Cabbage indicators

The flowers that hydrangeas produce differ in colour depending on where these plants are growing. Cabbage leaves can help us to figure out why.

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EQUIPMENT NEEDED

- Red cabbage
- Water
- Blender
- Sieve
- Large jug
- Drinking glasses
- White vinegar
- Spoon
- Laundry powder
- Common household substances to test, eg, milk, lemon juice, baking soda, coffee, flour, self-raising flour, window cleaner

WHAT TO DO

1. Put three or four big red cabbage leaves in a blender.
2. Fill the blender with cold water until it is half full.
3. Blend the mixture until most of the content is liquid.
4. Pour the mixture from the blender through a sieve into a large jug to remove any cabbage chunks.
5. Place three clear drinking glasses in a row and half-fill each with some strained cabbage juice.
6. Pour a little bit of vinegar into the first glass. Compare it with the second glass and note what happens in the table below.
7. Sprinkle some laundry powder into the third glass. Compare it with the second glass and note what happens in the table below.
8. Empty and refill the first and third glasses. Repeat steps 6 and 7 with other common household substances.

The cabbage solution shows whether the substance you add to it is an acid or a base. Acids make the juice turn red and bases make it turn green. Neutral substances will not make the juice change colour.

Substance tested	Colour of indicator	Acid or base?

QUESTION FOR YOU

Why do you think the hydrangeas produce different-coloured flowers depending on where they are growing?

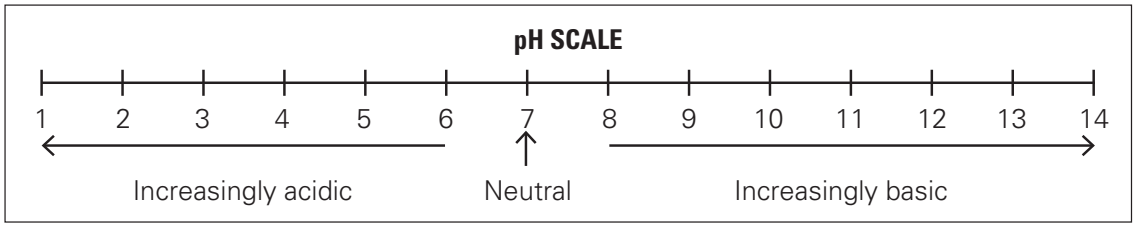
Teacher notes: Cabbage indicators

THE SCIENCE BEHIND IT ALL

Some substances are acids or bases and other substances change colour when they come into contact with an acid or base. The substances that change colour are called **indicators**. Indicators usually turn red in the presence of an acid and turn blue or green (depending on the particular the indicator being used) in the presence of a base.

A molecule in red cabbage called **anthocyanin** dissolves in water and acts as an indicator. It turns red in acids and bluish-green in bases. Stronger acids and bases generally make for a more dramatic colour change.

Scientists use the pH scale to measure how acidic or basic a substance is. The scale goes from 1 to 14, where 1 is the most acidic, 14 is the most basic and 7 is neutral.



TIPS

- As a general rule, cleaners are basic and citrus fruits are acidic.
- Try to use clear liquids because coloured liquids will interfere with the colour changes that occur. For example, milk will probably make the solution a bit more blue than green because of its colour.
- It can be useful to dissolve powders in a bit of water before you add them to the cabbage mixture as a way of avoiding lumping and of dispersing them thoroughly to show any colour change more effectively.
- If you are conducting this experiment with a very young class, make up a large batch of indicator solution and distribute it rather than requiring the students to do it.
- You don't have to use drinking glasses – any clear container will do. The smaller the containers you use, the less indicator solution you need to make!
- **Safety note:** Wash the glasses thoroughly between tests to avoid cross-contamination.

ANSWERS TO SOME TRICKY QUESTIONS

What is an acid or a base? Acids create hydrogen ions (H^+) when dissolved in water and bases create hydroxide ions (OH^-). It is the levels of these ions in the solution (mixture of the acid/base and water) that determine the strength of the acid or base: the more ions (ie, the stronger the concentration), the stronger the acid or base.

Why does the indicator change colour? This colour change occurs because it reacts with the acid or base and this reaction changes the molecule's structure so that it absorbs different wavelengths of light, making it change colour. We see substances as coloured because they absorb some wavelengths of visible light and reflect others, and we see the colours that are reflected. Different substances absorb different wavelengths of light depending on their structure, which is why they appear to be different colours.

What are some other natural indicators? Many other natural indicators are readily available, including turmeric, beetroot, grape juice, turnip skin, tomatoes, cherries, onions and curry powder. Olfactory indicators are another kind of indicator – they change their smell in the presence of acids and bases. Some examples of olfactory indicators are onion, vanilla extract and clove oil.

Regrowing food from scraps

Most plants grow from seeds but some types of vegetables can regrow from your kitchen scraps to become a whole vegetable again. Here's how you can make it happen.

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EQUIPMENT NEEDED

- Glass jars or drinking glasses
- Water
- Rubber bands (optional)
- Pots
- Potting mix
- Rubber gloves for handling potting mix
- Vegetable scraps (see suitable types of vegetables under "What to do")

IMPORTANT SAFETY NOTE

When working with potting mix, wear rubber gloves and work out in the open in a well-ventilated area.

WHAT TO DO

The two main ways of regrowing vegetables from scraps are in a jar of water or in some soil in a pot. For this experiment, you can try one or both of these methods.

Jar of water. Some plants – such as spring onions, leeks, fennel, lemongrass, celery, bok choy and most lettuces – will regrow their leafy bits as long as the roots are still attached.

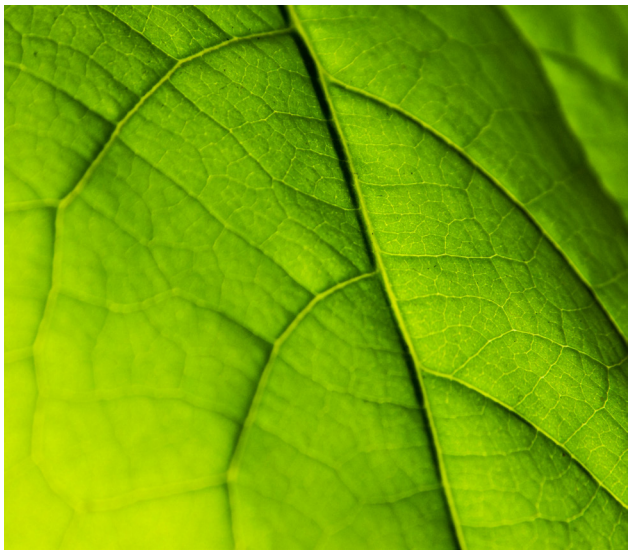
1. Cut your vegetable scraps to leave the roots plus a few centimetres of the plant above the roots.
2. Bundle together this root portion of your vegetable scraps with a rubber band (optional).
3. Place the vegetables into a glass jar with the roots on the bottom and add some cold water until about 1 cm of it covers the roots.
4. Wait for a few weeks and watch what happens. Replace or top up the water every few days.

Soil and pots. Other plants – such as ginger, turmeric, potatoes and sweet potatoes (such as kūmara) – grow new shoots from buds on their surface.

1. Wait until your vegetable has started to bud new shoots.
2. Cut up your vegetable into small pieces – each piece should be a few centimetres long and contain a new bud.
3. Fill a pot with some potting mix and carefully place your vegetable pieces on the potting mix with the buds facing up.
   - If you have potato pieces, plant them about 12 cm deep in the pot with about 8 cm of potting mix on top. Add more soil as the shoots grow higher.
   - For sweet potatoes, ginger and turmeric, cover them with about 1 cm of potting mix.
4. Wait for a few weeks to see what happens. Water the pots every few days.

Teacher notes: Regrowing food from scraps

Students can get a real kick out of growing their own food. This experiment can be a good way to start a vegetable garden at your school on the cheap or to inspire students to save some money at home by doing this as a homework project.



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THE SCIENCE BEHIND IT ALL

Plants need nutrients and sunlight to grow. They absorb nutrients in water through their roots and use chlorophyll in their green leaves to convert these nutrients into new cells. The green leafy plants in this experiment will regrow their leaves as long as the water around their roots is freshened every so often.

Plants store energy in their fruits and seeds to let them grow enough to start making chlorophyll so they can make their own food. Potatoes and sweet potatoes have enough energy stored in them to grow many new plants.

TIPS

- Using a narrower glass or jar will help the green vegetables stand up straight in the water. Alternatively you can use toothpicks or skewers to create a mesh for them to grow through and lay this over the mouth of the glass.
- If the leafy vegetables are not regrowing, students may not have left enough green material attached to the roots or may have damaged the roots. Try again with a new plant, leaving a bit more of the vegetable above the roots.
- Do not cut the potatoes into pieces smaller than a couple of centimetres squared, otherwise they will not have enough stored energy to grow a new plant.
- You can re-pot potato plants into larger pots to grow more potatoes from. You need to keep heaping more soil around potato plants as they grow upwards and outwards to produce more potatoes. Sweet potatoes do not need the same treatment as they grow down.
- Vegetables in the supermarket are often treated with chemicals to stop them from sprouting new shoots. Wash any root vegetables thoroughly to remove any such chemicals and so to encourage the vegetables to sprout. Storing them in a dark place will also help the sprouting process.

ANSWERS TO SOME TRICKY QUESTIONS

Where are the leafy plants getting their nutrients from? The nutrients are coming out of the water. Tap water is not pure water so it contains many dissolved nutrients that the plants can absorb through their roots.

Why does the water need to be changed every few days? The purpose of changing the water is to prevent bacteria or fungi from growing in the container and to keep providing enough nutrients for the plants to absorb (see the question above).