



## Investigating the effect of temperature on plant cell membranes

The purpose of this activity is:

- to practise experimental and investigative skills
- to investigate the effect of temperature on cell membrane structures

### Procedure

**SAFETY:** Always carry scalpels clasped to a tile and with the tip pointing away from you.

Beetroot cells contain pigments called *betalains* that give the tissue its dark purple-red colour. The pigment is contained in the cell vacuole.

### Investigation

- Collect 3 or 4 beetroot cores from the beaker provided. Cut each core into 2 cm sections until you have enough for one core for each temperature of water bath that you will be using. Put your 2 cm sections into a test tube with plenty of distilled water.
- Label a set of test tubes (one for each temperature of water bath) with the temperature and your initials. Add exactly 5 cm<sup>3</sup> of distilled water to each test tube and place your tubes, one in each water bath, for 5 minutes to equilibrate to the temperature of the water bath.
- Remove your beetroot cores from the distilled water and blot gently on a paper towel. Decide whether forceps or mounted needles are best for handling the tissue and what damage this might cause to the cores.
- Place one 2 cm beetroot core into each of your test tubes and leave in the water bath for 30 minutes.
- After 30 minutes, shake the test tubes gently to make sure any pigment is well-mixed into the water, then remove the beetroot cores.
- Describe the depth of colour in each test tube. A piece of white card behind the tubes will make this easier to see. Arrange the tubes in order of temperature of the water bath. Describe any relationship between the amount of pigment released from the beetroot and the temperature.
- If you have access to a colorimeter, set it to respond to a blue/ green filter (or wavelength of 530 nm) and note whether you are measuring absorbance or transmission. Check the colorimeter reading for distilled water.
- Note the results for each tube and plot a graph of absorbance (or transmission) against temperature. Describe any trends or patterns in your results.



## Results

Temperature (°C)	Observation	
	Group 1	Group 2

## QUESTIONS

- 1 Describe what happens when you trim the beetroot cores and place the 2 cm sections in distilled water. Use what you know of plant tissue structure to explain this observation. What does it tell you about where the pigment is located in the plant cells? Make a hypothesis about the effect of temperature on the plant cells and predict the amount of betalain that will leak from the cells at different temperatures.
- 2 Evaluate the method for this investigation. Think about which factors have been controlled to make it a fair test. Consider whether any factor other than temperature could be responsible for the colour leaking from the beetroot cores. Do you think this experiment will give you valid results? Describe how you could improve the experiment to give more reliable (or more valid) results.
- 3 What is the relationship between the amount of pigment released from the beetroot and the temperature?
- 4 Plan an investigation to investigate why handling raw red cabbage does not stain your fingers very much, but handling pickled cabbage does.



## ANSWERS

- 1** Dark purple pigment leaks from the cut ends of the beetroot for a while and then stops. Plant cells are surrounded by cellulose cell walls. When you cut through a piece of plant tissue, you cut through some of the cell walls and rupture the cell contents. The pigment then leaks out. The fact that it does not continue to leak suggests that further cells are not being damaged. If the beetroot tissue is treated with increasing temperatures, as the temperature rises, the phospholipid bilayer of the cell-surface membrane and the vacuole membrane will be disrupted. This means that the vacuole contents will more readily leak into the water in the test tube. The higher the temperature, the greater the disruption to the plasma membranes and the more pigment will leak out in 30 minutes.
- 2** The factors controlled in this test are the ones that are the same from one group to another – the size of the beetroot cores (their surface area and volume), the advance treatment of the beetroot cores, the volume of water in the test tubes, the pre-heating (or chilling) of the water in the test tubes using the water baths, the length of time the cores spend in the water baths, the treatment of the cores after heating. The experiment could be made more reliable by using more samples of beetroot, and by maintaining the temperature with thermostatically-controlled water baths.
- 3** The higher the temperature, the greater the amount of pigment released from the tissues.