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TOMATOSPHERE

Learner Outcomes:

- Describe the general structure and function of plant seeds

The Tomatosphere Project is a scientific investigation in which the germination properties of seeds are examined. Based on the outcome of this investigation conclusions will be drawn which will facilitate the planning of long term missions on the International Space Station, to the Moon and eventually, to the planet Mars.

Background Information:

Seeds are exceptionally resistant to damage from environmental extremes. We know from experience that plant seeds are hardy and resist damage from a wide range of environmental conditions on Earth, including heat, cold and drought.

From your knowledge of seeds, what characteristics of seeds make them so resistant to damage from environmental extremes on Earth?

The question in this investigation is: Will seeds be resistant to the conditions experienced when placed in a simulation of the Martian environment?

The tomato seeds used in this project, 9478 F1 Hybrid, have been supplied by Heinz Canada. There are two groups of seeds provided:

- Control Group: tomato seeds especially cultivated for food production on Earth. These are ordinary tomato crop seeds used for Earth-based tomato production
- Non-control Group: The treatment group of Tomatoshpere seeds was taken into space to the International Space Station (ISS) by CSA Astronaut Julie Payette, on Mission STS-127, aboard Space Shuttle Endeavor from July 15th – 31st 2009.
    - During that mission, the astronaut crew delivered critical supplies to the Station, as well as experiments that were continued at the Space Station. The Tomatosphere seeds were sent in four packages of 100 000 seeds each and spent approximately two months on the Station.

    - The "treatment" to which the seeds were exposed included a number of elements during their two-month stay on the ISS. These were:
        1. An increase in pressure on the Shuttle flight to the ISS
        2. The weightless environment while on board the ISS
        3. A slight increase in the amount of radiation which all living things experience outside of the Earth's protective atmosphere
        4. On return to the Earth's atmosphere, the seeds are again exposed to increased pressure

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- The non-control group of Tomatosphere seeds was also subjected to a simulation of the Martian surface environment for a period of one week. This was carried out at the Kennedy Space Center in Florida. The temperature in the simulator was -50^{0}C, with 95% concentration of CO_2 and an increased intensity of ultraviolet radiation, similar to that found of the surface of Mars. The pressure in the simulator was very low, 0.6 kPa, compared to Earth which averages 101.32 kPa

Prediction:

Based on what you know about seeds, what do you think will happen when they are exposed to the conditions listed previously?

Choose ONE of the situations in the left-hand column. Explain why you made that prediction. Add any questions that your prediction raises that you want to try and answer

Prediction	Seeds that have been on the International Space Station.
No Effect: Seeds will germinate the same as the control group	
All seeds will survive but some will be slower to germinate than the control group	
Some seeds will NOT survive but germination will be at the same rate as the control group	
Most seeds will NOT survive and few will germinate compared to the control group	
All of the seeds will not survive; there will be no germination of the seeds that were in space and on the International Space Station for two months	
Other	

We cannot be certain that our predictions are valid, so we must test our predictions!

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Experiment:

This is a "blind study," designed to eliminate unintentional bias in the experimental process. Seeds exposed to each of the two conditions have provided – a control group, and the seeds exposed to the conditions of space flight, two months on the ISS and the Mars simulation. The two sets of seeds are labeled "B" and "T". The origin of the seeds will be revealed following the completion of the experiment.

The planting of the seed treatments will be measured and compared.

What are the manipulated and responding variables in this lab?

The attempted germination of all seeds will be undertaken simultaneously and under identical conditions in order to control as many variables are possible. **What conditions do we need to control when attempting to germinate the seeds and grow our tomato plants?**

Planting the Seeds

What conditions are necessary for germination?

Once the seeds have germinated, what conditions are necessary for optimal plant growth?

Observations:

Record the number of seeds planted for each group and the number of seeds which germinate in each group.

Observations should be taken daily and recorded accurately. For the purpose of this experiment a seeds can be considered to have successfully germinated who two distinctly separate cotyledons (embryonic leaves) can be seen. Qualitative observations that might prove to be useful later when the analysis of the data takes place should be noted (eg. Accidents, changes in room temperature over weekends)

When you are recording the number of seeds that germinate are you making a qualitative or quantitative observation?

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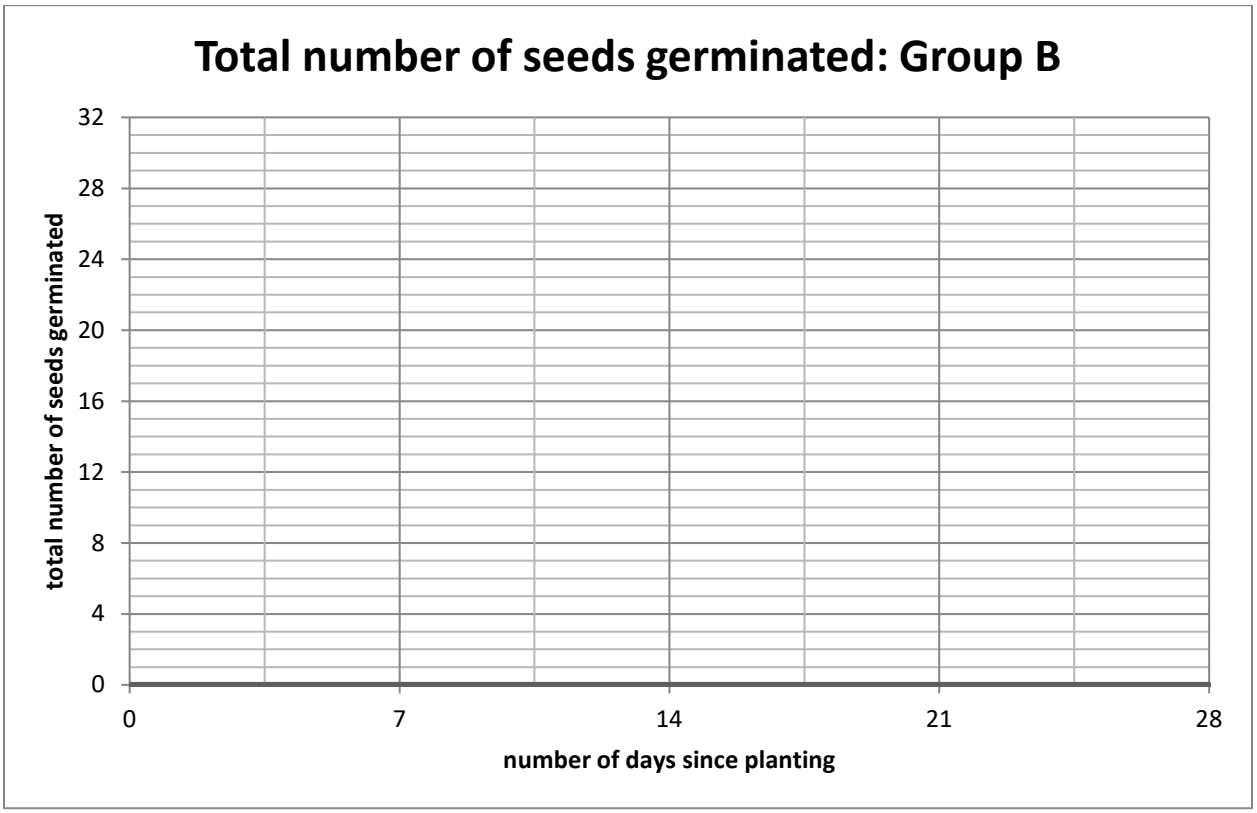
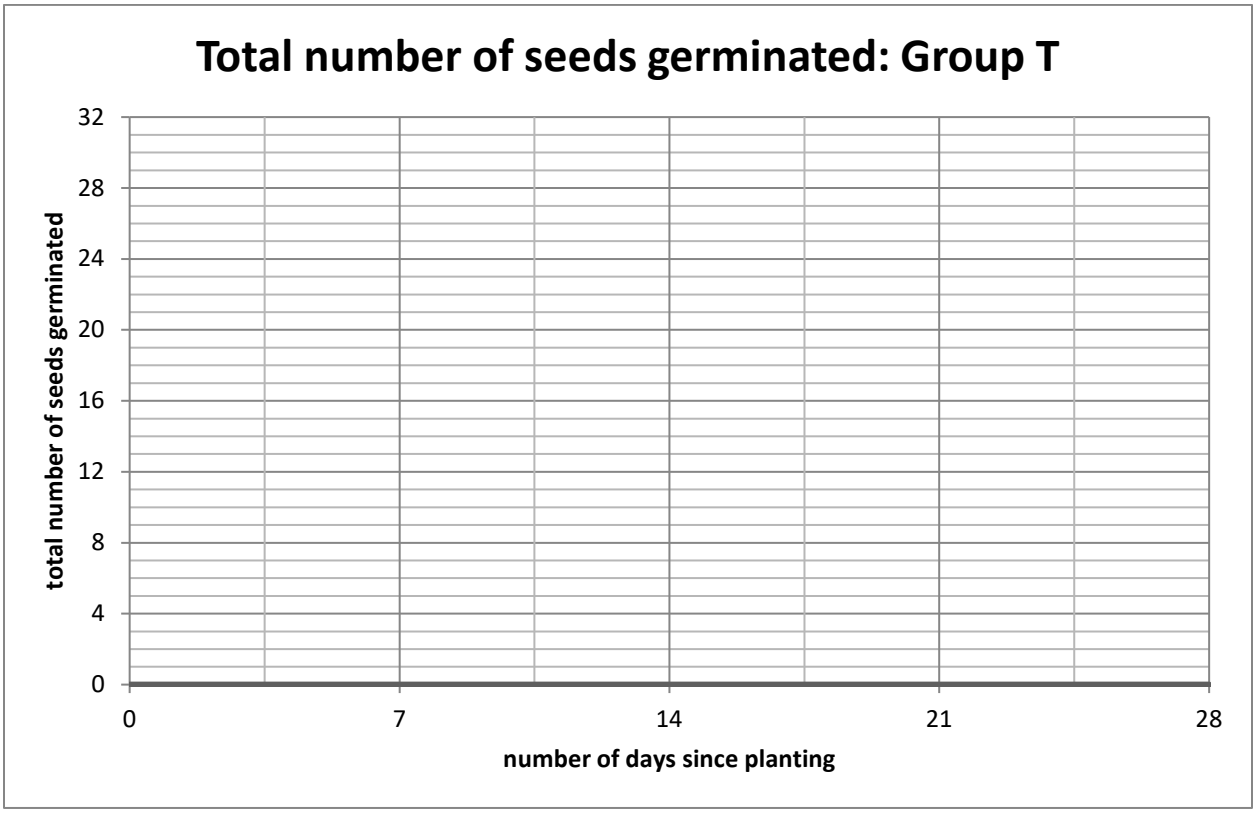
Germination Results





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Summary Table

	Group B	Group T
Number of seeds planted		
Number of days until first seed germinated		
Number of days until last seed germinated		
Total number of seeds that germinated		
Important qualitative observations about any changes to the growing environment over the course of the investigation		

After germination is complete begin recording your observations about the tomato plant growth. Both qualitative observations and quantitative observations should be made. Ensure to note the day that your observations are made.

What information will you record for you quantitative observations?

What information will you record for your qualitative observations?

	Group B	Group T
Qualitative Observations		
Quantitative Observations		

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Analysis and Interpretation:

What conclusions can you make about the impact of the space environment on seeds?

Describe the general function of the following parts of your tomato plant:

Roots:

Stem:

Leaves:

Tomato:

Describe how the tomato plants moves the following substances in or out of the plant

Water

Carbon dioxide and Oxygen

Nutrients

If one of our tomato plants produces "perfect" tomatoes, what could be done to produce more plants that also produce "perfect" tomatoes?

Describe two ways of controlling pests (insects, fungus or weeds) that could damage our tomato plants.