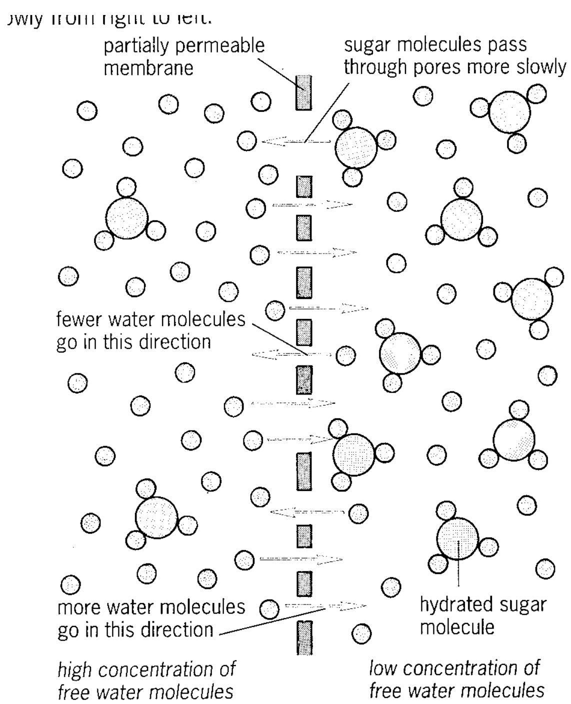
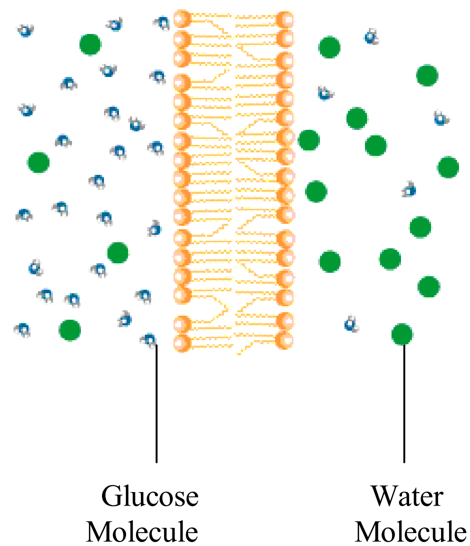
# An experiment to determine the osmotic values of Chinese radish and Potato cores.

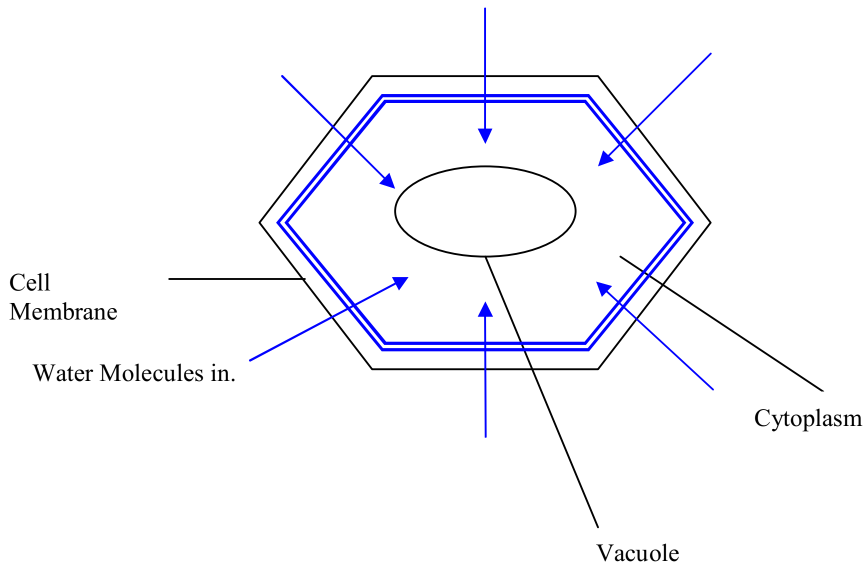
***Osmosis is the movement of water from an area of high water potential (Ψ) to an area of low water potential through a selectively permeable membrane.***




The diagrams  above shows that only the water molecules can move quickly through the pores in the selectively permeable membrane. The sugar molecules (glucose arde too big to move through the gaps withease. Since there is a higher water potential on the left-hand side more water molecules will move from right to left, than from left to right.

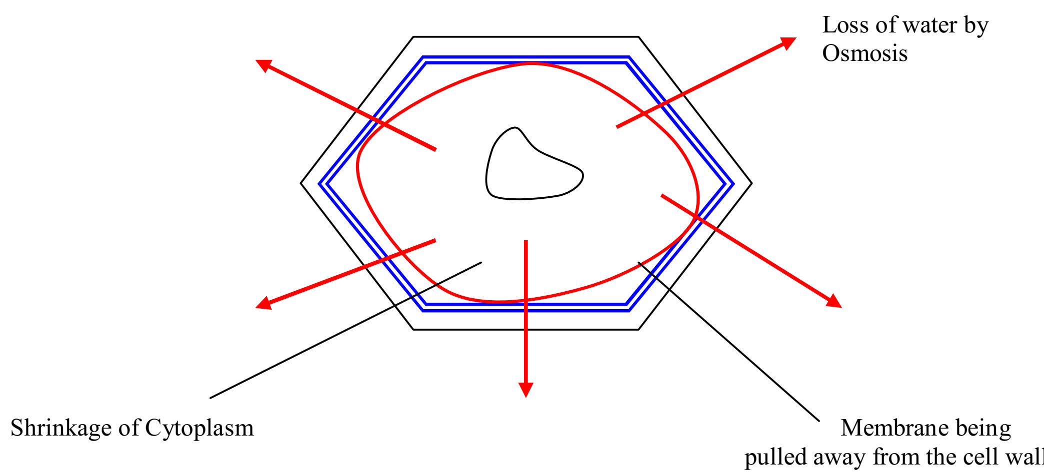
**What happens if a cell is placed in pure Water $H_20$:**




If a plant cell is placed in pure water, water outside the cell will flow into the cell by osmosis as the interior of the cell has a lower water potential than the pure water. The reason why the interior has a lower water potential is because the cytoplasm has substance like glucose dissolved into it. As more and more water flows into the cell the cell becomes more and more rigid. Eventually the cell becomes turgid and this is when the cell will not accept anymore water as the water potential inside and outside now balanced.

If we replicated this with an animal cell it would burst as water would enter osmotically and then the cell would become rigid and there would be no support from a cell wall, and thus the cell will burst.

**What happens to a plant cell in 1.0M Glucose Solution:**



In the conditions of 1.0M Glucose solution the cell will tend to lose water as it has a higher water potential than the outside medium, Water leaves the cell via osmosis and the cell become less rigid in other words **flaccid**. If the water loss continues the cytoplasm shrinks and the membrane gets pulled away from the cell wall, leaving the cell in a state of **plasmolysis**. If this happens the plant will wilt.

**How to make 1.0M Glucose Solution:**

To make 1 1.0M Glucose solution the molecular mass of glucose in grams is dissolved in 1dcm$^{-3}$ of water. Below is the molecular mass of glucose.

$$C^{6}\ H^{12}\ O^{6}$$

$$(6x12)+(1x12)+(6x16)$$

$$72+12+96=180g$$

From 1.0M Glucose solution it is possible to make any desired molarities lower than 1.0M by mixing with the correct ratio of water.

| Molority M | cm$^3$ of water | cm$^3$ of 1.0M Glucose |
|---|---|---|
| 0.2 | 8 | 2 |
| 0.4 | 6 | 4 |
| 0.6 | 4 | 6 |
| 0.8 | 2 | 8 |
| 1.0 | - | 10 |

**Aim:**

To find and prove the molarities of Chinese Radish and Potato, along with scientific backing, and also to see how they 'perform' when exposed to differing molarity solutions.

**Predictions:**

I have made some predictions on how I think the experiment will go and what the results should be. I have also used some data collected from previous experiments to give me an educated guess on the exact percentage changes.

| Molarity of solution | Potato Core | Prediction % Change | Chinese Radish Core | Prediction % Change |
|---|---|---|---|---|
| 0.0 | The potato core will gain a significant amount of mass as the potato core has | 15 | The radish core will gain a significant amount of mass as it has a significantly | 15 |

| | | | | |
|---|---|---|---|---|
| | a lower water potential than pure water. | | lower water potential than pure water. | |
| 0.2 | The mass will increase slightly as the potato core still has a slightly lower water potential. | 5 | The mass will increase slightly as the radish core will have a slighter lower water potential. | 5 |
| 0.3 | The mass will stay the same as the water potential inside the cores and the solution will be balanced. | 0 | The mass will stay the same as the water potential inside the cores and the solution will be balanced. | 0 |
| 0.4 | The cores will lose a slight amount of mass as it has a higher water potential than 0.4M Glucose solution. | -5 | The cores will lose a slight amount of mass as it has a higher water potential than 0.4M Glucose solution. | -5 |
| 0.6 | The cores will lose a slightly larger amount of mass as it has a reasonably higher water potential than the medium outside. | -15 | The cores will lose a slightly larger amount of mass as it has a reasonably higher water potential than the medium outside. | -10 |
| 0.8 | The cores will lose a larger amount of mass as they now have a significantly higher water potential. | -20 | The cores will lose a larger amount of mass as they now have a significantly higher water potential. | -20 |
| 1.0 | The cores will lose a large amount of mass. | -25 | The cores will lose a large amount of mass. | -25 |

**Apparatus:**

14 Boiling Tubes, 14 Potato Cores, 14 Chinese Radish Cores, 300ml of per -made 1.0M Glucose solution, 300ml of Pure Water, 1 White Tile, 1 Scalpel, 2 10ml Syringes, 15cm Ruler, Test Tube Rack, Sieve and a Scale.

**Method:**

1. Measure out 30ml of 0.0M, 0.2M, 0.3M, 0.4M, 0.6M, 0.8M and 1.0M glucose solutions and put them into their respective test tubes and label.

2. Cut seven cores into 5 cm lengths and seven into 4.5cm lengths using the scalpel on the white tile.

3. Weigh the cores separately and note their respective masses. Separate the cores into one long and one short pair (5cm and 4cm).

4. Place one pair into each test tube. And note how firm the cores are for later comparison.

5. Leave the cores in their test tubes for no less than 75 minutes.

6. After 75 minutes remove the cores from their test tubes at the same time using a pair of forceps or the sieve, then dry the cores in a uniform fashion; this will reduce the likely hood of human error in the experiment. Then note their masses, and their firmness for comparison with the earlier readings.

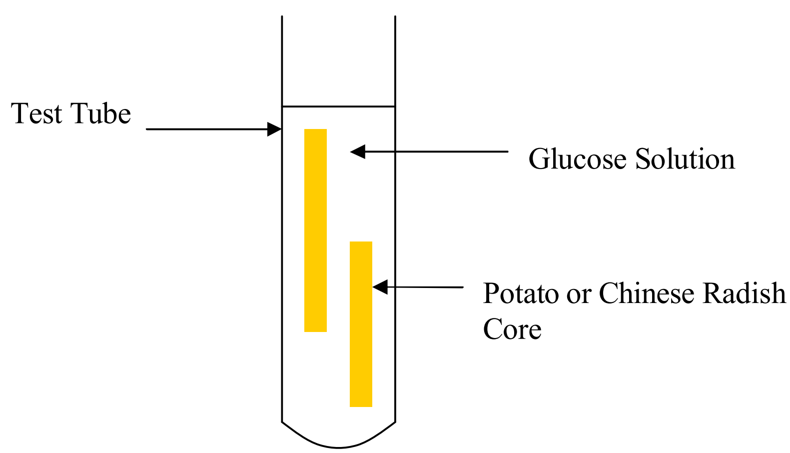
7. Find the percentage change in mass of the cores. Using the method below

$$\frac{\text{(Difference between original and final mass)}}{\text{Original Mass}} \quad \text{x100}$$

8. Compare the firmness of the cores.

9. Obtain a graph from the results, and interpret these results to form the conclusion and evaluation.

**Diagram:**



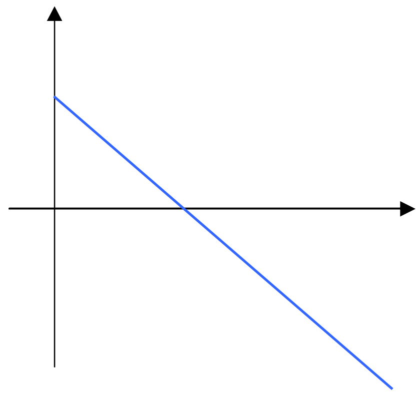
**Results:**

| Potato Cores | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Molarity of Glucose (M)*** | ***4.5cm Cores (cm)*** | | ***Percentage Change (%)*** | ***5cm Cores (cm)*** | | ***Percentage Change (%)*** | ***Mean Percentage Change (%)*** |
| | **Before (g)** | **After (g)** | | **Before (g)** | **After (g)** | | |
| 0.0 | 2.46 | 2.79 | 13.415 | 2.48 | 2.77 | 11.694 | 12.554 |
| 0.2 | 2.63 | 2.78 | 5.703 | 2.57 | 2.69 | 4.670 | 5.186 |
| 0.3 | 2.23 | 2.25 | 0.897 | 2.96 | 2.96 | 0 | 0.448 |
| 0.4 | 2.47 | 2.3 | -6.883 | 2.93 | 2.73 | -6.826 | -6.854 |
| 0.6 | 2.53 | 2.06 | -18.577 | 2.74 | 2.24 | -18.248 | -18.413 |
| 0.8 | 2.43 | 1.82 | -25.103 | 2.97 | 2.19 | -26.263 | -25.683 |
| 1.0 | 2.54 | 1.75 | -31.102 | 2.87 | 2.08 | -27.526 | -29.314 |

| Chinese Radish Cores | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Molarity of Glucose (M)*** | ***4.5cm Cores (cm)*** | | ***Percentage Change (%)*** | ***5cm Cores (cm)*** | | ***Percentage Change (%)*** | ***Mean Percentage Change (%)*** |
| | **Before (g)** | **After (g)** | | **Before (g)** | **After (g)** | | |
| 0.0 | 2.06 | 2.30 | 11.650 | 2.56 | 2.99 | 16.797 | 14.224 |
| 0.2 | 2.17 | 2.25 | 3.687 | 2.85 | 2.97 | 4.211 | 3.949 |
| 0.3 | 2.26 | 2.36 | 4.425 | 2.77 | 2.79 | 0.722 | 2.573 |
| 0.4 | 2.25 | 2.25 | 0 | 2.58 | 2.47 | -4.264 | -2.132 |
| 0.6 | 2.16 | 1.97 | -8.796 | 2.71 | 2.31 | -14.760 | -11.778 |
| 0.8 | 2.36 | 2.00 | -15.254 | 2.42 | 1.90 | -21.488 | -18.371 |
| 1.0 | 2.00 | 1.55 | -22.5 | 2.48 | 1.93 | -22.177 | -22.339 |

**Conclusion:**

Looking at the results I can conclude that it is a very successful experiment. The results show that as the Molarity of the solution increases the mass of the Potato and Chinese Radish Cores decreases.




Looking at the results for the **Potato Cores** it shows that the results from the two cores and their relationship is a strong negative correlation and this proves the theory that the as the molarity of the glucose increases, the mass of the core decreases. This is due to the fact of *osmosis* as the cores have a higher water potential than the glucose solution as its molarity increases and thus the greater the water loss and thus a greater loss in mass.

As I predicted all the Potato cores in glucose solutions with a molarity higher than 0.3+M lost mass this is due to the fact of *osmosis*, thus the cores have a molarity of 0.3M. This is so because all the cores in solution 0.3+M lost mass as the cores had a higher water potential than the outside solution, and due to *osmosis* water molecules would move out of the cores. And all the cores in solutions lower than 0.3M gained mass as this time then cores had a lower water potential than the solution outside.

The evidence also shows that the cores tend to lose an extra 7% of their mass every time the molarity of the solution goes up by 0.1M. My predictions for the 0.0M solution was reasonably accurate as I predicted a significant gain in mass at approximately +15% and the mean change was 12.6% this is very close to my actual predictions as it was only 2.4% away. So I am happy about this prediction.

For the 0.2M solution I predicted a slight increase at approximately +5% and the actual percentage change was +5.2% so this was very accurate. For the 0.3M solution I predicted ‘par’ results at 0% and I wasn’t too far off with the result being at 0.4%.

For the 0.4M solution I had expected a -5% change in mass and like the 0.0M solution I was a little bit off with the prediction, this could be due to the fact that these predictions were made with the help of a prep-experiment, and the readings could have been a little bit off.

For the 0.6M solution I had expected a sharper drop in mass at -15% but the final result was -18.4% so I was a quite a bit off. With the 0.8M and 1.0M solutions I was off by quite a bit as the results exceeded my predictions by quite a bit, around 6% and 5% respectively.

For the **Chinese Radish Results** they were on the whole slightly more off than the predictions. But it also proves the theory that as the molarity of a solution increases the mass decreases.

The prediction for the 0.0M solution was on the whole accurate as I had predicted a +15% change and the cores produced a +14.2% change. For the 0.2M glucose solution I predicted a +5% change and there was a +4% change. For the 0.3M solution I expected the cores to be a 'par' mass because the water potential is equal. But as a matter of fact it was out by +2.6% and the 0.4M solution in which I predicted a shaper loss in mass I recorded a -2.1% change instead of a predicted -5% change. Thus the water potential of the Chinese Radish is about 0.35M.

The 0.6 and 0.8M cores did pretty much as predicted. But the 1.0M solution loss less mass than I expected, I had predicted a -25% change but I recorded a -22.3% change. This may be due to the fact that cores that were used in that experiment were slightly higher in water content.

So I conclude that the molarity values of Potato and Chinese Radish are 0.3M and 0.35M respectively. This means that Potato has a slightly higher water potential than Chinese Radish. I am able to conclude this because of the experiment and another prior prep-experiment where I concluded that the value of Potato was approximately between 0.3M and 0.4M. Due to this experiment and the ability to have a 0.3M test tube I was able to confirm my prediction that Potato has a molarity of 0.3M.

The Chinese Radish was a new substance for me to work with in Biology and I didn't really know what to expect, but from 'past experiences' I knew that Potato and Chinese Radish had a reasonably similar water content, so I was able to make an educated guess. And this guess showed as I was slightly off with my predictions but as a first time experiment I guess for the Chinese Radish it was satisfactory.

**Evaluation:**

Overall I believe that this has been a very successful experiment as, I believe that the process/experiment used to obtain my collected data was very fair as they solutions were made out by ourselves and that removed any chance of an error which may have been made is the solutions had been made in mass quantities.

But the only major problem I had with this experiment was that after weighing the cores I placed them onto a normal sheet of A4 paper as I needed to note their masses and keep them somewhere, the tiles were not big enough so paper was the next best option. This may or may not have altered the results but ever so slightly, as this depends on the amount of fluid the cores had on their surface area. And this could have been absorbed by the paper that the cores were placed on, so that could have lowered the mass of the cores by maybe 1 or 2 grams, but I believe this was only a small problem as many of the potato cores had really very little or no surface water and for the Chinese Radish this would have been a greater problem but again this was a very small amount of water, but the recorded results turned out ok.

Another problem that may have affected some of the cores is that sometimes when the two cores in a test tube touched they would be 'stuck' together as the water pressure and density of the liquid made them do so. This could mean in theory for each of the two cores there is less surface area (about 1/4) for the water molecules to move in and out of the cells osmotically, as the surface area is not in contact with the outside solution. And this will ultimately affected the final mass of the cores.

The overall quality of the experiment was very good as there were only two anomalies in my results and these both accrued with the Chinese Radish cores, they were the 4.5cm core in the 0.3M glucose solution as it gained 4.4% mass whilst the 5cm core gained only 0.7%. This may have been due to the core having some water absorbed from by paper it was placed on. And the final anomaly is the 5cm core in the 0.4M solution as it lost 4.3% of its mass whilst the other core had a 'par' result. This again may be due to the paper absorbing some of the water.

In other prior prep-experiments I had some problems with the means in which I dried my cores, and that caused may anomalies in my results as they cores were either being dried too thoroughly or not enough. But I believe with this experiment I had perfected the technique which all the cores strained within 1minute of each other and then being dried at the same time with the same technique.

A very small problem is air humidity as when the cores are left whilst the others are being cut or weighed could even have gained mass due to the fact that water could have moved in osmotically from the air and altered the mass, but this would have been a very slight change and I doubt it altered the results much.

But overall, the quality of the results obtained, through the experiment was very satisfactory. I am very happy about the results as they give a fair reflected on the experiment and the theorems and predictions put forward.

If I were to this experiment again I would do each core in its own respective test tube and I would use more test tubes with more cores in maybe even 5 cores per molarity of solution, and this way if I got any anomalies I would be able to discount them from my results as there would be 4 other cores to obtain a mean result from. I would also test from 0.0 right through to 1 .0 and all the intermediate stages, i.e. 0.0M, 0.1M, 0.2M etc. this would enable a more accurate 'line of best fit' and a better understanding of the 'performance' of the cores through the intermediate stages.

I would also have the cores cut from the same vegetable, as there is the possibility of there being so many cores to supply one persons set of cores may have come from 2 different sources which could mean an unfair result, as one may have been harvested longer than the other one. I would also like to have the cores cut by myself, freshly, as undoubtedly the cores will have been pre-cut and this would mean that the cores could have lost moisture which could have affected the results if the cores had been freshly cut.

I reliability of the results obtained by through the experiment on the whole were very reliable and they are more than enough to support the conclusion even with the anomalies as we can tell by the graphs where the points should have been. Looking at these results as well as the prep results I believe they are a fair reflection of the predictions and the aim.

To further prove this conclusion I would repeat this experiment several times, but at spaced out intervals just in case the outside humidity or tiredness make would make human error more of a chance. I would also make sure that the 'freshness' of the materials used were the same. The extra experiments would be carried out with amendments stated above.

But I honestly believe that this was a very fair and accurate experiment so I am happy with the results. Although any extra experiments would iron the last few small creases and cement my conclusion together.