Implementing.

Once I had started this experiment I noticed that certain parts of my original plan were vague or incorrect. These problems were that I hadn't specified the amount of distilled water I was to use or the length and weight of the beetroot I was to use. I decided when doing the experiment to use 10cm³ of water and exactly 4cm of beetroot to the width of the corer. I also realised that the temperatures I had chosen weren't ideal, as the lower temperatures wouldn't be very different from each other and 60°C wouldn't be high enough to get a wide enough set of results in order to see a clear pattern or trend on the graph. So I decided not to carry the experiment out at 10°C and to add a temperature of 75°C.

As I said in the plan I did carry out the experiment a further 2 times for each temperature to ensure that the results were as reliable as they could be and to minimise the chances of an anomaly result affecting the final results. When repeating the experiment I had

Aim:
This experiment aims to determine what effect an increase in the surrounding temperature has on the plasma membrane of a typical plant cell structure.

Hypothesis:
An increase in temperature will damage and denature the plasma membrane and cause the cytoplasm and other substances contained within the membrane to leak out.

Introduction:
The purpose of a cell membrane is to control the transport of substances moving into and out of a cell. The membrane is an extremely thin layer (8 to 10 manometers (nm)) thick, which is partially permeable. It consists mostly of lipids and proteins. The lipids found in cell membranes belong to a class known as triglycerides, so called because they have one molecule of glycerol chemically linked to three molecules of fatty acids. The majority belong to one subgroup of triglycerides known as phospholipids.

Despite their many differences in appearance and function, all cells have a surrounding membrane (called the plasma membrane) enclosing a water-rich substance called the cytoplasm. All cells host a variety of chemical reactions that enable them to grow, produce energy, and eliminate waste. Together these reactions are termed metabolism (from a Greek word meaning, "change"). All cells contain hereditary information, encoded in molecules of deoxyribonucleic acid (DNA), that directs the cell's activities and enables it to reproduce, passing on its characteristics to its offspring. These and other numerous similarities (including many identical or nearly identical molecules) demonstrate that there is an unbroken link between modern cells and the first primitive cells that appeared on earth.

In the cells of a beetroot plant, a substance called anthocyanin is contained within the plasma membrane. It is anthocyanin, which gives the beetroot its characteristic blue/purple colour. If a cell is damaged in a beetroot plant and the membrane is broken, the anthocyanin 'bleeds' from the cells like a dye. It is this characteristic that can be exploited to test which conditions affect the integrity of the cell membrane.

Because we are experimenting with the effects of temperature on the membrane, we will place the samples of beetroot into a water baths of varying temperatures and measure the colour change in the water. Temperature is just one of the possible variables. Others include effects of poisonous substances such as alcohol and/or various solvents. The dependant variable (DV) in this experiment is colour change in water caused by anthocyanin leakage.

Materials:
Beetroot Plant Corers (various diameters) White tile Heat proof mat Bunsen burner Tripod Gauze Beaker (for water bath) Thermometer ColorimeterDistilled Water7 test tubes containing 10cm³ of waterTongsScalpelStop-clockTest tube rack

Methods:
Before the experiment can start, the beetroot must first be prepared. To do this, we need the white tile and the corers. The same diameter corer must be used for all the pieces so keep the surface area of each beetroot piece fairly similar. To collect a cylinder of beetroot, simply push the corer into the vegetable and then withdraw it. The cylinder will remain inside the corer, so it must be pushed out with a corer of a smaller diameter. Once a few good, uniform cylinders have been collected, they must then be cut into 7 pieces of equal length. The beetroot was cut to 1cm. Because the beetroot has been cut some of the cell membranes had been broken, which means some anthocyanin will leak out. This must be completely washed off in order to maintain the reliability of the results.

A water bath must then be heated to 85¢XC (the maximum temperature for our experiment) using the Bunsen burner and tripod. Once the water bath is at the correct temperature (measured using our thermometer), one piece of beetroot is placed into the hot water directly and left for exactly 1 minute. When the minute is up, the beetroot piece will then be placed into 10cm³ of distilled water. This procedure will be repeated with the other six pieces of beetroot with the only difference being the temperature of the water. The temperatures will be using are 85¢XC, 70¢XC, 65¢XC, 60¢XC, 55¢XC, 42¢XC and 36¢XC.

Each time a piece of beetroot is removed from the heated water, it will be left in the distilled water for exactly 30 minutes, before being discarded. The fluid in each of the test tubes will be analysed using a colorimeter and compared against the control, which is distilled water to check for any variations in the colour of the water.

Results:

Table 1, showing how readings from colorimeter vary with temperature.

Fig 1

Figure 1 shows the correlation between temperature and colour reading.

Conclusions:
After collecting and correlating the results, I have come to the conclusion that the experimental hypothesis is correct in that an increase in temperature will damage and denature the plasma membrane and cause the cytoplasm and other substances contained within the membrane to leak out. This has been shown by a steady increase in anthocyanin leaked out of plant cells as the temperature increases.

The results increased fairly steadily with one exception at 65¢XC where the amount of anthocyanin actually reduces. This is almost certainly due to experimental error. It is the breakdown of the lipids which make up the plasma membrane that causes 'holes' to appear in the membrane, allowing fluids to pass out freely, but when the temperatures begin to get higher still, the proteins in the cells begin to decompose as well which blocks some of the holes and therefore slowing down the release of anthocyanin. It is these findings which explain why cells cannot maintain life in extreme temperatures.

Evaluation:
The results that were collected follow the same pattern as results collected by similar studies carried out within our class, so therefore it is safe to say that the results can be repeated reliably and the methods can be used universally.

It would have been beneficial to have repeated the experiment more times to make certain that the results were not gained through chance or by an external factor. The control experiment used was highly accurate, using distilled water, which is the clearest possible liquid, meant that even the slightest deviation in colour could be detected by the colorimeter.

Controlling the variables in the experiment is not an easy task. The first major problem is the size of the beetroot piece. The pieces could be the same mass, but have a very different surface area to one another. This obviously alters the effect of the experiment. The other difficult variable to maintain was the temperature of the heated water. With only basic equipment, keeping the water at the correct temperature was made a complicated task. External variables were well controlled. If the experiment was to be repeated, the use of a proper controlled water bath may be a consideration, and also a template made for cutting the beetroot pieces.

Using a beetroot as the sample is not a good representation of the whole eykaryote group. Other cell membranes may have better or worse heat tolerance, some may not be affected at all, however, using a beetroot does give a good representation of the theories behind the plasma membrane and how it behaves.