Ollscoil na Gaillimhe University of Galway

EpiSeed Link

Funded by the European Union

cell EXPLORERS

Taighde Éireann Research Ireland



LAB BOOK

Name:

School:

Class:

WELCOME TO SEEDPOP!

In this project you'll be learning about seed **germination, plant stress** caused by **climate change,** and a process call seed **priming** which can help plants grow, even in **stressed conditions**.

This is your Lab Book, the place where you'll find lots of information, worksheets that you'll be using during the project, a guide on how to run the experiment, and more.

Table of Contents

Glossary of Terms _____ 4
Seed Germinaiton Worksheet _____ 5
The Scientific Method Diagram _____ 6
Forming a Hypothesis Worksheet _____ 7
Experiment Protocol_____ 9
Root Measurement Tables _____ 12
Graphing Your Results _____ 16
Scientific Poster Guide _____ 18
Comparing All Four Conditions _____ 19

We hope you enjoy taking part in the SeedPop! project!

.

GLOSSARY OF TERMS

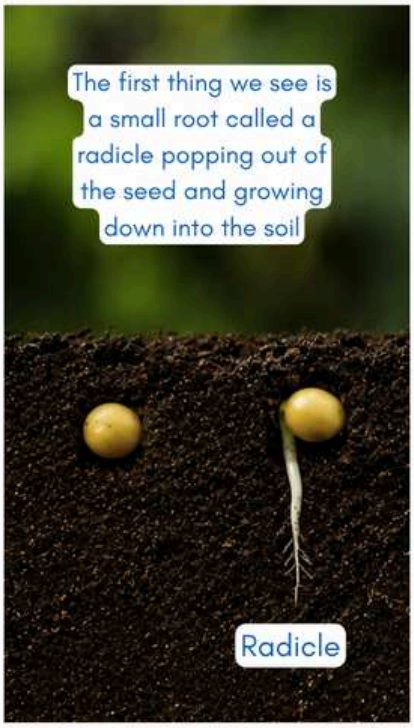
Here are the definitions of some new words you will learn during the SeedPop! project.

Activate: To make something (for example, a seed) ready to begin a process.
Analysis: Looking closely at your results to understand what they mean.
Climate change: Long-term changes in the Earth's climate. Today's climate change usually refers to more extreme weather conditions.
Conditions: The surroundings or circumstances that can affect an experiment or an organism.
Concentration of salt: How much salt is mixed into a certain amount of water. The more salt there is in the same amount of water, the higher the concentration.
Data: Information collected through measurements and observations during an experiment.
Dormant seed: A seed that cannot germinate.
Drought: A long period with much less rain than usual. Drought makes it difficult for plants to get enough water and can cause salt to build up in the soil.
Food security: Making sure everyone has enough safe and nutritious food.
Germination: A process that allows a seed to grow into a new plant.
Hypothesis: An idea or possible explanation that can be tested through an experiment.
Observations: Information gathered by carefully using your senses (such as sight, hearing or touch) or scientific tools, such as a ruler, magnifying glass or thermometer.
Photosynthesis: How plants make their own food and other chemicals using light.
Plant stress: Anything that acts negatively on a plant.
Priming: A method to improve a seed's ability to germinate and grow, even when stressed. There are many ways to prime a seed. In SeedPop!, we use seeds that have been primed by soaking them in a chemical solution.
Protocol: A detailed set of step-by-step instructions explaining how to do an experiment.
Radicle: the first small root to emerge from a seed during germination.
Resilience: To be able to resist a stress.
Stress memory: The ability to remember a previous stress to resist better a second one.
Stress-response: What a plant or animal does to protect itself against a stress.

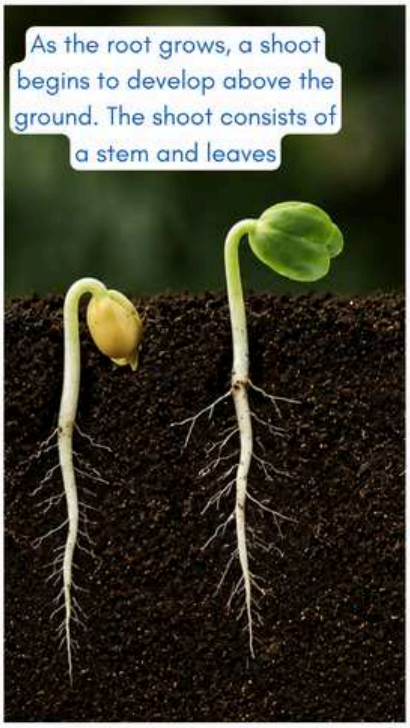
SEED GERMINATION

Seed germination allows a dormant seed to transform into a growing plant. It requires the right combination of water, light, warmth and oxygen to activate the seed and initiate root and shoot growth.

Stage One



Stage Two



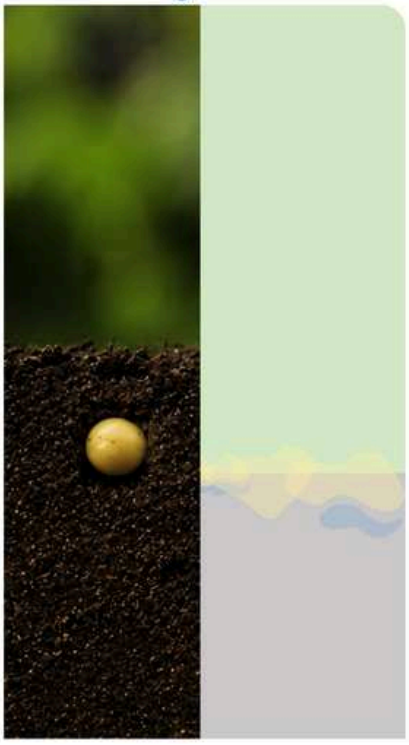
Stage Three



FILL IN THE BLANKS

The images below show the first part of each stage of germination. Can you draw what happens next in each stage and label the different parts of the plant?

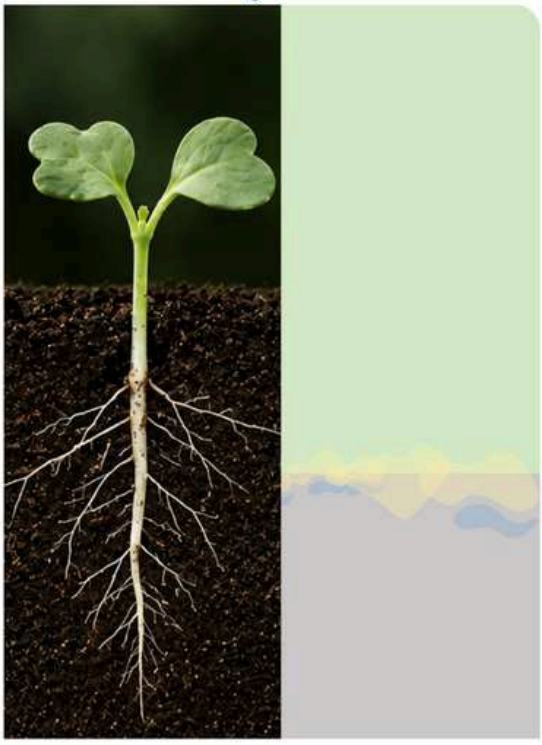
Stage One



Stage Two



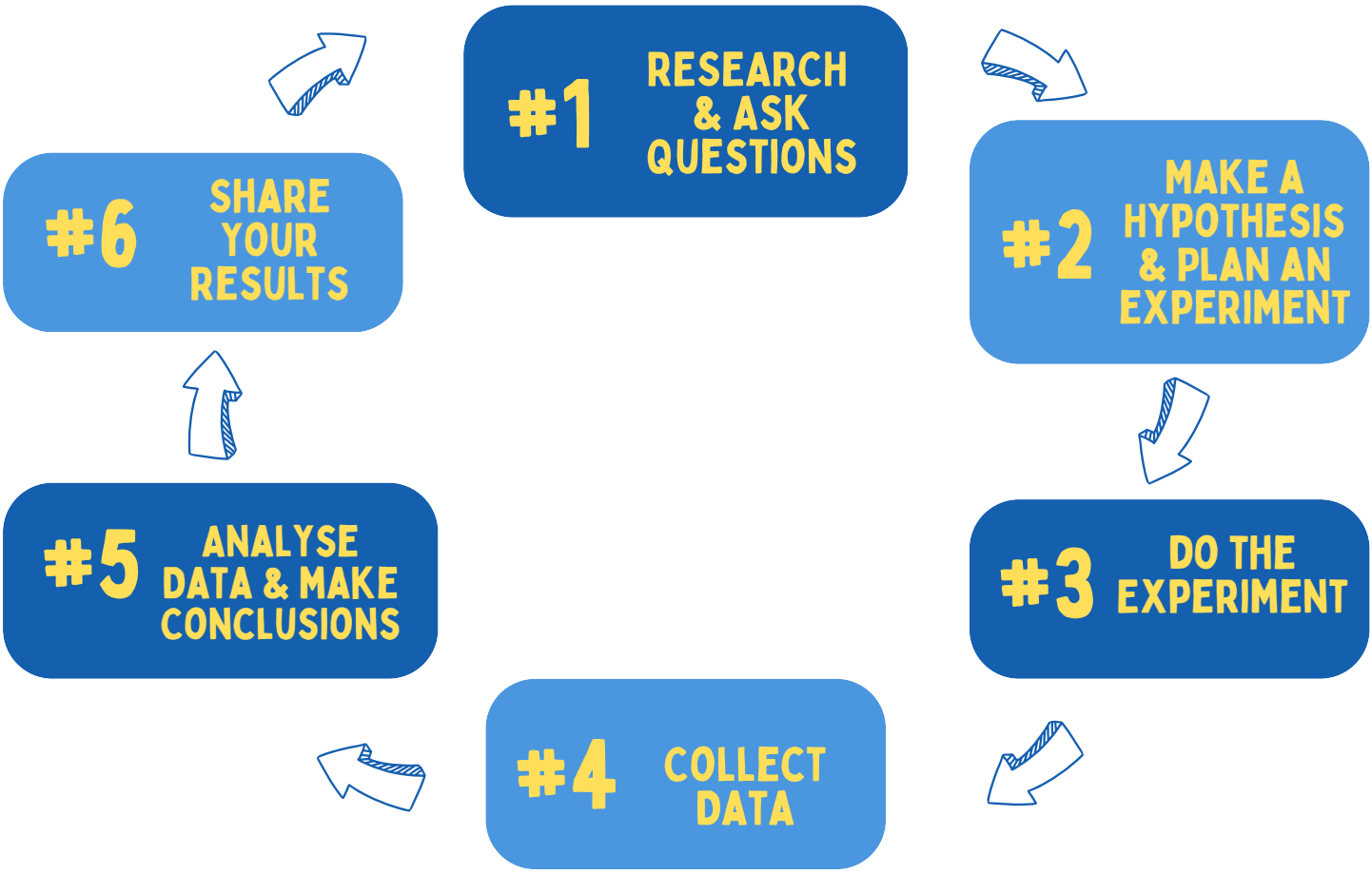
Stage Three



Q: Why do roots grow down towards soil and the shoot goes up?

A: Because plants can sense gravity and know which way is up and which way is down.

THE SCIENTIFIC METHOD



Scientists research a topic, ask questions and make hypotheses. They then do experiments to collect data, analyse their results, draw conclusions and share what they have discovered.

Sometimes, the results do not support their hypothesis – but that is not a bad thing! Unexpected results can teach us something new and help us ask further questions and solve problems.

FORMING A HYPOTHESIS

A hypothesis is your best idea about the answer to a scientific question. You test it with an experiment to find out if it is correct.

The easiest way to write a hypothesis is to use this "fill-in-the-blanks" sentence.

IF [What will you change or test?]...
THEN [What do you think will happen?]...
BECAUSE [Why do you think this will happen?].

Here is an example:
Question:
"What happens to a seedling when light comes from only one side?"
Hypothesis:
"***IF*** a seedling receives light from only one side,
THEN it will grow towards the light,
BECAUSE plants need light to grow."

Now you give it a try with these questions:

Question 1:
"What happens to seeds if they do not receive any water?"

Hypothesis:

IF

THEN

BECAUSE

Question 2:
"How does salty water affect seed germination and growth compared with fresh water?"

Hypothesis:

IF

THEN

BECAUSE

Your SeedPop! Experiment Hypothesis

Now let's write a hypothesis for our experiment. Think about Liam and Lisa's problem and use the research question below to help you.

We are trying to figure out if primed seeds might help Liam and Lisa grow a strong crop of rapseed plants on their farm, even drought conditions when soil becomes salty.

Your research question: Does priming help rapeseed seeds germinate and grow, especially in salty conditions?

IF

THEN

BECAUSE

Predict the Results!

Our experiment has four different conditions:

1. Fresh water + Unprimed seeds
2. Fresh water + Primed seeds
3. Salt water + Unprimed seeds
4. Salt water + Primed seeds

How well do you think the seeds will germinate and grow in each condition?

Discuss your predictions with your partner, then complete the table using the symbols below.

Your Predictions

	Fresh water	Salt water
Unprimed seeds		
Primed seeds		

Prediction key:

\+ Few seeds germinate / short roots
++ Some seeds germinate / medium-length roots
+++ Many seeds germinate / long roots

Remember: After the experiment, compare your predictions with your actual results. Were you surprised by anything?

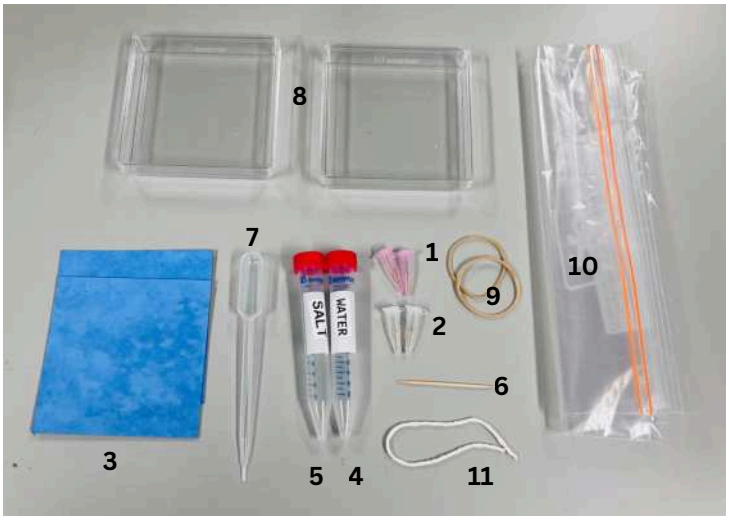
SeedPop! Experiment Protocol

This protocol will guide you through setting up your experiment, observing changes and measuring root growth. Follow the instructions step by step and record what you discover.

Materials Checklist

Check that you have everything you need before starting your experiment.

1. 2 small tubes, each containing 5 primed seeds (pink tubes marked P)
2. 2 small tubes, each containing 5 unprimed seeds (transparent tubes marked UP)
3. 2 square blue filter paper sheets
4. 1 empty tube (15 mL)
5. 1 tube with salt (15 mL)
6. 1 toothpick
7. 1 transfer pipette
8. 2 square petri dishes
9. 2 rubber bands
10. 1 plastic bag
11. 1 measuring string



The following items are also needed but are not included in the kit:

- Permanent Marker
- Cup/jug of water
- Ruler (minimum 10 cm)

Experiment Set-up (Day 0)

Step 1: Label the Dishes



- Label one Petri dish lid **Water** and the other **Salt**.
- Draw **a line down the middle** of each lid.
- Label one half **UP** (unprimed) and the other **P** (primed).

- Label the Petri dish **lids**, not the bases.
- Keep the **open side facing UP**!

Step 2: Prepare the Solutions

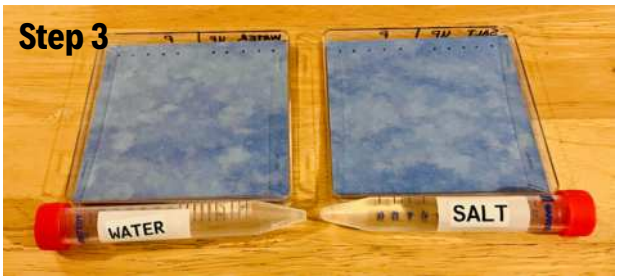
- Use the transfer pipette to add **12 mL** of water to each tube.
- Shake the salt tube until the salt has completely dissolved.



Use the pipette to add **12 mL** of water

Step 3: Prepare the Filter Papers

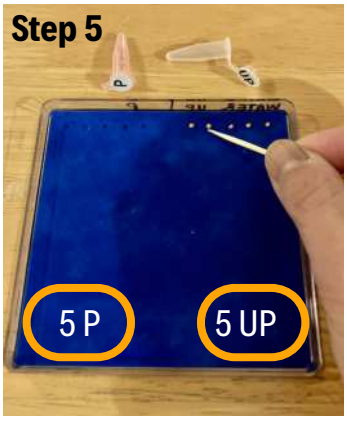
- Place one blue filter paper inside each Petri dish lid.
- Spread fresh water over the filter paper in the Water dish and salt solution over the filter paper in the Salt dish.



Step 4: Remove Air Bubbles

- Gently smooth the filter papers to remove any trapped air bubbles.





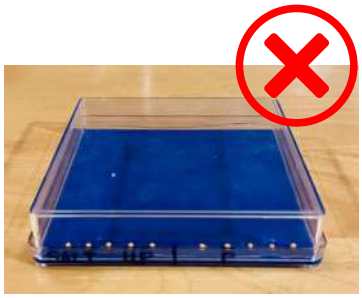
Step 5: Place the Seeds

- Using the **toothpick**, place **5 primed seeds** and **5 unprimed seeds** on the filter paper **in each dish**.
- Keep the seeds on their labelled sides and place them in the small holes on the filter paper.

Step 6: Close the Dishes

- Gently place the **dish bases** over the seeds in the labelled lids.
- Secure each dish with a rubber band.
- **Do not squash the seeds.**



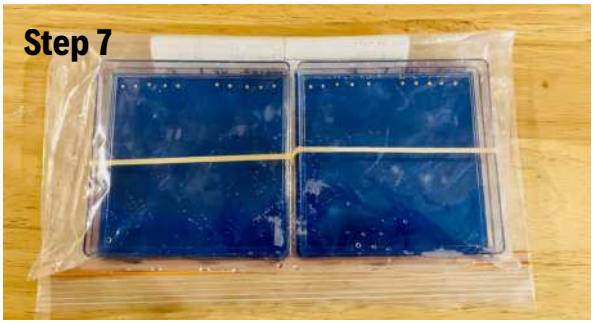


Keep the **open side facing UP**!



Step 7: Place in the Plastic Bag

- Place both dishes inside the plastic bag.
- Fold any extra plastic behind the dishes and write your names on the bag.



Step 8: Position Your Experiment

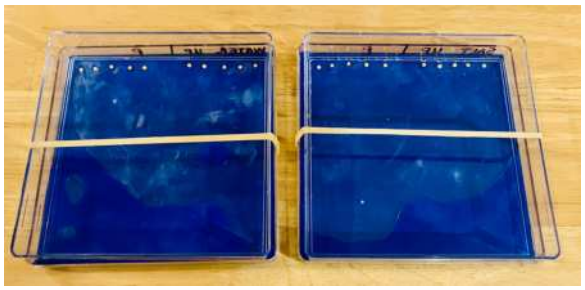
- Stand the experiment upright near a window.



Observing Changes (Days 3, 6 & 7)

On each observation day:

1. Bring your experiment to your desk and place the two dishes **side by side**.
2. **Look** carefully.
   - Which seeds have **germinated**?
   - Are some **roots** longer than others?
3. **Compare** the **primed** and **unprimed** seeds in **fresh** and **salt** water.
4. **Record** what you observe in your Lab Book.



Fresh Water
UP | P

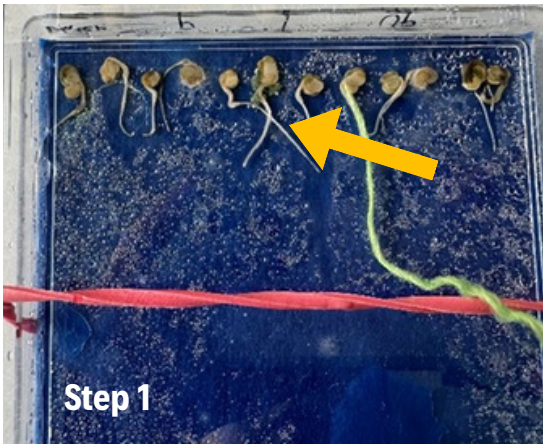
Salt Water
UP | P

Measuring Root Growth (Days 3, 6 & 7)

Some roots may be very short, and some seeds may not have germinated yet. This is normal.
Do not open the Petri dishes when measuring the roots.

How to measure a root:

1. **Place the string alongside the root**, following its curve from the seed to the root tip.
2. **Mark** the root length on the string **with your fingers**.
3. **Straighten the string against a ruler** and read the length in millimetres (mm).
4. **Record** the measurement in your Root Measurement Table.
5. Repeat for each seed with a visible root.





If there is no root to measure, record your observation in the table.
Repeat the observations and measurements on Days 6 and 7.

ROOT MEASUREMENTS: FRESH WATER – UNPRIMED SEEDS

Use this table to write down the **length of the roots** emerging from each seed on **Day 3, 6 & 7**. Be as ***precise*** with your measurements as possible. You can also note your **observations**- look closely to see **differences** between the two dishes!
Do your observations match your hypothesis? Do you need to double check any measurements?

Day	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
3 Measurement						
Notes						
6 Measurement						
Notes						
7 Measurement						
Notes						

ROOT MEASUREMENTS: FRESH WATER – PRIMED SEEDS

Use this table to write down the **length of the roots** emerging from each seed on **Day 3, 6 & 7**. Be as ***precise*** with your measurements as possible. You can also note your **observations**- look closely to see **differences** between the two dishes!
Do your observations match your hypothesis? Do you need to double check any measurements?

Day	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
3 Measurement						
Notes						
6 Measurement						
Notes						
7 Measurement						
Notes						

ROOT MEASUREMENTS: SALT WATER – UNPRIMED SEEDS

Use this table to write down the **length of the roots** emerging from each seed on **Day 3, 6 & 7**. Be as ***precise*** with your measurements as possible. You can also note your **observations**- look closely to see **differences** between the two dishes!
Do your observations match your hypothesis? Do you need to double check any measurements?

Day	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
3 Measurement						
Notes						
6 Measurement						
Notes						
7 Measurement						
Notes						

ROOT MEASUREMENTS: SALT WATER – PRIMED SEEDS

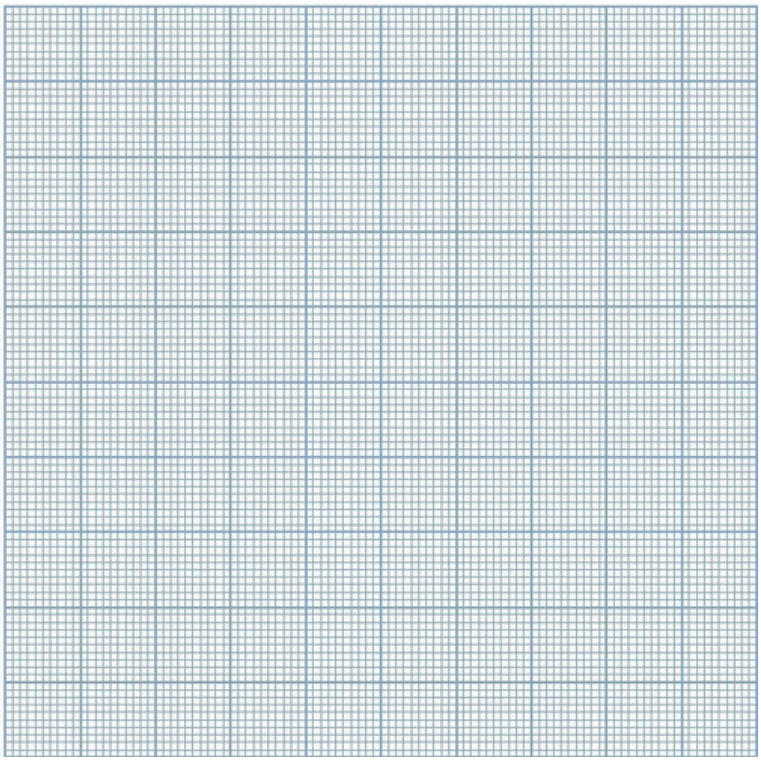
Use this table to write down the **length of the roots** emerging from each seed on **Day 3, 6 & 7**. Be as ***precise*** with your measurements as possible. You can also note your **observations**- look closely to see **differences** between the two dishes!
Do your observations match your hypothesis? Do you need to double check any measurements?

Day	Seed 1	Seed 2	Seed 3	Seed 4	Seed 5	Average
3 Measurement						
Notes						
6 Measurement						
Notes						
7 Measurement						
Notes						

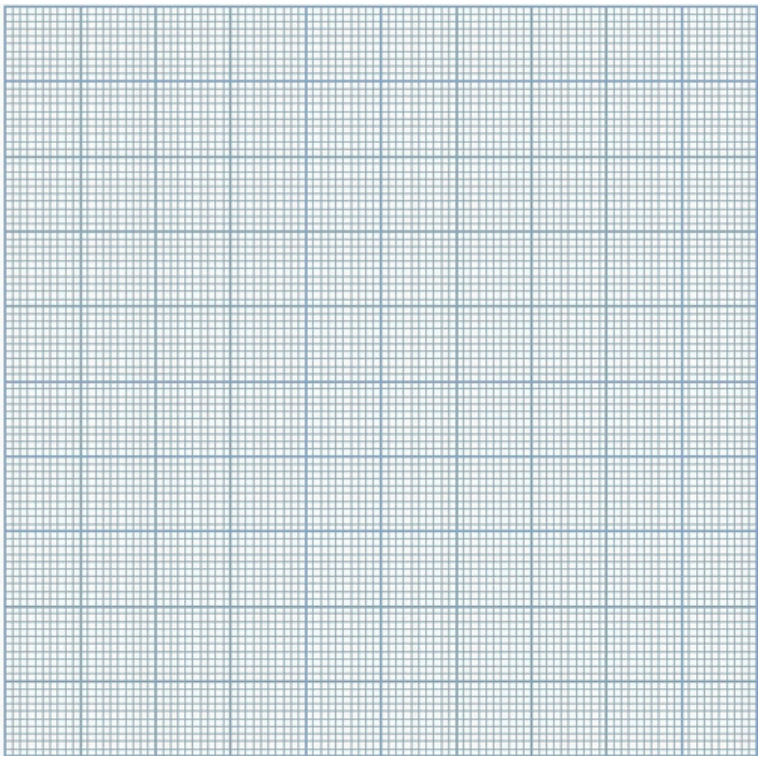
AVERAGE ROOT GROWTH IN FRESH WATER

Graphs help us present our data clearly, spot patterns and make sense of our results. Use the two grids to draw line graphs showing the average root measurements for primed and unprimed seeds grown in water.

Fresh Water - Unprimed Seeds



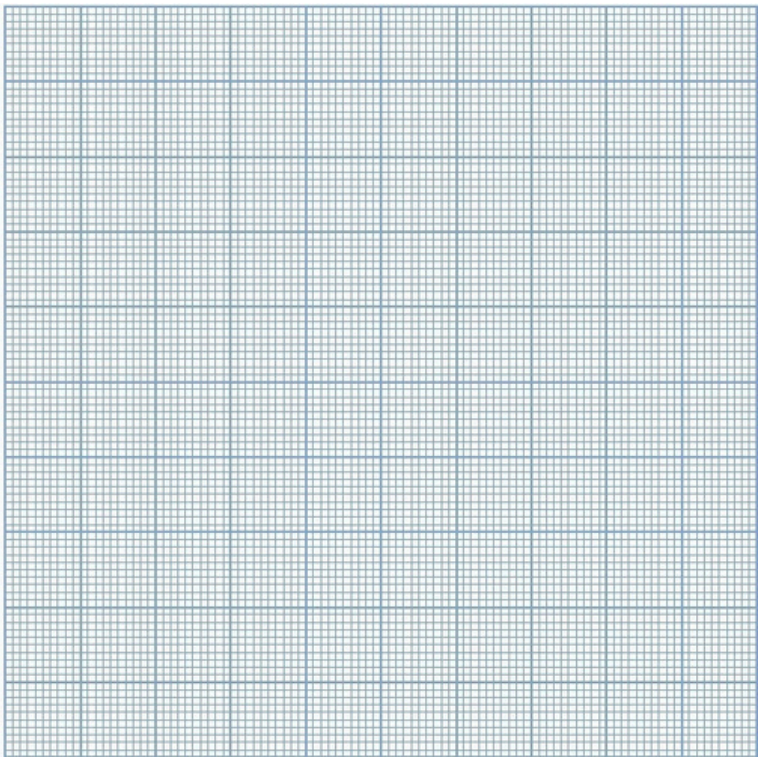
Fresh Water - Primed Seeds



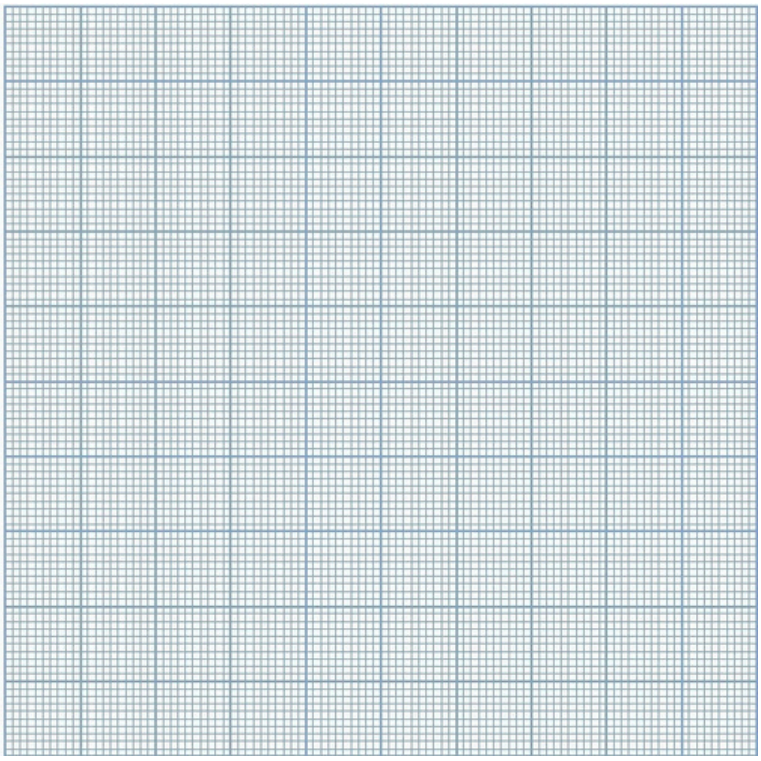
AVERAGE ROOT GROWTH IN SALT WATER

Graphs help us present our data clearly, spot patterns and make sense of our results. Use the two grids to draw line graphs showing the average root measurements for primed and unprimed seeds grown in salt water.

Salt Water - Unprimed Seeds



Salt Water - Primed Seeds



TITLE: GIVE YOUR POSTER AN INTERESTING TITLE

Authors: Your names

INTRODUCTION:

WHY DID YOU DO THIS EXPERIMENT?

EXPLAIN THE PROBLEM LIAM AND LISA ARE FACING ON THEIR FARM.

HYPOTHESIS:

WHAT DID YOU PREDICT WOULD HAPPEN, AND WHY?

WRITE YOUR HYPOTHESIS USING IF, THEN AND BECAUSE.

PROCEDURE:

HOW DID YOU DO YOUR EXPERIMENT?

BRIEFLY EXPLAIN HOW YOU TESTED YOUR HYPOTHESIS.

RESULTS:

WHAT DID YOU FIND OUT?

CUT OUT AND PASTE YOUR GRAPH COMPARING ALL FOUR EXPERIMENTAL CONDITIONS.

WHAT DIFFERENCES CAN YOU SEE?

CONCLUSION:

WHAT DO YOUR RESULTS TELL YOU?

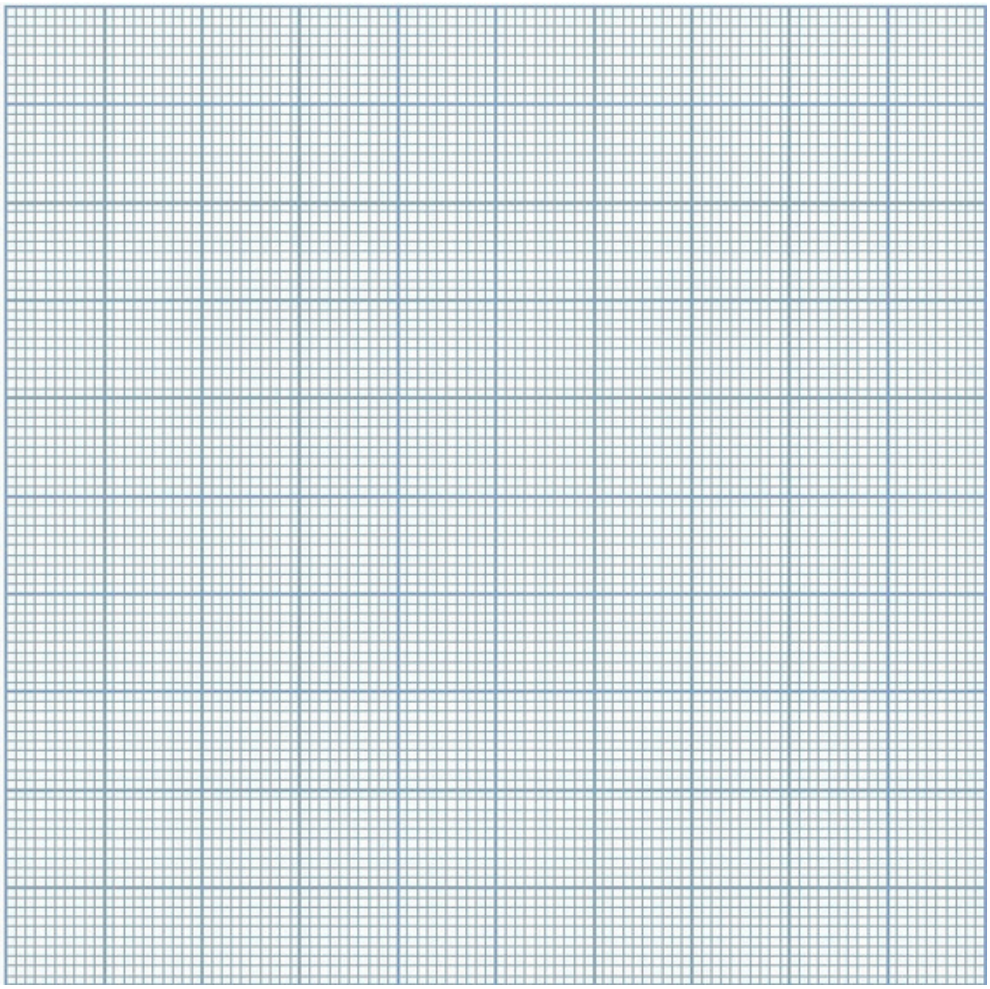
DID THE RESULTS SUPPORT YOUR HYPOTHESIS?

HOW COULD YOUR FINDINGS HELP LIAM AND LISA?

COMPARING ALL FOUR CONDITIONS

Plot the **average** root measurements for **all four conditions** on the same graph. Use a **different colour or symbol** for each condition, and label each line clearly.
Comparing all four conditions on one graph will help you spot differences in root growth.
Cut out your completed graph along the dashed line and stick it onto your scientific poster.

Average Root Length of Rapeseed Seeds Over Time



Key: Draw the colour or symbol you used beside each condition

FreshWater + Unprimed Seeds

Fresh Water + Primed Seeds

Salt Water + Unprimed Seeds

Salt Water + Primed Seeds

SEEDPOP! SKETCHES & SCRIBBLES

Use this blank page to write down your own thoughts or draw sketches....