The effect of temperature on permeable membranes biology essay

The aim of this experiment was to determine what effect an increase in the surrounding temperature has on the selectively permeable membranes of plant cells, e. g., red cabbage (Lane, 2010a).

The cell membrane is the fluid-mosaic model. The proteins are embedded in the cell membrane. The lipid exists as a phospholipid bilayer form. The hydrophobic which mean water hating portions of the lipid molecule face the inside while the hydrophilic which mean water loving parts face either the cytoplasm or extracellular aqueous environment. The protein molecules are of two types in the membrane. Internal proteins are embedded in the phospholipid bilayer which enhance the membrane's shape, providing passageways for the movement of substances through the membrane while the peripheral proteins are attach to the surface of membrane and are easier to extract (Losos, Manson and Singer, 2008) The purpose of a cell membrane is to controls what enters and exits the cell. It acts as a selective barrier between the internal and external fluid that means the cell membrane to be selectively permeable. This process supplies the cell with useful material and removes waste products. Normally, this is done by active or passive transportation. The passive transportation allows substances to move from high concentration to low concentration without energy required. The active transportation carries substances such as ions and glucose from low concentration to the high concentration, requiring energy and a carrier to support (Losos, Manson and Singer, 2008).

Figure 2 (Adapted from Garland, 2004) shows the process of transportation through the cell membrane

Figure 2: Transportation through the Membrane (Adapted from Garland, 2004)

Certain conditions can damage the cell membrane. For instance, high temperature leads to violent collisions that can destroy a membrane. There is a hypothesis that an increase in temperature denatures the membrane and causes the substances within the membrane to leak out (Answers, 2010). The high temperature can make the cell membrane more permeable and allow it to be more prone to leakage.

Red cabbages are used as a model to investigate how the temperature affects the selectively permeable membranes. Red cabbages contain a large mount of a water-soluble red pigment called anthocyanin, which is located in the vacuole and unable to pass through the tonoplast membrane. If these cells are affected by changes in temperature, the integrity of the cell membrane becomes damaged. As a result, anthocyanin which as antioxiants and protects cell from oxidative damage can leak out of the cells and into the surrounding water. The extent of damage to the cell membrane is directly associated to the intensity of red color and it would appear in the water surrounding the red cabbage (Manhattan, 2009).

Method

Apparatus

7 test tubes

Test tube rack

Cork borer

Scalpel

Tile

Small beaker

Mounted needle

Large beaker

Thermometer

Burner

(Lane, 2010b)

Firstly, a leaf of red cabbage tissues was cut into 42 discs of the same size (approximately 1mm wide) by a cork borer. 42 red cabbage discs were placed in a small beaker and were washed. 7 test tubes were labelled 30â„ ƒ, 40â„ ƒ, 50â„ ƒ, 60â„ ƒ, 70â„ ƒ, 80â„ ƒ and 100â„ ƒ. The first two test tubes which labelled 30â„ ƒ, 40â„ ƒ and approximately 6 cm3 cold water was added using a measuring cylinder. The remaining test tubes had 6 cm3 cold water added to each. Meanwhile, a water bath was prepared using a large beaker, tripod and gauze. The 7 test tubes with 6 cm3 water were heated in the water bath. A thermometer was placed into each test tube to measure the temperature. 6 red cabbage discs were impaled on a mounted needle with space between each disc. When the water inside the test tube labelled 30â„ ƒ reached 30â„ ƒ temperature, the burner was removed and 6 discs on the

needle was placed in the test tube for exactly 1 min then the test tube was removed from the water bath. The disks were left in this tube.

When the water inside the test tube labelled 40â„ ƒ reached 40â„ ƒ temperature, the above procedure was repeated. The test tube labelled 50â„ ƒ reached the temperature. All the procedures were restarted according to the guide. To all the test tubes were added 6 cm3 cold water and a water bath was prepared using a large beaker, tripod. When the water was heated gently to 30â„ ƒ, the burner was removed and the 6 red cabbage discs on an impaled needle were placed in the water bath for exactly 1 minute. The discs was pushed off and dropped into the test tube labelled 30â„ ƒ. The procedure was repeated for the other tubes. From 40°to 90°C, all the procedures in own water bath. For 100â„ ƒ the discs, needle were placed in other's water bath with the temperature at 100â„ ƒ for 1 minute, then the discs were pushed off and dropped into the test tube labelled 100â„ ƒ. The discs in the test tubes were left for 20 minutes and then the tubes were shaken and compared.

Result

Temperature /â„ ƒ

Observation

30

The 6 red cabbage discs were still purple and unchanged the water was still colourless.

40

The colours of the 6 red cabbage discs were remained and unchanged purple and the water was still clear.

50

The colours of 6 red cabbage discs were a little faded and the water became a little purple.

60

The colours of 6 red cabbage discs were faded lighter purple more than 50â„ ƒ and the colour of water changed from colourless into light purple.

70

The colours of 6 red cabbage discs were faded more than 60â„ ƒ and the colour of water changed from transparent into a light blue.

80

The colours of 6 red cabbage discs were very faded than 70â„ ƒ and the colour of water changed from transparent into a light green.

100

The colours of 6 red cabbage discs changed from purple into white and the colour of water was strongly changed from transparent into green.

Table 1: Heating the Red Cabbage Discs

Discussion

Table 1 shows clearly that an increase temperature on the red cabbage fades the purple of these discs and they become more and more faded while the colour of the surrounding water inside the test tube becomes darker and darker. This phenomenon purple-blue-green result from that the red cabbage dices have permeable membranes losing the permeability of their cell membranes. If the temperature goes against what the membranes can withstand, the permeability of membranes increases as the protein becomes denatured, the lipid parts of membranes liquefies and the proteins create holes in the fabric, and the membranes fall apart. The high temperature produces an increase in kinetic energy that makes atoms in the protein to vibrate and move more breaking hydrogen and ionic bonds in protein molecules and changing the 3D shape of the system. These proteins are unable to translate substances in and out of the membrane. All the factors lead to the anthocyanin leaking out of the membranes producing a colour in the water surrounding the red cabbage cells (Erik, 2002). The results of investigating the effect of temperature on permeable membranes are largely as predicted.

There were several variables that controlled this experiment to make sure the results were comparable. The first major key variable was the size of red cabbage discs. The red cabbage tissue was cut into discs which were used to ensure accuracy by increasing precision in the volume of water. The cylinders should be same for all experiments because the volume of water affected the concentration of the pigment. The second variable was allowing enough time (20 minutes) for colour to be seen. All the test tubes should be

left the same and enough time for observations after putting the red cabbage discs into the test tubes. Time altered the effect of the experiment; some tubes had a longer effect than others, more of the pigments in the red cabbage cells will leak out and the pigments in the surrounding water. All the material should be washed very thoroughly after cutting. This process made the experiment more highly accurate, because using water to wash the material meant that impurities were minimised.

Possible errors may have arisen during this experiment. Firstly, the procedure at the beginning of the experiment was not correctly followed according to the instructions (Lane, 2010c). For instance, 6 cm3 cold water was measured not accurate, the red cabbage leaf did not wash under running water and using another water bath which resulted from the instruction had not been read carefully and seriously. Secondly, the phenomenons purple-blue-green in this test was a little different from the theory that as the temperature increases, the colour of the surrounding water will become darker (Lane, 2010d). This may stem from much of the red pigment escaping from the discs while heating the red cabbage in the beaker. The result of the higher temperature may have affected this more as a lot of the pigment has already leaked out into the beaker. Another reason may be the concentration of pigment leading to change the stability of the pigment molecule. Thirdly, the time was not sufficient for repeating the experiment, which made the results less accurate.

A future experiment should be improved in follow ways. The instruction should be read carefully and thoroughly, so the experiment can go on logical. Secondly, the temperature should be checked at the start of when

the red cabbage was put in the water and at the end of the last minute using a thermometer to maintain the temperature of the heated water. Thirdly, a colorimeter should be provided to measure the amount of light absorbed by solution of each reaction temperature. The higher concentration of anthocyanin means a higher reading on the colorimeter. Fourthly, the experiment should be repeated more times to make sure the results were not obtained by chance or by external factors. In addition, the effect of cooler temperature even under 0â„ƒ could be tested to observe if the membrane is broken down in a similar way.

Conclusion

It can be concluded that as the temperature was increased, more of the red pigment leaked out of the permeable membrane. The permeability of the membrane in red cabbages can be damaged by high temperature.