Science coursework
Osmosis Investigation

Background

Osmosis

Osmosis is the diffusion of water only, the movement of water particles from an area of a high water concentration to an area if lower water concentration through a partially permeable membrane. Cell membranes are partially permeable because they allow water to pass through, but not others. When the diffusion gradient of water has disappeared, osmosis stops.

Osmosis in plant cells

Cell, in nature fluctuate between being flaccid and fully turgid. Osmosis is very important for the plants.

- *Helping to support a plant*

  The vacuole of a plant cell contains cell sap, which is a solution of different solutes in water. Water therefore enters the cell sap by osmosis, and the vacuole has the appearance of blo wn up a balloon. This forces the cytoplasm against the cell wall. The cell is said to be 'Turgid'. If a plant is short of water, for example a pot plant which has not watered recently, the cell vacuole if 'Flaccid' and the plant wilts.

- *A plant root cell taking in water*

  The vacuole of the root hair cell is more concentrated than the soil water. Water therefore enters the root by osmosis.

- *Controlling the stomata in leaves*

  The size of the stomata is controlled by the guard cells which surround them. As the guard cells become turgid they cause the

stomata to open, thus allowing more gases to enter and leave the leaf.

- *Plasmolysis*

  If a plant is not watered, water may leaves it by osmosis and cytoplasm may also shrink from cell wall. This process is called plasmolysis.

Transpiration

The xylem transports water and dissolves minerals from the roots to the leaves. They are 'sucked' up the xylem by a process called 'Transpiration'.

Transpiration is the evaporation of water from inside the leaves to the surrounding air. The water vapour passes out the leaves by diffusion.

This is what happens in transpiration:

- Water molecules diffuse from the xylem into the spongy mesophyll cells through cell membranes.
- Water evaporates into air space.
- Water vapour diffuses out the stomata.
- Water lost from the spongy mesophyll cells is replaces by more water from the xylem.

Transpiration is increased by:

- More light because water is used up as the photosynthesis more.
- Increased temperatures because photosynthesis and evaporation increase with temperature.
- Increased air movement, which increase evaporation.
- Decreased humidity because water evaporates more easily into dry air.
- The state of the stomata, their number, distribution, position and size.

Importance of water

Water is so important for plants; they can't survive without it because:

- *It enable transport of minerals*
- *Keep leaves cool*
- *Enable growth*
- *Form fruits*
- *Produce glucose*
- *Provides support*
- *React with carbon dioxide during photosynthesis.*

Cell wall

- made of cellulose
- Freely permeable to all kinds of molecules.
- Supports and protects the cell

Cell membrane

- freely permeable to water and gases only
- selectively permeable to other molecules
- controls what goes in and out of the cell

Vacuole

- space filled with a fluid called cell sap which helps to provide support

Cytoplasm

- a watery jelly in which most of the cell's chemical reactions occur

Chloroplasts

- large bodies containing chlorophyll needed for photosynthesis
- Chlorophyll converts sunlight energy into chemical energy; it is used to combine carbon dioxide with water making glucose - which stores the energy in its bonds.

Nucleus

- carry the genetic information
- control everything a cell does

Mitochondria

- release energy from food(respiration)

Aim

My aim is to find out the concentrate of cell sap in potato.

Prelim work

Method

Cut out ten 1cm³ potatoes and weight their mass before I put them into a 0M solution (water) weak solution and 0.6M (salt water) strong solution, put five cubes into each solution. Leave them for 20 minutes and weight their again and calculate out the difference of mass after dip them in the water.

Results

Solution	Mass at start (g)	Mass at finish (g)	Change in mass
0M	5.48	5.73	0.25
0.6M	6.13	5.64	-0.49

Conclusion

The potato cubes in 0M (water) is slightly heavier after they were dipped into the water because the solution has a higher concentration of water than the potato cubes so osmosis occur, the water diffuse from the solution to the potato cubes so they are heavier than before. On the other hand, the potato cubes dipped into the 0.6M solution were lighter after that because the solution has a lower concentration of water than the potato cubes so the water diffuse from the potato cubes to the solution so they are lighter than before. This process is called osmosis.

Prediction

My prediction is when a solution has a lower concentration of water; the potato cubes will lose weight because water goes out from the potato. But when the solution has a higher concentration of water: the potato cubes will gain weight because water goes in the potato. This is because osmosis is the diffusion of water from a high concentration to a lower concentration. I noticed that after I gone through the prelim work.

I have planned to use five different solutions in my experiment; they have different concentrations of water. They are 0M (water), 0.2M, 0.4M, 0.6M, 0.8M and 1M. I will keep them in same volume, it means 60cm³ each times and cut out the potato cubes as 1cm³ every time and put 5 cubes in each solution as to make a fair test. I will do the experiment for each solution for 3 times and calculate the average of them, which makes the results more accurate and reliable. I will also dry the surface water of the potato cubes before the experiment and after the experiment, so that I may not weight the mass of water outside them, this also make my results more accurate. I may leave them in the solution for 20minutes.

Method

Step1) cut potato into 1cm³ potato cubes.
Step2) prepare the solutions-three for each (60cm³).

Step3) dry out all the potato cubes
Step4) take 5 cubes each times, weight them and record the mass (g).
Step5) put them into the solution and start the timer.
Step6) wait for 20 minutes
Step7) pour out the solutions from each breaker.
Step8) dry out the potato cubes and weight again. Record the mass (g).

I will draw a result table and rewrite the results which may make them clearer to read. Find out the difference between the mass at start and the mass at finish then calculate out the average change in mass. After that, I will calculate the percentage change in mass and also find out the average of them. Later, I may use the data from average change in mass and average %change in mass to plot a graph for each data.

Variables

The mass of each potato cubes may be different because it is hard to keep cutting each cubes into same mass and the cell sap of them may be dissimilar because they depend on the ages of potato and where they were planted, etc.

Equipment

Potatoes
3 breakers
Timer
Water
0.2M,0.4M,0.6M,0.8M,1M solutions
Knife
Electrical scale
Tissue paper
Ruler

Safety

If hands are stained with solutions accidentally, then wash them immediately.
Be careful when cutting potatoes beware of cutting hands.
Use all equipments, for example, breakers, timer and knife. Do not damage them.

Solution		Mass at start (g)	Mass at finish (g)	Change in mass (g)	Average change in mass (g)	%
0M (water)	1	5. 34	5. 57	0.23		
	2	4. 84	4. 89			
	3	4. 38	4. 48	0.05	0.13	
				0.10		
0.2M	1	4. 10	3. 96	-0.14		
	2	5. 74	5. 56			
	3	6. 33	6. 22	-0.18	-0.14	
				-0.11		
0.4M	1	6. 74	6. 51	-0.23		
	2	7. 06	6. 79			
	3	6. 37	6. 21	-0.27	-0.22	
				-0,16		
0.6M	1	7. 43	6. 98	-0.45		
	2	5. 91	5. 52			
	3	7. 62	7. 21	-0.39	-0.42	
				-0.41		
0.8M	1	7. 17	6. 68	-0.49		
	2	8. 46	8. 08			
	3	7. 89	7. 38	-0.38	-0.46	
				-0.51		
1M	1	7. 90	7. 23	-0.67		
	2	8. 14	7. 43			
	3	6. 76	6. 13	-0.71	-0.67	

			-0.63		

Analysis

I found out that the potato cubes only gain water in 0M (water) solution and then all the others both losses water. Although the patterns of the graph are not that fit, I also noticed that more water is losing when the solutions have lower concentration of water. It means that the potato cubes have a higher concentration of water than the solutions, wat er diffuse from an area of high concentration of water to an area of lower concentration of water, from the potato cubes to the solutions.
From Graph1 (average change in mass) showing the pattern of it is at 0M the mass of the potato cubes have a positive change then it goes straight down to negative change as at 0.2M then it keep on goes down as it at 0.4M, 0.6M, 0.8M and 1M. But when I join the plots, I found out that the plots at 0.4M and 0.8M do not fit the patterns. They are a bit deviated then the route, they are not loss weight enough to fit the pattern. From Graph2 (average % change in mass) showing the pattern of it is at 0M the mass of the potato cubes are still in positive changed. I can see that the % change in mass keep on going down to negative as the solutions have a lower concentration of water. The pattern of this graph is not fit again at 0.4M and 0.8M, but this time is a bit unusual at 0.8M. The average % change of 0.6M is –6.01 but 0.8M is –5.93, so the route goes up after reach 0.6M.
In conclusion, the results agree with my prediction because my predict is when a solution has a lower concentration of water, the potato loss weight but when it has a higher concentration of water, it gain weight. The potatoes lose and gain weight because osmo sis occur as I put the cubes in the solutions, osmosis is the diffusion of water only, The potatoes lose weight because the solutions have lower water concentration than the potatoes, so water goes out from the potatoes. On the other hand, the potatoes gain weight because the solution has a higher concentration of water than the potatoes so water diffusion from the solution to the potatoes.

The concentration inside my potato is 0.1M on my graph. I can notice that because while the route cross 0g (the isotonic point), the concentration of the solution is 0.1M, I got the same result in both graph. There may be water and salt inside the potato sap to make up this concentration.
There are only one result which don't support your predict and it is significant. It is the result from 0.8M- the average % change in mass because it got less loss weight than 0.6M, its' average change is –5.93% but 0.6M is –6.01% so it don't fit the pattern.

Evaluation

It was quite easy to carry out this investigation but I think my results are not good enough. There are totally two anomalies in my results, I have highlight them on my results table and graph. They are the results for 0.4M and 0.8M. I think there are some reasons that cause them to be like that. For example, I had not completely dry out the surface water of them before and after each experiment which made me also weight the water not belong to the potatoes. Also one reason for that is I had not keep to potato cubes approximately have the same mass which may affect their percentage change in mass.
To improve the procedure, I will:

- Leave potato for longer time, maybe 25 -30 minutes,
- Cut potatoes into fine slices that they will have a large surface area.
- Try to use only one potato to do this experiment, which make a fair test as all cubes are come from that potato.
- Completely dry out all potato cubes.
- Weight them carefully, be ware that someone/something is affecting the electrical scale.

This would improve my data because if I leave them longer in the solutions, the results will be more observable. If I cut potato into slices, they will have a large surface area. This help particles goes in and goes out more quickly, the results may be also more observable. Dry out them completely which make me do not weight the mass of surface water which could make my result anomaly, this help me to have an accurate mass of potato cubes/ slices. Careful when weighting the potato, this also makes me to an accurate mass of potato.
I think my evidence is not that reliable although I have repeat each

experiment for 3 times and get the average of them but I had not repeated any odd results. I might make my data more reliability if I repeat that experiment when I faced an odd result.
I think the best comparison is the average change in mass but no the average percentage change in mass because the % change depends on the actual mass of potato. For addition or further work I can do is to do the experiment for more than 3 times, which may make an odd result not that easy to affect my data as I will calculate out the average.