Biology Taster
Mrs Pearson

OCR AS/A2 Biology A
H020, H420
Starter

Have you ever boiled vegetables and wondered why the water surrounding them changed colour?

Why does this happen?
Investigating the effect of temperature on plant cell membranes

The objective of this activity is:
1. To practise experimental and investigative skills
2. To investigate the effect of temperature on cell membrane structures
Beetroot pigment

Beetroot cells contain a pigment called betacyanin (an anthocyanin) that give the tissue its dark purple-red colour. The pigment is contained in the cell vacuole and retained here by a selectively permeable barrier, the tonoplast (similar structure to cell membrane).

Task 1.

Make a hypothesis about the effect of temperature on the plant cells and predict the amount of betacyanin that will leak from the cells at different temperatures.
Beetroot pigments

- Vacuole containing BETACYANIN
- Cytoplasm
- Cell wall
- Nucleus
Variables:

Name the:

• Independent variable
• Dependent variable
• Controlled variables
• Control – give a reason for this
• Independent variable: Temperature 0-60°C

• Dependent variable: Amount of pigment lost through the membrane.

• Control variables: (identify control variables to ensure that results are valid and can be used to make a conclusion).

  • Amount of distilled water (10mls)
  • Leave test tube of distilled water for 5 minutes
  • Size of the beetroot cylinders.
  • Leave beetroot in distilled water at correct temperature for 15 mins.
  • Shake tubes once before decanting liquid.

Suggest a control for this experiment
Water with no beetroot
## Precautions

Can you suggest some hazards and preventative measures?

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Preventative measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass wear</td>
<td>Take care to prevent breakages</td>
</tr>
<tr>
<td>Sharp objects</td>
<td>Take care when handling knives</td>
</tr>
<tr>
<td>Handling hot materials</td>
<td>Take care when handling hot objects to prevent burns</td>
</tr>
<tr>
<td>Pouring hot liquids</td>
<td>Take care to prevent scalds</td>
</tr>
<tr>
<td>Temperature °C</td>
<td>Depth of colour</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>
Exploring the fluid mosaic model

What is the fluid mosaic model of cell membranes?

The fluid mosaic model is the currently-accepted model of the structure of cell membranes.

Click "play" or the cell to find out more about it.
Factors affecting membrane fluidity

What factors affect membrane fluidity?

There are three main factors that affect the fluidity of cell membranes.

Click on the buttons to find out more.

- Temperature
- Lipids
- Cholesterol
## Results

<table>
<thead>
<tr>
<th>Temperature $^\circ$C</th>
<th>% Absorbance</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>0.11</td>
</tr>
<tr>
<td>50</td>
<td>0.42</td>
</tr>
<tr>
<td>60</td>
<td>0.82</td>
</tr>
<tr>
<td>70</td>
<td>1.29</td>
</tr>
<tr>
<td>80</td>
<td>0.89</td>
</tr>
</tbody>
</table>
What is happening to the membrane?

1. What effect does temperature have on water in the vacuole?

2. What happens to lipids in the bilayer as they are heated?

3. What happens to protein structure under high temperatures?
What is happening to the membrane?

1. When you heat something you give it energy. Molecules start to spin and vibrate faster. The water will expand too. This will have a disruptive effect on any membrane.

2. Lipids become more fluid as temperature goes up (think of what happens when you heat butter) so the membranes become more fragile.

3. Proteins are formed of coiled and folded strings of amino-acids, held together by hydrogen bonds and disulphide bridges. If you heat them too much, they will untangle and break apart (vibrations again). When this happens to the proteins spanning a lipid membrane, they will form holes that will destroy the delicate structure. Now, any pigments in the innermost compartment will spill out.
Extension

• Why do you think that handling raw red cabbage does not stain your fingers very much, but handling pickled cabbage does?
Scientific Investigations

Qualitative Analysis
Vs
Quantitative Analysis
Scientific Investigations

- Qualitative Analysis

Example:

- **Colour** of the candy being investigated......
- Detect the **presence** of **vitamins** inside a kiwi......
- The **kind** of **gas** being released in a biochemical reaction......
Scientific Investigations

• Quantitative Analysis

Example:
– The amount of individual colour detected in a candy......
– The number of vitamin types detected in a kiwi......
– The amount of gas released in a biochemical reaction......
Results
• The temperature greatly affects the rate of diffusion. As the temperature increases, the rate of diffusion or the movement of molecules also increases.
Molecules are continuously moving due to their kinetic energy, so movement of the phospholipids in the bilayer and movement of the pigment molecules cause pigment to leak out. The higher the temperature the faster the movement and more pigment leaves through the membrane.
• The decrease in colour sometimes seen at 63°C may be due to melting lipids filling in the gaps before the membrane finally breaks down.

• At very high temperature, the protein molecules in the membrane become completely denatured and the membrane develops holes or gaps through which the pigment can flood out.