The effect of osmosis on potato cells

 Introduction In this experiment I am going to investigate the effect of varying concentration of a differing glucose solution on the amount of osmotic activity, between the solution and a potato tuber of a given size. The purpose of this experiment is to demonstrate how living cells rely on osmosis, the diffusion of water. Osmosis is the movement of water molecules (H20) from a region in which they are highly concentrated to a region in which they are less concentrated.

This movement must take place across a partially permeable membrane such as a cell wall, which lets smaller molecules, such as water, through but does not allow bigger molecules, such as glucose, to do so. The molecules will continue to diffuse until the area in which they are found reaches a state of equilibrium, meaning that the molecules are randomly distributed throughout an object, with no area having a higher or lower concentration than another. Investigation – Preliminary Experiment

Strategy In my preliminary experiment I am going to be seeing how potato tubers react when placed in of 0m (distilled water) 0. 5m and 1m (glucose solution). I am doing this to gain some knowledge about how the potato tubers will be affected; so when I do my main experiment I will have basic knowledge on what will happen, this means I will be able to spot outliers more easily and learn from any mistakes which may have been made in the preliminary. Molar = (m) Mass/weight = (g)

Depending on certain factors the osmotic activity between the potato tuber and glucose solution will either increase, decrease, or unaffect the mass of

the potato, such as – whether the sugar to water ratio inside the potato and outside of the potato differ or not. Variables that could affect the amount of osmotic activity include factors such as: o Temperature – Cells move quicker at higher temperatures, therefore the higher the temperature the higher the rate of osmosis. o Variety of Potato – Different varieties of potatoes may vary in the quantity of water and/or glucose inside them. Volume of Glucose Solution – The more solution there is the larger quantity the glucose has to equalize over. o Pressure – Areas of different pressure have different water potentials. o Surface area – The larger the surface area, the more water can be absorbed into the cells, therefore altering the rate of osmosis. All of these factors will affect the experiment due to the nature of the potato cells, but the only variable I will be changing is the concentration of the glucose solution. Reliability Fair testing is essential in all investigations.

If this experiment is not a fair test, i will obtain incorrect results, which could lead us to the wrong conclusions as they are not providing a true representation of the data at hand. Prediction My prediction is that when the potato tubers are put into the distilled water, it will increase in mass; I believe this because there are more water molecules in the water than there is in the potato cells, the water molecules will move by osmosis into the potato cells through the partially permeable membrane to create equilibrium.

This means that the mass of the potato piece will increase and the potato will feel turgid. When the potato tubers are put into a high concentrated glucose solution there are more water molecules in the potato cells then in the solution; therefore the water molecules move by osmosis from the potato

into the highly concentrated solution. This means that the mass of the potato tuber will decrease, and its appearance will be flaccid. The stronger the concentration of the glucose solution the more it will decrease in mass. Collecting Data – Plan

For this experiment I am choosing a set size for the potato tuber to be 3cm. This will ensure that it is a fair test throughout. I have also made sure that the first solution is distilled water, the second a concentration of 0. 5m and the third and final solution 1m. A potato tuber will be left in each solution for a period of 24 hours, I repeated each concentration twice times to try and get consistent results for each one. I will then work out an average of these three times, this helps to get as accurate results as possible. Results

I created a graph compiled of all the evidence in the tables in a concentration (m) and mass change % (g) comparison. I have done a line graph as I believe this is the best way to portray my results accurately and clearly. Note: The graph and table have been attached overleaf. Interpreting Data – Evaluating Evidence I believe that the experiment was successful as the results were as expected and were all in a similar range of one another; from looking at my graphs I can see that changing the concentration of the glucose solution affects the potato in differing ways according to the strength of the solution.

The potato tuber in the 0m solution (distilled water) reacted as I expected it to, its mass increased as the concentration of glucose inside of the potato was greater than on the outside, thus the water entered the potato to try and create equilibrium. In the experiment with 0. 5m glucose solution, the

mass of the potato decreased by a substantial amount, the average percentage change was -9. 53%; considering it wasn’t an extremely strong solution, it is a useful and unexpected result. The potato tuber that was placed in the glucose solution with a concentration of 1m lost even more mass than the 0. m solution; this was to be expected. The average mass change percentage was -17. 28%. This is a good result because the average of 1m is almost double the average of 0. 5m, this helps to show that the results are reliable as they follow the pattern they are expected to take. My graph and table were quite conclusive as they seemed to follow extremely closely to the line of best fit; the aero-bars are very close to the average which makes me believe that the experiment was accurate and reliable as the results are all very similar and follow the predicted ‘ route’.

Conclusion The potato tuber in the distilled water was the only one to gain in mass. This is because the potato became turgid as it soaked up the water molecules, by osmosis. The others decreased in mass. This is because the concentration of the solution was higher than the concentration of glucose inside the potato, this made them contract and shrink; whereas if the concentration of the solution had been lower, they would have expanded. Evaluation Generally, I think my results obtained were fairly accurate.

From my preliminary test I have learnt that the three solutions were not enough, so I decided to have 6 solutions instead. This would make the graphs clearer and easier to notice any trends or patterns. During my preliminary test I also found that leaving the potato tuber in the test tube for 24 hours was not long enough to ensure that the process of osmosis was complete. So for my actual investigation I have decided to keep them in for

four days, this would give the potato tuber enough time to complete osmosis as best it can achieve; it would also give me a bigger range between each result recorded.

Investigation – Main Experiment Strategy Depending on certain factors the osmotic activity between the potato tuber and glucose solution will either increase, decrease, or unaffect the mass of the potato, such as – whether the sugar to water ratio inside the potato and outside of the potato differ or not. Molar = (m) Mass/weight = (g) Variables that will affect the amount of osmotic activity include factors such as: o Temperature – Cells perform quicker at higher temperatures, therefore the higher the temperature the higher the rate of osmosis. Variety of Potato – Different varieties of potatoes may vary in the quantity of water and/or glucose in them. o Volume of Glucose Solution – The more solution there is the more the glucose has to equalize over. o Pressure – Areas of different pressure have different water potentials. o Surface area – The larger the surface area, the more water can be absorbed into the cells, therefore altering the rate of osmosis. All of these factors will affect the experiment due to the nature of the potato cells. The only variable I will be changing is the concentration of the glucose solution.

Equipment ? ‘ Number 5’ Cork Borer – I decided to use this particular cork borer because it was a good size for the experiment, it wasn’t too large or too small. I needed a medium sized cork borer to allow sufficient osmotic activity to take place and for the changes in weight and length to be measured accurately. ? Potatoes of the same breed and age – A reactant. The potatoes need to be the same breed and of a similar age because if a potato is old compared to another its water content could be lower.

Also the breed of the potato needs to stay constant because different breeds of potato have different water contents, and therefore have different water potentials. ? Distilled Water – A reactant. ? Glucose Solutions (0. 2, 0. 4, 0. 6, 0. 8 and 1 molar) – A reactant. ? Electronic Scales – To weigh the potato tubers accurately to 2 decimal places. ? Film Canister x18 – Used to contain the different solutions and the potato tubers during the course of the experiment. ? Ruler – To measure the length of the potato tubers to the nearest millimetre. White Tile – A clean, safe place to cut up the potato without worry of contamination. ? Knife/Scalpel – A sharp, clean object in which to cut up the potato with. ? Measuring Cylinder – To measure volumes of solutions (distilled water and glucose solutions (0. 2m, 0. 4m, 0. 6m, 0. 8m and 1m) accurately. ? Blotting Paper – Used to remove excess liquid from the potato tubers. Fair Test To ensure the experiment is a fair test I am going to: ? Make sure I use the same volume of solution in each section of the experiment. Have the same size and weight of potato tubers. ? Same size film canister. ? Ensure all potato tubers are covered by the solution. ? Leave the potato in the test tube for the same length of time. ? All the potatoes enduring the same temperatures to one another throughout. ? Zero the scales before each weight measurement is taken. Also to help aid accuracy I will repeat the experiment twice, totalling 3 results for each solution. The two repeats of my test will help make sure that any human mistakes are clear so as to be rectified.

I also need to be certain that all the instruments I use are both clean and have no flaws such as cracks or chips that may cause inaccurate results. If I am going to conduct a fair test, then I need to control other factors, such as

temperature; for the purpose of my experiment I am going to do all the experiments at room temperature. Safety To make sure my experiment is safe I will wear goggles at all times and take care when using the equipment, especially when cutting the potatoes using the scalpel, as it could injure someone if it is not handled properly. Reliability

I intend to improve the reliability of my results by doing the test three times. I will do this because then I can find the average of the results, when all the anomalous results have been eradicated I will know that I have taken enough repeats. Prediction I predict that the size of the potato chip placed in the weakest solution (0m; distilled water) will increase in size and weight because some of the water will move into the potato cells by osmosis; this is because the concentration in the cells will be much higher than the concentration on the solution. The size of the potato tuber in the glucose solution of 0. m should stay roughly the same size because they will have similar quantities of glucose to one another. The size of the potato in the increasing strengths of glucose solution (0. 4m, 0. 6m, 0. 8m and 1m) I believe will decrease because the concentration in the cells will be lower than the concentration in the solution. Therefore the water will move out of the cell. Collecting Data – Variables The only variable I am going to change in this experiment is the concentration of the solution, this is because it makes the experiment a lot easier to recreate and should produce more accurate results.

I will try and control the other factors and keep all the tubers with their solutions in exactly the same environment; this means that if one sample is affected by something, they all will be. Method 1) Collect all equipment

before starting the experiment; this is so the experiment can be done smoothly rather than rushing about trying to find pieces of equipment once parts of the experiment have begun. 2) Write out 18 labels, each stating the different concentrations; Distilled water, 0. 2m, 0. 4m, 0. 6m, 0. 8m, 1m (3 labels for each concentration as the experiment will be repeated 3 times. 3) Place each label on to separate film canisters; labels are needed so canisters of differing solutions do not get mixed up as this would ruin the experiment. 4) Using the measuring cylinder, measure out 20ml of each solution and pour each solution into its correct film canister. 5) Cut out 18 potato chips using a core borer. 6) Ensure the potato tubers are all precisely 3cm in length, using the scalpel to do so. All of the tubers need to be as accurately cut as possible as any difference could greatly affect the weight and/or mass.) Place each tuber in its own labelled film canister, ensuring they are covered by the solution, and seal it. 8) Leave for four days. 9) Carefully remove the potato tubers and blot off any excess liquid; all the tubers need to be blotted equally, otherwise the weight could be affected creating unreliable and inaccurate results. 10) Weigh them, recording the results in a pre-drawn table. Interpreting Data I knew from looking at the results of my preliminary test vaguely what to expect. For the potato tube in the distilled water (0m), I predicted that the potato chip was going to increase in length and mass.

Here I predicted correctly because the potato tube increased by an average of 32. 79% in mass and 11. 11% change in length. I predicted that the potato chip in the weak glucose solution was going to increase in its dimensions because the concentration in the potato cell was higher than the concentration in the solution. In my results the potato in the weak glucose

solution (0. 2m) did increase on average in mass from its beginning size of 3cm by 1. 11%; my prediction had not been exactly correct but it was very close to the results obtained.

I also predicted that the size of the potato in the strongest glucose solution would decrease in size because the concentration in the cells would be much lower than the concentration of the solution, therefore the water would move out of the cell. The original size of the tube was 3cm, the size decreased on average by 23. 80% – I had predicted correctly. The experiment was very successful in my opinion. I obtained a large quantity of seeming accurate and reliable results from which I was able to create informative graphs.

These graphs showed a clear negative correlation – as the glucose concentration increased, the mass and length of the potato cylinders decreased. For example, when the glucose concentration was 0M, the % change in mass was 32. 95g, whereas when the concentration was 0. 6M, the average % change was -18. 35g. I think I took enough results for the amount of concentrations that I was using, and the time that I used for the experiment to last was enough to allow sufficient osmosis to occur. Graph Analysis My graphs have helped me to draw a conclusion from my results, by showing them in a more visual way.

They also improved the reliability of my conclusion, because the error bars were fairly small. As I repeated my experiment three times for each glucose concentration, the error bars would have allowed me to identify any outliers. Most of my results were on the line of best fit, and the others were very close to it. This shows that my results were accurate, which means that it is

reasonable to draw a conclusion based on these results. Conclusion In conclusion living cells rely on osmosis because for a cell to survive, the concentration of substances within the cell must stay within a safe range.

A cell placed in a solution more concentrated than itself will shrink due to loss of water, (It may eventually die of dehydration.) By contrast, a cell placed in a solution more dilute than itself will expand as water enters it, under these conditions the cell may absorb too much and burst. In general, plant cells are protected from bursting by the rigid cell wall that surrounds the cell membrane. As water enters the cell, it expands until it pushes up tight against the cell wall. The cell wall, which is made up of cellulose, pushes back with an equal pressure, so no more water can enter; when this happens the cell is known as fully turgid.

This process involving osmosis is important within a plant as it allows the stems to become strong and upright. The movement of water across cell membranes and the balance of water between the cell and its environment are crucial to organisms; osmosis is a pure mechanical diffusion process by which cells absorb water without spending any amount of energy. Evaluation I think that I can draw a fairly reliable conclusion from my experiment; the equipment I used was fairly scientific, and I used the best equipment that I could access.

The scales I used calculated up to two decimal places which helps improve the accuracy. I think that my results were quite precise, but if I was doing this experiment with more developed equipment my results would be more accurate and more reliable. If I had used scales to four significant figures,

this would have been even more accurate and my conclusion would have been more reliable. Also in my experiment I only used 6 different molars of glucose solution to note down results, draw graphs, and finally write a conclusion.

But, if I was doing this experiment on a more scientific level I would probably use about twenty different solutions and this would help me to see any patterns and/or changes as well as being able to put forward a more accurate conclusion. During my investigation I found it very difficult to get all the potato tubes exactly the same dimensions. After weighing them on the electronic scales I found that each was slightly bigger or smaller than the other in mass. This made the investigation slightly inaccurate but the differences were minimal enough not to cause any major problems.

This was also the case with the length. If I were to repeat the experiment I would have possibly found a machine to cut the potato as it would ensure that all potatoes would be the same weight and dimensions. As well as this, I could have found a more accurate way to measure out the solutions, for this I could have used a burette to ensure that I had an accurate amount of fluid in each test tube. There were not any anomalous results that I came across, but some were not as close to the line of best fit as others. This may have been caused by human error.

When the potato tubes were removed from the film canisters and dried, some may have been dried more thoroughly than others and so some would have more excess water. This would add to the mass. If the experiment was repeated I could find another way to dry the potatoes that would ensure that

they were affected equally, making it a much fairer test. To improve the experiment I would find a way of making the results more accurate, by using better apparatus such as electronic measuring systems to make sure all potato tubes were exactly the same length and diameter, giving them the same surface area.

Another complication is that there is no guarantee that the potato was the same density throughout; in fact it is highly unlikely. A final obstacle was that some of the tubes remained in the solution while I dried and weighed the others, a partial answer to the problem would be to empty all of the film canisters out of the test tubes first, then dry them all, then weigh them.

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