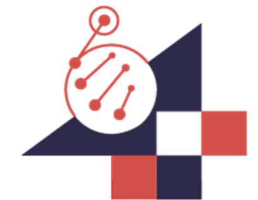
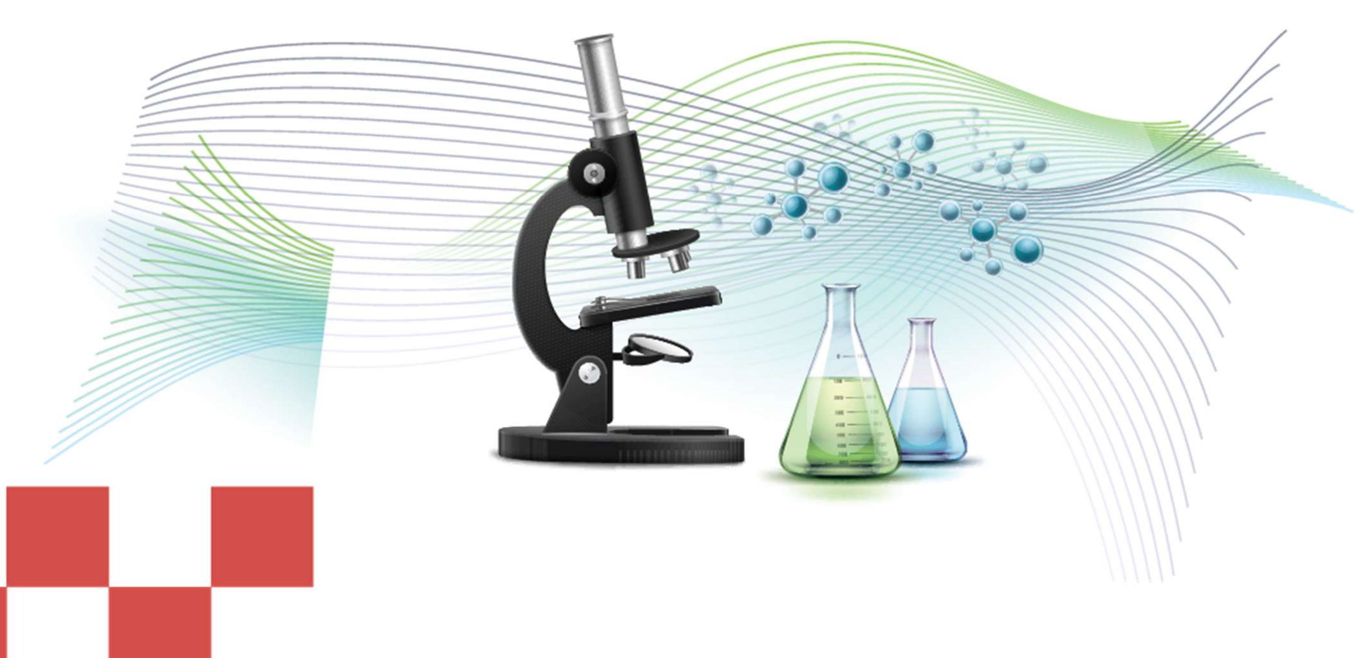
National Science and
Mathematics Olympiad

Practical experiences
Biology





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Laboratory Safety Symbols Table

Symbol	Safety Symbol	Hazard	Examples	Precautions	Treatment
	Waste Disposal	Laboratory waste may pose risks to human health	Chemicals and biological materials	Do not dispose of these materials in sinks or regular trash	Dispose of waste according to your teacher's instructions
	Biological Contaminants (Biohazard)	Biological agents that can cause harm to humans	Bacteria, fungi, blood, unpreserved tissues, plant materials	Avoid skin contact; wear a mask and gloves	Report to your teacher and wash hands thoroughly
	Extreme Temperature Hazard	Materials that can cause injury due to extreme temperatures	Boiling liquids, hot plates, dry ice, liquid nitrogen	Use protective gloves	Seek immediate assistance from your instructor for first aid
	Sharp Objects	Sharp tools or glassware that may cause cuts	Scissors, blades, knives, dissecting tools, broken glass	Handle tools carefully and follow instructions	Go to your teacher immediately for first aid
	Harmful Vapors	Possible respiratory hazard from vapors	Ammonia, acetone, hot sulfur, mothballs (naphthalene)	Ensure good ventilation; do not inhale vapors directly; wear a mask	Leave the area and inform your teacher immediately
	Electricity	Risk of electric shock or fire	Improper grounding, liquid spills,	Check electrical connections	Do not attempt repairs; ask

			short circuits, exposed wires	with the help of your teacher	your teacher for help immediately
	Irritating Materials	Materials that irritate skin or respiratory tract	Pollen, mothballs, steel wool, fiberglass, potassium permanganate	Use a dust mask and gloves; handle carefully	Go to your teacher immediately for first aid
	Chemical Hazard	Chemicals that can damage living tissues or materials through chemical reactions	Bleaches, strong acids, strong bases	Wear goggles, gloves, and lab coat	Rinse affected area with water and notify teacher
	Toxic Materials	Substances that can cause poisoning if ingested, inhaled, or absorbed	Mercury, metal compounds, iodine, toxic plants, formalin	Follow teacher's instructions carefully	Wash hands thoroughly; seek first aid
	Flammable Materials	Substances that can easily ignite	Alcohol, kerosene, acetone, potassium permanganate, clothing, hair	Avoid open flames when using these chemicals	Notify teacher; use fire extinguisher if needed
	Open Flame	Open flames may cause fires	Hair, clothing, paper, flammable materials	Tie back long hair; avoid loose clothing; follow instructions	Notify teacher; use fire extinguisher if available

Laboratory Equipment

Compound Light Microscope
Digital Balance
Microscope Slide
Cover Slip
Graduated Cylinder
Petri Dish
Glass Erlenmeyer Flask
Glass Funnel
Rubber Stopper
Test Tube Rack
Test Tube Cleaning
Test Tube Holder
Dissecting Scalpel
Forceps (Tweezers)
Thermometer
Watch Glass
Dissecting Needle
Glass Beaker (Graduated)

Figure 1 Laboratory equipment

Parts of a Compound light microscope

Parts of a compound light microscope	
Part	**Function**
1- Base	Supports and stabilizes the microscope
2- Arm	Used to Safely carry the microscope
3- Stage	Platform where the the specimen slide is placed
4- Stage Clips	Secure the slide in place on the stage
5- Ocular Lens	Magnifies the image for observation (typically 10×)
6- Objective Lenses	Provide different levels of magnification (e.g., 4×, 10×, 40×)
7- Coarse Adjustment Knob	Used for rough focusing; should be used only with the low-power objective
8- Fine Adjustment Knob	Used for fine, precise focusing of the image
9- Condenser	Focuses light onto the specimen to improve image clarity
10- Light Source	Provides illumination for viewing the specimen

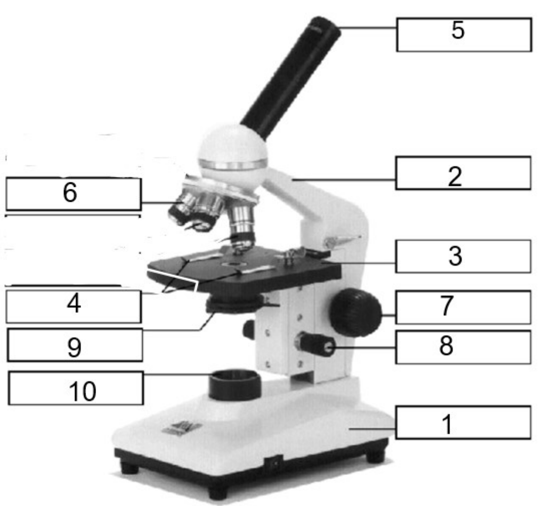

Figure 2 Parts of a light microscope

A video demonstrating how to use a light microscope:

https://youtu.be/ghdWc94ZIYU?si=ZT7qrQuHJRiCRsBW

Study of Osmosis in Plant Cells

First: Potato Osmoscope Experiment

Aim:

To demonstrate osmosis in living plant cells by potato osmoscope model

Material Required

Potato tuber, knife or scalpel, 20% sugar solution, red colour, distilled water, petri dish, marker pin, peeler

Procedure:

- Peel off the skin of a potato of medium or large size. Make a cavity in it with the help of knife
- Clean a large petri-dish and fill it with water. Add 2 or 3 drops of red colour so that water of the dish becomes coloured.
- Fill the cavity of the tuber with 20% sugar solution and keep it in the dish, containing coloured water.
- Insert an Alpin on the wall of the potato cavity to mark the original level of sugar solution in it.
- Leave the setup for about one hour.

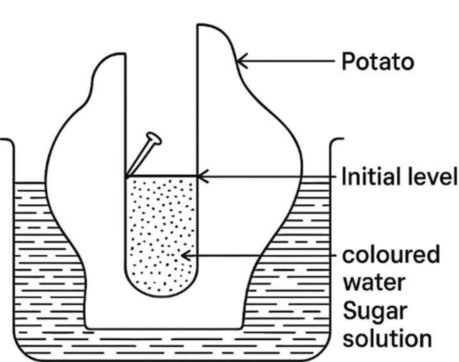

Figure 3 Potato Osmoscope

Precautions:

Wall of the potato at the base should be thin.

Potato should be kept vertically.

Use the fresh and recently peeled potato.

Observation:

Explanation:

Potato

Potato

Potato Osmoscope
Initial set up

Potato osmoscope
Final set up

Figure 4 Potato Osmoscope

Second: Effect of Solution Concentration on Osmosis

AIM:

To demonstrate the process of osmosis with varying solution concentration

Material Required:

Potato tubes, potato peelers, knives, ruler, petri-dishes, and sucrose solution of 0.2M, 0.4M, 0.6M and 0.8M.

Procedure:

- Prepare 1 molar solution of sucrose.
- Now prepare the rest of the solutions as following.

Serial dilution table for preparation of final sucrose concentration.

	mount of distilled water to be added	mount of sucrose solution to be added	Final sucrose concentration
1	8ml	2ml	0.2ml
2	6ml	4ml	0.4ml
3	4ml	6ml	0.6ml
4	2ml	8ml	0.8ml
5	0ml	10ml	1ml

1. Take 4 petri-dishes and label them 1,2,3,4 and 5.
2. With the help of knife take 4 potato strips of the size of 3 cm x 0.5 cm x 0.5 cm .
3. Record the initial weight and length.
4. Place each piece in petri-dishes labeled 1, 2, 3,4 and 5 containing 0.2M, 0.4M, 0.6M , 0.8M and 1M sucrose solution in each.
5. Cover the petri-dishes and keep them aside.
6. After 30 minutes, take out the piece from the petri-dish 1, dry it on a filter paper and measure it and weigh it.
7. Repeat the procedure with the pieces kept in petri-dishes2, 3,4 and 5.
8. Record the length and weight of the pieces in a tabular form.

Figure 5 potato strips

OBSERVATION:

Table showing change in the size and mass of the potato tissue

	At the start		After 30 minutes		Change in	
	Length	Weight	Length	Weight	Length	Weight
0.2ml						
0.4ml						
0.6ml						
0.8ml						
1ml						

Conclusion :

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Study of Plasmolysis

Aim :

To demonstrate the process of plasmolysis in onion cells.

Material required:

Onion bulb, watch glass, petri-dish, slides, cover-slips, forceps, brush, needles, microscope and 20% concentrated sucrose solution.

Procedure :

- Take an onion bulb, with the help of forceps pull a thin transparent peel gently.
- Keep this peel in water filled watch glass.
- Transfer the peel gently on a clean slide in a drop of water with the help of a brush and needle.
- Examine it under high power of a microscope.(40X)
- Observe the individual cells and make a sketch of the cells showing the cell wall and cell membrane. (observation 1)
- With the help of dropper put the sucrose solution on the slide by the sides of cover-slip so that it reaches the peel under the cover-slip.
- Examine the peel again after 10 mins. (observation 2)
- Drain out the concentrated sugar solution from the peel and add few drops of water into the peel.
- Observe the cells again after 10 mins.(observation 3)

Figure 6 Preparation of onion Peel

	Condition of the cell	Explanation
observation 1		
observation 2		
observation 3		

Precautions:

-Always use a brush to transfer the peel.

-The peel should be cut to a proper size and its curling must be avoided..

A video illustrating plasma lysis in onion cells

https://youtu.be/gWkcFU-hHUk

Inference:

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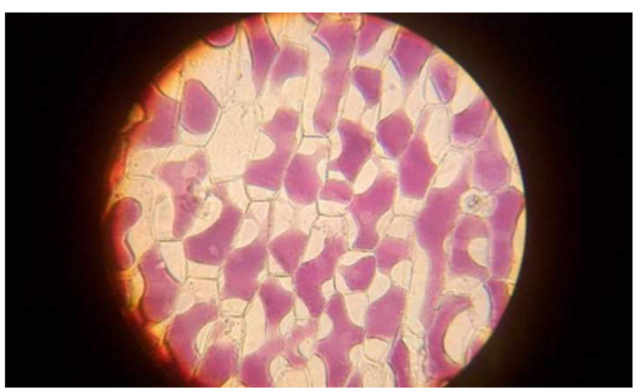

Figure 7 Plasmolyzed cells under microscope (10X)

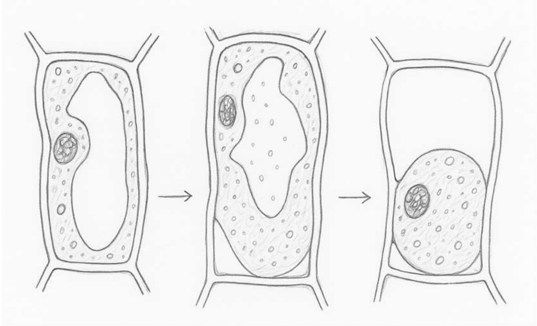

Figure 8 Stages of Plasmolysis

What factors affect mold growth?

Mold commonly grows on bread under suitable environmental conditions.

Where does this mold originate from? What factors influence its growth?

In this investigation, you will design an experiment to test one factor affecting mold growth.

Problem

To determine the optimal conditions for mold growth on bread.

Aims

- To determine the effect of temperature on mold growth rate.
- To measure the percentage of mold coverage over time.
- To analyze the relationship between moisture and mold growth.
- To observe fungal structures (hyphae and spores) under a microscope.

Material required:

Paper plates, dropper, bread (without preservatives), tap water, adhesive tape, light microscope, glass slides, coverslips, glycerin.

Hypothesis

Formulate a hypothesis predicting how temperature and moisture affect mold growth.

Precautions:

Warning: Do not consume any food in the science laboratory, and do not open any of the sealed bags.

The release of mould spores may exacerbate allergies, asthma, and certain other medical conditions in some students.

Procedure :

- Obtain equal-sized pieces of bread from the same type, without preservatives.
- Place each piece in a resealable plastic bag.
- Add an equal amount of water (approximately two drops) to each piece to control moisture.
- Prepare two groups of bags:
    - One group kept at room temperature (approximately 25 °C).
    - One group kept in a refrigerator (approximately 4 °C).
- Seal the bags tightly and ensure that each group is clearly labelled.
- Observe the bags daily for 6 days without opening them, and record each day:
    - The percentage (%) of mould coverage on the surface of the bread.
- At the end of day six, compare the two groups in terms of the rate and density of mould growth.
- Construct a graph showing changes in the percentage of mould growth over time for each group.
- Dispose of the sealed bags safely according to laboratory safety instructions.
- Under teacher supervision, carefully open the bag.
- Gently touch the mould surface with transparent adhesive tape.
- Place the tape onto a glass slide containing a drop of water and glycerin.
- Examine the sample under a light microscope at ×10 or ×40 magnification.
- Draw accurate scientific diagrams of the microscopic observations.

Data and observations

Use the table below to record your daily data on the presence of mold.

Data table:

Days	Mold Coverage (%) – Room Temperature	Mold Coverage (%) - Refrigerator
1		
2		
4		
5		
6		
7		

Analyze and conclude:

1- How did the appearance of the bread pieces change over the six-day period?

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2- How can the differences in the appearance of the bread be explained?

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3- Which variable was changed in the experiment, and why was it necessary to control the other variables?

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4- What are the potential sources of error in your experiment?

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5- Describe the control group in your experiment. What does it demonstrate?

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6- Review the procedure and data with other groups in the class, and discuss any differences in the results.

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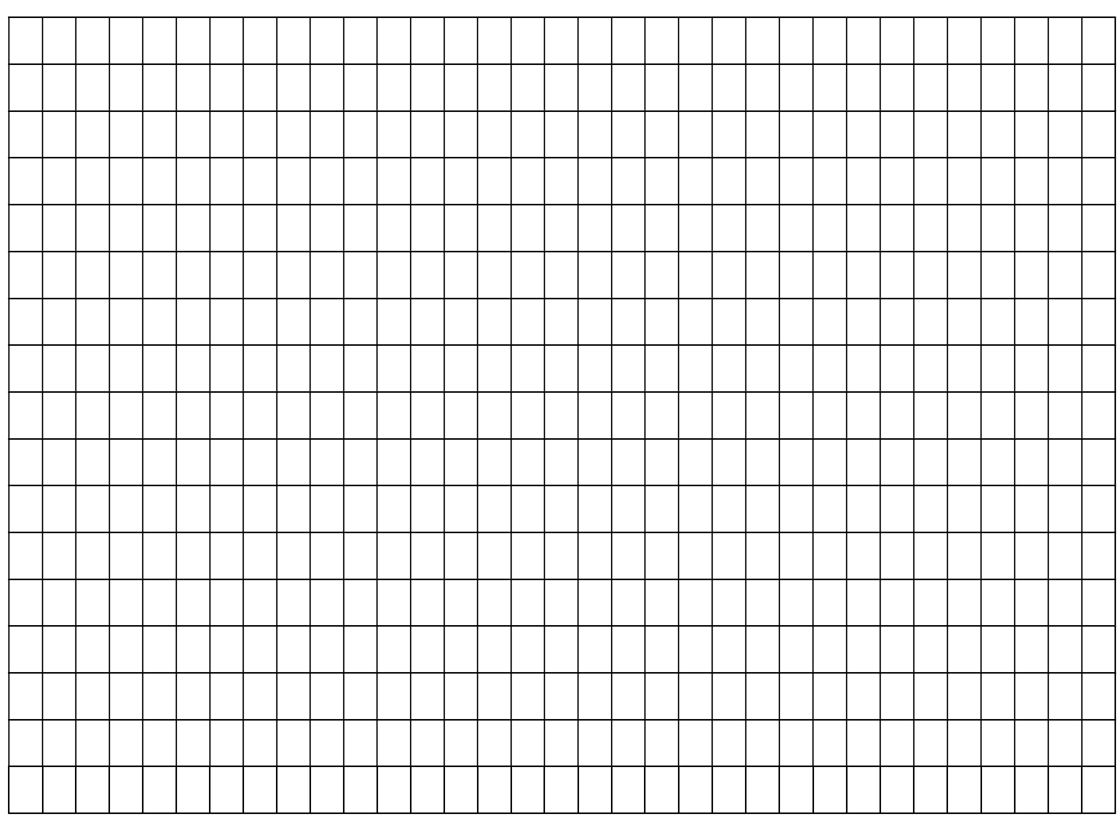
Graph:



Yeast growth Investigation:

Yeast are unicellular fungi that primarily metabolize sugars. During fermentation, they produce carbon dioxide (CO_2) and ethanol as byproducts. Yeast reproduce asexually by budding, and their rate of reproduction increases under favorable conditions.

Aims

- • To investigate the effect of sugar concentration on yeast activity.
- • To measure carbon dioxide production as an indicator of fermentation rate.
- • To monitor changes in pH during fermentation.
- • To observe yeast cells under a microscope.

Material required:

- Prepare four flasks and label them (1–4).
- Materials: a quantity of sugar, dry yeast, a glass stirring rod, four small balloons, pH strips, and a stopwatch.

Procedure :

- Add 100 mL of warm water to each flask.
- Add the following amounts of sugar:
  - Flask 1: 0 g
  - Flask 2: 2 g
  - Flask 3: 4 g
  - Flask 4: 8 g
- Add 1 g of dry yeast to each flask.
- Stir the mixture thoroughly using a glass rod.
- Place a small balloon over the mouth of each flask.
- Use a pH strip and record the initial pH value before starting.
- Start the stopwatch and observe changes for 20 minutes, recording observations every 5 minutes.
- Measure the volume of gas produced by measuring the diameter or circumference of the balloon, or by using the displacement method:
- Use a measuring tape to record the balloon's diameter or circumference and enter the value in the table ,or gently remove the balloon and seal its opening.
- Submerge it in a container of water.

The volume of displaced water = volume of gas (mL).

- Take a drop from the flask and examine it under a microscope.
- Draw the yeast cells as observed.

Drawing yeast cells :

Data and observations::

Hypothesis testing steps	amounts of sugar (g)	Yeast reproduction	Measuring gas volume using a balloon (cm)	Gas volume by the displacement method (ml)	pH before	pH after	Result
	0g	......	cm	.....ml	.....	.....	.....
	2g	......	cm	....ml	.....	.....	.....
	4g	......	cm	....ml	.....	.....	.....
	8g	......	cm	....ml	.....	.....	.....

Analysis:

1- Conclude: What is the relationship between yeast reproduction and sugar availability?

2- Analyze: How might your results change if you covered the four flasks during the experiment?

3- What is the relationship between pH change and yeast activity during fermentation?

4- What is the relationship between the amount of sugar and the volume of gas produced in the balloon?

Investigating the Effect of Salt on Mold Growth

How does salt affect mold growth? Chemical preservatives—such as sodium chloride (table salt)—are commonly used to influence mold growth in different types of food.

Aims :

Verify the existence of a relationship between salt addition and mold growth.

Material required:

Bread pieces – salt – plastic bags – a spray bottle of water.

Procedure :

1. Read the safety guidelines in the practical experiments notebook.
2. Obtain two slices of bread, and touch both sides of each slice with an object from the laboratory.
3. Moisten both sides of the slices equally using a spray bottle of water.
4. Place one slice of bread in a plastic bag and seal it היט היט. Then write your name, the date, and the object that touched the slice.
5. Sprinkle salt on both sides of the second slice, place it in another bag, seal it well, and write the same information as on the first bag, adding that salt was used.
6. Create a table to record your observations.
7. Record your daily observations over ten days, ensuring that your results include a detailed description of any mold that forms.

Day	Mold Coverage with Salt (%)	Mold Coverage without Salt (%)
At the beginning of the experiment		
After two days		
After five days		
After ten days		
After one week		

Analysis:

1- Identify which slice showed more mold growth.

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2- Conclude: Did salt affect mold growth?

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3- Analyze: Why did salt affect mold?

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Conclusion :

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Effect of physical activity on respiratory rate and heart rate:

Aims :

Study the relationship between physical activity and respiratory rate and heart rate

Material required:

1. Stopwatch
2. Data recording sheet
3. Participants (Volunteers)
4. A sufficient and safe space for movement

Procedure :

1. Measure resting respiratory rate (breaths per minute).
2. Measure resting heart rate (beats per minute).
3. Perform a standardized physical activity (e.g., running in place for 1 minute).
4. Immediately measure respiratory and heart rates after activity
5. Record all data systematically.

Data and results:

Condition	Respiratory rate (breaths/min)	Heart rate (beats/min)
At rest		
After activity		

Analysis and discussion:

1- What do you observe about the changes in the values?

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2- Why did the respiratory rate and heart rate increase after activity?

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3- How does this help the body produce energy?

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Conclusion :

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Questions :

1- What is the relationship between increased respiratory rate and the body's increased need for oxygen?

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2- How does physical activity affect the circulatory system?

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Identifying blood groups using the Agglutination

Aims :

1. To identify ABO blood groups (A, B, AB, and O).
2. To understand the role of antigens and antibodies in blood typing.

Material required:

1. Simulated blood samples.
2. glass slides.
3. Anti-A and Anti-B antibody solutions.
4. Mixing sticks or plastic pipettes.
5. Gloves and disinfectant materials.

Precautions:

• Do not use real human blood in the experiment.

• Wear gloves and avoid direct contact with the samples.

Procedure :

1. Place a drop of artificial blood on a glass slide.
2. Add a drop of Anti-A solution next to the sample, and a drop of Anti-B in another spot.
3. Gently mix each sample using stirring sticks.
4. Observe agglutination:
   • If agglutination occurs with Anti-A only = blood type A.
   • If agglutination occurs with Anti-B only = blood type B.
   • If agglutination occurs with both = blood type AB.
   • If no agglutination occurs = blood type O.

Analysis and discussion:

- Why does agglutination occur?

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- What is the role of antigens and antibodies in determining blood type?

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- How does this affect blood transfusion?

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Identifying the four types of tissues in vertebrates:

Aims :

To identify and distinguish between epithelial, connective, muscle, and nervous tissues using a microscope.

Material required:

1. Compound light microscope.
2. Prepared slides of stained tissue samples.
3. Epithelial tissue: such as skin epidermis or intestinal lining.
4. Connective tissue: such as a sample of bone tissue or a blood smear.
5. Muscle tissue: such as skeletal (striated) muscle.
6. Nervous tissue: such as a section of the spinal cord or a peripheral nerve.
7. Colored pencils and a drawing notebook (for recording observations).

Procedure :

Follow the steps below:

❖ **Preparation:**

1. Make sure the microscope is working properly.
2. Start with the lowest magnification objective lens (usually 4× or 10×) to easily locate the sample.

❖ **Observation of epithelial tissue:**

1. Place the epithelial tissue slide on the microscope stage.
2. Locate the stained area and focus the image.
3. Switch to a higher magnification (40×) if necessary.
4. Observe: Cells appear tightly packed in one or multiple layers, with very little intercellular space. Draw what you observe in your notebook.

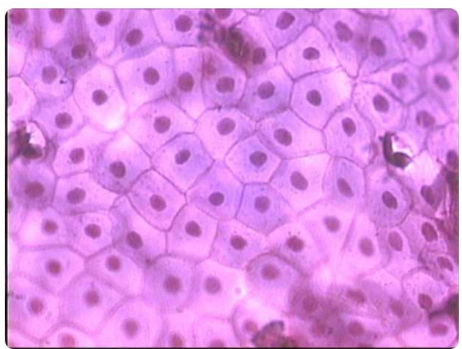

Figure 9 epithelial tissue

❖ **Observation of connective tissue:**

1. Replace the slide with a connective tissue slide (e.g., bone).
2. Focus the image under an appropriate magnification.
3. Observe: In bone, you will see a rigid and organized structure. In blood, you will see cells scattered within a fluid (plasma). The common feature is the presence of abundant intercellular material separating the cells. Draw your observations.

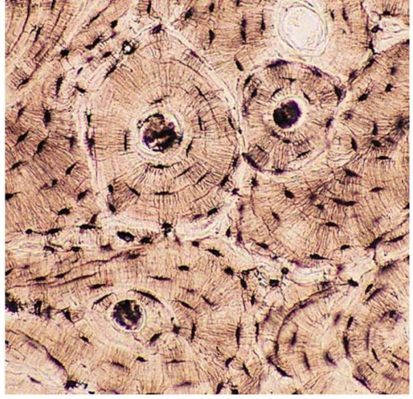

Figure 10 connective tissue in bone

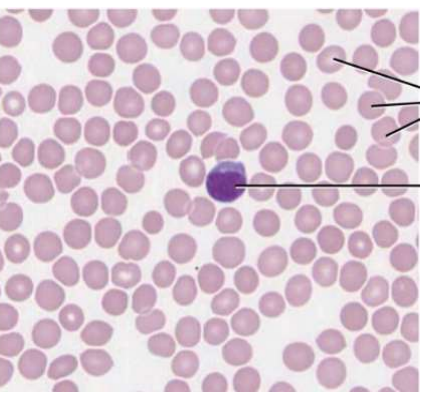

Figure 11 connective tissue in blood

❖ **Observation of muscle tissue:**

1. Use a slide of skeletal (striated) muscle.
2. Focus the image.
3. Observe: The cells are long and cylindrical, and distinct transverse striations may be visible if the muscle is skeletal. Draw the fibrous structure.

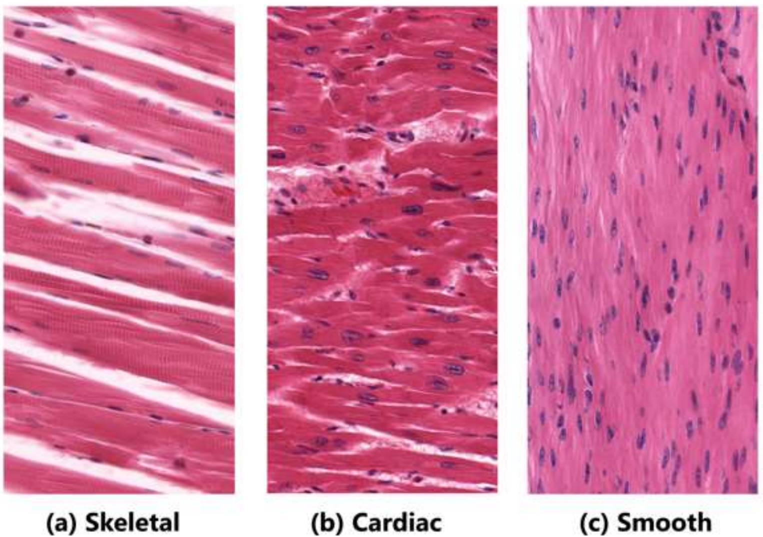

Figure 12 muscle tissue

❖ **Observation of nervous tissue:**

1. Place the nervous tissue slide (e.g., a section of the spinal cord).
2. Focus the image.
3. Observe: You will see neuron cell bodies with long, thin extensions resembling arms or tails (axons and dendrites). This structure is unique and distinctive. Draw what you observe.

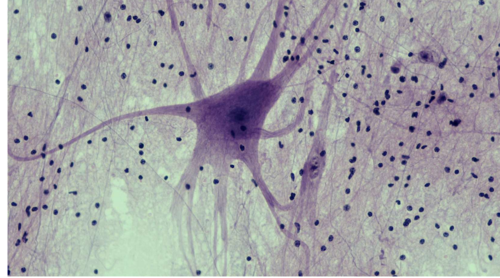

Figure 13 nervous tissue

Expected results::

After completing the observations and drawing the different structures, the student should be able to relate each structure to the function performed by the tissue:

Tissue Types	Microscopic Features	Main function
epithelial tissue	....	....
connective tissue	....	....
muscle tissue	....	....
nervous tissue	....	....

Conclusion :

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DNA Extraction from plant cells

Aims :

1. To extract visible DNA from plant cells.
2. To understand the basic components of the cell and the location of DNA.
3. To Understand the basic steps involved in DNA extraction.

Material required:

Ripe banana or strawberry – dishwashing liquid – table salt – cold ethanol (e.g., 70%) – plastic strainer – test tubes – mortar and pestle – pipette – glass beaker – distilled water.

Procedure :

1. Mash 50 g of banana thoroughly in a mortar until it becomes a smooth paste.
2. Add 100 mL of distilled water and 10 g of salt, and mix well.
3. Add 10 mL of dishwashing liquid and gently mix approximately for 5 minutes.
4. Filter the mixture using a strainer into a glass beaker.
5. Slowly add 50 mL of cold ethanol along the side of the beaker to form a top layer.
6. Wait 5–10 minutes until white DNA strands precipitate at the interface.
7. Use a glass rod to spool and collect the DNA strands.

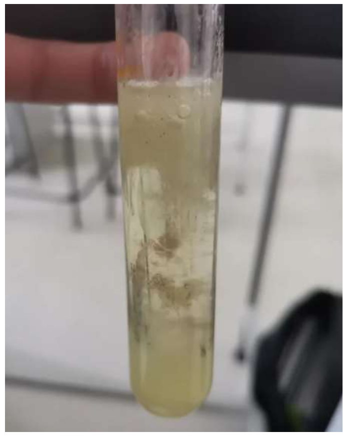

Figure 14 white DNA strands

Figure 15 spool and collect the DNA strands

A video explaining how to extract DNA from plant cells

https://youtu.be/3RihHuK1sGw?si=sD3kwrOGT3fldx0e

Expected results:

- Appearance of white, translucent strands between the solution layer and the alcohol.
- The amount of extracted DNA depends on the type of plant tissue.

Analysis and discussion:

1. What is the role of salt in this experiment?

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2. Why is dishwashing liquid used?

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3. What is the purpose of adding cold alcohol?

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Separation of Plant pigments using paper chromatography

Aims :

1. To separate plant pigments using paper chromatography.
2. To identify different pigments present in plant leaves.
3. To analyze how pigment properties affect their movement during chromatography.

Material required:

Spinach leaves or other green plants – mortar and pestle – acetone – filter paper – a stoppered glass cylinder – separation solvent (benzene + alcohol) – pipettes – ruler.

Procedure :

1. Grind 10 g of spinach leaves with 20 mL of acetone in a mortar.
2. Filter the extract into a glass beaker.
3. Cut a strip of filter paper 5 cm wide and 20 cm long.
4. Place a drop of the extract 3 cm from the edge of the paper.
5. Place the paper in a cylinder containing the solvent so that the spot does not touch the solvent.
6. Close the cylinder and leave it until the solvent front nears to the top of the paper.
7. Remove the paper, let it dry, and record the results..

Figure 16 Separation of plant pigments on filter paper

A video explaining Separation of Photosynthetic Pigments by Chromatography

https://youtu.be/W56RHxu2Hpc?si=Wmy5-Yd_mA_SclWf

Expected results:

- Appearance of different colored bands representing chlorophyll a, chlorophyll b, and carotenoids.
- Each pigment travels a different distance on the chromatography paper during the separation process..

Analysis and discussion:

1. What factors affect the rate of pigment separation?

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2. How are the separation results related to the genetic composition of the plant?

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3. What are the applications of chromatography techniques in the field of genetics?

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and Mathematics
Olympiad

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Ministry of Education

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