Wonder Project

Ice Cream Challenge

Key concepts

Engineering New Zealand
Te Ao Rangahau

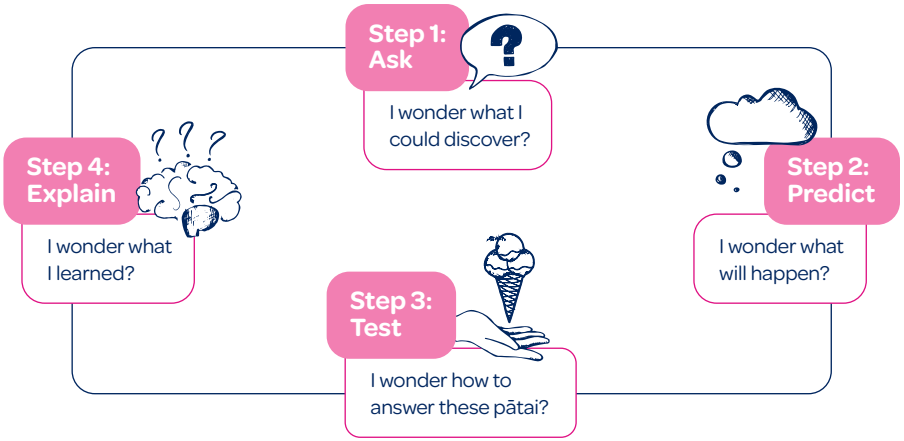
NOURISHED BY Fonterra
Dairy for life

Contents

Scientific inquiry process

The scientific inquiry process is a series of simple steps that scientists use to discover how things work and solve problems.

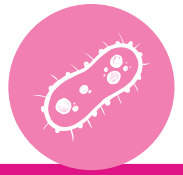
Ākonga will follow this process to complete experiments and unpack the challenge goals.



Step 1: Ask	Scientists ask pātai (questions) about the world around them to help them understand what they're curious about.
Step 2: Predict	Scientists use what they already know to predict what they think will happen, and why.
Step 3: Test	Scientists do experiments to test their prediction and gather data.
Step 4: Explain	Scientists use their data to explain what happened, whether it matched their prediction, and what they've learned.

Food microbiology

Food microbiology is the study of microorganisms in food. Microorganisms are living things too small to see with the human eye.

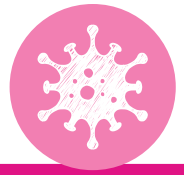


Bacteria

- Tiny living things made of just one cell.
- They're found almost everywhere, including in soil, water, air, and inside our bodies.
- Most bacteria are harmless, and some are helpful.

Examples:

- E. coli – lives in the gut and helps digest food. Some types can also make you sick.
- Lactobacillus – used to turn milk into yoghurt and cheese.
- Streptococcus – bacteria that can cause a sore throat.



Viruses

- Even smaller than bacteria and technically not "alive" on their own.
- They grow and multiply by getting inside another cell, like a plant, animal or human cell.

Examples:

- The common cold virus (rhinovirus).
- Influenza (the flu).
- Chickenpox virus.

Fungi

- Includes yeast and moulds.
- Yeast is a single tiny cell, while mould grows as fuzzy patches made of thread-like strands.
- Fungi help break down dead plants and food – that's why bread gets mouldy over time.

Examples:

- Yeast – used to make bread rise.
- Mould – the fuzzy stuff that grows on old bread or fruit.
- Mushrooms – the fruiting part of some fungi that grow in soil or on logs.

Sometimes microorganisms can be helpful, like the yeast in bread or the bacteria in cheese. But some microorganisms are not as friendly and can make us sick. So, it's important that food safety rules are followed to limit exposure to bad microorganisms.

Ice cream goals

To find a solution to the challenge pātai, ākonga will unpack three ice cream goals.

Each goal is impacted by:

1. States of matter
2. Performance properties
3. Ice cream ingredient selection

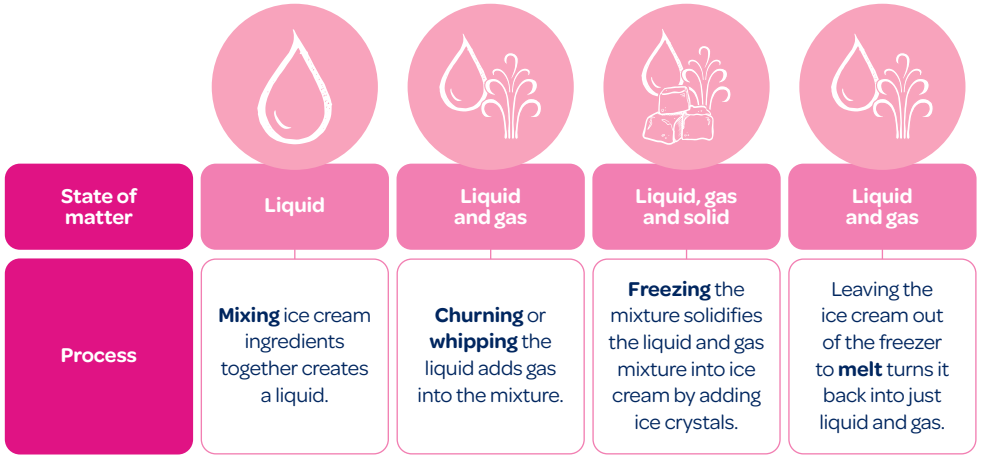
States of matter

Matter is anything that you can touch, hold or that takes up space. It can exist in three different states:

Matter can change from one state into another state through processes like:

- **Freezing:** When a liquid turns into a solid due to decreased temperature
- **Melting:** When a solid turns into a liquid due to increased temperature
- **Vaporisation:** When a liquid turns into a gas due to increased temperature
- **Condensation:** When a gas turns into a liquid due to decreased temperature

The ingredients in ice cream are all "matter". When you make ice cream, the ingredients experience lots of different changes. And how they change, has a big effect on the ice cream goals.



Performance properties

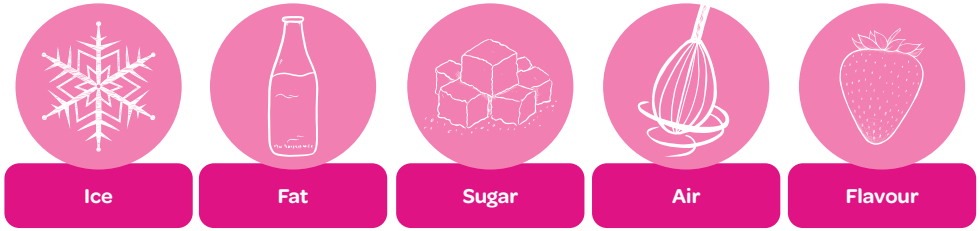
The concept of "performance properties" is not covered explicitly in the challenge. Instead, it is woven throughout all key concepts, where ākonga learn how the properties of different ingredients influence the performance of their final ice cream. They will explore:

- The properties of different ice cream ingredients
- How ingredients behave when mixed, whipped and cooled
- How ingredient choices affect creaminess (texture), scoopability and flavour

They'll use this knowledge to design the ultimate ice cream that meets the three challenge goals.

Ice cream ingredients

The 5 types of ice cream ingredients ākonga will explore are:



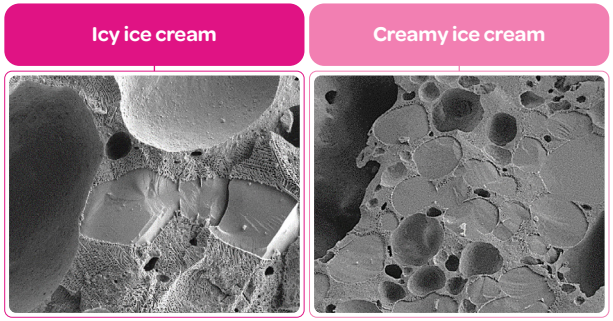
Ice

Impacts: Goal 1: Creamy

Cream and milk both have water in them. When ice cream is frozen, the water inside cream and milk freezes into ice crystals.

- When ice crystals are big and uneven, ice cream is icy and not creamy.
- When ice crystals are small and evenly spread, ice cream is smooth and creamy.

The faster ice cream freezes, the smaller the ice crystals will be. Ice crystal formation is also influenced by fat, another ice cream ingredient.



Fat

Impacts: Goal 1: Creamy

Cream and milk are both sources of fat.

Cream comes from milk. When raw milk sits, the lighter fat rises to the top. This is skimmed off to form cream. This means cream has a much higher fat content than milk.

When ice cream freezes, fat coats the ice crystals and stops them from getting too big and uneven. So, changing the amount of fat in ice cream changes how creamy the ice cream will be – ice cream with more fat will be creamier than ice cream with less fat.

Sugar

Impacts: Goal 2: Scoopable

Freezing point depression

Sugar lowers the freezing temperature of the water inside ice cream mixture:

- Your freezer is around -18 degrees Celsius. This is cold enough to freeze cream into a solid block.
- But, if you add sugar into the cream, the mixture's freezing point is lowered.
- This means, the freezer is no longer cold enough to turn the mixture into a solid block.
- This is because the mixture needs a temperature lower than -18 degrees Celsius to freeze solid.

The sugar inside ice cream stops it from getting too hard and frozen inside the freezer. This keeps it soft and easy to scoop. So, changing the amount of sugar in ice cream changes how scoopable the ice cream will be.

Air

Impacts: Goal 2: Scoopable

Air bubbles are added into ice cream mixture when it's churned or whipped. These air bubbles get trapped amongst the ice crystals and fat.

Air is much lighter than ice cream mixture. This helps make the ice cream light and fluffy instead of frozen solid. This keeps it soft and easy to scoop. So, changing the amount of air in ice cream changes how scoopable the ice cream will be.

Overrun

The measure of how much air gets whipped into the ice cream is called overrun. Food scientists calculate overrun by working out the weight difference between 1 cup of ice cream mixture, and 1 cup of ice cream.

If the finished ice cream weighs less, that means it contains more air.

If you wish to calculate overrun as an optional extension, you can do so with this formula:

Overrun (%) = (Weight of 1 cup of mix – weight of 1 cup of ice cream) ÷ weight of 1 cup of ice cream x 100

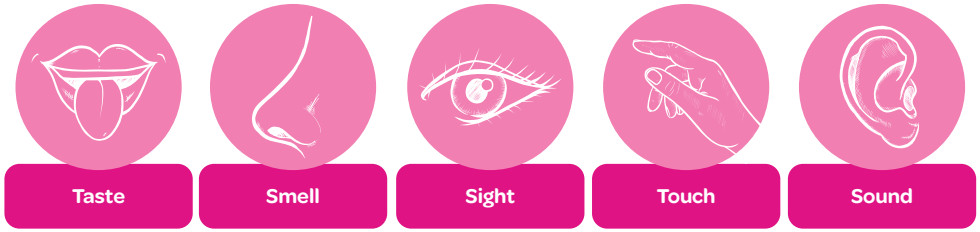
You can also use this online overrun calculator.

Flavour

Impacts: Goal 3: Flavourful

5 senses

The flavour of ice cream is impacted by our five senses:



Sense 1: Taste

Tastebuds contain cells that receive messages from food, like whether it's sweet, salty, sour, bitter or savoury.

They send these messages to your brain through nerves. Then, your brain figures out what the flavour is, and how you feel about it.

Sense 2: Smell

When you eat, tiny particles travel up your throat and into your nose. Your brain mixes these smell signals with your taste signals to figure out the flavour. So, your tongue might tell you an ice cream is sweet. But your nose will tell you if it's strawberry or chocolate.

Sense 3: Sight

Your eyes make guesses about something's flavour before you've eaten it. In fact, your eyes can trick your tastebuds into thinking a flavour is something different, just by the way it looks. You might think a banana-flavoured milk tastes like strawberry if it's pink, because that's what your brain expects.

Sense 4: Touch

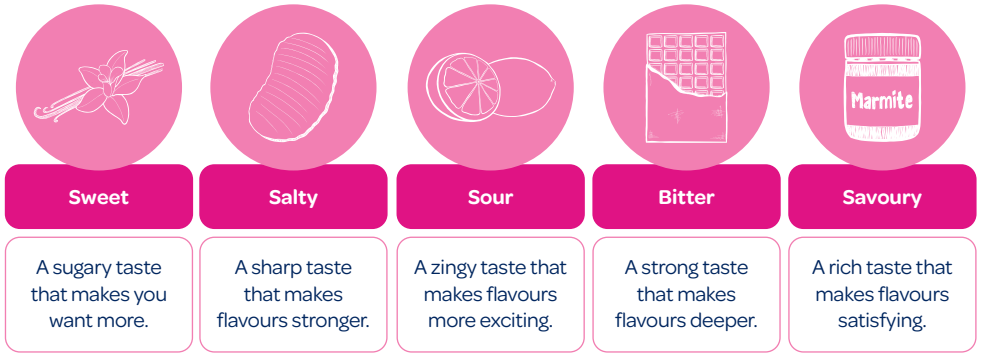
For touch, ice cream experts use the word "mouthfeel" which is about how something feels in your mouth. Your brain uses mouthfeel to help decide the quality of something and whether or not you like it.

Sense 5: Sound

While less important than other senses, how food sounds impacts your taste experience too. Eating a raw carrot is much more satisfying with a loud crunch because it tells you it's fresh.

Basic tastes

There are five basic tastes that food can be:



Food scientists mix these basic tastes to create flavour matches. The flavour matches that ākonga will explore in the challenge are:

Match	Why does it work	Example
1: Taste twins	When you match flavours that share the same basic taste, their flavours become even stronger.	Mango and coconut
2: Taste opposites	When you match flavours with opposite basic tastes, they can make each other better.	Salted caramel
3: Taste boosters	When you match flavours with different basic tastes, it can help make each flavour shine.	Lemon on berries