# *Tasty science* Teaching and learning plan

## Learning intentions

Students will be able to:

* understand that the tongue is an organ with different specialised cells;
* conduct experiments to determine the types of tastes which the tongue can sense;
* investigate the claim that the taste buds on the tongue can be mapped to show different tastes associated with different regions;
* make and record accurate observations;
* identify patterns from observations;
* evaluate the evidence gathered and compare this to the ‘tongue map’ claim;
* understand that scientific knowledge changes as new evidence becomes available.

## Suggested timeframe

The time need to complete the *Tasty science CLE* will depend on the depth of the prior knowledge of students, the time to perform the two investigations—‘What can you taste?’ and ‘Investigating the tongue map claim’ and follow up with any further extension activities. Allow 3–5 hours.

[**Planning ahead and equipment list**](http://assist.asta.edu.au/sites/assist.asta.edu.au/files/Planning_and_equipment_list_yr8_Tasty_science.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.

* Students may be allergic to the substances being tasted.
* Students could contaminate tasting solutions if the cotton bud taster is used more than once.

**Note:** This activity requires students to eat/taste, which **should not be done** in a science laboratory (see ‘Eating in labs?’, *Science ASSIST* website, <https://assist.asta.edu.au/question/2296/eating-labs>).

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## Introduction

This CLE focuses on the tongue, a multicellular organ involved in detecting tastes and digesting food. The investigations provide opportunities for students to plan and conduct experiments, make and record observations, identify patterns and evaluate claims as well as links to the Year 8 Australian Curriculum: Science.

### Equipment needed

Per student:

* mirror (could be a plane or convex mirror from light kits)
* a small packet of Maltesers® or equivalent (sweet that requires chewing and then the mouth cleaned with the tongue)

### What to do

1. Explain to the students that they will be investigating what the tongue does. They will need to observe what their tongue does before, during and after the activity.
2. Instruct the students to use the mirror to look at their tongue and to observe its shape and texture.
3. Then, whilst looking at their tongue, they are to imagine they are going to eat something really delicious. Ask them to observe any changes.
4. Instruct students to place a Malteser® in their mouths and to observe what they feel with their tongue.
5. Ask the students to swallow the food and then notice what their tongue does after they swallow.
6. Instruct students to tell a nearby person about their experience and to notice what their tongue does as they do this.
7. Ask students to describe what the tongue does.

Consider providing an organisational table like the one below.

|  |  |  |
| --- | --- | --- |
| When… | Observation | Inference |
| they think of eating something delicious… | Extra moisture/saliva—fluid forming on the tongue and in the mouth. | The tongue **contains saliva cells** (glands which secrete fluid). |
| they eat the Malteser®… | The tongue moves the food around the mouth (and helps with mastication). | The tongue contains **muscle cells,** which contract and relax causing movement. |
| The taste of the Malteser® is sweet. | The tongue contains specialised **nerve cells,** which can taste. |
| The Malteser® can be felt (presence of solid then liquid as chocolate melts and the temperature can be assessed). | The tongue contains specialised nerve cells, which can determine temperature and touch. |
| they swallow… | The tongue moves the food around the mouth and towards the oesophagus. | The tongue contains muscle cells, which contract and relax causing movement. |
| they clean… | The tongue licks the teeth and ensures no food particles stick to the teeth. | The tongue contains muscle cells, which contract and relax causing movement. |
| they talk/discuss… | The tongue helps form the different sounds in the mouth. (Ask the students to talk and not move their tongue if they don’t observe this straight away.) | The tongue contains muscle cells, which contract and relax causing movement. |

1. Discuss the students’ observations.

* What are the different things that the tongue can do?
* Each action (producing mucus, tasting and moving) requires special cells. Does this mean the tongue is an organ?

## Core

### Investigation 1: What can you taste?

### Equipment needed

Per group of 4:

* 16 sterile cotton buds or equivalent
* plastic cups labelled 1, 2, 3, 4
* liquids that taste ‘salty’, ‘sweet’, ‘sour’, ‘bitter’
* sweet: straight cordial
* sour: lemon juice
* salty: soy sauce or water with salt added
* bitter: strong, cold coffee

It is suggested that the cups be set up prior to the activity. Also, ensure the teacher has a record of what liquid is in each numbered cup. If possible, make all the liquids of similar appearance so the taste is the only difference.

|  |  |  |  |
| --- | --- | --- | --- |
| Cup 1 | Cup 2 | Cup 3 | Cup 4 |
| sweet | salty | sour | bitter |

## Safety considerations

Determine if any of the students are allergic to the tasting liquids and substitute where possible. Advise students not to participate if there are concerns. Students should not ‘double dip’ to prevent possible contamination. It would be ideal if students could rinse their mouth with water after tasting.

### What to do

1. Ensure students have access to 4 liquid-filled cups labelled 1–4 (as in table above).
2. Instruct each student to dip one cotton bud into cup 1 and then place the cotton bud on the top of the tongue. (Ensure there is no second dip after tasting). They should record what taste is detected, not what the liquid actually is.
3. Students should repeat with the other liquids using a new cotton bud each time.
4. Every student should complete the activity.

#### **Discuss the observations**

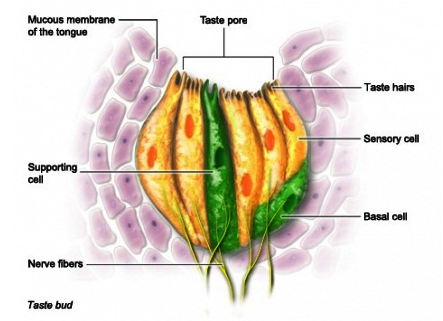
The teacher could lead a discussion to determine if the students could differentiate the different tastes. Which cup is sweet, salty, sour and bitter? (This is an opportunity to suggest that the understanding/claims being developed, for example, cup 1 contains liquid that is sweet, is based on more than one observation.)

Why does being able to detect different tastes help you survive? (It is thought the capacity enables people to readily identify rich energy food like sugars and avoid harmful or poisonous food when the taste is bitter or sour. In the past, this would have helped people know what they should eat but it is not as relevant now as many foods are labelled.)

### Expected results and explanations

The taste buds contain bundles of hair-like or columnar receptor cells (between 50 and 150 in each taste bud). There are different types of receptor cells, which respond to different chemicals within the taste bud. When a chemical combines with a receptor cell, it triggers a nerve attached to the tastebud, which ‘fires’, sending a message to the brain. Depending on the chemical, the brain interprets the message to recognise a specific taste. Research shows that if the specific receptor protein is eliminated from the receptor cell then that particular taste will not be experienced. Cats do not have the gene to produce the protein T1R2 that detects sweet tastes, so cats do not respond to sweet tastes.

A typical taste bud (<https://bcachemistry.wordpress.com/tag/bcan7/>)

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There may be some variation in the results, but generally the class numbers should validate the respective tastes in the various cups. The purpose of this investigation is for the students to identify the different tastes of sweet, salty, sour and bitter.

Note: Some students may have heard about a recently discovered fifth taste called Umami—the taste of amino acids.

## Conclusion

Students should conclude that the tongue is able to detect various types of tastes including: ‘salty’, ‘sweet’, ‘sour’, ‘bitter’.

### Investigation 2: Investigating the tongue map claim

### Aim

To investigate if Hanig’s tongue map is accurate and reliable.

Students will design an investigation to determine the reliability of the Hanig tongue map. They should consider how they will conduct the research fairly, how they will collect the evidence and how this will be evaluated. Some students in Year 8 will need very little support once timelines, equipment options and safety parameters are discussed/determined. Teachers could ask students to design their own investigations and then check these before students implement.

An acceptable investigation design is provided below for students who need the scaffolding/guidance.

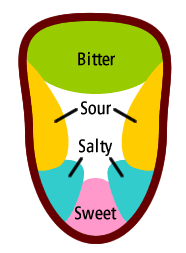
#### **Equipment needed**

Per group of 3

* 12 sterile cotton buds or equivalent
* plastic cups labelled 1, 2, 3, 4
* liquids that taste ‘salty’, ‘sweet’, ‘sour’, ‘bitter’
* sweet: straight cordial
* sour: lemon juice
* salty: soy sauce or water with salt added
* bitter: strong, cold coffee
* blindfold

### What to do

1. Introduce the students to the tongue map claim.



In 1901, a German scientist, Deiter Hanig, engaged volunteers to determine positions/areas on the tongue where they could perceive the taste sensations of salt, sweet, sour or bitter. He developed a map of the tongue based on his research. The results showed that different parts of the tongue had differing sensitivities to the four tastes he tested, as shown on the diagram.

The research conducted by Hanig was accepted and published and can be found in many textbooks, and on websites and videos.

1. Discuss the scenario. Ask students the following questions.

* How do you think Hanig conducted his research?
* What variables would need to be controlled?
* How could he be sure his claim was accurate?

1. Introduce students to the tongue map review

The Hanig tongue map was accepted as reliable and accurate by the science community until 1974. In 1974, a scientist named Virginia Collings changed the thinking about the tongue map.

1. Discuss the scenario. Ask students the following questions.

* What do you think Collins did to get people to change their mind about the tongue map?
* Why would people believe her?

This is an invitation for students to talk about the need to gain/examine evidence for claims.

|  |  |
| --- | --- |
| **The claim** | Hanig claimed the respective tastes: salty, sweet, sour and bitter are detected in the respective areas:  1 = sweet  2 = salty  3 = sour  4 = bitter |

#### **Investigation design**

1. Place students into groups of three. Inform students that one person is the tester; one person is the subject (testee) and the other person is the recorder. The testee wears a blindfold to ensure the liquids are not seen.
2. The tester hands the testee the first cotton bud, which has been dipped in the first liquid. (The order should not be known to the testee and should be varied.)
3. The testee places the cotton bud on area 1 and reports the taste.
4. The recorder records the taste reported.
5. The student should rinse their mouth in between tastes so no cross-contamination occurs.
6. Repeat steps 2–5 with the same liquid on the other areas, i.e., 2, 3 and 4.
7. Steps 2–6 are to be repeated with each of the other liquids in the same way.
8. The student roles are rotated so that all students are tested.
9. Collate the class results (if appropriate—if they have completed the tests with the same design).
10. Represent the data in an appropriate way for evaluation.

An ideal way to record the data is in a table (encourage students to design their own table for recording data).

**Sample table for recording data**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Taste | Area 1  [https://openclipart.org/image/2400px/svg_to_png/167549/Kliponious-green-tick.png](https://openclipart.org/detail/167549/green-tick-simple) = can taste | | | Area 2  [https://openclipart.org/image/2400px/svg_to_png/167549/Kliponious-green-tick.png](https://openclipart.org/detail/167549/green-tick-simple) = can taste | | | Area 3  [https://openclipart.org/image/2400px/svg_to_png/167549/Kliponious-green-tick.png](https://openclipart.org/detail/167549/green-tick-simple) = can taste | | | Area 4  [https://openclipart.org/image/2400px/svg_to_png/167549/Kliponious-green-tick.png](https://openclipart.org/detail/167549/green-tick-simple) = can taste | | |
| Group member | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| sweet |  |  |  |  |  |  |  |  |  |  |  |  |
| salty |  |  |  |  |  |  |  |  |  |  |  |  |
| sour |  |  |  |  |  |  |  |  |  |  |  |  |
| bitter |  |  |  |  |  |  |  |  |  |  |  |  |

### Summarise data

An ideal way to present the data is using a graph to provide a visual representation of the data.

Ask the students: What is the best way to present their data to help identify/show whether there are trends/patterns in the data? Discussion could involve manipulation of data—whether the raw data should be averaged or converted to percentages (small numbers suggest presentation using percentages may be misleading). Ask the students if any identified relationships or patterns would be more ‘believable’ if based on group or class data.

### Reflect on the method

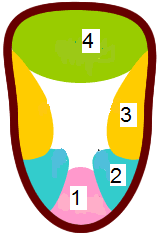
Ask the students the following questions.

* In what ways did your method work well?
* How could their method be improved to improve the quality of data collected?

Graph 1 (below) shows the expected results according to Hanig’s theory.

Graph 1. Percentage of students who taste the respective taste in the respective tongue areas

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 100 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 95 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 90 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 85 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 80 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 75 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 70 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 65 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 55 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 50 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 45 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 40 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 35 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 | swe | sal | sou | bit |  | swe | sal | sou | bit |  | swe | sal | sou | bit |  | swe | sal | sou | bit |
|  | Area 1 | | | |  | Area 2 | | | |  | Area 3 | | | |  | Area 4 | | | | |

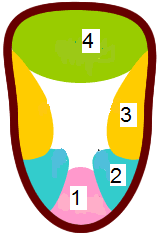
Key

|  |  |  |
| --- | --- | --- |
| swe | sweet |  |
| sal | salt |
| sou | sour |
| bit | bitter |
|  | |

Graph 2 is more likely to reflect the results when data is gathered from the students. This shows that taste perception is not limited to certain areas of the tongue. This evidence gathering provides a chance for students to examine whether they support the theory of the tongue map provided by Hanig.

Graph 2. Percentage of students who taste the respective taste in the respective tongue areas

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 100 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 95 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 90 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 85 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 80 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 75 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 70 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 65 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 55 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 50 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 45 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 40 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 35 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 30 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 25 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 20 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 0 | swe | sal | sou | bit |  | swe | sal | sou | bit |  | swe | sal | sou | bit |  | swe | sal | sou | bit |
|  | Area 1 | | | |  | Area 2 | | | |  | Area 3 | | | |  | Area 4 | | | |

Key

|  |  |  |
| --- | --- | --- |
| swe | sweet |  |
| sal | salt |
| sou | sour |
| bit | bitter |
|  | |

Discuss the evidence collected by the investigation and compare this to the theory presented by Hanig. (Note: A discrepancy is expected.)

### Evaluate claims

Ask students to discuss the impact of this ‘new’ evidence. Does this mean Hanig was wrong? What would it take to change the concept of the tongue map presented by Hanig?

Ask students what other actions they could take to evaluate the tongue map presented by Hanig? (Students may indicate further experimentation and/or research.)

### Conclusion

Students may reflect that their learning has involved considering what claims need to provide (evidence) in order to be accepted. They have had the opportunity to design their investigation, collect and analyse results and determine if they have gathered evidence to support or refute the Hanig tongue map claim. Their conclusion should reflect their investigation findings and a statement of their evaluation.

Taste buds containing the receptor cells (for all tastes) are distributed over the entire tongue. This means all parts of the tongue can ‘taste’ all types of tastes. Therefore, the tongue map claim should be rejected.

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### Additional lessons and activities about the tongue:

Students could plan and conduct further investigations regarding the following statements.

* The initial awareness of a taste is strong at first but reduces over time. (This appears to be true, as the nerves seem to diminish their response after the initial strong stimulus.)
* Temperature affects the taste. (There is evidence to suggest that warming the front of the tongue produces a sweet sensation and cooling may lead to a salty or sour taste sensation.)
* The concentration of the chemical that can be detected differs depending on the taste. This appears to be true:

|  |  |  |
| --- | --- | --- |
| Examples of some human thresholds | | |
| Taste | Substance | Threshold for tasting |
| Salty | NaCl | 0.01 M |
| Sour | HCl | 0.0009 M |
| Sweet | Sucrose | 0.01 M |
| Bitter | Quinine | 0.000008 M |
| Umami | Glutamate | 0.0007 M |

Adapted from ‘Physiology of Taste’, Colorado State University website, <http://www.vivo.colostate.edu/hbooks/pathphys/digestion/pregastric/taste.html> (10 December 2006)

Teachers must ensure any further investigations are conducted with a risk assessment and safety precautions in place.

### Assessment opportunities

Investigation 2 provides an opportunity to assess student understanding of the concepts related to the following aspects of the Australian Curriculum: Science.

* Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people’s understanding of the world ([ACSHE134](http://www.australiancurriculum.edu.au/curriculum/contentdescription/acshe134))

In addition, the level of student achievement of the science-inquiry skills listed below, could be assessed.

* Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed ([ACSIS140](http://www.australiancurriculum.edu.au/curriculum/contentdescription/acsis140))
* In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task ([ACSIS141](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS141))
* Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate ([ACSIS144](http://www.australiancurriculum.edu.au/Curriculum/ContentDescription/ACSIS144))
* Summarise data, from students’ own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions ([ACSIS145](http://www.australiancurriculum.edu.au/Curriculum/ContentDescription/ACSIS145))
* Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method ([ACSIS146](http://www.australiancurriculum.edu.au/curriculum/contentdescription/acsis146))
* Use scientific knowledge and findings from investigations to evaluate claims ([ACSIS234](http://www.australiancurriculum.edu.au/curriculum/contentdescription/acsis234))