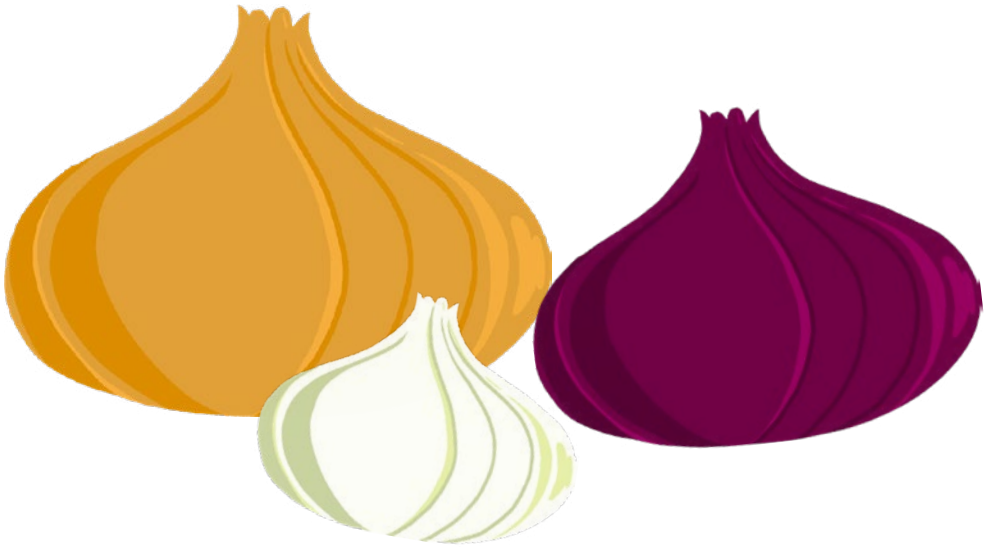
Tears Before Dinner

Years 4–8 – Science



(Science; Year 4, ACSSU074)
Natural and processed materials have a range of physical properties that can influence their use

(Science; Year 4, ACSHE062)
Science knowledge helps people to understand the effect of their actions

(Science; Year 4, ACSIS065)
With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment

(Science; Year 5, ACSSU043)
Living things have structural features and adaptations that help them to survive in their environment

(Science; Year 5, ACSSU077)
Solids, liquids and gases have different observable properties and behave in different ways

(Science; Year 5, ACSHE083)
Scientific knowledge is used to solve problems and inform personal and community decisions

(Science; Year 5, ACSIS086)
Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks

(Science; Year 6, ACSSU095)
Changes to materials can be reversible or irreversible

Hort Innovation

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Tears Before Dinner

Why chopping onions makes you cry.

What does every budding cook know about onions? Cutting them really can make you cry! Onion juice contains an enzyme that works just like tear gas on sensitive human tear ducts. There are some serious chemical reactions at work. So grab a hankie and get ready for some hard core kitchen chemistry as we find out how – and why – onions make us cry.

Equipment:

Several raw brown, white and red onions

A few spring onions and/or leeks

A metal spoon

Chopping boards and chefs knives – for adult or proficient student use with adult superivision

Stopwatches

Bowls to hold chopped onions

Data sheet to record observations

Duration:

45 minutes

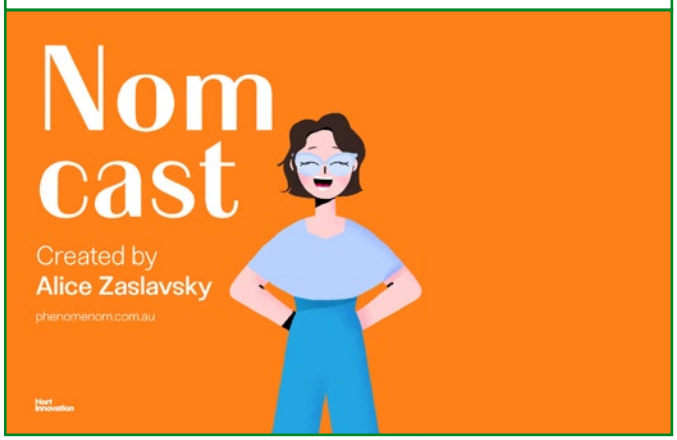
Location:

The classroom or kitchen

Notes:

What's in an onion?

Listen to **Nomcast Episode 1 – Onions: tears, mayhem and tasty bass notes**



? Ask students what they learned that surprised them. Was there anything they wanted to know more about?

? Ask for hands up – who has sliced onions and found themselves weeping over their dinner? Why do students think this happens? Why don't whole onions make you cry?

No cut, no cry

- Why do these aromatic bulbs make us blub? The process whereby onions produce volatile chemicals that make us cry is a chemical reaction.
- Chemical reactions occur when two or more substances react with each other and change. In this case, a third substance is produced.
- In onions, the chemicals in question are a sulfenic acid precursor in the watery filling of cells, and alliinase, a protein that is kept in little sacs (vacuoles) in the same cells.
- Damage the cell and you set off the reaction. Chop, crush, bash or bite an onion, and the reaction begins.
- The new chemical that's created is called propanethial-S-oxide. And it's super-volatile – which means that it evaporates quickly at room temperature. Airborne particles react with the water in our noses and eyes and create a mild acid – which is why our eyes get irritated, go red and itchy. The body's response is to produce more water to dilute the acid and wash it away from causing potential harm – i.e. we cry, snuffle and sniff.

? Ask students if they think these two substances in the cells could be separated – i.e. could we reverse the reaction? (No, we can't.)

Down to details

? Explain:

- Scientists used to think that the enzyme that makes us cry was produced in a single step, when cells of onions were broken (by cutting, biting or grating), and two different, naturally occurring chemicals mixed.
- But in 2002, Japanese scientists worked out that the chemical reaction that happens when you cut an onion is actually a two-step process. (Their article can be found online https://www.nature.com/articles/419685a). A simple explanation from Chemistry World is as follows:
  - ◇ "First, when an onion cell is damaged, this opens little biological bags filled with alliinase, which enables water and S-1-propenyl-L-cysteine sulfoxide to react together to produce a variety of sulfurous compounds. One of them – 1-propenyl sulfenic acid – is then converted into nasty, stingy propanethial-S-oxide by another enzyme, lachrymatory-factor synthase."
- As a class or in pairs, explore the full explanation of the chemistry behind onions.

Teacher resources

- Chemistry World – How Chopping Onions makes you cry: https://www.chemistryworld.com/podcasts/propanethial-s-oxide-how-chopping-onions-makes-you-cry/3009790.article
- New York Times – Why onions make you cry: https://www.nytimes.com/2017/09/05/science/onions-crying-chemicals.html

Onion Experiment 1

- The first task for students is to quantify how much an onion makes a person cry.
- How will they measure the irritant power of onions safely and efficiently?
- Provide different kinds of onions, such as red, white, brown onions, spring onions and leeks (in the allium family).
- Discuss and agree how students will measure the power of the sulphur compounds emitted by the different types of onions.
  - ◇ Will a person be exposed to cut onion for a set length of time? (e.g. 30 seconds of sniffing at a 30cm distance?)
  - ◇ Who will cut the onion? (This can be a teacher or a student if they demonstrate they know how to handle a knife safely.)
  - ◇ How quickly does the test person need to sniff the cut onion? (Onion enzymes are volatile which means they disperse, or evaporate, over time. Onions are more irritating immediately after being cut.)
  - ◇ What will the control be?
- Agree on a test plan and document the plan and procedure.
- Before the experiment, ask students to predict the results.
- Run the experiment. Document students' findings and discuss them in relation to predictions.

Lexicon

Alium the onion family, this includes garlic, leeks, and hundreds of other plants.

Allinase one of the chemicals naturally occurring in onions, and part of the chemical reaction that makes you cry.

Lachrymatory-factor synthase an enzyme that converts sulphurous compounds into propanethial-S-oxide. The word 'lachrymatory' literally means 'causing tears'.

1-propenyl sulfenic acid a naturally occurring chemical in onions, it is made of several molecules including sulphur, a common irritant.

Propanethial-S-oxide a chemical formed after a reaction inside an onion: the culprit for your crying.

Onion Experiment 2

- Ask students to design an experiment for you to find the 'best' (least tearful) way to cut onions. Here are a few suggestions and myths for how to avoid weeping:

◇ Wear swimming goggles
◇ Put a clothes pin on your nose
◇ Wear ordinary eyeglasses
◇ Clutch a metal spoon between your teeth
◇ Wear a wet bandanna over nose and mouth
◇ Put a tea towel on the opposite shoulder to your cutting hand.

- Discuss and agree how students will measure the effectiveness of these potential solutions.

◇ Which type of onion will we use? (The most volatile from our first experiment?)

◇ What will the control be?

◇ How will we record the efficacy of each method in such a way that we can effectively compare one method to the others?

◇ Will a person try each method for a set length of time?

◇ Should we sniff from the same distance as in the first experiment?

◇ Who will cut the onion? (This can be a teacher or a student if they demonstrate they know how to handle a knife safely.)

◇ How quickly does the test person need to sniff the cut onion? (Onion enzymes are volatile which means they disperse, or evaporate, over time. Onions are more irritating immediately after being cut.)

- Agree on a test plan and document the plan and procedure.
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