Digestion: model gut

Transcript

Ingested food is digested and then absorbed into the bloodstream or removed as waste.

Absorption takes place through the wall of the small intestine, which is a partially permeable membrane. Small food molecules can pass through but large ones cannot.

Chemical digestion breaks down large molecules, such as starch, into small molecules, such as glucose.

The resulting glucose molecules are small enough to pass through the wall of the small intestine and are absorbed into the bloodstream.

This experiment will demonstrate that the starch in our food needs to be digested into smaller molecules before it can be absorbed into the bloodstream.

The experiment will take place at room temperature.

Visking tubing is used to model the small intestine because it is an artificial[lly] partially-permeable membrane. It will let small molecules pass through but not large ones.

The starch and glucose solution represents food molecules in the intestine; starch and glucose are common carbohydrates in the foods we eat.

The beaker of distilled water represents the blood.

Samples of water from the beaker will be taken every 10 minutes and later tested for the presence of starch and glucose, to see if any has diffused through the Visking tubing into the water. The longer the length of time the Visking tubing is in the water, the longer amount of time there is for diffusion to take place.

A piece of Visking tubing about 15 centimetres in length is cut. The tubing is held under a running tap and gently rubbed between thumb and forefinger to help soften the tubing so that it opens. Care is taken not to tear the tubing.

A knot is tied at one end.

Starch and glucose solution is gently added to the Visking tubing until it is about two thirds full.

The top of the tubing is tied tightly to make a small bag.

The seal must not leak at this would make the results invalid.

The excess Visking tubing is cut off using a pair of scissors.

The tubing is gently rinsed under a tap to remove any starch and glucose solution that may have splashed onto the outside of the tubing, which would contaminate the beaker of water.

Two sets of test tubes are labelled at the top, to represent each time interval.

The Visking tubing is placed into a beaker and completely covered with distilled water so that diffusion can occur along the full length of the tubing.

The timer is immediately started, and a sample of 4 centimetres cubed is taken from the beaker and added to one of the test-tubes labelled zero. This is repeated for the other test-tube labelled zero. These are the control samples.

After 10 minutes, four centimetres cubed of water is added to both test tubes labelled ‘10’. The volume of each sample must be the same for comparisons to be valid.

After 20 minutes, another sample is taken and added to both test tubes labelled 20. Again, the volume of sample added to each test-tube is the same as before.

After 30 minutes, a final sample of the water is taken and added to both test tubes labelled 30.

Each sample is now tested, one at a time, for the presence of starch and glucose.

First, the samples are tested for starch. Iodine solution changes colour from orange-brown to blue-black when starch is present.

Five drops of Iodine solution are added to one of the test-tubes labelled zero.

Five drops of Iodine solution are then added to each of the other test tubes in the same test tube rack.

The colour of the solution in each test-tube is observed.

The solution at time zero is an orange-brown colour, indicating that the beaker of water did not contain any starch at the start. All the other samples are also still an orange-brown colour, indicating that no starch is present.

Next, the samples are tested for glucose. Benedict's solution is used because it changes colour when glucose is present. A light blue, which means no colour change, indicates a negative result.

A colour change indicates that glucose is present; the range of different colours indicates different concentrations of glucose.

The other set of samples is used for this test.

The same amount of Benedict's solution as there is sample, is added to each test-tube.

Benedict's solution requires heat to be activated. The test tubes are moved to a water bath set at 80°Celcius. Eye protection should always be worn and care is taken when handling very hot water and glassware.

The samples are left in the water bath for two minutes.

After this time, the test-tubes are carefully removed from the water bath using a pair of test tube holders; the tubes are held by the rim. For safety, the rack is not removed from the water bath as it will be hot. Care should be taken not to break the test tubes or spill hot water during the transfer of the tubes.

The test-tubes are stacked in the rack in the same order as before.

The colour of the solution in each test-tube is observed.

The solution at time zero is blue, indicating that glucose was not present in the beaker of water at the start of the experiment.

The solutions in the other samples have all changed colour, indicating the presence of glucose.

The colour change from green through to orange, suggests that the concentration of glucose has increased over time.

What does each set of results suggest about the diffusion of starch and glucose across the Visking tubing?

At time zero, the samples tested negative for both starch and glucose. This suggests that the starting beaker of water was not contaminated by starch or glucose solution; so any colour changes in the samples are due to diffusion across the Visking tubing.

The negative result for the starch test in all samples, even after 30 minutes, indicates that starch cannot pass through the tubing's partially-permeable membrane.

The positive result for glucose at 10, 20 and 30 minutes, suggests that glucose can pass through the Visking tubing's partially permeable membrane. The different coloured solutions from 10 to 30 minutes, suggests that the longer the tubing was left in the water, the more glucose diffused across, causing an increase in glucose concentration in the beaker of water over time.

The wall of the small intestine is also a partially-permeable membrane. This experiment has demonstrated that the starch in the foods we eat must be broken down before it can be absorbed into the bloodstream.