MISSION X

TRAIN LIKE AN ASTRONAUT

TASTE IN SPACE

Team Leader Guide

MISSION OVERVIEW

Students will explore taste sensations on the tongue and conduct experiments to see which senses influence taste.

FAST FACTS

Subject: Biology
Age: 8-12
Prep: 40 mins
Lesson Time: 1 hour 15 mins lesson
Cost: 10-20 Euros
Location: Lab recommended

LEARNING OBJECTIVES

- Conducting an experiment to see where on the tongue students can identify the five basic taste sensations.
- Understand why the basic taste sensations evolved in humans.
- Learn how an astronaut experiences the changes in taste intensity before and during a mission.
- Understand how reduced gravity affects the human body.
- Analysing information to come up with a conclusion.

Skills: Scientific Methodology, Communication, Teamwork, Problem-solving.

SUMMARY OF ACTIVITIES

Summary of activities					
	Title	Description	Learning Outcome	Requirements	Time
1	The Five Basic Tastes	Learning about the five basic tastes and identifying foods that contain each taste.	• Understand why humans evolved the ability to detect the five basic tastes. • Applying prior knowledge and using critical thinking to identify foods that contain the five basic tastes.	None	**Preparation:** 5 minutes **Lesson time:** 15 minutes
2	Taste testing	Creating a hypothesis about whether the five basic tastes are tasted in different areas of the tongue and tasting flavoured liquids to prove or disprove this hypothesis.	• Understanding that, whilst different regions of the tongue can taste different flavours to an extent, the tongue map is a myth. • Creating hypotheses. • Building evidence to prove or disprove a hypothesis.	Completion of activity 1	**Preparation:** 15 minutes **Lesson time:** 30 minutes
3	Taste like an astronaut	Covering the eyes and nose to see how the sense of sight and smell affect the taste of food.	• Understanding that other senses affect the flavour of food. • Evaluating the intensity of flavours. • Understanding that fluid shift impacts the sense of taste of astronauts.	Completion of activity 1 and 2	**Preparation:** 25 minutes **Lesson time:** 30 minutes

INTRODUCTION

Astronauts need to eat a balanced diet to stay healthy in space, but living in weightlessness affects their sense of taste. This resource focuses on the five basic tastes and how our other senses affect how we taste food.

Older literature suggests there is a tongue map: that the tongue has specific regions that detect specific tastes. Modern literature suggests that this model is a myth, and that all areas of the tongue can taste all five basic tastes. However, some regions of the tongue may be better at detecting specific tastes, which is where the myth may have originated. As an example, the back of the tongue may be better at detecting bitter tastes more than the other tastes, which is hypothesised to prevent oneself from swallowing poisonous or toxic substances by spitting the substance out.

We recommend starting your lesson with this video, where Japanese astronaut Kimiya Yui shows Paxi how food is prepared on the ISS: Paxi on the ISS: Food in space.

ACTIVITY 1: THE FIVE BASIC TASTES

Most scientists recognise there are five basic tastes. These are: sweet, sour, salty, bitter, and umami. Some scientists think that fat and spice are two more basic tastes. Other scientists think that spice is a form of pain and not classed as a basic taste, because spice is detected by the same receptors that detect heat and not from the tastebuds, and therefore does not count as a basic taste.

In the first part of this activity, students will fill in the gaps of these sentences using the word bank. Here are the answers:

- **Sweetness** helps the tongue to detect **sugars** and carbohydrates in food, which the body needs for **energy**.
- **Sourness** helps the tongue to detect the presence of **acid** in food, so that we know if certain foods (like **milk**) have gone off, or whether fruit is **ripe**. Unripe fruit contains more **acid** than ripe fruit.
- **Saltiness** helps the tongue to detect **salt** in food, which is needed to help **regulate** the body.
- **Bitterness** helps the tongue to detect toxins and **poisons** in food. Some chemicals that are **toxic** to other animals can **taste** nice to humans in small quantities, such as **caffeine**.
- **Umami** is believed to be the taste of **protein**, which is important to keep your **cells** healthy and your **muscles** strong.

Flavour differs from the five basic **tastes** because the flavour of food comes from a mixture of the basic **tastes** the food has, as well as the food's smell, **aroma** and texture.

In this activity, students will give an example of foods that have each of these flavours. Here are some suggestions:

Taste	**Examples of food in which this taste is found** (each food can have multiple of the five basic tastes)
Sweet	Sugar, honey, sweets, doughnuts, cookies, biscuits, apples, pears, watermelon, strawberries
Sour	Greek yoghurt, lemons, limes, kimchi, vinegar, crab apples
Salty	Salt, soy sauce, fish sauce, crisps, salted peanuts, bacon, sausages, gammon, ham, some cheeses, pretzels
Bitter	Coffee, tea, dark chocolate, broccoli, Brussels sprouts, kale, potatoes (sometimes)
Umami	Beef, chicken, ham, bacon, gammon, pork, fish, seafood, aged cheeses, seaweed, fish sauce, soy sauce

ACTIVITY 2: TASTE TEST

In this activity, students will work in small groups and drop a small amount of liquid onto the tongue of another student, who will identify which of the five basic tastes are in the liquid.

Important warning:
Before starting the activity, please check whether any students have allergies, dietary restrictions, or health conditions. Any necessary arrangements to enable these students to take part should then be discussed and agreed on a case-by-case basis.

Preparation

Divide the class into groups and prepare the equipment beforehand, including printing out the student worksheets.

Equipment

- 4 clean containers, at least 1 L in size, labelled 1 to 4
- In container 1: mix 1 litre of water with 5 teaspoons salt to make a salty solution
- In container 2: mix 1 litre of water with 15 teaspoons of sugar to make a sweet solution
- In container 3: add lemon juice
- In container 4: add grapefruit juice
- A supply of drinkable water available in cups
- A small hand mirror and magnifying glass per group

Please read page 10 of the student section for the procedure.

Results will differ for this experiment. The traditional "tongue map" of the five basic tastes is a myth, and this activity will help your students discover that through hands-on exploration. It also shows that scientific research does not always lead to simple or definitive conclusions. All parts of the tongue can detect all five tastes, but some areas may be slightly more sensitive than others, so individual results might vary slightly between students.

ACTIVITY 3: TASTE LIKE AN ASTRONAUT

In this activity, students will taste various foods with a reduced sense of smell, just like astronauts.

Important warning:
Before starting the activity, please check whether any students have allergies, dietary restrictions, or health conditions. Any necessary arrangements to enable these students to take part should then be discussed and agreed on a case-by-case basis.

Preparation

As well as gathering the equipment on page 13 of the student worksheets, please also gather the following foods:

- Applesauce
- Mushroom soup
- Blueberry/raspberry yoghurt
- Black coffee (can be decaffeinated) or grapefruit juice
- Chocolate drink
- Orange juice

Place a sample of each food in a container and cover with a lid. For safety, store foods at refrigerated temperatures. When testing, use the food close to room temperature so temperature will not influence results.

- Label each container 1 to 6.

Make sure students are not aware of the content or smell the food.

Equipment

Please gather the equipment list on page 13 of the student worksheets.

Procedure

Students will be blindfolded and pinch their nose when testing food, then taste the food normally and compare the description and intensity of flavours.

Questions

1. How do the astronauts keep themselves and their food secure in the weightless environment of space?

   Astronauts use hook and loop fasteners, sliding their feet under bars attached to the station.

2. Describe what is meant by 'fluid shift'.

   On Earth, gravity causes most of the body's fluids to be distributed below the heart. In contrast, living in space in weightlessness allows fluids to spread evenly throughout the body.

3. Explain the purpose of using a blindfold and pinching the nose before tasting.

   Vision and smell affect the sense of taste. When someone can't see or smell the food, it will taste different.

4. Suggest a reason for rinsing the mouth between each tasting.

   Rinsing the mouth will prevent the previous taste test from affecting the other taste tests.

5. Humans have been on the Moon before, and space agencies are discussing sending humans to Mars. Suggest how fluid shift might be different between floating in the International Space Station and standing on the surface of the Moon and Mars, and how would this effect taste.

   Mars has more gravity than the Moon, so the fluid shift throughout the body will be less pronounced there. In terms of gravitational strength, Earth has the highest gravity, followed by Mars and then the Moon. Mars has about 37% Earth's gravity , while the Moon has about 16% of Earth's gravity. Astronauts on the ISS live in weightlessness environment, so they do not feel the force of gravity; hence, the fluid is greatest on the ISS. Therefore, taste will be most affected on the ISS due to the largest fluid shift, followed by the Moon, and then Mars, where the fluid shift is the least.

6. You are asked to recruit students to participate in a taste test for a major food company in your country. Would you allow people with colds to participate? Why or why not?

   Answers will vary depending on the student. Example answer:

   Having a cold will affect the participant's sense of taste, which could make the company's food taste different to them. For this reason, many people might choose not to include participants who have a cold. On the other hand, some customers who buy our food will inevitably have colds, so it can be useful to include a few participants with colds to ensure that our food still tastes good for them as well.

STUDENT WORKSHEET

TASTE IN SPACE

Student Worksheet

MISSION OVERVIEW

You will explore taste sensations on the tongue and conduct experiments to see which senses influence taste.

INTRODUCTION

From the early 1960s, astronauts found that their taste buds did not seem to be as effective when they were in space.

Why do astronauts lose their sense of taste in space?

Microgravity conditions on the ISS, along with the confined space, affects how astronauts experience the taste of food.

Space dessert. Credit: ADF - Pierre Desgrieux

Taste testing for astronauts. Credits: ESA/NASA

On Earth, gravity pushes the fluids in our bodies downward into our legs. In space – due to weightlessness – this fluid is distributed equally in the body. This is known as fluid shift.

Astronauts can notice fluid shift within the first few days in space. Their faces become puffy as fluid moves upward, blocking the nasal passages and reducing their ability to smell. After a few days, the effects of fluid shift decreases as the body adapts.

Did you know?

Eating is an important part of crew morale, and it is one of the few times when the crew can gather, share a meal and talk with each other.

The puffy face feels like a heavy cold, and this can cause taste to be affected in the short term.

But, in the long term, it could be that in the confines of such a small space like the space station, the food competes with other odours in the station (e.g. body odours, machinery), which could also 'dull' the sense of taste. The sense of smell is very important in tasting food.

Homemade space food. Credit: ESA

ACTIVITY 1: THE FIVE BASIC TASTES

Most scientists recognise there are five basic tastes. These are: sweet, sour, salty, bitter, and umami. Some scientists think that fat and spice are two more basic tastes. Other scientists think that spice is a form of pain, so does not count as a basic taste.

Read the following passage and fill in the missing words:

- **Sweetness** helps the tongue to detect_____and carbohydrates in food, which the body needs for _____.
- **Sourness** helps the tongue to detect the presence of _____ in food, so that we know if certain foods (like _____) have gone off, or whether fruit is _____. Unripe fruit contains more _____ than ripe fruit.
- **Saltiness** helps the tongue to detect _____ in food, which is needed to help _____ the body.
- **Bitterness** helps the tongue to detect toxins and _____ in food. Some chemicals that are _____ to other animals can _____ nice to humans in small quantities, such as _____.
- **Umami** is believed to be the taste of _____, which is important to keep your _____ healthy and your _____ strong.

Flavour differs from the five basic _____ because the flavour of food comes from a mixture of the basic _____ the food has, as well as the food's smell, _____ and texture.

Word bank:

energy	tastes	acid	cells	aroma	muscles	taste
caffeine	toxic	sugars	poisons	salt	protein	milk
ripe	regulate	tastes				

Give an example of foods that have each of these flavours:

Taste	Examples of food in which this taste is found (each food can have multiple of the five basic tastes)
Sweet	
Sour	
Salty	
Bitter	
Umami	

Did you know?

Food seems to lose its flavour in space, which may be due to the competing odours and fluid shift.

So, astronauts usually ask for condiments (such as hot sauces) to give the food some intensity of flavour.

A variety of condiments are available for the crewmembers to add to their food, such as honey, and sauces like soy sauce, BBQ, and taco. Notice how many of these condiments include more than one of the five basic tastes.

ACTIVITY 2: TASTE TEST

HYPOTHESIS

Your hypothesis should be a statement that answers the question, based on your observations, predictions, and the materials available.

Question: Do you taste different tastes in different parts of the tongue?
Hypothesis:

_____
_____
_____
_____

PROCEDURE

1. Before you begin tasting, examine your tongue using the magnifying glass and mirror. Make a note of what you see.

2. Collect 4 cups, 4 droppers, and a black marker.

3. Label cups 1-4. Pour solutions from each container to the labelled cups.

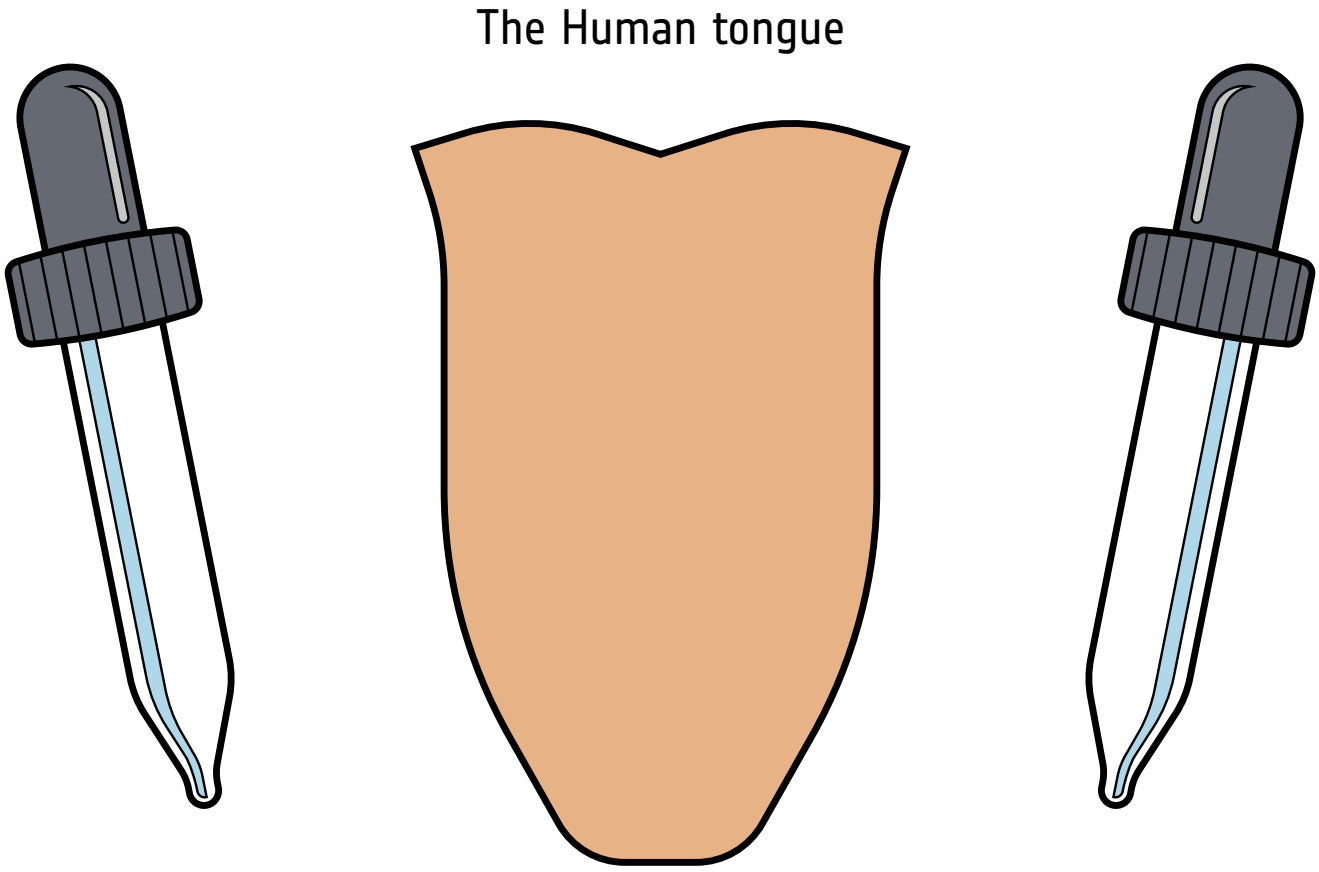
4. One person in each group should do the tasting and another one should give the test solution. Take turns being the tasters and be careful not to cross-contaminate the droppers.

5. Each taster should stick out their tongue and receive about 5 drops of the liquid. After a few seconds, they should describe what they taste and where, on the tongue, the taste seems strongest, or whether it seems the same all over the tongue. Record their answer on the tongue map provided on the student sheet.

6. Each taster should rinse their mouth with water between each tasting.

7. At the end of the experiment, discuss what tastes have been identified and where they seem to 'taste' on the tongue.

Mark where each liquid could be tasted on the tongue:



QUESTIONS

These questions will help you to form a conclusion.

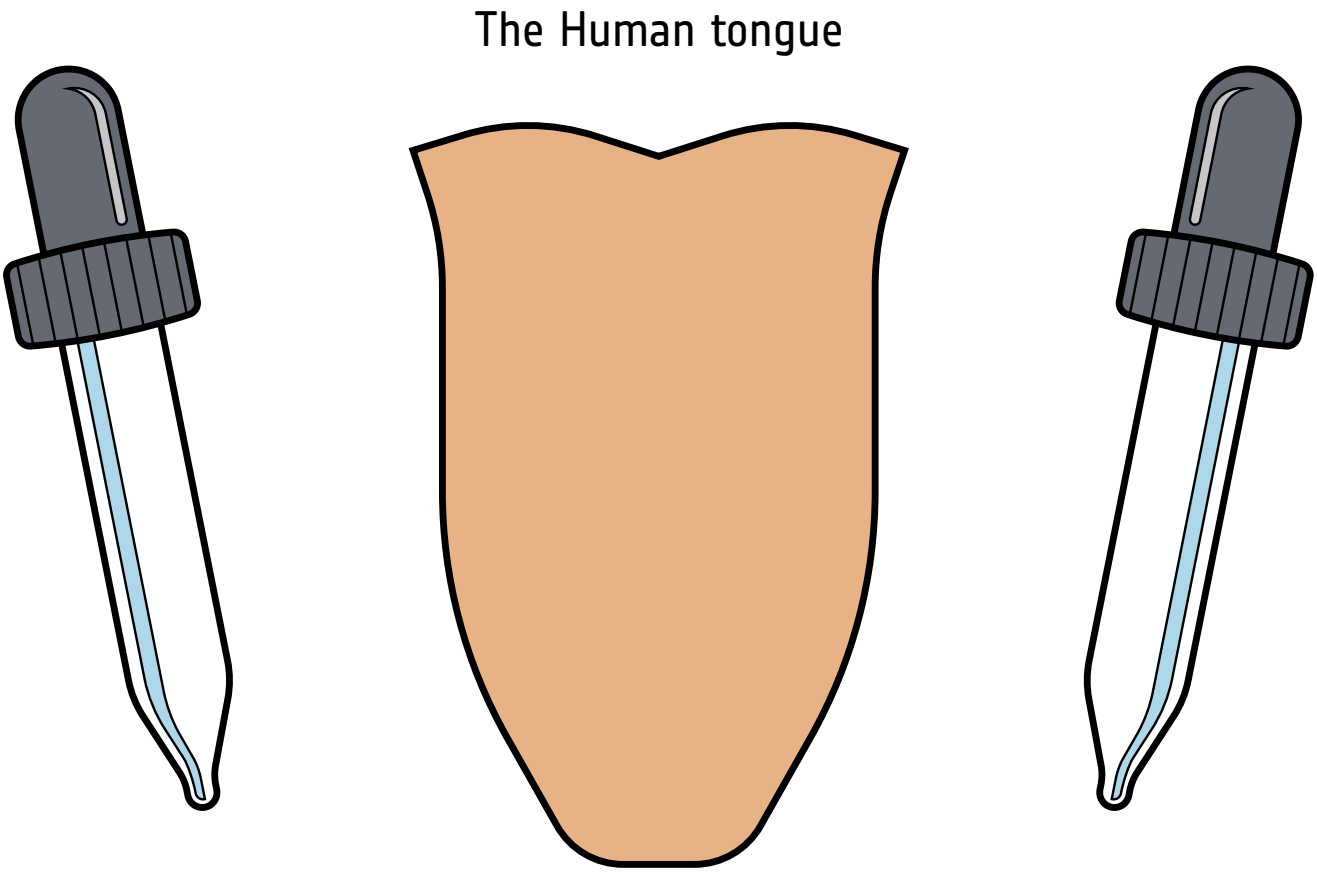
1. Which tastes where you able to identify in each liquid?

Liquid	Tastes that you could identify (sweet, sour, salty, bitter or umami)
1	
2	
3	
4	

2. Therefore, in which part of the tongue could you detect each of the five basic tastes?

Taste	Describe where on the tongue each flavour is detected (e.g. centre, right-hand side, all over, etc)
Sweet	
Sour	
Salty	
Bitter	
Umami	

Mark on this diagram of the tongue where you tasted each of the five basic tastes:



CONCLUSION

Restate your hypothesis, then explain what happened during testing, including your results.

Problem: Do you taste different flavours in different parts of the tongue?
Conclusion:

ACTIVITY 3: TASTE LIKE AN ASTRONAUT

In this activity, you will try to identify foods (similar to the ones tried by astronauts) by first pinching your nose and then releasing your nose.
You'll be blindfolded – no peeking!

Did you know?

For astronauts, all their food and drinks need to be carried to the International Space Station (ISS). Water is recycled but sometimes needs replenishing from Earth.

MATERIALS

Per student:

- Safety glasses or goggles
- Disposable gloves (optional)
- Student worksheets and data table

Per group:

- 6 covered containers labelled 1 to 6
- 3 droppers or syringes
- 3 plastic spoons
- Water (to rinse out mouth)
- Blindfold
- Pair of disposable gloves (optional)

Safety:
You should **wear eye protection** during this activity. Always **wash your hands** before and after touching any of the equipment, the surfaces and anything else, and **wash your hands again** after finishing the activity. Review your classroom and lab safety rules.

TEST PROCEDURE

If possible, work in groups of two people.

1. One student wears the blindfold (Crew A), one gives the food (Crew B) and can write down the observations.
2. Crew A: When you are ready, put on your blindfold. Pinch your nose and stick out your tongue.
3. Crew B: Place a small amount of food on the top of Crew A's tongue and gently move it along the surface of the tongue.
4. Crew A: Once the food is in your mouth, release your nose and describe what you taste and how intense is the taste with your nose open and closed. Use a scale of 0-10 to estimate the intensity of taste. (0 is no taste, 10 is maximum taste intensity)
5. Note the observations on the data sheet. The mouth is rinsed with water, swallowed and the next food item is offered.
6. For liquids, use a dropper to gently squirt 5 drops over the surface of the tongue, or offer a cup to take a sip.
7. When Crew A has tasted all the items, look at the results with the nose open and closed. Collect the class results and draw a bar graph or a similar tool to show the results.
8. Comment on any differences you noticed in taste when your nose was pinched and suggest reasons for these differences.

Item	With nose closed Taste description	With nose closed Intensity	With nose open Taste description	With nose open Intensity
Container 1				
Container 2				
Container 3				
Container 4				
Container 5				
Container 6				

QUESTIONS

1. How do the astronauts keep themselves and their food secure in the weightless environment of space?

2. Describe what is meant by 'fluid shift'.

3. Explain the purpose of using a blindfold and pinching the nose before tasting.

4. Suggest a reason for rinsing the mouth between each tasting.

5. Humans have been on the Moon before, and space agencies are discussing sending humans to Mars. Suggest how fluid shift might be different between floating in the International Space Station and standing on the surface of the Moon and Mars, and how would this affect taste?

6. You are asked to recruit students to participate in a taste test for a major food company in your country. Would you allow people with colds to participate? Why or why not?

RESOURCES AND LINKS

ESA Resources

- In this video, ESA Astronaut Samantha Cristoforetti talks about snacks on the ISS: Space snack time with Samantha Cristoforetti
- Japanese astronaut Kimiya Yui shows Paxi how food is prepared on the ISS: Paxi on the ISS: Food in space
- More information about life in space could be found at this link ESA - Life in Space

Extra information

Read the healthy diet guide provided by the World Health Organisation: Healthy diet

Read this FAO article to learn more about the five basic tastes, based on an investigation caried out with 11-year-old children. Investigating the Relationships between Basic Tastes Investigating the Relationships between Basic Tastes Sensitivities, Fattiness Sensitivity, and Food Liking in 11-Year-Old Children

Read these papers to understand how the five basic tastes are detected all over the tongue:

- In brief: How does our sense of taste work? - InformedHealth.org - NCBI Bookshelf
- The tongue map and the spatial modulation of taste perception - ScienceDirect
- Regional Differences in Suprathreshold Intensity for Bitter and Umami Stimuli | Chemosensory Perception

Read this paper to learn more on the structure of tastebuds: Human Biology of Taste - PMC

Acknowledgements

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