, Forestry, Fisheries, Agriculture, and Taxonomy-based research.

Teacher's Signature: _____

Date: _____

Remarks: _____





Observation and Identification of Plants and Animals Based on Taxonomic Characters

Students' Learning Outcome

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

- Observe and record the external characters of local plants and animals.
- Differentiate between monocot and dicot plants using simple leaf and flower characters.
- Distinguish vertebrates from invertebrates, and identify basic animal groups by their body features.
- Apply a simple dichotomous key for identification.
- Demonstrate responsible field behaviour (safety, minimal disturbance to living organisms).

Background Information

Living organisms show enormous diversity. To study them scientifically, biologists classify organisms based on similarities and differences in their structures.

Kingdom Plantae is divided into non-vascular plants (e.g., mosses) and vascular plants. Vascular plants are seedless (ferns) and seed plants (gymnosperms and angiosperms). Angiosperms are further divided into monocots (e.g., wheat, rice) and dicots (e.g., hibiscus, beans).

Kingdom Animalia is divided into **invertebrates** (animals without a backbone e.g., insects, snails, starfish, earthworms) and **vertebrates** (animals with a back bone e.g., fishes, amphibians, reptiles, birds, mammals).

Some key distinguishing characters:

- **Plants:** leaf venation (parallel vs. netted), presence of flowers/cones, type of seeds.
- **Animals:** presence/absence of backbone, body covering (scales, feathers, hair, shell), segmentation, type of limbs.

Classification helps us understand relationships among organisms, their adaptations, and their ecological roles.



Materials / Apparatus Required

Field notebook or worksheet, pencil/eraser/clipboard, hand lens (optional), simple field guide/dichotomous key (teacher-provided), smartphone/camera (optional for recording), First-aid kit, water bottle, hat (for safety in fieldwork)



Precautions

- Do not pluck plants or disturb animals unnecessarily.
- Maintain a safe distance from insects, birds, and stray animals.
- Stay within designated areas and be cautious near water, thorny plants, or uneven ground.
- Wash hands after completing fieldwork.





Procedure

- Teacher briefs students about safety, observation ethics, and recording methods.
- Students form groups and walk around the selected field/garden/campus area.
- Each group chooses at least 3 plants and 3 animals (or animal signs like feathers, tracks, shells) for study.
- For Plants: Record leaf type and venation, flower/fruit structure, habit (herb/shrub/tree), and any special features.
- For Animals: Record external features such as symmetry, segmentation, covering (hair/feathers/scales), type of limbs, and presence of backbone (if identifiable).
- Use the simple key to identify the probable group (e.g., monocot vs dicot; arthropod vs mollusc; fish vs amphibian).
- Fill in the observation table and make at least one labelled sketch of a plant leaf and one of an animal observed.
- Compare results with classmates and finalize identifications.



Observations

Sr. No.	Specimen	Feature Examined	Observation	Inference (Probable Group)
1.	Grass near path	Leaf venation, habit	Narrow leaves, parallel venation, fibrous roots	Monocot Angiosperm
2.	Hibiscus hedge	Leaf venation, flower	Broad leaves, netted venation, 5-petaled flower	Dicot Angiosperm
3.	Pine tree	Cones, leaves	Needle-shaped leaves, cones present	Gymnosperm
4.	Ant	Body segmentation, legs	Exoskeleton, segmented, 6 legs, antennae	Insect (Arthropoda)
5.	Pigeon	Body covering, limbs	Feathers, wings, beak, bipedal	Aves
6.	Lizard	Body covering, limbs	Scales, 4 limbs, tail, terrestrial	Reptilia



Students should record their own observations:

Sr. No.	Specimen	Feature Examined	Observation	Inference (Probable Group)
1.				
2.				
3.				
4.				
5.				
6.				



Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Which feature helps to identify insects among other invertebrates?

Ans. Insects have three pairs of legs (six legs) and a body divided into head, thorax, and abdomen.

2. Name one character that distinguishes reptiles from amphibians.

Ans. Reptiles have dry, scaly skin, while amphibians have smooth, moist skin.

3. Write one difference between amphibians and reptiles.

Ans. Amphibians usually lay eggs in water, while reptiles lay eggs on land with protective shells.

4. Give one example each of a gymnosperm and an angiosperm.

Ans.

- Example of a gymnosperm: Pine
- Example of an angiosperm: Mango



5. Why is it important not to disturb animals or pluck plants during field studies?

Ans. Because disturbing them can harm their natural habitat, reduce their chances of survival, and upset the balance of the ecosystem.

Brain Benders

1. An animal has dry scaly skin and lays eggs with leathery shells. To which class does it belong?

Ans. It belongs to the class Reptilia.

2. A plant has cones but no flowers. Which group does it belong to?

Ans. It belongs to gymnosperms

3. You see a flying animal. How will you distinguish whether it is a bird or an insect?

Ans. • Birds have feathers, beaks, and two wings with bones.
• Insects have six legs, three body parts (head, thorax, abdomen), and wings made of thin membranes, not feathers.

4. A segmented animal lives in soil. Which animal could this be?

Ans. It could be an earthworm.

5. A feather is found on the ground. What does it indicate about the animal?

Ans. It indicates that the animal is a bird, since feathers are unique to birds.

6. A student says "starfish is a fish." How will you correct this misconception?

Ans. I would explain that a starfish is not a fish. It has no backbone, while true fish are vertebrates backbone.

REAL-LIFE APPLICATIONS

Agriculture & Gardening: Helps in identifying crops and weeds for proper cultivation practices.

Public Health: Recognition of insect vectors (like mosquitoes) helps in disease prevention.

Conservation Biology: Field identification supports biodiversity monitoring and habitat protection.

Daily Life: Knowing local plants and animals increases safety and awareness of the natural environment.

Teacher's Signature: _____

Date: _____

Remarks: _____





Using a Microscope to Measure the Size of Cells

Students' Learning Outcome

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

- Learn to set up and focus a microscope.
- Measure size of plant, animal, and microbial cells.

Background Information

- Microscopes magnify small objects to make them visible.
- Approximate cell size can be estimated using:

$$\text{Cell size} = \text{Diameter of field of view (FOV)} / \text{Number of cells across FOV}$$



Materials / Apparatus Required

Compound light microscope, Prepared/temporary slides of onion epidermis and human cheek cells transparent ruler.



Precautions

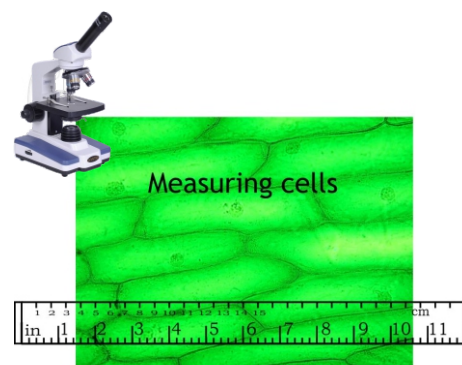
- Handle the microscope carefully with both hands.
- Always start with the lowest power objective.
- Never use coarse adjustment with high-power objective.



Procedure

1. Place the microscope on a flat surface.
2. Adjust the mirror or light source for proper illumination.
3. Place the prepared onion/cheek cell slide on the stage.
4. Secure it with stage clips.
5. Start with the **low-power objective (10×)**.
6. Adjust the coarse focus knob until cells appear clearly.
7. Place a transparent ruler on the stage.
8. Look through the eyepiece and measure the visible diameter under low power.
(For example, if 2 mm is visible under 10× objective and 10× eyepiece, total magnification = 100×).
9. Focus on the slide and count how many cells fit across the diameter of the field of view.
10. Apply the formula:

$$\text{Cell size} = \text{Diameter of FOV} / \text{Number of cells across FOV}$$



Example Calculation:

- Diameter of FOV under low power = 2 mm = 2000 μm
- About 20 onion cells fit across the FOV

$$\text{Cell size} = 2000\mu\text{m}/20 = 100\mu\text{m}$$

So, the average onion cell length $\approx 100 \mu\text{m}$.

**Observations**

Specimen	Diameter of FOV	Number of cells across FOV	Cell size
Onion epidermis			
Cheek cell			
Yeast			
Bacteria (rods)			

**Conclusions**

FOLLOW-UP TASKS**Assessment Questions**

1. Why do we start focusing with the lowest power objective?

Ans. Because it provides a wider field of view and makes locating the specimen easier.

2. What is the formula used to calculate cell size?

Ans. Cell size = Diameter of FOV $\div$ Number of cells across FOV.

3. If the FOV is 2000 μm and 20 cells fit across, what is the size of one cell?

Ans. $2000 \div 20 = 100 \mu\text{m}$.

4. Why is a transparent ruler placed on the stage?

Ans. To measure the diameter of the field of view.

5. What is the total magnification when using a 10 $\times$ eyepiece with a 40 $\times$ objective?

Ans. $10 \times 40 = 400\times$.



Brain Benders

1. Why is proper illumination important in microscopy?

Ans. It ensures that cells are clearly visible for observation and measurement.

2. What errors can occur while measuring cell size?

Ans. Errors can occur if the microscope is not focused properly, if the scale on the eyepiece is misread, if cells are not measured along the correct axis, or if the cells are squashed, stretched, or overlapping on the slide.

REAL-LIFE APPLICATIONS

Microscope helps identify abnormalities in blood cells, tissues, and pathogens. In clinical labs microscope is used for estimating sizes of blood cells and microbes, aids diagnosis. Yeast cell size and budding assessment in brewing and baking quality control. Clinicians and researchers examine cell size in tissue samples to diagnose diseases, as abnormal cell size can be a key indicator.

Teacher's Signature: _____

Date: _____

Remarks: _____





Examination under the microscope an animal cell (e.g., from frog's blood) and a plant cell (e.g., from onion epidermis), using an appropriate temporary staining technique, such as iodine or methylene blue.

Students' Learning Outcome

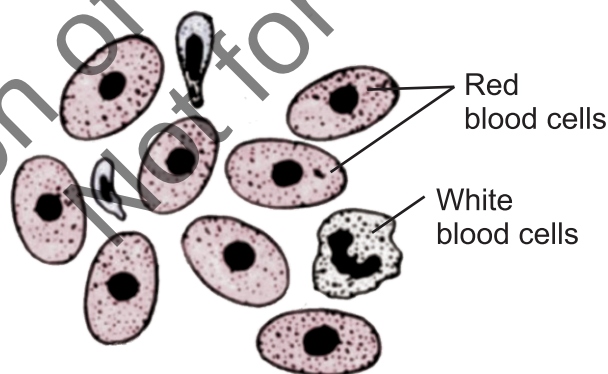
After performing this experiment, students will be able:

- To prepare temporary mounts of plant (onion epidermis) and animal (frog's blood) cells using appropriate staining techniques such as iodine or methylene blue.
- To identify and distinguish the structural differences between plant and animal cells under the microscope.
- To label key cell components (e.g., cell wall, cell membrane, cytoplasm, nucleus) observed in plant and animal cells.

Background Information

A cell consists of cytoplasm, nucleus, and cell membrane. Cells are of different shapes and sizes. In frog, red blood cells are oval and biconvex and they possess a nucleus. Unlike the animal cells, plant cells have cell wall, a large vacuole and plastids.

Part 1: Study of animal cell



Blood cells of frog



Materials / Apparatus Required

Frog, Microscope, glass slide, cover slip, dropper, jar, methylene blue, ethyl alcohol, dissecting box, cotton swab, spirit, syringe.



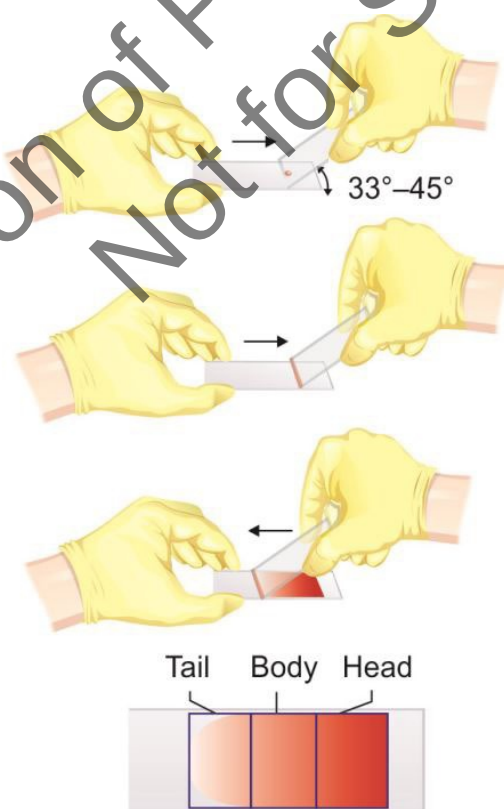
Precautions

- Clean the slide, ocular lens, and objective of microscope before observing.
- Handle the chemicals carefully as they cause stains or irritation.
- Dispose of used slides and stains properly after the experiment.



**Procedure**

- 1- Prepare a smear of frog's blood. For this purpose:
 - Place a small drop of blood of frog on clean glass slide.
 - Place the edge of second slide across the drop at an angle of 33° - 45° . The drop of blood will spread along the edge of second slide.
 - Push the second slide in one smooth motion to the opposite end of the first slide. The drop of blood will spread across the slide, and a thin smear will form.
- 2- Dry the blood smear in the air.
- 3- Fix the smear by dipping the slide in absolute alcohol.
- 4- Add a few drops of methylene blue over the smear and leave it for 3-4 minutes.
- 5- Add a few drops of distilled water to the stain, and shake the slide gently to mix it thoroughly. Leave it for about 10 minutes.
- 6- Wash the slide under a gentle stream of water.
- 7- Remove excess liquid with blotting paper and dry the slide in air.
- 8- Examine the slide, first under low power then high power of microscope.

**Preperation of blood smear**

**Observations**

- Draw and label what you have observed.

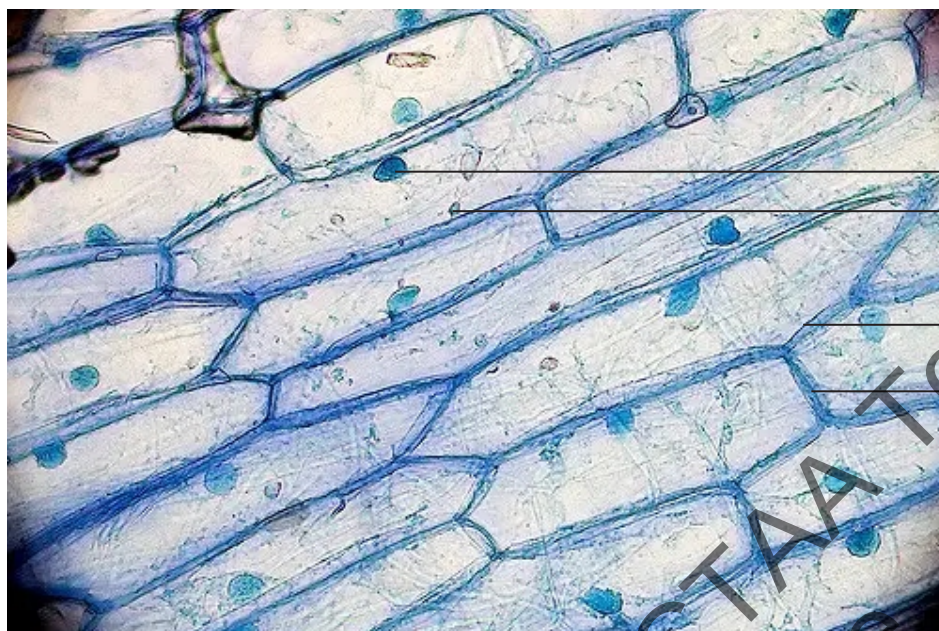
Web Version of PECTAA Textbook
Not for Sale

**Conclusions**

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Part 2: Study of plant cell



Nucleus

Vacuole

Cell wall

Cell membrane

Figure: Onion epidermis as seen under microscope

**Materials / Apparatus Required**

Microscope, glass slide, forceps, cover slip, razor blade, scalpel, mounted needle, dropper, dilute iodine or methylene blue, onion, blotting paper.

**Precautions**

- Remove the folds with the help of needles.
- Cover slip should be placed gently to avoid the air bubbles.

**Procedure**

1. Cut onion bulb into four pieces, vertically.
2. Hold one of the scale leaves with your fingers and thumb of both hands with the concave side facing you.





Peeling off the onion epidermis

3. Using fingers or forceps, gently peel off the thin transparent membrane i.e., epidermis from the inner surface of the scale leaf.
4. Place the peeled epidermis in a watch glass containing water and cut a small piece of the epidermis.
5. Place a drop of water in the centre of a clean glass slide and then put the piece of epidermis on it.
6. Spread the epidermis flat using a dissecting needle, ensuring no folds or overlaps.
7. Cover the material with cover slip and remove excess water around cover slip with blotting paper.
8. Observe the slide under microscope.
9. Place a drop of dilute iodine (or methylene blue) at one edge of cover slip and place blotting paper at the opposite edge.
10. Examine the slide, first under low power then high power of microscope.



Observations

Draw and label what you have observed.





Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Why do we use stains like iodine or methylene blue when observing cells under a microscope?

Ans. To make the cell structures more visible, as many cell parts are transparent and hard to see without staining.

2. Name one difference in structure between an animal cell and a plant cell visible under the microscope.

Ans. Plant cells have a cell wall while animal cells do not.

3. Which part of the onion cell takes up the iodine stain more prominently?

Ans. The nucleus and sometimes the starch granules (if present) stain more prominently.

4. Why is it important to place the coverslip gently over the specimen on the slide?

Ans. To avoid trapping air bubbles and to prevent damaging the specimen.

5. What is the function of the nucleus observed in both plant and animal cells?

Ans. The nucleus controls the activities of the cell and carries genetic material (DNA).

6. What is the shape of red blood cells in the frog's blood smear?

Ans. They are oval, biconvex in shape and have a distinct nucleus.

Brain Benders

1. Why is there no need of cover slip to place on the slide?

Ans. Because the specimen (like blood) spreads easily on its own and is very thin, so it can be observed directly under the microscope without needing a cover slip. A cover slip is usually used to protect thicker samples and prevent them from drying, but in this case, it is not necessary.

2. Why is an anticoagulant added to blood immediately after it is taken from the body?

Ans. An anticoagulant is added to prevent the blood from clotting. If the blood clots, it becomes solid and cannot be used for tests or observation under the microscope.



REAL-LIFE APPLICATIONS

Students learn to help identify cell components (nucleus, cytoplasm, membrane, cell wall), essential for diagnostics and microscopy-based analyses. It also teaches staining methods (iodine, methylene blue) used in pathology labs to observe cell morphology, bacteria, blood smears, or tissue samples.

Teacher's Signature: _____

Date: _____

Remarks: _____





Identify, from fresh preparations, the cell membrane, nucleus, and cytoplasm in an animal cell and the cell wall, cell membrane, sap vacuole, cytoplasm, nucleus, and chloroplast in a plant cell.

Students' Learning Outcome

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

- Recognize major cell structures in animal and plant cells under a microscope.
- Identify cell membrane, nucleus, and cytoplasm in animal cells (e.g., cheek cell).
- Identify cell wall, cell membrane, sap vacuole, cytoplasm, nucleus, and chloroplasts in plant cells (e.g., onion peel/leaf cell).
- Compare structural differences between plant and animal cells.
- Develop skills of scientific observation and recording.

Background Information

All living organisms are made up of cells, which are the basic structural and functional units of life. **Animal Cells** are eukaryotic, bounded by a cell membrane, and contain cytoplasm and a prominent nucleus. They lack a cell wall and chloroplasts. **Plant Cells** are also eukaryotic but have a rigid cell wall outside the cell membrane. They usually have a large central sap vacuole and may contain chloroplasts (photosynthetic plastids).

Key Differences between plant and animal cells

- **Cell wall:** Present in plant cells, absent in animal cells.
- **Chloroplasts:** Present in plant cells, absent in animal cells.
- **Vacuole:** Large and central in plant cells, small or absent in animal cells.
- **Shape:** Plant cells often rectangular/regular, animal cells irregular/rounded.



Materials / Apparatus Required

Prepared slide of onion peel (plant cell), Prepared slide of cheek cell (animal cell), Compound light microscope, Cover slips, droppers, and stains (methylene blue, iodine, or safranin), Blotting paper, distilled water, and forceps.



Precautions

- Handle the microscope carefully, using both hands.
- Adjust the mirror/illumination for a clear view.
- Avoid overstaining the specimen slides.
- Place coverslip gently to prevent air bubbles.



Procedure

1. Place the prepared onion peel slide under the microscope.
 - Focus under low power, then shift to high power.
 - Identify the cell wall, cell membrane, cytoplasm, nucleus, vacuole, and chloroplasts.



- Place the prepared cheek cell slide under the microscope.
 - Focus similarly, observing the cell membrane, cytoplasm, and nucleus.
- Record the observations in the table below.
- Draw neat, labelled diagrams of one onion cell and one cheek cell.



Observations

Sr. No.	Cell Type	Structures Identified	Observation	Inference
1	Plant Cell (Onion/Leaf)	Cell wall, cell membrane, cytoplasm, nucleus, sap vacuole, chloroplasts	Rectangular compartments with thick wall; nucleus at periphery; large central vacuole; green plastids visible in leaf cells	Plant Cell
2	Animal Cell (Cheek)	Cell membrane, cytoplasm, nucleus	Irregular outline; thin boundary (cell membrane); central prominent nucleus	Animal Cell

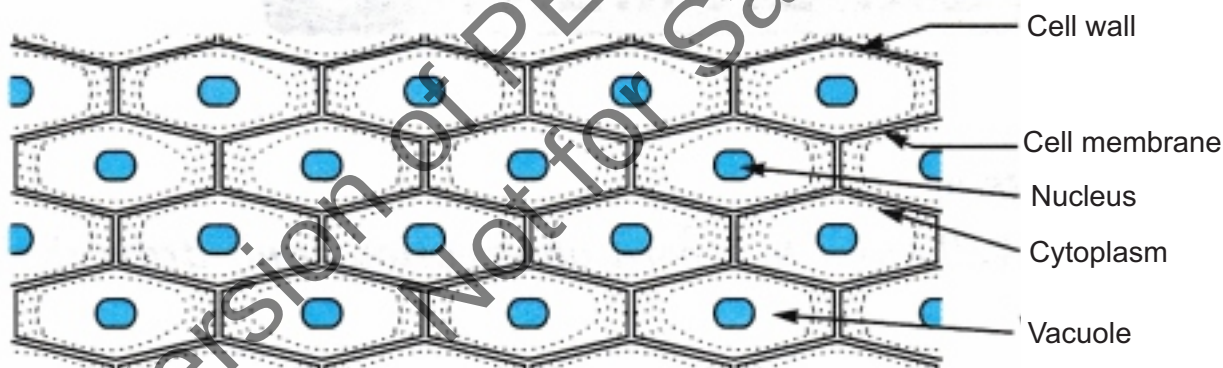


Figure: Cell structure of onion peel

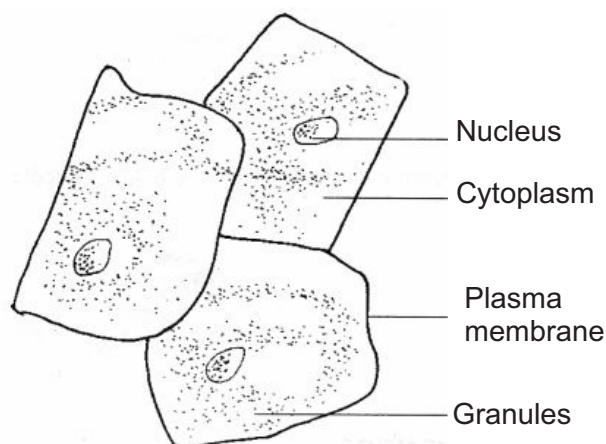


Figure: Human cheek cell



Students are advised to record their own observations and draw the diagrams

Sr. No.	Cell Type	Structures Identified	Observation	Inference
1.				
2.				



Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Name two structures present in plant cells but absent in animal cells.

Ans. Cell wall and chloroplasts.

2. Which stain is commonly used for cheek cells and why?

Ans. Methylene blue, because it makes the nucleus more visible.

3. What is the function of the cell wall in a plant cell?

Ans. It provides support, strength, and protection, and helps maintain the cell's shape.

4. How do onion cells and cheek cells differ in shape under the microscope?

Ans. Onion cells are rectangular (brick-like), while cheek cells are irregular and round.

5. Which structure stores water and maintains shape in plant cells?

Ans. The large central vacuole.



Brain Benders

1. If an onion cell is stained with iodine, why does the nucleus become more visible?

Ans. Because iodine binds to parts of the cell, especially starch and proteins, it adds contrast. This makes the nucleus stand out clearly under the microscope.

2. Why do cheek cells lack chloroplasts?

Ans. Cheek cells are animal cells. They do not carry out photosynthesis, so they don't need chloroplasts.

3. Suppose a plant cell loses water and its vacuole shrinks. What happens to the cell membrane?

Ans. The cell membrane pulls away from the cell wall, a process called *plasmolysis*.

4. Why do animal cells have irregular outlines compared to rectangular plant cells?

Ans. Animal cells lack a rigid cell wall. Their shape is flexible, so they appear round or irregular, unlike plant cells which have a firm cell wall giving them a rectangular shape.

5. Imagine you observe a green leaf cell. Which structures confirm photosynthesis?

Ans. The presence of chloroplasts (green structures) confirms photosynthesis, since chloroplasts contain chlorophyll that captures sunlight for the process.

REAL-LIFE APPLICATIONS

Medical science: Identifying animal cells in blood smears or tissue samples aids in diagnosis.
Botany & Agriculture: Study of plant cells helps understand photosynthesis and crop science.
Biotechnology: Cell structures form the basis for genetic engineering, cloning, and tissue culture.
Everyday life: Awareness of cell structure deepens understanding of life processes and health.

Teacher's Signature: _____

Date: _____

Remarks: _____



Practical Based Assessment

Time Allowed: 02 hours

Maximum Marks: 30

INSTRUCTIONS FOR TEACHERS:

The teacher will divide students into groups and assign each group a specific practical from No. 1 to 5. Students are required to list the necessary apparatus, describe the procedure and note any precautions. They should also record their observations in the Observation Table, if necessary. The teacher will conduct a Viva Voce with each student to evaluate their performance. The teacher will also provide guidance to students on any discrepancies in their work and award marks accordingly.

- Q.1.** Prepare a temporary mount of the given specimen (onion epidermis) and draw its labelled diagram 3+3
- Q.2.** Identify the slides/models A, B, C, D and E. Give at least one important characteristic and reason for its identification. 5+5
- Q.3.** Differentiate plant and animal cells and also draw the diagrams highlighting the differences. 4+4
- Q.4.** Viva 3
- Q.5.** Copy 3





Observation of Various Stages of Mitosis and Meiosis by Slides, Models and Charts

Students' Learning Outcome

After performing this activity, students will be able:

- To observe and identify the various stages of mitosis and meiosis using prepared slides, models, and charts.
- To understand the sequential events and significance of each stage in the process of cell division.

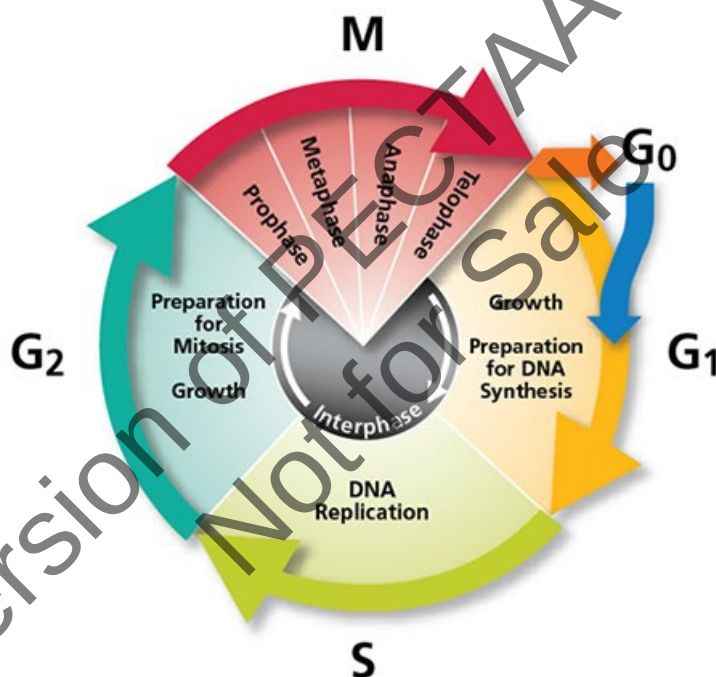


Figure: Cell cycle

PART 1: STUDY OF MITOSIS

Background Information

Mitosis is a cell division in which the two daughter cells receive the same number of chromosomes as are present in the parent cell. It is a continuous process in which sequence of events is divided into two major phases: karyokinesis (division of nucleus) and cytokinesis (division of cytoplasm). Karyokinesis is divided into four phases, i.e. prophase, metaphase, anaphase and telophase.



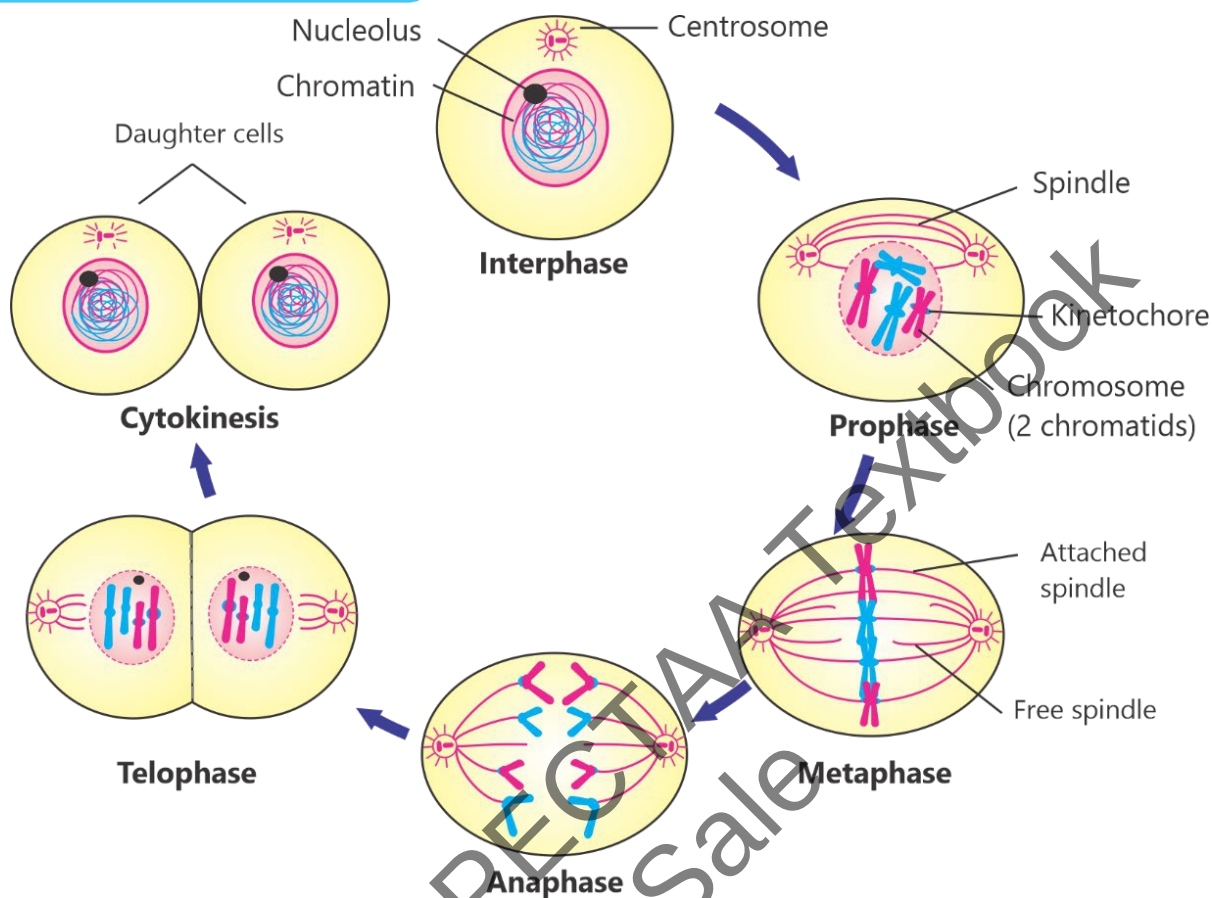


Figure: Different stages of mitosis



Materials / Apparatus Required

Models, charts and prepared slides of mitosis, microscope



Precautions

- Handle the slides carefully.
- Clean the slide, ocular lens, and objective of microscope before observing.



Procedure

1. Examine the prepared slides showing various stages of cell division (mitosis) through microscope.
2. Observe charts and models of various stages of mitosis.
3. Compare the slides with charts and models.



Observations

Fill the table after observing the slides/charts/models.



Slide	Characteristic of each stage	Diagram



Conclusions

Compare the slides with charts and models on the basis of position of chromosomes and identify the phases of mitosis.

Slide/chart/ model	Position of chromosome	Phase of mitosis



PART 2: STUDY OF MEIOSIS

Background Information

In meiosis, one diploid cell divides to produce four haploid daughter cells. Meiosis consists of two subdivisions, i.e., meiosis-I and meiosis-II. Each sub-division is further divided into prophase, metaphase, anaphase and telophase.

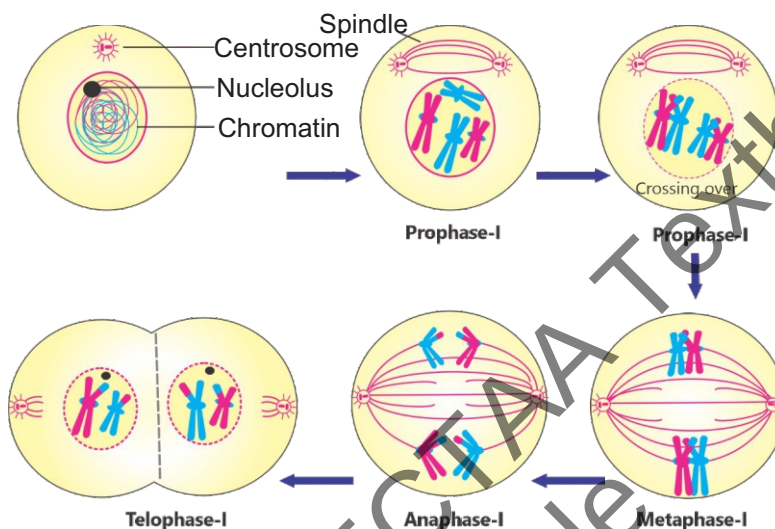


Figure: Different stages of meiosis I

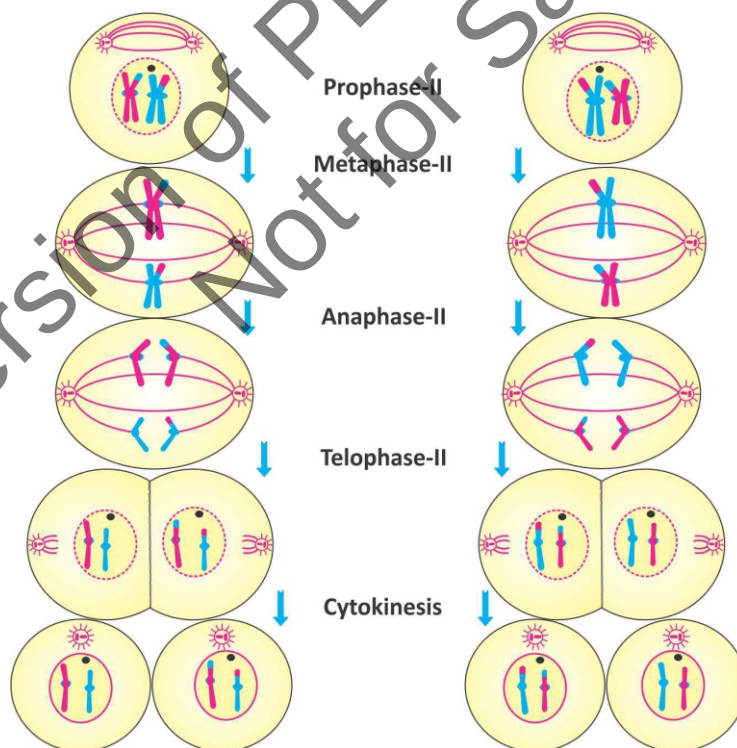


Figure: Different stages of meiosis II



Materials / Apparatus Required

Models, charts and prepared slides of meiosis, microscope





Procedure

1. Examine the prepared slides showing various stages of meiosis through microscope.
2. Observe charts and models of various stages of meiosis.
3. Compare the slides with the charts and models.



Observations

Fill the table after observing the slides/charts/models.

Slide	Characteristics	Diagram





Conclusions

Compare the slides/charts/models and identify the phases of meiosis on the basis of position of chromosomes.

Slide	Position of chromosome	Phase of meiosis



FOLLOW-UP TASKS**Assessment Questions**

1. If reduction division does not take place, what will be the consequences?

Ans. If reduction division (meiosis) does not take place, the chromosome number will not be halved in gametes. As a result, after fertilization the zygote will have double the normal number of chromosomes, leading to abnormalities.

2. Which type of cell division occurs during healing of wound?

Ans. Mitosis occurs during wound healing, because it produces identical cells for growth and repair.

3. What is the difference between mitosis and meiosis in terms of the number of daughter cells produced?

Ans.

- Mitosis produces 2 daughter cells.
- Meiosis produces 4 daughter cells.

4. In which stage of mitosis do chromosomes align at the equatorial plane?

Ans. In the Metaphase stage of mitosis.

5. What is the significance of anaphase in mitosis?

Ans. In Anaphase, sister chromatids are pulled apart and move to opposite poles. This ensures each daughter cell receives an equal set of chromosomes.

6. In which stage of meiosis do homologous chromosomes separate?

Ans. Homologous chromosomes separate during Anaphase I of meiosis.

Brain Benders

1. In which kind of cells does mitosis occur?

Ans. Mitosis occurs in somatic cells (body cells). These are the cells that make up tissues and organs like skin, muscles, and blood.

2. Why meiosis is referred to as reduction division?

Ans. Meiosis is called reduction division because it reduces the number of chromosomes in the daughter cells to half of the parent cell. For example, in humans, cells go from 46 chromosomes (diploid) to 23 chromosomes (haploid).

3. Where in the body does meiosis occur in (i) women (ii) man (iii) plants?

Ans.

- (i) In women, in the ovaries, to form egg cells (ova).
- (ii) In men, in the testes, to form sperm cells.
- (iii) In plants, during spore formation.

4. What would happen to a cell if it does not go through the G1 phase of cell cycle? Explain.



Ans. The G1 phase allows the cell to grow and prepare for DNA replication. If a cell skips G1, it would not grow properly, may lack enough proteins and organelles, and might not be able to function or divide correctly.

5. A great deal of research on the causes and a possible cure for cancer focuses on the genes that control the cell cycle. Why?

Ans. Cancer happens due to the uncontrolled division of cells. This usually occurs because the genes that control the cell cycle get damaged or mutated. Studying these genes helps scientists understand how cancer starts and how to stop it.

REAL-LIFE APPLICATIONS

The observation of various stages of mitosis and meiosis has significant real-life applications in medical diagnostics, agriculture, genetics, and biotechnology. In medical sciences, understanding mitosis is crucial to study cancer. By observing mitosis stages, researchers and oncologists identify how certain drugs work to treat cancer. In agriculture and plant breeding, knowledge of meiosis is applied to create hybrid varieties through controlled crossing and to study genetic recombination for improved crop traits such as disease resistance and higher yield. In genetic counselling, meiosis study helps in understanding chromosomal abnormalities. In forensic science and research, understanding cell division processes is fundamental for tissue culture, cloning, and genetic engineering.

Teacher's Signature: _____

Date: _____

Remarks: _____





Preparations of Root Tip Squashes and Study Stages of Mitosis

Students' Learning Outcome

After performing this activity, students will be able:

- To identify and study different stages of mitosis – prophase, metaphase, anaphase, and telophase – in the root tip cells.
- To develop practical skills in slide preparation, staining, and microscopic observation.

Background Information

The number of cells within an organism increases by mitosis, and this is the basis of growth in multicellular organisms. In plants, the roots continue to grow. These root tips are good for studying the stages of mitosis.



Materials / Apparatus Required

Microscope, slides, root tips provided by teacher, dissecting needle, oceto orcin, tissue paper



Precautions

Do not place too much material on a slide.



Procedure

1. Trim around 3 cm of newly grown roots and place them on slide.
2. Place each root tip on a clean slide containing water drop.
3. Dry it with a piece of soft tissue paper. It is important to remove as much water as possible.
4. By using a dissecting needle, chop the root tip thoroughly and spread it on the slide.
5. Add 1 drop of oceto-orcin stain on the root tips and stay for 3 minutes
6. Remove the extra stain by filter paper.
7. Place a cover slip gently by avoiding air bubbles.
8. Observe the slide under the microscope at low and high powers.

Note:

The laboratory attendant may place the bulbs of onion in beaker containing water to growth tips. It may take around 4 to 6 days for new roots to grow and appear.



Onion bulbs growing in beaker





Observations

Fill the table after observing the slides.

Slide	Characteristic of each stage	Diagram



Conclusions



FOLLOW-UP TASKS**Assessment Questions**

1. Instead of root tip, which other part of plant can be used to study mitosis?

Ans. The shoot tip or young flower buds can also be used because their cells are actively dividing.

2. Do all cells in the human body undergo mitosis? Explain.

Ans. No, not all cells undergo mitosis. Somatic (body) cells like skin cells, blood cells, and bone marrow cells undergo mitosis for growth and repair. But specialized cells like nerve cells do not divide once fully formed.

3. Why is it important to dry the root tip with tissue paper before chopping?

Ans. Drying removes excess water so the root tip does not slip while cutting. It also makes the tissue softer and easier to squash on the slide.

4. Name the four stages of mitosis studied in this experiment.

Ans. The four stages are:

- Prophase
- Metaphase
- Anaphase
- Telophase

5. Which mitotic stage has a clear nuclear membrane disappearance?

Ans. In Prophase, the nuclear membrane breaks down and disappears, making the chromosomes visible.

Brain Benders

1. Why is the root tip specifically chosen for mitosis studies instead of mature root regions?

Ans. Because the root tip contains the meristematic region where cells are actively dividing. In mature root regions, cells are mostly elongated and differentiated, so mitosis is rare.

2. How can you identify metaphase under the microscope in root tip squash slides?

Ans. In metaphase, the chromosomes are aligned in the center of the cell, forming the equatorial plate. They look like dark, thick lines arranged in the middle.

3. If a cell shows V-shaped chromosomes moving towards poles, which mitotic stage is it?

Ans. That stage is anaphase, where sister chromatids are pulled apart to opposite poles. The V-shape comes from the centromeres leading the movement.



4. What structural feature distinguishes prophase from metaphase?

Ans.

- In prophase, chromosomes condense and become visible, but they are scattered and not aligned.
- In metaphase, chromosomes are fully condensed and arranged at the equatorial plate.

5. In which stage do sister chromatids separate to become individual chromosomes?

Ans. This happens in anaphase.

6. How does telophase differ from cytokinesis in microscopic observations?

Ans.

- In telophase, chromosomes reach the poles and nuclear membranes start to reform, but the cell is still one unit.
- In cytokinesis, the cytoplasm divides, forming two distinct daughter cells.

7. Why is interphase not considered a stage of mitosis despite being part of the cell cycle?

Ans. Because in interphase the cell is preparing for division (DNA replication, growth, protein synthesis) but the actual division of the nucleus does not occur. Mitosis refers only to the stages where the nucleus and chromosomes actively divide.

REAL-LIFE APPLICATIONS

The study of mitosis using root tip helps in studying the chromosomal behaviour of plants. It identifies chromosomal abnormalities in crops to ensure healthy plant varieties and improved yields. Root tip squash experiments form the foundation for understanding cell division for biology students

Teacher's Signature: _____

Date: _____

Remarks: _____





Identification of xylem and phloem tissues in the prepared slides of stem, root and leaf.

Students' Learning Outcome

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

- Identify xylem and phloem tissues in stem, root, and leaf sections using prepared slides.
- Differentiate between xylem and phloem based on structure and arrangement.
- Recognize vascular bundles and relate structure to function.

Background Information

Xylem is a complex tissue that transports water and minerals from roots to aerial parts. It consists of tracheids, vessels, xylem fibers, and xylem parenchyma. Phloem is a complex tissue that transports food (sugars, amino acids) from leaves to other plant parts. It consists of sieve tube elements, companion cells, phloem fibers, and phloem parenchyma.

Vascular bundles are the groups of xylem and phloem tissues arranged together. Their arrangement differs in stem, root, and leaf:

- Stem: Xylem inside, phloem outside, forming concentric circles.
- Root: Central xylem with radiating arms, phloem between arms (radial arrangement).
- Leaf: Xylem facing the upper epidermis, phloem towards the lower epidermis (dorsiventral arrangement).



Materials / Apparatus Required

Compound light microscope, Prepared slides stem, root, and leaf (cross-sections), pencil, ruler, eraser, practical notebook



Precautions

- Handle microscope and slides carefully.
- Draw neat diagrams with a sharp pencil; label correctly.
- Always start observation with low power and then move to high power.



Procedure

1. Set up the microscope on a clean table. Adjust the mirror/illuminator for proper light.
2. Place the prepared slide of the **stem** under the microscope.
3. Start with **low power (10×)** to locate the vascular bundle; then switch to **high power (40×)** to observe details.



4. Identify:
 - **Xylem** (thick-walled cells, usually red/pink with safranin).
 - **Phloem** (thin-walled cells, often green/blue with fast green).
5. Sketch the arrangement in your notebook and label clearly.
6. Repeat the steps for **root** and **leaf** slides.
7. Compare the arrangement of vascular tissues in the three organs.



Observations

Organ	Arrangement of Vascular Bundles	Xylem Features	Phloem Features	Sketch with Labels
Stem				
Root				
Leaf				



Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. What is the primary function of xylem tissue?

Ans. The primary function of xylem is to transport water and minerals from the roots to the rest of the plant. It also provides structural support.

2. What is the main function of phloem tissue?

Ans. The main function of phloem is to transport food (mainly sugars like sucrose) made in the leaves to other parts of the plant for growth, storage, and energy.



3. Name two types of cells found in xylem and two found in phloem.

Ans. Xylem cells: tracheids, vessel elements (also fibers and xylem parenchyma).

Phloem cells: sieve tube elements, companion cells (also phloem fibers and phloem parenchyma).

4. Which stains are commonly used to differentiate xylem and phloem in microscope slides?

Ans. Safranin (stains xylem red) and Fast Green (stains phloem green).

Brain Benders**1. Why is xylem always positioned towards the upper epidermis in leaves?**

Ans. Xylem is placed near the upper side of the leaf because it needs to supply water and minerals directly to the photosynthetic cells (palisade mesophyll), which are found just below the upper epidermis. This helps the leaf carry out photosynthesis efficiently.

2. What will happen to the plant if xylem is blocked?

Ans. If xylem is blocked, water and minerals from the roots cannot move upward to the leaves. As a result, the leaves will wilt, photosynthesis will slow down, and eventually, the plant may dry out and die.

REAL-LIFE APPLICATIONS

Understanding vascular tissues helps in studying water and nutrient transport in crops. Identifying xylem (wood) quality is crucial for timber industry. Many herbal medicines are extracted from bark (phloem) or wood (xylem). Diseases blocking xylem/phloem (e.g., wilts, viral infections) directly affect crop yield.

Teacher's Signature: _____

Date: _____

Remarks: _____



Practical Based Assessment

Time Allowed: 02 hours

Maximum Marks: 30

INSTRUCTIONS FOR TEACHERS:

The teacher will divide students into groups and assign each group a specific practical from No. 6 to 8. Students are required to list the necessary apparatus, describe the procedure and note any precautions. They should also record their observations in the Observation Table, if necessary. The teacher will conduct a Viva Voce with each student to evaluate their performance. The teacher will also provide guidance to students on any discrepancies in their work and award marks accordingly.

- Q.1.** Prepare a temporary mount of the given specimen (onion root) and draw its labelled diagram (Only metaphase stage) 3+3
- Q.2.** Identify the slides/models A, B, C, D and E. Give at least one important characteristic and reason for its identification. 5+5
- Q.3.** Write steps of procedure, observations and results of the following experiment. Draw a diagram wherever necessary.
- Q.4.** Prepare root tip squashes and discuss the stages of mitosis. 3+2+3
- Q.5.** Viva 3
- Q.6.** Copy 3





Experiment to Show Working of Enzyme In Vitro, e.g., Pepsin Working on Meat in Test Tube

Students' Learning Outcome

After performing this activity, students will be able:

- To demonstrate and explain the action of the enzyme pepsin on proteins by conducting an in vitro experiment using meat in a test tube.
- To analyse the results to understand enzyme specificity and optimal conditions for enzyme activity.

Background Information

Enzymes are found in living things and they speed up specific biochemical reactions. Pepsin is an enzyme, which is secreted in the stomach of most animals and helps in the break down of proteins. All the biochemical reactions take place within the body (in vivo). But these reactions are also possible outside the body (in vitro), e.g., in the laboratory.

DO YOU KNOW?

A single cell contains thousands of enzymes, each with its own function



Materials / Apparatus Required

Test tube, pipette, beaker, pieces of meat, pepsin solution, 10% HCl, Biuret solution, water bath

Precautions

- Handle the chemicals carefully.
- Don't try to taste pepsin solution.





Procedure

1. Take four test tubes and label them A, B, C, and D.
2. Add equal pieces of meat in each test tube.
3. Add 2ml of HCl in test tube A.
4. Add 2ml of pepsin in Test tube B.
5. Add 2ml of HCl and 2 ml pepsin solution in test tube C.
6. Add 2ml HCl and 2ml boiled pepsin solution (provided) in test tube D.
7. Place the test tubes at 37°C in water bath.
8. Add three drops of Biuret solution in each test tube and observe the changes.
Purple or pink colour will indicate the presence of proteins.
9. Observe the changes in the test tubes.



Observations

Test Tube	Changes	Protein present or absent
A		
B		
C		
D		



Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Set up the same apparatus as set in tube C. Use pulses in place of meat. Find out whether you get the same results.



Ans. No, you will not get the same results. Meat mainly contains proteins which are broken down by pepsin in the presence of dilute HCl. Pulses contain proteins but also starch and fibre. The conditions in tube C are suitable for digesting meat proteins, not starch, so the results will be different.

2. Name some of the in vivo biochemical reactions (other than digestion) catalyzed by enzymes.

Ans.

- Respiration
- Photosynthesis in plants
- DNA replication

3. Why is dilute HCl added in the experiment?

Ans. Dilute HCl provides an acidic medium (around pH 2) which is necessary for pepsin to work. It also helps to kill harmful microorganisms present in the food.

4. Why the experiment is performed at 37°C?

Ans. The experiment is carried out at 37°C because it is the optimum temperature of pepsin

Brain Benders

1. Which animal produces less pepsin, a herbivore or a carnivore? Why?

Ans. A herbivore produces less pepsin. This is because herbivores eat mainly plants, which contain less protein, so they don't need as much pepsin. Carnivores eat mostly meat (rich in protein), so they need more pepsin for digestion.

2. What would happen if the temperature is kept above 37°C during the experiment?

Ans. If the temperature is higher than 37°C, the pepsin enzyme may start to denature (lose its shape). As a result, it will not work properly, and protein digestion will slow down or stop.

3. Did pepsin act in the absence of HCl? Why?

Ans. No, pepsin did not act in the absence of HCl. This is because pepsin needs an acidic medium (provided by HCl) to become active. Without HCl, it cannot digest proteins effectively.

REAL-LIFE APPLICATIONS

This experiment is applied in digestive enzyme supplements given to patients with low or absent stomach acid, where natural pepsin secretion is insufficient. Pepsin tablets or pepsin-containing syrups are prescribed to aid protein digestion in people with stomach enzyme deficiency, mimicking the in vitro breakdown process demonstrated in the test tube.

Teacher's Signature: _____

Date: _____

Remarks: _____





Demonstration of the Process of Photosynthesis Using an Aquatic Plant, Like *Hydrilla*

Students' Learning Outcome

After performing this experiment, students will be able to:

- To demonstrate and explain the process of photosynthesis by observing oxygen bubble formation in an aquatic plant (*Hydrilla*) under light, thereby understanding that oxygen is released during photosynthesis.

Background Information

Photosynthesis is the process in which green plants prepare their food (carbohydrates) in the presence of sunlight and chlorophyll from carbon dioxide and water, and oxygen is released.

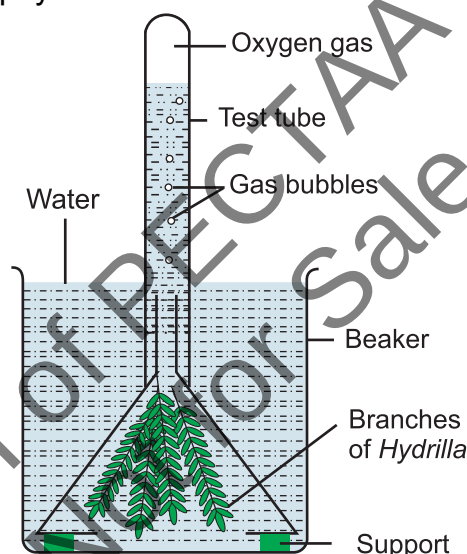


Figure: Experiment setup to demonstrate photosynthesis in an aquatic plant



Materials / Apparatus Required

Beaker, funnel, test tubes, sodium bicarbonate, *Hydrilla* or any other aquatic plant shoots, match box



Precautions

Air should not enter the test tube while you invert it on the funnel



Procedure

- Fill up 3/4 portion of 500 ml beaker with water.
- Dissolve little sodium bicarbonate in the water, which provides CO_2 to the plant.
- Put some *Hydrilla* shoots in beaker and cover it with inverted funnel.



4. Invert the test-tube, filled with water, on the funnel neck.
5. Place the apparatus in sunlight for few hours for photosynthesis.
6. Bring out the test tube from funnel (by putting your thumb on its mouth).
7. Test for the presence of oxygen in the test tube by using a glowing match stick.



Observations

Record your observations after the experiment.

S. No.	Changes in the inverted test tube
1.	
2.	
3.	



Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. You did not use a control set up for this experiment. If you are asked to do so, what do you think would be an appropriate control?

Ans. An appropriate control would be a Hydrilla kept under the same conditions but in the dark (or without light). This way, we can compare and see that any bubbles observed are due to photosynthesis and not some other factor.

2. What is the effect of amount of chlorophyll on the rate of photosynthesis?

Ans. The more chlorophyll present, the faster the rate of photosynthesis, because more chlorophyll can trap more light energy. If there is less chlorophyll, the rate of photosynthesis will be slower.

3. Suggest what will be the rate of photosynthesis in the absence of water/carbon dioxide?

Ans. If either water or carbon dioxide is absent, photosynthesis will not take place at all, because both are raw materials needed for the process.



4. How do you know that photosynthesis is taking place in Hydrilla?

Ans. When Hydrilla is placed in water under sunlight, bubbles are seen coming out from the leaves. These bubbles are oxygen released during photosynthesis, which shows that photosynthesis is occurring. Test for the presence of oxygen in the test tube can be checked by using a glowing matchstick.

5. What is the source of carbon dioxide for Hydrilla in water?

Ans. Sodium bicarbonate in the water, which provides CO_2 to the plant.

Brain Benders**1. Because plants make their own food through photosynthesis, why is it necessary for plant seeds to contain food reserves?**

Ans. Seeds contain food reserves because when a seed begins to germinate, it cannot yet perform photosynthesis. The young seedling does not have developed leaves or chlorophyll to capture sunlight. The stored food provides the energy and nutrients needed for growth until the seedling can make its own food.

2. The enzymes of light reactions are confined to the thylakoid membranes of chloroplast rather than dissolved in the stroma. What is its advantage?

Ans. Keeping the enzymes in the thylakoid membranes allows the light reactions to happen in a very organized way. The membrane holds together all the pigments, enzymes, and electron carriers in the right order, so energy transfer is fast and efficient. If they were floating in the stroma, the process would be slower and less controlled.

REAL-LIFE APPLICATIONS

Demonstrating photosynthesis with *Hydrilla* shows how aquatic plants release oxygen into water, crucial for aquatic life survival (fish). This underpins aquaculture management, where submerged plants maintain oxygen balance in fish ponds. Hydrilla and similar plants are used in aquariums and water bodies to maintain oxygen levels and reduce CO_2 , preventing fish suffocation. The experiment validates their role practically.

Teacher's Signature: _____

Date: _____

Remarks: _____





Investigation of the Necessity of Chlorophyll, Light, Carbon Dioxide, using Appropriate Controls

Students' Learning Outcome

After performing this activity, students will be able to:

- To demonstrate understanding of photosynthesis requirements by investigating the necessity of chlorophyll, light, and carbon dioxide for starch production in plants.
- To set up and use appropriate experimental controls to validate experimental results scientifically.

Background Information

During the process of photosynthesis CO_2 combines with water to form glucose and oxygen is released. Chlorophyll traps sunlight and converts it into chemical energy which is used to synthesize food. Some leaves (e.g., leaves of ivy plant, money plant, hibiscus plant) have yellow areas because of the absence of chlorophyll. Such spotted leaves are called variegated leaves.

PART A: Investigation of the Necessity of Chlorophyll



Materials / Apparatus Required

Plant with variegated leaves, ethanol, iodine solution, dropper, Petri dish, beaker, test-tube, burner, water bath, tripod stand, match box



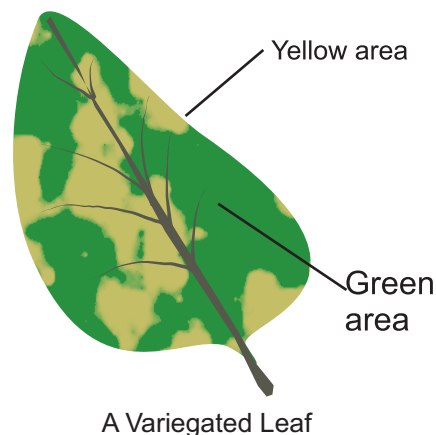
Precautions

Never heat the tube of alcohol directly over the burner flame.



Procedure

- Take potted plant having variegated leaves.
- Expose the plant to strong sunlight for three to four days.
- Remove a leaf from the plant. Draw its upper surface making a distinction between green and non-green areas.
- Perform the starch-test on the whole leaf.



Starch test

- Put the detached leaf in boiling water for about half a minute to kill its protoplasm.
- Put the boiled leaf in a test tube containing ethanol, to remove its chlorophyll.
- Place test tube in a beaker of water and boil it for 10 minutes till the leaf gets decolorized.
- Remove the leaf and wash it in water, which will make it soft.



5. Place it in petri dish and put a few drops of iodine solution on the leaf.
6. Observe colour changes in the upper surface and make drawing.

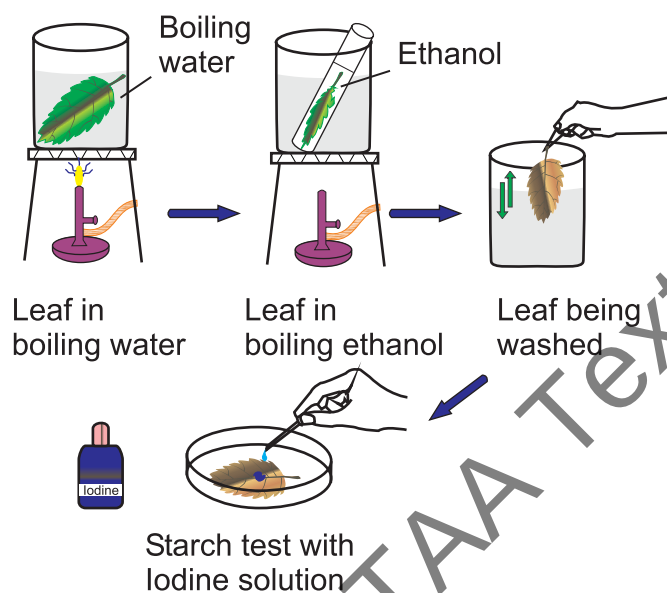


Figure: Experiment setup to investigate the necessity of chlorophyll in photosynthesis



Observations

- Record the changes in the leaf.

- Make drawings of the leaf before and after application of starch test.

- Compare the two drawings.





Conclusions

PART B: Investigation of the Necessity of Light



Materials / Apparatus Required

A potted plant with healthy leaves, black paper, paper clips, beaker, forceps, test tube, ethanol, iodine solution, dropper, burner



Procedure

1. De-starch the potted plant by placing it in a dark place for about 2-3 days.
2. Wrap a "leaf A" with black paper as shown in the diagram.
3. Cut out a certain pattern on black paper and wrap "leaf B" with this black paper as shown in the diagram (use paper clips to hold the black paper in place).
4. Place the plant in strong sunlight for 4-6 hours.
5. Remove both leaves from the plant.
6. Apply starch test to both of the leaves.

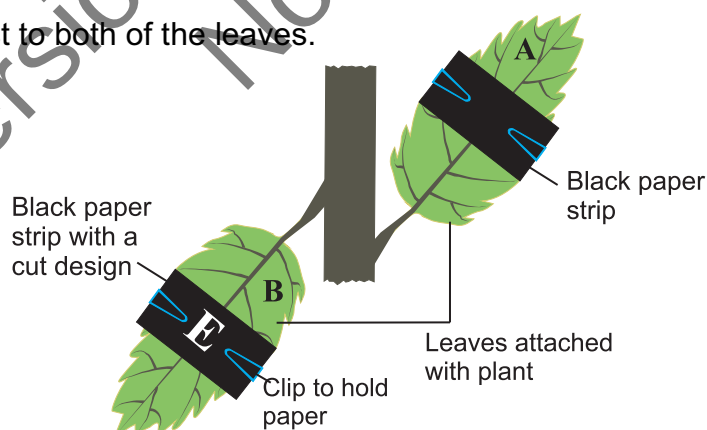


Figure: Experiment setup to investigate the necessity of light in photosynthesis



Observations

- Record your observations after applying starch test on leaves.



Leaf A	Leaf B

- Make drawings of the leaves, showing the result.



Conclusions

PART C: Investigation of the Necessity of Carbon Dioxide



Materials / Apparatus Required

Potted plant, split cork, wide mouth bottle/flask, potassium hydroxide (KOH) solution, beaker, test-tube, ethanol, iodine solution, dropper, burner, petri dish, water, vaseline

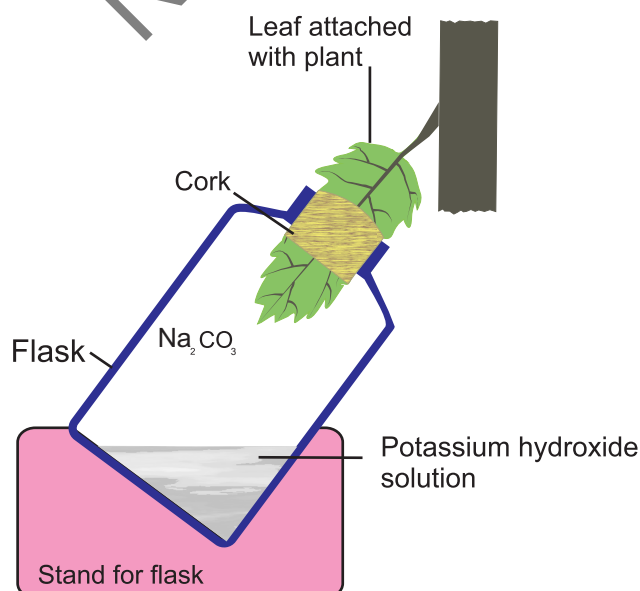


Figure: Experiment setup to investigate the necessity of CO₂ in photosynthesis





Precautions

Don't leave any space between cork sections and the leaf.



Procedure

1. De-starch the potted plant by placing it in a dark place for 2-3 days.
2. Add potassium hydroxide solution into the wide mouth bottle (KOH will absorb all the CO_2 present in the bottle).
3. Cut a cork length wise into two pieces.
4. Pass leaf of the potted plant (without detaching) through the cut section of the cork in such a way that half portion of the leaf remains out of the bottle.
5. Make the apparatus airtight by applying vaseline on the cuttings of cork.
6. Place the apparatus in bright sun light for a few hours for photosynthesis.
7. Remove this leaf from the plant.
8. Apply starch test to the leaf.



Observations

- Record your observations after applying starch test on leaf.

Area of leaf outside bottle	Area of leaf inside bottle

- Make a drawing of the leaf showing your observations.





Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Apart from cutting of the light from part of the leaf, what other effect might the black paper have on the leaf which could influence the results?

Ans. The black paper could also block air movement, reduce the temperature on that part of the leaf, or cause the leaf to become slightly damaged, which might affect photosynthesis and starch production.

2. What was the relationship between the distribution of chlorophyll in the variegated leaf and the distribution of starch revealed by iodine?

Ans. Starch was only found in the green areas of the leaf where chlorophyll was present. The non-green parts without chlorophyll did not turn blue-black with iodine, showing no starch.

3. Assuming that the accumulation of starch in a leaf is evidence of photosynthesis, make a general statement about photosynthesis and carbon dioxide.

Ans. Photosynthesis requires carbon dioxide, and when it is available, plants can produce starch in their leaves as a result of photosynthesis.



Brain Benders**1. Why did we use variegated leaves?**

Ans. We use variegated leaves because they have both green parts (with chlorophyll) and non-green parts (without chlorophyll). This helps us compare which parts make starch during photosynthesis.

2. Why starch test is applied?

Ans. The starch test is done to check whether photosynthesis has taken place. Starch is formed when plants make food using sunlight, so the test proves if photosynthesis happened.

3. Why is it needed to de-starch the plant?

Ans. De-starching removes the starch already stored in the leaves by keeping the plant in darkness for 1–2 days. This ensures that any starch found after the experiment is only made during the test period, not from before.

4. What is the purpose of covering the leaf with black paper?

Ans. Covering part of a leaf with black paper blocks sunlight from reaching that area. This shows that photosynthesis happens only where light is available.

5. Why should large quantities of fertilizers not be added to the soil?

Ans. Too much fertilizer can damage plant roots, reduce soil fertility, and cause pollution of water bodies. Plants only need a certain amount; extra fertilizer can harm them instead of helping.

REAL-LIFE APPLICATIONS

The necessity of chlorophyll, light, and carbon dioxide builds foundational knowledge in students on how photosynthesis sustains life, making them aware of plant care, ecosystem balance, and global climate implications.

Teacher's Signature: _____

Date: _____

Remarks: _____



Practical Based Assessment

Time Allowed: 02 hours

Maximum Marks: 30

INSTRUCTIONS FOR TEACHERS:

The teacher will divide students into groups and assign each group a specific practical from No. 9 to 11. Students are required to list the necessary apparatus, describe the procedure and note any precautions. They should also record their observations in the Observation Table, if necessary. The teacher will conduct a Viva Voce with each student to evaluate their performance. The teacher will also provide guidance to students on any discrepancies in their work and award marks accordingly.

- Q.1.** Write steps of procedure, observations and results of the following experiments. Draw a diagram wherever necessary.
1. Design and perform an experiment to demonstrate the action of the enzyme pepsin on protein in vitro. 3+2+3
 2. Demonstrate the process of photosynthesis in an aquatic plant (e.g., Hydrilla). 3+2+3
 3. Design and carry out investigation to test whether chlorophyll is necessary for photosynthesis. 3+2+3
- | | |
|------------------|---|
| Q.2. Viva | 3 |
| Q.3. Copy | 3 |





12

Measurement of Difference in Length / Weight of Raw Potato Strips in Concentrated Salt Solution and Water

Students' Learning Outcome

After performing this experiment, students will be able to:

- Define osmosis as the movement of water molecules from a region of higher water potential to a region of lower water potential through a selectively permeable membrane.
- Formulate a testable hypothesis predicting the effect of placing potato strips in distilled water and concentrated salt solution.
- Accurately measure and record the initial and final lengths and/or weights of potato strips using appropriate laboratory equipment.

Background Information

If we place a cell in hypotonic solution, water will move from outside to the inside. The entry of water in cell causes it to swell and it becomes turgid. This increases the weight and length of the cell. Hypertonic solution causes water to move out from cell. It reduces weight and length of cell. In isotonic solution equal amount of water moves in and out of cell, thus the cell's weight and length remain same.



Materials / Apparatus Required

Potato, cork borer, knife/blade, test tubes, test tubes stand, 20% salt solution, water, electric balance, scale, pipette



Precautions

- Measure the sizes of potato strips carefully.
- Cut the potato strips into equal size.
- Do not use same pipette for different solutions.



Procedure

1. Take a large potato and push a cork borer into it.
2. With the other end of the cork borer, push the potato strip out of the cork borer. Cut another strip using the same method.
3. Use a knife/blade to cut the equal lengths of strips. Measure the length (should not be less than 5 cm) and weight of each strip. Both strips should be of equal size and weight.
4. Place one strip in a test tube of pure water and the other strip in a test tube of 20% salt solution.
5. Wait for one day and then remove the potato strips from test tubes.
6. Blot dry and measure the weight and length of both potato strips.





Observations

- Record the changes in weight and length of potato strips

	Initial weight	Final weight	Change in weight	Initial length	Final length	Change in length
Potato strip in Pure water						
Potato strip in 20% salt solution						



Conclusions

FOLLOW-UP TASKS

Assessment Questions

- What is responsible for the increase in the length of potato strips?

Ans. The increase in length of potato strips is caused by osmosis. Water moves from the solution (where water concentration is higher) into the potato cells (where water concentration is lower), making the cells swell and the potato strip increase in length.

- In this experiment which concentration is the isotonic for potato cells?

Ans. The isotonic concentration is the solution where the potato strips do not change in length or mass. This happens because the concentration of water inside the potato cells is equal to the concentration of water outside, so there is no net movement of water.

- Repeat the same experiment with the same solution concentration but using apple strips. Is the concentration, isotonic for potato is also isotonic for apple? Why?

Ans. No, the concentration that is isotonic for potato is not always isotonic for apple. This is because potato and apple cells have different natural sugar concentrations inside them. Since the internal solute concentration is different, the isotonic solution for potato may cause either gain or loss of water in apple cells.



Brain Benders

1. If a potato strip gains mass in pure water but loses mass in salt solution, what does this tell you about the concentration of solutes inside the potato cells compared to the external solutions?

Ans. If a potato strip gains mass in pure water but loses mass in salt solution, it means the solute concentration inside the potato cells is higher than pure water (so water enters the cells by osmosis), but lower than in the salt solution (so water leaves the cells in that case).

2. You placed two identical potato strips in water and salt solution respectively. After 30 minutes, both strips show no change in mass. What could be a possible explanation for this observation?

Ans. If both strips show no change in mass after 30 minutes, it means the water concentration inside the potato cells is equal to the water concentration in the external solution (the solutions are isotonic). No net movement of water by osmosis occurs.

3. If the potato strip loses mass in salt solution but does not change in length, what could this imply about its internal structure or water loss?

Ans. If the potato strip loses mass in salt solution but does not change in length, it could mean that water left the cells, reducing their mass, but the cell walls prevented the cells from shrinking in size. The rigid cell wall maintains the overall structure even though the cells lose water.

4. If you measure the mass change of potato strips in solutions of increasing salt concentration, what pattern would you expect to see, and why?

Ans. As salt concentration increases, the potato strips would lose more and more mass. This is because higher salt concentration means a lower water concentration outside, so water moves out of the potato cells by osmosis to balance the concentration difference.

REAL-LIFE APPLICATIONS

There are clear real-life applications for the osmosis experiment. **Salting food items such as pickles, fish, or meat for preservation.** High salt concentration draws water out of microbial cells via osmosis, dehydrating them and inhibiting growth, thus preventing spoilage. **In industry,** potato strips are sometimes soaked in salt solutions to reduce water content before frying, ensuring crispier fries and reduced oil absorption. **Salting vegetables** like cucumbers to make pickles or olives less bitter and firmer. Osmosis removes excess water and sometimes bitter compounds, enhancing texture and taste.

Teacher's Signature: _____

Date: _____

Remarks: _____





Investigation of Transpiration in Potted Plant Under a Bell Jar

Students' Learning Outcome

After performing this experiment, students will be able to:

- Define transpiration.
- Describe the process of transpiration and its role in water movement within plants.
- Set up and conduct the experiment to investigate transpiration under a bell jar correctly, ensuring fair testing conditions.
- Relate transpiration to plant physiology, such as water absorption, cooling effect, and nutrient transport.

Background Information

Transpiration is the loss of water through stomata from plant surface. Transpiration pull brings minerals to the aerial parts of the plant. It also helps in cooling plant body under high temperature.



Materials / Apparatus Required

A potted plant, 2 bell-jars, polythene bag, copper sulphate



Precautions

Remove moisture from bell jar before experiment (by tissue paper etc.)



Procedure

1. Take a potted plant and cover the pot and base of stem with polythene bag.
2. Place the potted plant on a glass plate and invert a dry bell jar over it.
3. Set up a control without plant.
4. Leave both the apparatuses in sunlight, minimum for one hour

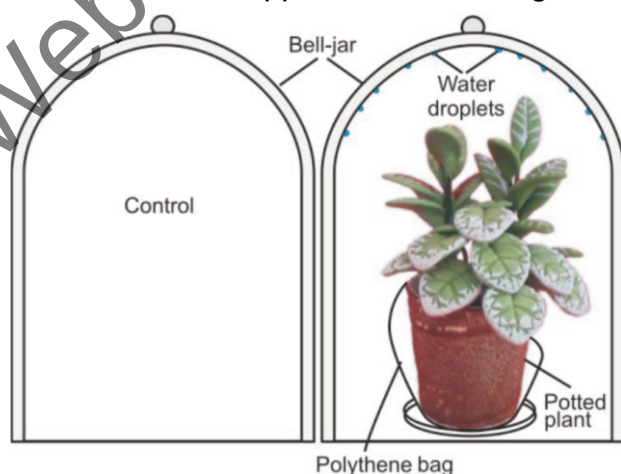


Figure: Experiment setup to investigate transpiration in potted plant under a bell jar





Observations

Bell jar without potted plant	Bell jar with potted plant



Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Why does water droplets appear on the inner surface of the bell jar during the experiment? Could these droplets form without the plant being present?

Ans. Water droplets appear because the plant loses water vapor through transpiration, which then condenses on the cooler surface of the bell jar. Without the plant, no water droplets would form, since the source of water vapor is the leaves.

2. Imagine you conducted this experiment in a cold air-conditioned room versus outside in the sun. How would the rate of transpiration differ?

Ans. In a cold air-conditioned room, the rate of transpiration would be slower because low temperature and humidity reduce evaporation. Outside in the sun, transpiration would be faster due to higher temperature, sunlight, and lower humidity.

Brain Benders

1. An agricultural practice reduces transpirational water loss from plants. Why would this practice be disadvantageous for plants?

Ans. Transpiration helps in the uptake of water and minerals from the roots. It also helps in cooling the plant and maintaining proper leaf temperature. Reducing transpiration too much can cause the plant to overheat and reduce the flow of minerals, which may slow down growth and photosynthesis.



2. If a student observed no water droplets on the bell jar and concluded that transpiration does not occur, what flaw is there in this conclusion based on experimental design?

Ans. The absence of droplets does not prove that transpiration did not occur. Water vapor might have escaped through leaks in the setup or the conditions (like low humidity, short time, or high ventilation) were not suitable for condensation. Therefore, the experiment only shows no condensation, not the absence of transpiration.

REAL-LIFE APPLICATIONS

By knowing how much water is lost via transpiration, farmers can plan irrigation schedules efficiently to avoid water stress or wastage, leading to optimal crop yield and water conservation.

Teacher's Signature: _____

Date: _____

Remarks: _____





14

Investigation of the pathway of water in a cut stem, using a suitable stain

Students' Learning Outcome

After performing this experiment, students will be able to:

- State the function of xylem tissue in transporting water within plants.
- Describe the experimental method to trace the pathway of water using a suitable stain (e.g. eosin, methylene blue, or red dye).
- Explain how staining helps to visualise water movement through the xylem.
- Relate the observations to the structure and function of xylem tissue.
- Identify the stained xylem vessels in the cut stem during observations.

Background Information

Water is absorbed by root hairs of the plant and reaches the upper parts of the plant through xylem tissues. The transport of water and salts from roots to the aerial parts of the plant body is termed as the ascent of sap. Xylem tissue consists of vessel elements and tracheids. Vessel elements are long tubes having short and wide cells, while tracheids are long cells with overlapping ends. Transpiration pull is the major force responsible for the ascent of sap.



Materials / Apparatus Required

Eosine solution, beaker, herbaceous plant, dissecting microscope, compound microscope, glass slides, stand, laser



Precautions

- Cut longitudinal sections with care.
- Don't use extra amount of eosin dye (the solution should be dilute).



Procedure

1. Fill a beaker with dilute eosine solution.
2. Take an herbaceous plant (e.g., white colored Petunia) with its roots intact.
3. Wash the roots and place the plant inside the beaker in such a way that its roots are completely dipped in coloured water as shown in the figure.
4. Keep the apparatus for a night.



5. Cut the longitudinal sections of stem. (You may also cut the cross section of the stem, to confirm the presence of eosine in xylem tissues.)
6. Examine and observe under dissecting microscope.
7. Cut transverse section of root and leaf with razor and observe them under the high and low power of microscope.
8. Compare the sizes of various types of cells through which water moves.

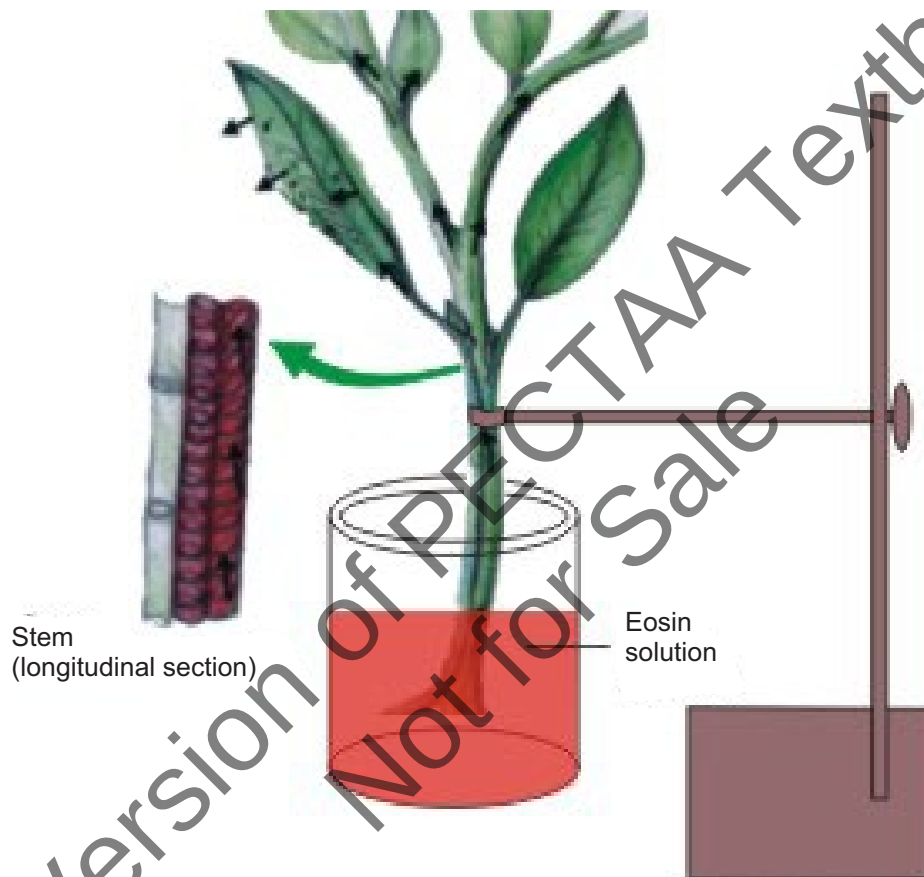


Figure: Experiment setup to investigate the pathway of water in a cut stem

Observations

Record your observations and draw figures of xylem tissues of root, stem and leaf.





Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Describe the path taken by water through the stem to the leaf as revealed by your experiment.

Ans. Water enters the root and moves upward through the xylem vessels in the stem. From the stem xylem, it is carried into the veins of the leaf and then spreads into the leaf tissues.

2. We will not observe the movement of water in the stem, if the leaves of plant are covered with cellophane paper. How is that?

Ans. Covering the leaves with cellophane prevents transpiration. Since transpiration creates the pull that helps water move upward in the xylem, without it, water will not rise through the stem and no movement can be observed.

3. Why do you think only certain parts of the stem are stained, while others remain colourless even after hours in dye solution?

Ans. Only the xylem tissues take up the coloured water because they are specialized for water transport. The other tissues (like phloem and cortex) do not conduct water, so they remain unstained.

4. You conducted the experiment but noticed no staining after a day. List two experimental errors that could cause this.

Ans.

- i. The cut end of the stem was left out of the dye solution, so no water entered.
- ii. The stem used was too old or damaged, and the xylem vessels were blocked



Brain Benders

1. It is assumed that the movement of dye through the shoot shows the normal route taken by water through a plant. What objections are there to this assumption?

Ans. It is not completely correct to assume that the movement of dye shows the normal route of water through a plant because:

Dye molecules are not the same as water molecules – they may move differently, or not enter all the same pathways as water.

Dyes can be blocked – some tissues might prevent the dye from moving, even though water normally passes through them.

REAL-LIFE APPLICATIONS

Understanding xylem transport helps diagnose and manage diseases such as vascular wilts (e.g., fungal infections that block xylem vessels).

Teacher's Signature: _____

Date: _____

Remarks: _____





Investigating the Effect of Temperature, Wind Speed & Light Intensity on Transpiration Rate

Students' Learning Outcome

After performing this experiment, students will be able to:

- Define transpiration and explain its role in water transport.
- Use a (bubble/Ganong) potometer correctly to estimate transpiration rate.
- Investigate how temperature, wind speed, and light intensity affect transpiration.
- Identify variables (independent, dependent, control) and justify controls.

Background Information

Transpiration is the loss of water vapor from plant aerial parts, mainly through stomata. It creates a transpiration pull, aiding ascent of sap via xylem.

Stomatal aperture responds to environmental factors:

- Temperature: higher temperature increases kinetic energy → faster evaporation and diffusion → typically higher transpiration.
- Wind speed: moving air removes the boundary layer → increases diffusion gradient → higher transpiration.
- Light intensity: stimulates stomatal opening (in many species) → higher transpiration (and photosynthesis).
- A potometer estimates water uptake by a cut shoot; with good practice, water uptake $\approx$ water loss by transpiration.



Materials / Apparatus Required

Healthy leafy shoot, Bubble potometer, Water basin, Scalpel / sharp scissors, Vaseline (for sealing joints), Beaker of water, Lamp (for light intensity), Fan (for wind speed), Thermometer (for temperature), Ruler, Timer, Paper towel



Precautions

- Cut stems under water; handle blades carefully.
- Keep electrical devices away from water; do not touch hot lamps/water baths.
- Avoid drafts when not testing wind. Ensure airtight seals (Vaseline if needed).

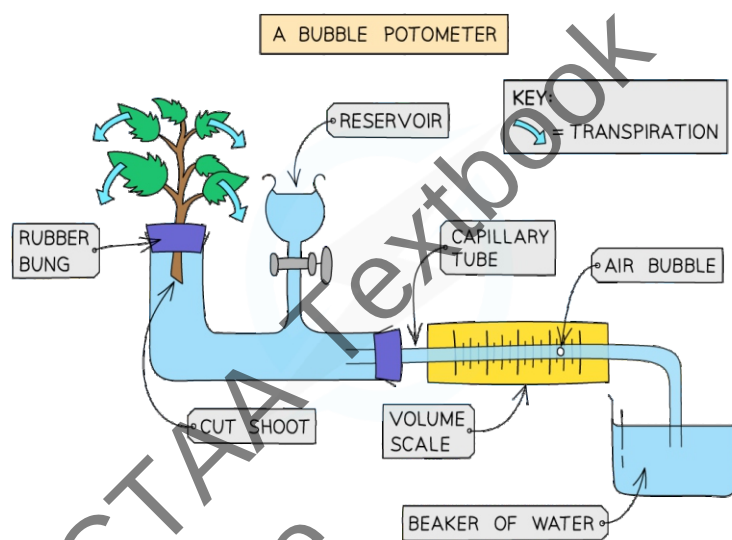


Procedure

1. Cut a leafy shoot underwater to prevent air entering the xylem.
2. Assemble the potometer under water and seal joints with Vaseline.



3. Remove excess water from leaves with a paper towel.
4. Introduce a small air bubble into the capillary tube.
5. Place the potometer on a bench with the capillary tube tip in a beaker of water.
6. Light intensity test: Place a lamp 10 cm from the shoot. Allow 5 min for adaptation, then record bubble movement along the ruler every 30 min. Repeat with lamp at 20 cm, 30 cm, etc.
7. Temperature test: Place the setup in rooms at different temperatures (or use warm/cool air currents) and record bubble movement.
8. Wind speed test: Place a fan at different speeds/distances from the shoot and record bubble movement.
9. Reset the bubble after each trial using the reservoir tap.
10. Run three sets of experiments. Between sets, use the reservoir to reset the bubble to near the zero mark.



Effect of Temperature

- Place the shoot (not the capillary) in a controlled environment at $\sim 15^{\circ}\text{C}$, 25°C , 35°C ($\pm 1-2^{\circ}\text{C}$).
- Allow 2 min equilibration at each temperature.
- Start the stopwatch and record bubble displacement every 60 s for 5 min.
- Note ambient RH% if possible.

Effect of Wind Speed

- Set lamp to a constant, moderate intensity; keep temperature roughly constant.
- Position fan at a fixed distance; test no fan, low, high.
- Measure bubble movement as above; if available, record approximate wind speed (m/s) with an anemometer.

Effect of Light Intensity

- Keep fan off; maintain room temperature.
- Vary lamp distance (e.g., 100 cm, 50 cm, 25 cm) or use a dimmer; measure lux if available.



- Avoid heating leaves: use LED or insert a heat filter/clear water beaker between lamp and plant.
- Record bubble displacement per minute.

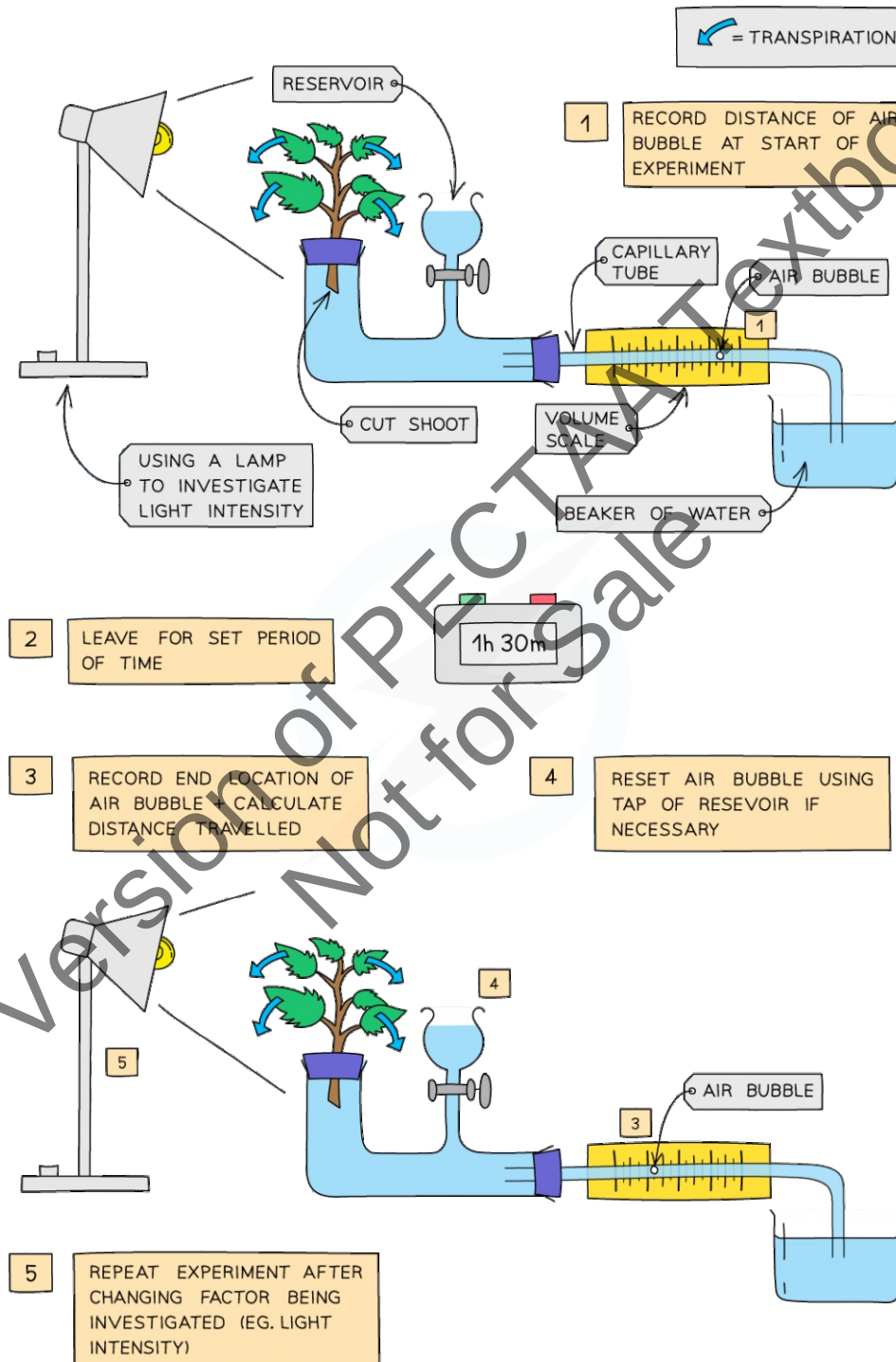


Figure: Investigating light intensity and transpiration





Observations

Table 1: Temperature vs Transpiration

Temperature (°C)	Time (min)	Bubble Position (mm)	Displacement in Interval (mm)	Rate (mm/min)
15	0–1			
15	1–2			
...	...	...		
25	0–1			
35	0–1			

Table 2: Wind Speed vs Transpiration

Fan Setting (or m/s)	Time (min)	Bubble Position (mm)	Displacement (mm)	Rate (mm/min)
Off (0 m/s)	0–1			
Low (~1–2 m/s)	0–1			
High (~3–5 m/s)	0–1			

Table 3: Light Intensity vs Transpiration

Distance (cm) / Lux	Time (min)	Bubble Position (mm)	Displacement (mm)	Rate (mm/min)
100cm/Lux	0–1			
50cm/Lux	0–1			
25cm/Lux	0–1			



Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. Why is Vaseline used in assembling the potometer?

Ans. Vaseline is applied around joints to make the apparatus airtight and prevent air bubbles or leaks, which could affect the accuracy of the results.

2. How does light intensity affect transpiration?

Ans. As light intensity increases, the stomata open wider to allow more carbon dioxide for photosynthesis, which also increases water loss through transpiration.



3. Define transpiration and state where most water loss occurs?

Ans. Transpiration is the loss of water vapor from the aerial parts of a plant, mainly through evaporation from leaf surfaces. Most water loss occurs through the stomata on the leaves.

4. Why must the shoot be cut under water for this experiment?

Ans. The shoot is cut under water to prevent air from entering the xylem vessels, which could form air bubbles (air locks) and stop the continuous flow of water.

5. Identify the independent, dependent, and at least four control variables in this investigation.

Ans. **Independent variable:** Light intensity.

Dependent variable: Rate of transpiration (measured by the movement of the air bubble/water uptake).

Control variables:

1. Type/species of plant used.
2. Size/length of the shoot.
3. Temperature of the environment.
4. Humidity of the air.

Brain Benders

1. What would happen if you performed this experiment in very humid air? Explain.

Ans. If you carried out the investigation in very humid air, the results would be different because the humidity around the leaf affects transpiration.

In very humid air, the space outside the leaf already has a lot of water vapor. This means the concentration difference between the inside of the leaf (where there is lots of water vapor) and the air outside (already full of moisture) is very small. Since transpiration depends on water vapor moving from high concentration (inside the leaf) to low concentration (outside), the movement slows down.

So, even if you change temperature, wind speed, or light intensity, the effect on transpiration would be reduced, because the main limiting factor is the high humidity.

2. Why might very high temperatures reduce transpiration instead of increasing it?

Ans. At very high temperatures, the plant may close its stomata to prevent too much water loss. When the stomata are closed, less water vapour can escape, so transpiration decreases. Also, extreme heat can damage cells, reducing the ability of leaves to carry out normal processes.



3. Compare the advantages and disadvantages of a bubble potometer vs a mass potometer.

Ans.

Potometer Type	Advantages	Disadvantages
Bubble potometer	- Easy and quick to set up - Can give instant results by watching bubble movement	- Not very accurate (bubbles can stick or leak) - Doesn't measure actual water lost, just uptake
Mass potometer	- More accurate (measures actual mass of water lost) - Less affected by leaks	- Slower to detect changes - Needs a balance to weigh mass

REAL-LIFE APPLICATIONS

In controlled environments, regulating temperature, humidity, light, and airflow helps optimize plant growth and reduce water loss. Rising global temperatures and shifting wind/light patterns directly affect transpiration, influencing crop yields and food security. Choosing drought-resistant plants (xerophytes) for landscaping in dry areas helps reduce irrigation needs. Transpiration contributes to the water cycle and rainfall patterns. Deforestation reduces transpiration, altering local climates. Scientists study transpiration rates to develop crop varieties that can withstand heat, drought, or strong winds.

Teacher's Signature: _____

Date: _____

Remarks: _____





Investigation of Conditions for Seed Germination

Students' Learning Outcome

After performing this experiment, students will be able to:

- Define seed germination and explain its importance in the plant life cycle.
- Identify and describe the essential conditions required for seed germination, including water, oxygen and suitable temperature.
- Formulate hypotheses about how different conditions (e.g. absence of water, low temperature, lack of oxygen) affect germination rates.

Background Information

Seeds have been an important development in the reproduction and spread of flowering plants (angiosperms). The process through which a seed becomes active to form a young seedling is called seed germination. Favourable conditions water, temperature, oxygen, etc. are required for seed germination. The embryonic stem below the point of attachment of the cotyledons is the hypocotyl and above the point of attachment is epicotyl. The root is the first structure that emerges from the radicle present in the seeds. Then plumule develops into tiny shoot which elongates and comes out of soil.

The seeds of most plants when ripe have low water content and germination can not occur until the seed coat and the other tissues have imbibed (taken in) water. Air provides oxygen for the respiration in the cells of embryo. Seeds differ greatly in their temperature requirement for germination. The optimum temperature for the germination of the seeds of most plants ranges from 25-40 C°.



Materials / Apparatus Required

Petri dishes, beakers, cotton wool, gram/bean/pea/wheat seeds, refrigerator, incubator

PART A: To Investigate the Water Requirement for Germination



Procedure

1. Label the three petri dishes as A, B and C.
2. Put a layer of cotton wool at the bottom of each dish.
3. Place 5-6 seeds (soaked for twelve hours) in Petri dish A on moist cotton wool.
4. Place 5-6 soaked seeds in Petri dish B but keep the cotton wool dry.
5. Place 5-6 un-soaked seeds of gram in Petri dish C on dry cotton wool.
6. Leave the three Petri dishes for a few days.



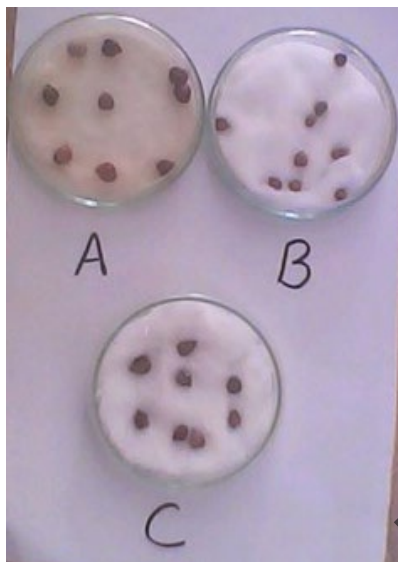


Figure: Experimental set up to investigate the water requirement for seed germination



Observations

Note down the germination of seeds in each Petri dishes and draw the observation.



Figure: Showing germination of seed



Conclusions



PART B: To Investigate the Temperature Requirement for Germination**Procedure**

1. Label the three Petri dishes as A, B and C and place a layer of moist cotton wool in each of them.
2. Put 5-6 soaked seeds in each Petri dish.
3. Place the Petri dish A at 35 °C (in incubator), Petri dish B at 4°C (in refrigerator) and Petri dish C at room temperature (20°C).
4. Leave the three Petri dishes for one week.

**Observations**

Note down the germination in three Petri dishes and draw their observations.

**Conclusions**



PART C: To Investigate the Oxygen Requirement for Germination**Procedure**

1. Take two 500 ml beakers and label them as A and B.
2. Fill half of beaker A with fertile soil and put some soaked seeds not more than 1-2 cm deep.
3. Put some soaked seeds in beaker B and fill this beaker completely with fertile soil.
4. Pack the beaker B in the polythene bag.
Keep the beakers for a few days.



Figure: Experimental set to investigate the oxygen requirement for seed germination

**Observations**

Note down the germination of the seed in each beaker and draw their observation.





Conclusions

FOLLOW-UP TASKS

Assessment Questions

1. If temperature is 50 °C but other conditions for germination are suitable, whether the seeds would germinate or not?

Ans. No, the seeds would not germinate. A temperature of 50 °C is too high and may kill the embryo inside the seed. Most seeds need an optimum temperature range (usually around 25–40 °C) for enzymes to work properly during germination.

2. When does a seed complete its germination?

Ans. A seed completes its germination when the radicle (the embryonic root) comes out of the seed coat and starts growing into the soil. At this stage, the seedling can absorb water and minerals from the soil.

3. Why is water needed for seed germination?

Ans. Water is needed because:

- It softens the seed coat.
- It activates enzymes that break down stored food into simple substances.
- It dissolves nutrients so they can be transported to the growing embryo.

4. What happens if seeds are kept in a refrigerator during germination?

Ans. If seeds are kept in a refrigerator, the low temperature will slow down or completely stop enzyme activity. As a result, the seeds will not germinate until they are returned to a suitable warm temperature.



Brain Benders

1. When the seeds are immersed in water, will they germinate? If not, what is the reason?

Ans. No, the seeds will not germinate if they are completely immersed in water. This is because the water fills all the spaces around the seed and prevents oxygen from reaching it. Seeds need oxygen for respiration during germination.

2. What happens to seeds kept without oxygen?

Ans. Seeds kept without oxygen cannot respire, so they do not get the energy required for germination. As a result, they fail to germinate.

3. Why are seeds kept in a warm place during germination experiments?

Ans. Seeds are kept in a warm place because warmth speeds up the activity of enzymes that help in breaking down stored food inside the seed. This provides energy for growth, so germination happens faster.

REAL-LIFE APPLICATIONS

By understanding seed germination, following real-life applications can be helpful:

Agriculture and Farming: Farmers test which conditions (water, oxygen, temperature, light) help seeds germinate best. It helps in choosing the right sowing time and place for crops. For example, wheat is planted in cooler months, while maize grows better in warmer seasons.

Food Security: Scientists and farmers ensure better crop yields, reducing the chances of food shortages.

Seed Storage and Preservation: Companies store seeds under specific conditions (dry, cool, low oxygen) to prevent premature germination and extend shelf life.

Crop Improvement (Plant Breeding & Biotechnology): Scientists test germination conditions to select strong seeds for breeding better, drought-resistant or high-yielding plants.

Space Research: NASA and other agencies study seed germination in microgravity to see if humans can grow food in space.

Teacher's Signature: _____

Date: _____

Remarks: _____



Practical Based Assessment

Time Allowed: 02 hours

Maximum Marks: 30

INSTRUCTIONS FOR TEACHERS:

The teacher will divide students into groups and assign each group a specific practical from No. 1 to 4. Students are required to list the necessary apparatus, describe the procedure and note any precautions. They should also record their observations in the Observation Table, if necessary. The teacher will conduct a Viva Voce with each student to evaluate their performance. The teacher will also provide guidance to students on any discrepancies in their work and award marks accordingly.

- Q1.** Design and carry out an experiment to measure the differences in length and weight of raw potato strips after they have been placed in distilled water and in concentrated salt solution. 3+2+3
- Q2.** Design and conduct an experiment to investigate the pathway of water in a cut stem. 3+2+3
- Q3.** Design an experiment to investigate how light and water affect the germination of seeds. 3+2+3
- Q.4.** Viva 3
- Q.5.** Copy 3

