# *The digestive system* Teaching and learning plan

## Learning intentions

Students will be able to:

* describe the role of the digestive system;
* identify the organs in the human digestive system and describe their function;
* explain the difference between mechanical and chemical digestion and identify where each occurs in the digestive system;
* describe the role of enzymes in the breakdown of food in the digestive system;
* identify the question for investigation;
* make predictions based on scientific knowledge;
* identify variables to be changed, measured and controlled in an investigation;
* record and represent observations and data;
* identify patterns and trends from observations and data;
* use patterns and trends observed to draw a conclusion;
* explain how modifications to their investigation could improve the quality of their data.

## Suggested timeframe

The time need to complete *The* *Digestive system CLE* will depend on the depth of the prior knowledge of students, the time to perform the four investigations and follow up with any further extension activities. Allow 8–12 hours.

## [Planning ahead and equipment list](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Planning%20and%20equipment%20list_Yr8_The%20digestive%20system.docx) Safety considerations

When you and your class are completing your Risk Assessment consider the following safety points and add any other relevant ones to the list.

* The starter activity for Investigation 1 requires students to eat a small piece of bread. To avoid eating in the laboratory, it is preferable this is done **before** entering the laboratory. You also need to be aware of students who maybe have a food intolerance, including to gluten and yeast.
* Investigation 3 and 4 use 2 molL-1 hydrochloric acid. Care needs to be taken with the use of the acid and students informed about what to do if they spill the acid on themselves or the bench.
* Investigation 4 uses hot water. Care needs to be taken to ensure students don’t get burnt or spill water on themselves. You should consider using plastic jugs or beakers to carry the water from the source to the desk.

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## Introduction

This CLE focuses on the structure and function of the human digestive system and links to Year 8 Australian Curriculum: Science.

### Equipment needed (demonstration)

* 100 mL orange juice
* 100 mL water
* 2 water crackers
* 1 banana
* 1 plastic laboratory tray or foil tray
* 2 plastic cups, one with the bottom removed
* 1 paper or polystyrene cup with a hole the size of a 10c piece in the bottom
* 1 medium resealable plastic bag
* 1 leg of a pair of stockings

### What to do

1. Ask students to think about their last meal. Ask the following questions.

* Besides feeling hungry, why did you eat that meal? (Try to elicit the answer that we eat to obtain the nutrients our body needs to survive.)
* What is the name of the system in the body that enables us to get the nutrients we need? (Answer: *The digestive system*.)

1. Explain to students that you are going to use a model to demonstrate what happens to food in your digestive system. Scientists often use models to demonstrate how things work. You might like to introduce the concept of scientific models and their limitations at this point. During the activity you could discuss the limitations as they arise.
2. Place the water crackers into the resealable plastic bag. Tell students this represents food entering the mouth. Ask the following questions:

* What happens to the food you put in your mouth? (Answer: *Chew*.)
* Why do we chew it? (Answer: *To break it into smaller pieces*.)
* What else happens to the food in your mouth? (Answer: *Mixes with saliva*.)

1. Squeeze the bag a few times to lightly break the crackers (= chewing).
2. Add the water (saliva) and squeeze a few more times (= mixing with saliva.)
3. Add the banana (more food) and squeeze a little bit more to mix. (Not too much, as it will be mixed up more in the stomach.)
4. Tell the students that the food will now be swallowed and will travel to the stomach. In this model we are now going to say that this bag with the food and water represents the stomach.

Ask students if they know what liquid is added to food in the stomach. (Answer: *Acid [hydrochloric acid]*)

1. Add the orange juice (stomach acid) and squeeze the bag until the food is all mashed up.
2. Pour the food into the leg of a stocking (small intestine) using the plastic cup with the bottom removed as a funnel.
3. Squeeze the stocking over the tray (blood). The ‘food’ in the tray represents the nutrients that have moved out of our intestines and been absorbed into our blood.
4. Squeeze the food out of the stocking through the leg opening into the paper cup (with a hole in the bottom), then squash the food with a plastic cup to force the food (poo) through the hole. Tell students that finally the undigested food that hasn’t been absorbed by our blood passes out of our body into the toilet.
5. Tell students that this model has demonstrated some of the processes that occur in the digestive system—ingestion (eating), digestion (breaking down food), absorption (nutrients passing into blood) and egestion (elimination of undigested food). Over the next few lessons they are going to investigate these processes further.

### Extension:

1. Ask students to draw and label what they think the digestive system looks like. This could be done individually in their notebook or as pairs/group on a piece of blank paper. Students could be provided with an outline of a body or they could draw their own. You could also provide students with some large sheets of paper to trace around their body.
2. Get students to share their drawings with a partner (individual drawings) or the class and compare and contrast the parts they drew. Using a gallery walk is a good method of sharing group posters.

## Core

### Investigation 1: Digesting starch

This investigation looks at chemical digestion in the mouth. It introduces students to the function of enzymes in the digestive system.

### Equipment needed

Per group:

* 3 test tubes
* 1 test tube rack
* 1 rubber stopper to fit test tube
* 1 x 10 mL measuring cylinder
* 3 Pasteur pipettes or droppers
* 3 sticky labels or a marker
* 1 spotting plate
* 1 dropper bottle of 1% starch solution
* 1 dropper bottle of 10 % glucose solution
* 1 dropper bottle of 1% amylase solution
* 1 dropper bottle of iodine solution
* 3 pieces of glucose test tape or test strips

Per student:

* 1 piece of white bread per student (~ 16th of a slice is plenty)
* [Worksheet 1: Digesting starch](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%201_Yr8_Digestive%20system.docx)

### What to do

1. When students are lining up for class, inform them that you will be giving them a piece of bread to chew whilst entering the room. They are to make some observations about the changes they observe to the taste and texture of the bread whilst they are chewing. Ask students not to swallow the bread until directed.
2. Once students are seated, you can direct them to swallow what is left of their piece of bread in their mouths.
3. Ask students the following questions and record their responses on the board.

* What did the bread taste like when you first started chewing?
* Did the flavour change whilst you were chewing the bread? If so what did it taste like?
* What was the texture of the bread like when you started chewing it?
* Did the texture change when you were chewing the bread? How did it change?

Answer: ***Taste****—Tastes like bread (starchy) at the start but should get sweeter as they chew. Depending on the brand of bread used, the amount of sweetness will vary. It may not taste sweet at all, but they will still notice a change in taste.* ***Texture****—Texture is coarse at the start but goes all mushy when chewed.*

Leave answers on the board so they can be referred to later.

1. Tell the students they are now going to investigate what was happening to the bread whilst they were chewing. Bread is mainly made up of a carbohydrate called starch.
2. Get the students to work through the investigation described on [Worksheet 1: Digesting starch](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%201_Yr8_Digestive%20system.docx).
3. Discuss the results and answers to Questions 1 and 2 with the students. Explain to them that the role of enzymes is to speed up reactions in the body. Starch will breakdown into glucose over time, amylase just speeds up the reaction.
4. Ask students to share their answers to Question 3 but don’t confirm the correct answer just yet. Tell students that they are going to investigate the effect of temperature on enzyme activity later.

### Expected results and explanations

The students should get the following results because the enzyme amylase speeds up the break starch down to glucose.

|  |  |  |
| --- | --- | --- |
| Test Tube | Present at the beginning | Present at the end |
| 1 | glucose | glucose |
| 2 | starch | starch |
| 3 | starch | glucose |

*Note*: If glucose is present in Test Tube 2, then the starch has started to breakdown.

Answers to worksheet questions:

1. What do your results indicate about the action of the enzyme amylase on starch?

*The results show that the enzyme is involved in the breakdown of starch to glucose.*

1. What is the purpose of including Test Tubes 1 and 2 in the investigation?

*Test Tubes 1 and 2 were controls. They are used as a comparison so you can see what has happened. Test 1 show that glucose doesn’t contain starch and allows you to see what colour the test tape/strip turns in the presence of glucose. Test Tube 2 shows that starch on its own doesn’t contain glucose, it also allows you to see what colour iodine turns if starch is present.*

1. What is the purpose of holding the test tubes in your hands?

*Students may say: The enzyme works best at body temperature/holding it in your hand heats up the test tube so the reaction goes faster.*

Conclusion: Use your observations from this investigation to explain the change in texture and taste of the bread you ate at the start of this lesson.

*Chewing breaks down bread into smaller pieces (mechanical digestion) and mixes in the saliva making it all soggy. Saliva contains the enzyme amylase, which speeds up the breakdown of the starch in the bread to glucose, a simple sugar. Glucose is sweet.*

### Investigation 2: Absorbing nutrients

In this investigation, students model the absorption of nutrients out of the gut into the blood.

### Equipment needed

Per group:

* 2 lengths of dialysis tubing (~12 cm)
* 3 x 250 mL beakers
* 4 rubber bands or twist-ties
* 1 dropper bottle of 10% glucose solution
* 1 dropper bottle of 1% starch solution
* 1 dropper bottle of iodine solution
* 2 pieces of glucose test tape or strips
* distilled water

Per student:

* [Worksheet 2: Absorbing nutrients](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%202_Yr8_Digestive%20system.docx)

### What to do

1. Inform students that they are going to use a special tubing called ‘dialysis tubing’ to model the process of absorption in the digestive system. Dialysis tubing is semipermeable, which means that it allows some substances to pass through but not others, just like our small intestine.
2. Before commencing the investigation, demonstrate to students how to prepare their dialysis tubing for the investigation.
3. Provide students with [Worksheet 2: Absorbing nutrients](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%202_Yr8_Digestive%20system.docx)
4. Students work in groups to complete the investigation.
5. Discuss results.

### Expected results and explanations

Answers for [Worksheet 2: Absorbing nutrients](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%202_Yr8_Digestive%20system.docx)

**Results:**

**Title:** The movement of nutrients through a membrane

|  |  |  |
| --- | --- | --- |
| Nutrient in dialysis tubing sausage | Nutrients found in the beaker at the end of the experiment | Did the nutrients move through the dialysis tubing?  (yes/no) |
| glucose | glucose | yes |
| starch | none | no |

**Discussion:**

What can you infer about the comparative particle size? Which particles are smaller, starch or glucose? How do your results support this?

*Glucose. Only small particles can move out of the dialysis tubing and glucose was present in the beaker.*

**Conclusion:**

The dialysis tubing behaves the same way as the wall of the small intestine. Use your results to describe the movement of substances out of the small intestine. Use what you have learnt in Investigation 1 and 2 to explain why food has to be digested before the body can use it.

*Food that enters the body needs to be broken down (digested) until it is small enough to be able to pass through the wall of the small intestines. Both mechanical and chemical digestion occur in the digestive system. Starch is broken down into glucose. Glucose is small enough to move through the intestinal wall. If the starch was not broken down it would not be able to be absorbed and the body would not be able to use this nutrient.*

**Find out more**

Use available resources to answer the following questions.

1. One of the functions of the small intestine is the absorption of nutrients. This occurs by a process called diffusion.
2. What is diffusion?

*Diffusion is the movement of molecules from areas of high concentration to areas of low concentration.*

1. Describe how diffusion occurs.

*Diffusion is a passive process (occurs without energy) where molecules move from areas of high concentration to areas of low concentration. The greater the concentration difference, the faster it occurs. Diffusion will continue until the molecules are evenly distributed or, as in the case of the digestive system, the concentration of molecules on both sides of the wall (membrane) is the same.*

1. One of the functions of the large intestine is the absorption of water. This occurs by a process called osmosis.
2. What is osmosis?

*Osmosis is the movement of water from a less concentrated solution (dilute) to a more concentrated solution through a semipermeable membrane.*

1. *Describe how osmosis occurs.*

*Water moves through the membrane from the less concentrated solution (dilute) into the concentrated solution until the concentrations are even.*

### Investigation 3: Digesting proteins

This investigation looks at chemical digestion in the stomach. The breakdown of the protein (egg white) is easily visible. This investigation will assist students with their planning for Investigation 4.

### Equipment needed

Per class:

* 1% pepsin solution + 100 mL beaker (to pour pepsin into measuring cylinder)
* 1 L of egg white suspension + 100 mL beaker (to pour egg white into measuring cylinder)

Per group:

* 1 test tube
* 1 rubber stopper to fit test tube
* 1 test tube rack
* 2 x 10 mL measuring cylinders or graduated Pasteur pipettes
* 1 dropper bottle of 2 molL-1 hydrochloric acid
* 1 stopwatch

### What to do

1. Show students the short video ‘A fun introduction to enzymes’, YouTube, (4:46 min) <https://youtu.be/XTUm-75-PL4>
2. Summarize the main points from the video on the whiteboard. Reiterate that there are three main groups of nutrients that are broken down (digested) in the digestive system—carbohydrates, proteins and fats. Identify the type of nutrient (substrate), the enzyme that acts on it and the resulting product of digestion.

**Amylase:**  carbohydrate 🡪 simple sugar

(starch) (glucose)

**Protease** (pepsin): protein 🡪 amino acids

**Lipase:** fat 🡪 fatty acid + glycerol

1. Provide students with [Worksheet 3: Digesting proteins](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%203_Yr8_Digestive%20system.docx)
2. Students work in groups to complete the investigation.
3. Discuss results.

### Expected results and explanations

Students should see the solution in the test tube change from cloudy (white) to clear if the protein has been digested.

Answers to questions on [Worksheet 3: Digesting proteins](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%203_Yr8_Digestive%20system.docx)

1. How do your results indicate the action of the enzyme pepsin on proteins?

*The change from cloudy to clear shows that the protein has changed into a new substance. The enzyme pepsin helped to break down the protein.*

1. Why do you think that acid was added to the test tube?

*Pepsin works best in acidic conditions/the stomach contains acid.*

1. What substances are proteins broken down into in the digestive system?

*Proteins are broken down into small enough particles to move out of the digestive system into the blood. The end product of the digestion of proteins is amino acids. This happens in stages*

*proteins 🡪 peptides (stomach) 🡪 amino acids (small intestine)*

(Note: In Year 8, it is acceptable for students to say that proteins are broken down into amino acids.)

1. What is the role of acid in the stomach?

*Acid in the stomach has several functions.*

1. *To sterilise food that enters the body (destroys microorganisms in the food).*
2. *To activate the pepsin enzyme. The stomach is made of protein. If the enzyme was present in the stomach without food auto digestion could occur. The release of acid is stimulated when we chew food. The stomach also has a mucus lining to help protect it from auto digestion.*

### Investigation 4: The effect of temperature on enzyme activity

In this investigation, students will design and conduct an investigation to look at the effect of temperature on enzyme activity. In Part A, students will work individually to plan an investigation. In Part B, students will conduct the investigation, using the method provided, and collect the data. In Part C, students will process the results and evaluate the investigation.

### Equipment needed

Per class:

* 1% pepsin solution + 100 mL beaker (to pour pepsin into measuring cylinder)
* 1 L of egg white suspension + 100 mL beaker (to pour egg white into measuring cylinder)
* kettle/urn for hot water
* ice
* cold water

Per group:

* 9 test tubes
* 3 rubber stoppers to fit test tubes
* 2 test tube racks
* 3 x 250 mL beakers (to use as water baths)
* 3 thermometers
* 2 x 10 mL measuring cylinders or graduated Pasteur pipettes
* 1 dropper bottle of 2 molL-1 hydrochloric acid
* 3 stopwatches

### What to do

1. Inform students that they are going to be completing an assessment task, which assesses their science inquiry skills. This task will be completed partly by themselves and partly in groups.
2. Ask students to think about the effect temperature has on enzyme activity. Record responses on the board.
3. Ask students to think back to Investigation 3 and ask them the following questions:

* How did you know that the protein was digested? (Answer: *Solution went clear.)*
* If you were going to investigate the effect of temperature on enzyme activity, how would you know whether the enzyme worked faster or slower? (Answer: *Time how long it took for the solution to go clear*.)

Record responses on the board.

1. Inform students they will work in groups to plan and conduct an investigation to investigate the effect of temperature on enzyme activity.

**PART A:**

1. Provide students with a copy of [Worksheet 4a: Planning](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%204a_Yr8_Digestive%20system.doc)
2. Ask students to rephrase the aim of this investigation as a question to investigate and to record this on the worksheet.
3. Ask students to predict what they think will happen. Remind students that if their results don't support their prediction they won’t be wrong. Scientists make predictions and then test their predictions to see if their predictions were correct.
4. Ask students to complete the worksheet. Collect worksheet and provide feedback to each group.

**PART B:**

1. Provide students with a copy of [Worksheet 4b: Conducting](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%204b_Yr8_Digestive%20system.doc)
2. Have the students read through the method for the investigation and reflect on their answers from Worksheet 4a.
3. Complete the Risk Assessment table on Worksheet 4b. Stop and have each group report back to the whole class. Discuss any issues at this stage.
4. Students work in groups to conduct the experiment and collect the results.

**PART C:**

1. Provide students with a copy of [Worksheet 4c: Processing and evaluating](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%204c_Yr8_Digestive%20system.doc)
2. Students work individually to complete the worksheet.

**Expected results and explanations**

Answers to questions on[Worksheet 4a: Planning](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%204a_Yr8_Digestive%20system.doc)

*Question:* (What is the question or problem you are trying to find out?)

Examples of questions could be:

* What affect does temperature have on enzyme activity?
* Does temperature affect enzyme activity?

*Prediction:* (What do you think will happen?)

Examples of predictions could be:

* If temperature increases then enzyme activity will increase.
* If temperature decreases then enzyme activity will decrease.
* Temperature will have no affect on enzyme activity.

*Variables:* (To make the investigation fair, which variable are you going to …)

* **Change?** (Independent variable)

Temperature of the solution

* **Measure?** (Dependent variable)

Time taken to digest the protein

* **Keep the same?** (Controlled variables)

For example:

* Volume of pepsin
* Volume of egg white suspension (protein)
* Volume of acid
* Size of water bath

Answers to questions on [Worksheet 4b: Conducting](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%204b_Yr8_Digestive%20system.doc)

Risk assessment:

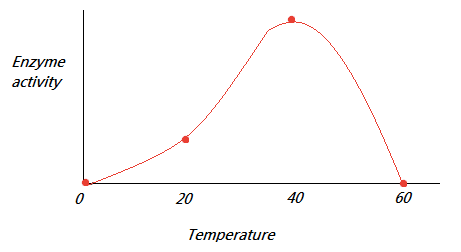
|  |  |
| --- | --- |
| Possible hazard | Planned solution |
| Burning yourself with hot water/hot equipment | Take care when pouring hot water/using hot equipment. |
| Breaking glass | Take care when using glassware. |
| Poisoning with chemicals | Don't drink chemicals.  Wash hands after handling chemicals. |
| Spilling acid | Wash up spills straight away.  Wash skin if it comes into contact with acid. |
| Spilling chemicals | Wash up spills straight away.  Wash skin if it comes into contact with chemicals. |

Answers to questions on [Worksheet 4c: Processing and evaluating](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%204c_Yr8_Digestive%20system.doc)

**Processing the investigation**

Graphing the data

The results should show that the test tubes in the ‘warm’ water bath should go clear the fastest. Those in the ‘cold’ water bath may go clear but should be a lot slower. Those in the ‘hot’ water bath shouldn’t go clear because the enzyme is denatured. The graph below shows the effect of temperature on enzyme activity.



**http://freeexamacademy.com/igcse-subjects/igsce-biology/enzymes/describe-the-effects-of-temperature-and-ph-changes-on-enzyme-activity/**

If the test tubes in the ‘hot’ water bath go clear, it could mean the temperature wasn’t hot enough to denature the enzyme.

Students should be graphing temperature (independent variable) on the x axis versus time (dependent variable) on the y axis. They should graph the average time.

* If students use discrete data (cold, warm and hot) then they should draw a column graph.
* If students use continuous data (actual temperatures) then they should draw a line graph. Using continuous data and drawing a line graph is a higher-order skill.

*Conclusion:* (What did your results tell you about your question or problem? Was your prediction correct?)

*As the temperature increases to about 40 oC the enzyme activity (time it takes to go clear) increases. After about 40 oC it started to decline.*

*Example of what students may say:*

*The enzyme activity was fastest at about 40 oC. There was some activity at 15oC but it wasn’t as fast as at 40 oC. There was no activity at 60 oC.*

*Evaluating: Judging the investigation*

What problems did you have when doing your investigation?

*Students will have had trouble getting the temperature correct at the start and may mention that the water started to cool.*

How did you overcome any problems you had with the investigation?

*They should mention anything they did to try to overcome the problem mentioned above.*

If you were to do this investigation again, what changes would you need to make it a fair (valid) investigation?

* *They could mention that having ice in the water meant it wasn’t fair and that they should probably use really cold water.*
* *The volume of water in each beaker may not have been exactly the same, especially when the ice melted.*
* *They might have:*
* *been slow at putting all the test tubes in at the same time*
* *had trouble reading the time it took to change*
* *stopped the stopwatch to read the time, this would then have affected the time for the other test tubes in the same beaker.*

What could you do to make your results more reliable?

*Repeat the investigation, do more trials for each temperature, test more temperatures.*

## Conclusion

In this activity, students will use the information they have gathered during their investigations and from other resources to produce a summary of the structures and function of the human digestive system. This can be achieved by students completing [Worksheet 5: The human digestive system](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Worksheet%205_Yr8_Digestive%20system.docx).

**OR** students could negotiate a product that suits both their skills and learning style. For example:

* Diagram
* students could be provided with a diagram to label. There are plenty of diagrams available in Google images.
* a list of terminology to include could be provided.
* labels and functions could be provided for students to cut out and glue onto diagram.
* Model
* Video
* Animation
* Creative story
* Computer game
* Role-play

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### Additional lessons and activities about the digestive system

Ask the students to imagine they are a piece of bread and describe their journey through the digestive system. The students could write a story or they could be more creative with their presentation. This could be used to assess student understanding of the structure and function of the digestive system

### Assessment opportunities

Investigation 4 provides an opportunity to assess student understanding of the concepts related to the role of enzymes in digestion and the effect of temperature on their activity. In addition, the level of student achievement of the science inquiry skills, **questioning and predicting, planning and conducting, processing and analysing data,** and **evaluating**could be assessed.

If the concluding activity is done as a closed book activity, it could be used to assess student understanding of the structure and function of the digestive system.