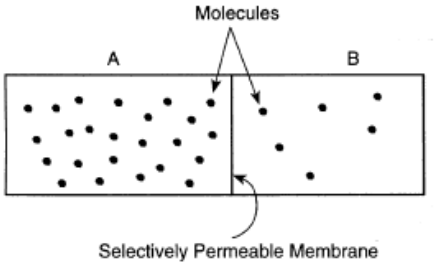
Investigation
Movement of Pigment through Cell Membranes

Aim

The aim of the investigation is to identify the effect of temperature of the movement of pigment through cell membrane of beetroot cells.

Prediction and Reasoning

I predict that the temperature will effect the movement of the beetroot pigment through the cell membrane. I believe an increase in temperature would result in an increase in the amount of pigment being released out of the cell. I base my prediction on the fact that an increase in temperature would provide the pigment molecules with more kinetic energy and therefore the rate of diffusion will increase.



The increase in temperature would also denature (damage or change the characteristics of) the cell membrane resulting in more pigment being lost. Allowing the pigment to diffuse more rapidly throughout the two dimensional surface of the membrane.

In the diagram the pigment from the beetroot (section A) would pass more readily into the water (section B) if it had more energy and also would pass quicker if the membrane becomes denatured by the increased kinetic energy of the molecules and the high temperatures.

Equipment

The equipment needed to carry out the experiment to a high standard includes:
-Beetroot- *To investigate the movement of pigment through the membrane at different temperatures.*
-Test Tube Racks- *To ensure safety and hold the test tubes.*
-Glass Marker- *Helps to reduce inaccuracies and misunderstanding with other specimen test tubes.*
-250ml Beaker- *To hold the distilled heated water.*
-Cork borers- *To cut through the beetroot and obtain a 5cm cylinder of it.*
-Thermometer-*To accurately measure the temperature of the water.*
-Bunsen Burner- *To heat the water to 85 °c.*
-Gauze- *For the heated beaker to sit on top of.*
-Heat proof mat- *To stop the table form catching fire.*
-Tripod- *To apply a safe distance between the beaker and Bunsen burner.*
-Colorimeter- *To show the concentration of the water once the beetroot pigment has diffused.*
-Ten Test Tubes- *To hold each different sample.*
-Pipette- *To fill each test tube with 10ml of distilled water precisely.*
-White tile- *To cut the beetroot on.*
-Stop Watch- *To time the time intervals.*
-Forceps- *To remove the beetroot out of the test tubes once the time is over.*
-Scalpel- *To help cut the beetroot to the correct size.*
-Cuvettes- *To hold each example and allow it to be examined in the colorimeter.*

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Method

Before beginning the experiment safety precaution have to be taken in order to reduce the chances of an injury. Safety goggles and an apron must therefore be worn. The apparatus needs to be set up accordingly. 200ml of distilled water needs to be heated to 85ºc. This will be done using a Bunsen burner. 200ml of distilled water have should be place in a 250ml beaker which would then be placed on a tripod and gauze and be heated with a Bunsen burner which is to be placed on a heatproof mat (see above diagram). While the water is being heated use puppets and place 10ml of distilled water into each of the ten test tubes and place them safely in a rack. Label the test tubes 85, 80, 75, 70, 65, 63, 60, 55, 50 and 45. Then use the cork borer to cut out a 5cm beetroot cylinder place it into the beaker of water at 85ºc and note the time. With the aid of a stop watch to gain maximum precision remove it form the beaker with forceps and place it into the test tube labelled 85ºc and note the time. As the water in the warm beaker cools, repeat the previous step by placing another fresh piece of 5cm beetroot cylinder in the beaker as it reaches the correct temperature labelled on the test tube and record the time. Repeat the step for all the ten test tubes when the correct temperature is reached. Leave each beetroot cylinder in its beaker for exactly thirty minutes. Once the thirty minutes are over shake the test tube and remove the cylinder. Do this for all ten test tubes and you should end up with ten test tubes containing water stained pigment from the beetroot. Finally place each solution into its own corvette and place it into to the colorimeter and record the readings.

Diagram

Variables

The variables included in this experiment are as follows:
-The temperature of the beaker.
-The amount of beetroot added.
-The duration of time the test tubes are in the warm beaker.

The variable which we chose to look at in more depth was the temperature of the beaker which would heat surrounding water in the test tube to where there would be a net movement of pigment. From this we can determine what the best temperature is for diffusion to take place.

Fair Test

It is vital that a fair test is carried out otherwise the results would be misleading and lead to a false conclusion and evaluation. To help make this investigation a fair test each substance and solution was measured accurately and to the nearest possibilities.

A fair test was recorded by using the same amount of beetroot in each test tube. The amount water added was measured using a measuring cylinder and pipette and the same quantities of water were used each time. The temperature when the water was heated was calculated correctly using a measuring cylinder. Each test tube was placed in the water for an equal amount of time and for accuracy a stopwatch was used.

Results

Temperature (ºC)	45	50	55	60	63	65	70	75	80	85
Colour Density	0.3945	0.4189	0.7095	0.8071	0.8074	0.865	0.9247	1.0206	1.0194	1.0309

Conclusion

My conclusion basing on the results is that with temperature rising, permeability of membrane is getting bigger so more pigment can pass through the cell and therefore proving my prediction correct. The more the temperature was increased the higher the concentration of the solution and therefore the more light was absorbed. However if the temperature was increased past a certain optimum temperature the proteins in the cell membrane that surrounds the beetroot cells become denatured, the damage caused by the denaturing allows the pigment to flow out of the cell more freely. Therefore if the cell membrane became denatured the percentage of light absorbed would increase. If complete denaturing occurred to all the beetroot cells the percentage of light absorption would be the same for all the pieces of beetroot after that point as shown within the results.

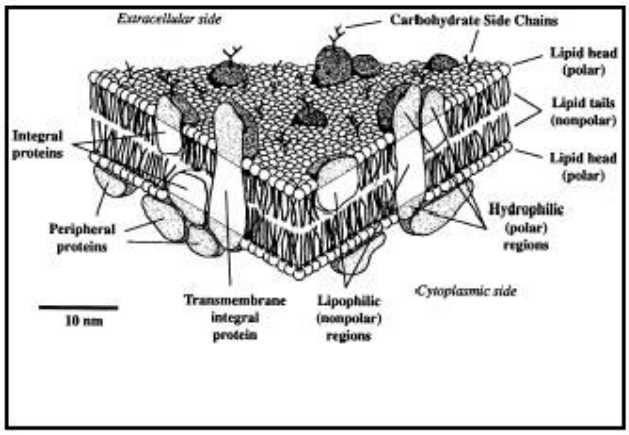

Fig. 8.37. Fluid mosaic model of the lipid bilayer membrane, with embedded proteins (redrawn from Murray et al[996]).

Lipid bilayers are fluid, and individual phospholipids diffuse rapidly throughout the surface of the membrane. This is known as the fluid mosaic model of biological membranes. The phospholipids can move to the opposite side of a bacterial cell membrane in a few minutes at room temperature. Membrane proteins diffuse throughout the membrane in the same fashion, though at a slower pace because of their massive size. This is similar to the movement of the pigment from a high concentration to a low concentration. Heat will also make the layer more fluid like, as it becomes more fluid like larger gaps are created within the layer; therefore the pigment can escape much easier. The gap increase as the heat applied to the membrane provides the fluid with more kinetic energy and therefore the particles drift further away for each other and therefore becoming more permeable.

The combined effect of the denaturing of the membrane and the increase in gaps within the membrane leads to a direct result of the pigment being released. The warmer the temperature the more these factors contribute to the amount of pigment released until a certain point is reached.

Evaluation

Quality of evidence
The experiment was only carried out once and although a similar pattern was likely to appear by carrying the experiment out a number of times the results would have been much more reliable and

much more accurate as an average result could have been found which would have reduced the amount of anomalies appearing. A few anomalies did appear in the results this could have been down to the colorimeter and the amount of water there was in the cuvette before placing it in the colorimeter as this varied.

Suitability of evidence and improvements

As we used a range of ten different temperatures the results would have been more reliable as if a anomaly appeared it would be clearly spotted within the results. Changes or improvements that could be made if I was to carry out the experiment again are that I would make sure that each beetroot cylinder would have been the exact same length, weight and thickness. Also I would make sure I had a much better way of measuring the amount of light absorption as the colorimeter was unable to measure some of the values correctly.

Further Work

For further work I would use different substances which would allow me to compare beetroot to another substance and therefore allow me to see hoe different substances actively different substances allow the movement of pigment through cell membranes.

Bibliography

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http://web.mit.edu/esgbio/www/cb/membranes/structure.html
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