**ACTIVITY: Lactose intolerance**

**Activity idea**

In this activity, students investigate the effect of the digestive enzyme lactase on a sugar found in milk called lactose. The digestive system condition known as lactose intolerance will also be looked at.

By the end of this activity, students should be able to:

* explain the term ‘disaccharide’
* discuss the structure of lactose and sucrose
* describe the role that lactase plays in the digestion of lactose
* define the term ‘enzyme specificity’
* explain in simple terms the digestive condition known as ‘lactose intolerance’.

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**Introduction/background**

Lactose is a disaccharide found in milk and milk products. Each lactose molecule consists of the 2 simple sugars, galactose and glucose, linked together.

When milk or milk products are consumed, an enzyme present in the small intestine called lactase breaks the link between the 2 simple sugars, freeing up glucose and galactose. These sugars can then be absorbed into the bloodstream.

Like lactose, sucrose is also a disaccharide made up of glucose and fructose. In order to break the link in sucrose, an enzyme called sucrase is needed. Both these enzymes, lactase and sucrase, are proteins, but each has its own individual shape, making them substrate specific.

Human babies depend on milk for their nutrition and produce the enzyme lactase to digest the lactose present in the milk. In the childhood years for some people, the production of lactase slowly declines, resulting in an inability to properly digest the lactose in milk and milk products. If such a person consumes large amounts of lactose in a short period of time, most of the lactose is not digested in the small intestine but passes on to the large intestine where gut bacteria break it down. The products of this process can create symptoms such as nausea, abdominal cramps and rumbling, bloating, diarrhoea and excess production of gas.

Ethnicity is also a factor, with over 90% of adults of belonging to the Asian racial grouping being lactose intolerant

**What you need**

* 25gL-1 lactose solution, 25gL-1 sucrose solution, 25gL-1 glucose solution
* Whole milk
* Lactase solution (1g of lactase in 50mL water) (Lactase enzyme is available in tablet form from most pharmacies but lactase solution is a better option.)
* Benedict’s solution
* Glucose test strips (The Keto-diastix brand is available from Life Plus Pharmacy. They are expensive at about $35 for 50 test strips. Prudent use of the strips will keep the cost down – if there is no colour change, rinse with distilled water and reuse.)
* 10mL measuring cylinder
* Teat pipette to transfer 1mL aliquots of lactase solution
* Beakers – 50mL and 250mL
* 5 x medium-sized test tubes and test tube rack
* Copies of the student worksheet: [Testing for lactase action](#testing)

**What to do**

1. Give out copies of the student worksheet [Testing for lactase action](#testing) and assist students to gather the materials they need and complete the experiment.

1. Discuss the findings:
* The preliminary tests should indicate a positive result for glucose in tube 4 only. The glucose test strip placed in this tube should turn from an aqua colour to a dark green.
* On heating, the Benedict’s solution added to test tube 4 should change colour from blue to an orange-red.
* The lactase action should indicate positive tests for glucose in test tubes 2 and 4.

***Class survey***

1. Discuss the concept of lactose intolerance.
2. Ask the class to assemble into 3 groups – lactose tolerant, lactose intolerant, unsure:
* Ask a willing member of the tolerant group about the role milk and milk-based products play in their diet.
* Ask a willing member of the intolerant group to describe when the symptoms developed and how they can be set off.
* Ask a willing member of the unsure group to describe the reasons for choosing this group.
1. If all the students are lactose tolerant, students could be asked about their family members, particularly older members. The following websites are useful sources of information about lactose intolerance:
* [Treating lactose intolerance](https://www.sciencelearn.org.nz/resources/2015-treating-lactose-intolerance)
* [Lactose intolerance](http://www.allergyclinic.co.nz/lactose_intolerance.htm)
* [Lactose intolerance - a patient's guide](http://www.familydoctor.co.nz/index.asp?U=conditions&A=28275)

**Testing for lactase action**

1. Label the test tubes 1–5.
2. Place 10mL of water into test tube 1, 10mL of lactose solution in test tube 2, 10mL of sucrose solution in test tube 3, 10mL of milk in test tube 4 and 10mL of glucose solution in test tube 5.

1. Dip a glucose test strip into test tube 1 and remove. Note any colour change that develops. Repeat with fresh test strips for tubes 2–5.

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| **Preliminary test** | **Tube #1** | **Tube #2** | **Tube #3** | **Tube #4** | **Tube #5** |
| **Glucose test strip** |  |  |  |  |  |

1. Add 2mL of Benedict’s solution to each of the tubes 1–5. Place the 5 tubes upright in a 250mL beaker one-third full of hot water (80°C).
2. Set aside for 5 minutes. Note any colour change to the contents of each test tube.

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| **Preliminary test** | **Tube #1** | **Tube #2** | **Tube #3** | **Tube #4** | **Tube #5** |
| **Benedict’s solution** |  |  |  |  |  |

1. Thoroughly rinse out the test tubes labelled 1–5.
2. Place 10mL of water into test tube 1, 10mL of lactose solution in test tube 2, 10mL of sucrose solution in test tube 3 and 10mL of milk in test tube 4.

1. Into each of test tubes 1–4, place 1mL of the lactase solution and gently shake each of the tubes to ensure proper mixing.
2. Place the 4 tubes upright in a 250mL beaker one-third full of warm water (35°C). Set aside for 15 minutes.
3. Dip a glucose test strip into tube 1 and remove. Note any colour change that develops. Repeat with fresh test strips for tubes 2–4.

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| **Lactase action** | **Tube #1** | **Tube #2** | **Tube #3** | **Tube #4** | **Tube #5** |
| **Glucose test strip** |  |  |  |  |  |

1. Add 2mL of Benedict’s solution to each of the tubes 1–4. Place the 4 tubes upright in a 250mL beaker one-third full of hot water (80°C).
2. Set aside for 5 minutes. Note any colour change to the contents of each test tube.

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|  | **Tube #1** | **Tube #2** | **Tube #3** | **Tube #4** | **Tube #5** |
| **Lactase action** |  |  |  |  |  |

1. Compare the results of the preliminary tests with the results of lactase action and record your conclusions.