SOCIETY OF Biology

Biology: Changing the World

Teacher Guidance Notes

BBSRC bioscience for the future

heritage lottery fund

LOTTERY FUNDED

Contents

Introduction

Biology: Changing the World **is a project aiming to celebrate and inspire great biologists across the UK.**

The Society of Biology 15-month project started in January 2014. It was funded by the Heritage Lottery Fund and has been developed in partnership with the Biotechnology and Biological Sciences Research Council (BBSRC).

The poster accompanying this guidance pack tells the story of three great biologists and provides insight into how they changed the world. The notes that follow aim to give some more information on each of the individuals listed on the poster in addition to background information on the linked subject areas.

In addition to these notes, also included are two CLEAPPS approved practicals linked to the topics and engagement tools for use in the classroom.

A website (biologyheritage.societyofbiology.org) and mobile app (Biology: Changing the World) for iOs and Android are also freely available for use in addition to these resources.

The National STEM Centre has kindly developed a dedicated webpage to support teachers in delivering lessons and activities linked to the themes covered in this booklet. You can view a selection of online resources (www.stem.org.uk/cx3xv) that link to Mary Anning, CB Williams and Beatrix Potter.

Mary Anning

Born: 21 May 1799 Died: 9 March 1847

Mary Anning was a British fossil collector and dealer in the 19th Century.

Anning lived in Lyme Regis in Dorset and collected fossils from the Blue Lias cliffs where landslides exposed new fossils that could be collected.

Anning and her family collected fossils, in particular ammonites, and discovered some of the first complete skeletons of plesiosaurs, pterosaurs and ichthyosaurs. The work was dangerous and collecting fossils from cliffs following landslides put her life in danger at times. The fossils that Anning and her brother collected were sold and became the family business.

As a woman who wasn't from a wealthy family, Anning wasn't able to interact with the science community. At the time that she lived women couldn't vote or attend University so although she knew a great deal about the fossils she found, the wealthy gentlemen who brought her fossils would publish details of the specimens without mention of her.

With the strong links to fossils, rocks and evolution, her story can be used as a way to start teaching these topics, as well as social history.

Fossils and ammonites

Fossils are the remains of organisms from millions of years ago, although usually animals and plants, fossils can be formed from bacteria and fungi.

Through burial and being covered in mud, silt and sand, the organism is preserved and over time transforms into sedimentary rock such as sandstone.

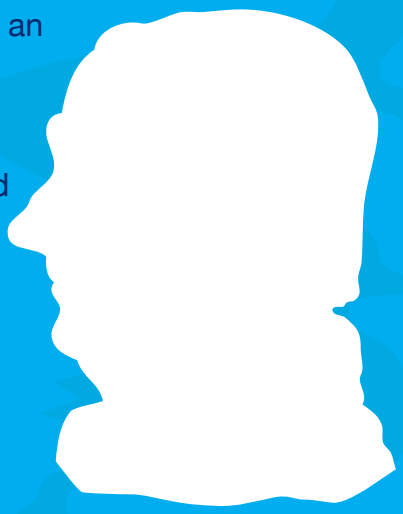
In most cases only the hard parts of the organism are fossilized. For animals these are the parts that contain biominerals, for example the shell, bones or teeth. Very rarely soft tissues can be fossilized, but when this happens the fossils don't keep their original composition.

After burial, the remains undergo chemical and physical changes. As solutions travel through the layers of rock, the minerals in the solutions fill the holes in the structure.

Related to squid and octopuses, ammonites are extinct organisms that lived at the same time as the dinosaurs. They have a flat spiral shell formed of chambers connected by a tube. The animals lived in one chamber and used the others to ensure flotation. They could vary greatly in size from tiny to as large as a human. Ammonites lived in the sea, so finding a fossil in a rock identifies the location as once being under the ocean.

C B Williams

Born: 7 October 1889 Died: 12 July 1981



Carrington Bonsor Williams, better known as C.B Williams was an English entomologist and ecologist in the 20th Century.

Born in Liverpool, he studied at Cambridge and spent time working at the John Innes Horticultural Institution. During World War 1 he trained with the London School of Tropical Medicine to help the Royal Army Medical Corps in finding pathogenic bacteria, and spent his time studying the stools of patients suffering from dysentery.

Following this he worked in Trinidad studying a pest of sugar cane, trying to carry out a plan to introduce a parasite to stop the pest, and prevent the destruction of the valuable crop.

Whilst travelling in the West Indies he noticed the flight patterns of insects, namely butterflies, and in particular he noticed that thousands of yellow Peirids flew every day for a fortnight. Williams encouraged his friends and colleagues around the world to record the migration of butterflies and to report these findings to him.

Williams gives a good example of early citizen science, and illustrates the benefits of using the power of people to obtain a large volume of data and become an expert on a particular topic.

Williams can be used to talk about insects, butterflies and identifying animals.

Citizen science

Citizen science has been around since the 1900s but has become increasingly popular in recent years with technology helping to improve how citizen science is carried out and driven an explosion in activity.

Citizen science can be individuals, teams or a network of volunteers working in partnership with professional scientists on a piece of scientific research. Using a large network of people allows a vast amount of data to be collected that wouldn't otherwise be possible. In recent years, mobile apps have allowed people to survey or report sightings with ease and has encouraged more and more people to engage with science.

Ongoing biological citizen science activities that students can get involved with can be found with a quick online search. The Society of Biology (www.societyofbiology.org) and People's Trust for Endangered Species (www.ptes.org) often have open projects that people can contribute too. Two long term projects are:

- Society of Biology's Flying Ant project
    - People are asked to report their sightings of flying ants over the summer months so that scientists can track 'flying ant days' over a number of years
- People's Trust for Endangered Species Mammals on Roads
    - Reporting any sightings of animals seen on roads between July and September (www.ptes.org/get-involved/surveys/road)

Citizen science is also popular across the other sciences, in particular for astronomy where the data that requires observation is so large.

Beatrix Potter

Born: 28 July 1866 Died: 22 December 1943

Beatrix Potter lived in the 19th and 20th Century and is known worldwide for her children's books. She had a great passion for natural science, drawn to their bright colours, Potter illustrated and drew mushrooms, becoming interested in how they reproduced. Her illustrations of fungi, and research into their reproduction, combined her love of nature and drawing, to scientific benefit. Potter spent time developing her scientific knowledge, learning about taxonomy and the names of different types of fungi. Her drawings were so accurate that they are still used today.

Potter developed theories about the reproduction of fungi and wrote a scientific paper about it, but being a woman needed a man to present her paper at a scientific conference. Her work is only now being properly evaluated and she received a posthumous apology from the Linnean Society for the sexism displayed in the handling of her research.

Potter also was a great preserver of nature and a conservationist. With profits from her books, she bought a number of farms in the Lake District and became an expert Herdwick sheep breeder, which helped to save the species from extinction. When she died, she left 4000 acres of land to the National Trust.

Beatrix Potter's love of nature was clear in all of her work, and her story can be used to link to topics such as classification of plants /animals / fungi / bacteria / protists (5 kingdoms), using identification keys, producing accurate scientific drawings and commenting on social history.

Mycology

Mycology is biology associated with the study of fungi (yeasts, moulds and mushrooms). These organisms have cell walls that contain chitin, making them different from plants (whose walls contain cellulose) and animals (who don't have cell walls).

Some fungi produce toxins, antibiotics and other metabolites and they play an important role as symbionts (organisms in a long-term interaction). Many fungi can break down organic molecules and play an important role in the global carbon cycle.

The British Mycological Society is an organisation that aims to promote fungal science, and has lots of information on fungi avaliable online (www.britmycolsoc.org.uk)

Practicals

Gopher Science Labs is an existing Society of Biology project that focuses on gaining practical experience.

The practicals 'How do butterflies drink' and 'Why do leaves change colour in Autumn' are CLEAPPS approved and have been included as they link to the work of C B Williams and Beatrix Potter.

Gopher Science Lab activities are designed to ease pupils' transition from primary to secondary education. Gopher Science Labs was created and developed by the Society of Biology in collaboration with the Biochemical Society. The Gopher Science Labs Wales resources were produced thanks to generous support from the Welsh Government's National Science Academy.

Gopher Science Lab Wales uses simple hands-on science activities designed to facilitate learning by primary aged children. Normal household items, familiar analogies, simple language and fun are used to encourage children's natural curiosity to find out how and why everyday things work.

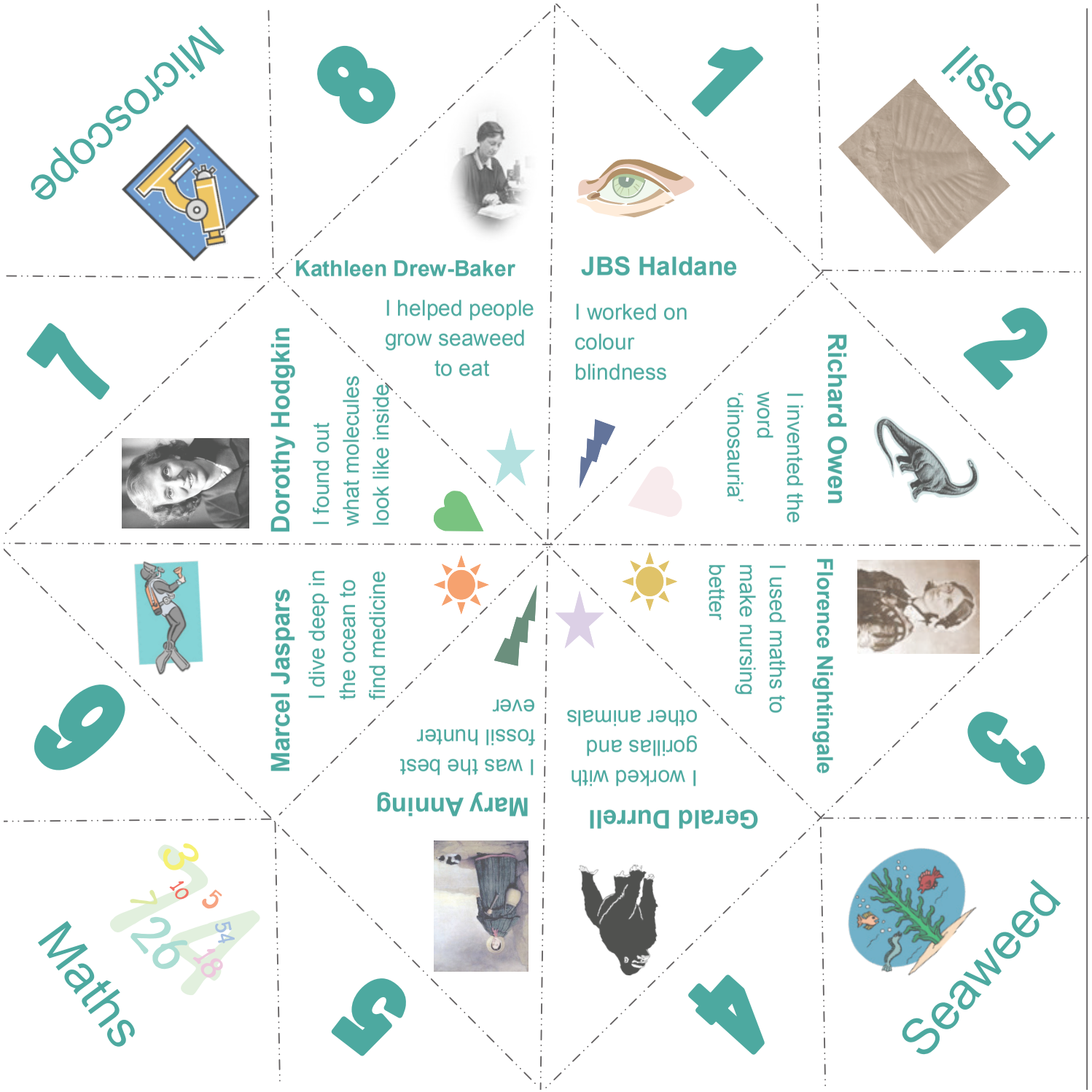
If you'd like more information on Gopher Science Labs, or how to register your interest in taking part in a session please visit our website (www.societyofbiology.org/gopher).

Fortune teller and matching pairs game

As part of Biology: Changing the World, we have designed a fortune teller and matching pairs game which have been used at public engagement festivals to great success. Both are copyright free and can be photocopied or printed for use in the classroom and beyond.

The full game can be played by creating the fortune teller, picking an individual and then timing how quickly people can find their person in the matching pairs game.

A blank version of the fortune teller has also been included to allow students to research biologists and create their own version.



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Fortune Teller How-To Make

1. Make sure your paper is face down. Fold your fortune teller along the four dotted lines so that the numbers appear in each corner of the square.
2. Turn the paper over. Bring each of the corners of the page in to touch the centre and fold. All you should see on the square is the eight numbers. This should make a square shape.
3. Now just fold in half horizontally. You should have pictures on each side of the fortune teller flaps.
4. Place your thumbs and forefingers under the flaps and start playing!

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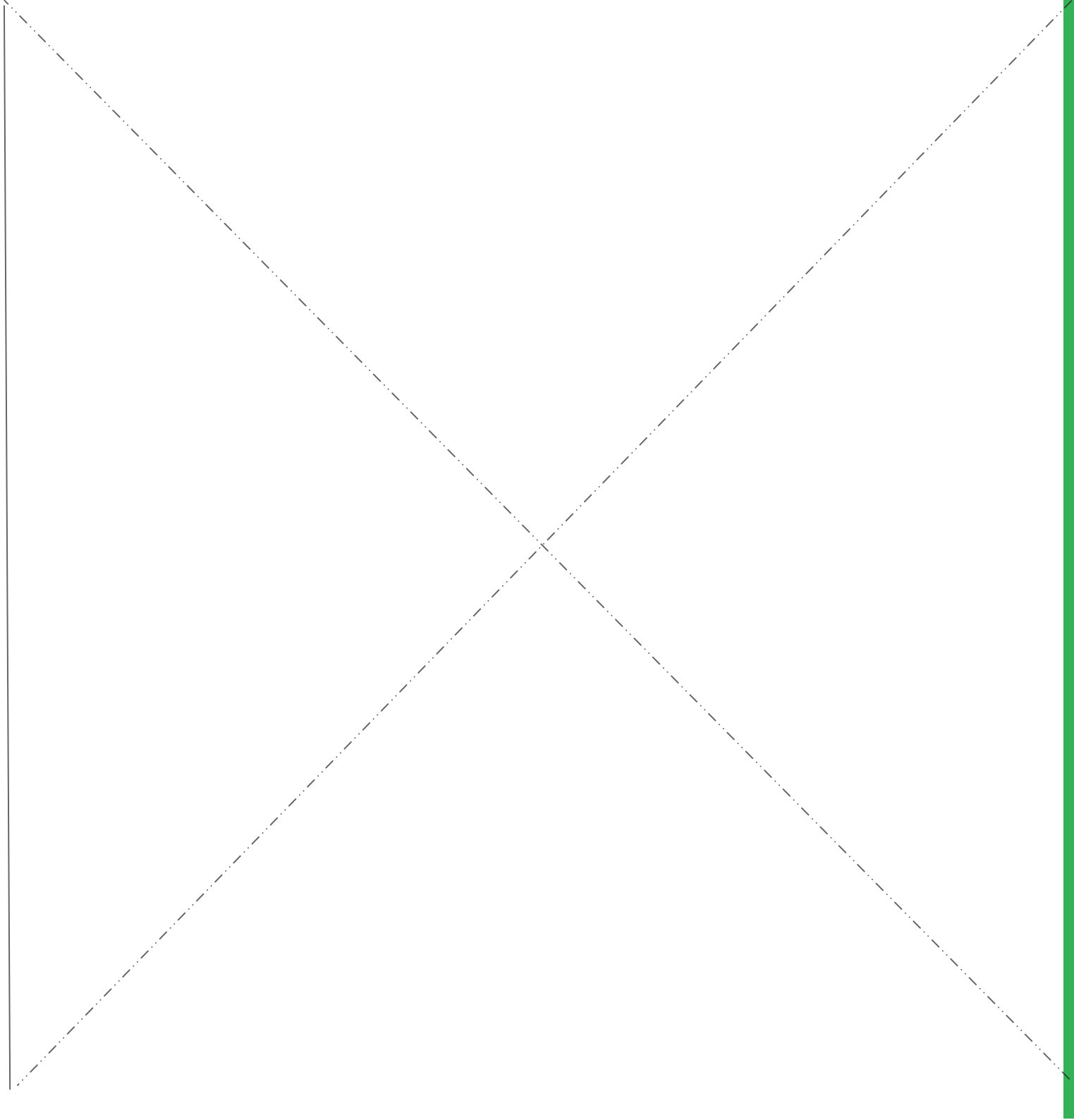
Fortune Teller How-To Play

1. With a partner take your fortune teller and let them pick one of the four starting squares
2. Spelling out each letter of the chosen word, move your fortune teller each time
3. Ask your partner to pick a number and then move your fortune teller the same number of times
4. Ask your partner to pick their final number, then move your fortune teller again
5. Your partner should now pick a number, and lift the flap to reveal their scientist
6. Finally switch roles and find your scientist!!

If you have time, you can then see how long it takes you to find this scientist in the matching pairs game. Look out for the symbol at the bottom of their segment!



I helped people grow seaweed to eat

I found out what molecules look like inside

Gerald Durrell

I worked with gorillas and other animals

Kathleen Drew-Baker

Dorothy Hodgkin

Richard Owen

I invented the word ‘dinosauria’

Marcel Jaspars

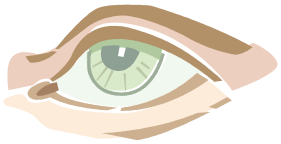
I dive deep in the ocean to find medicine

Florence Nightingale

I used maths to make nurs-ing better

Mary Anning

I was the best fossil hunter ever



JBS Haldane

I worked on colour blindness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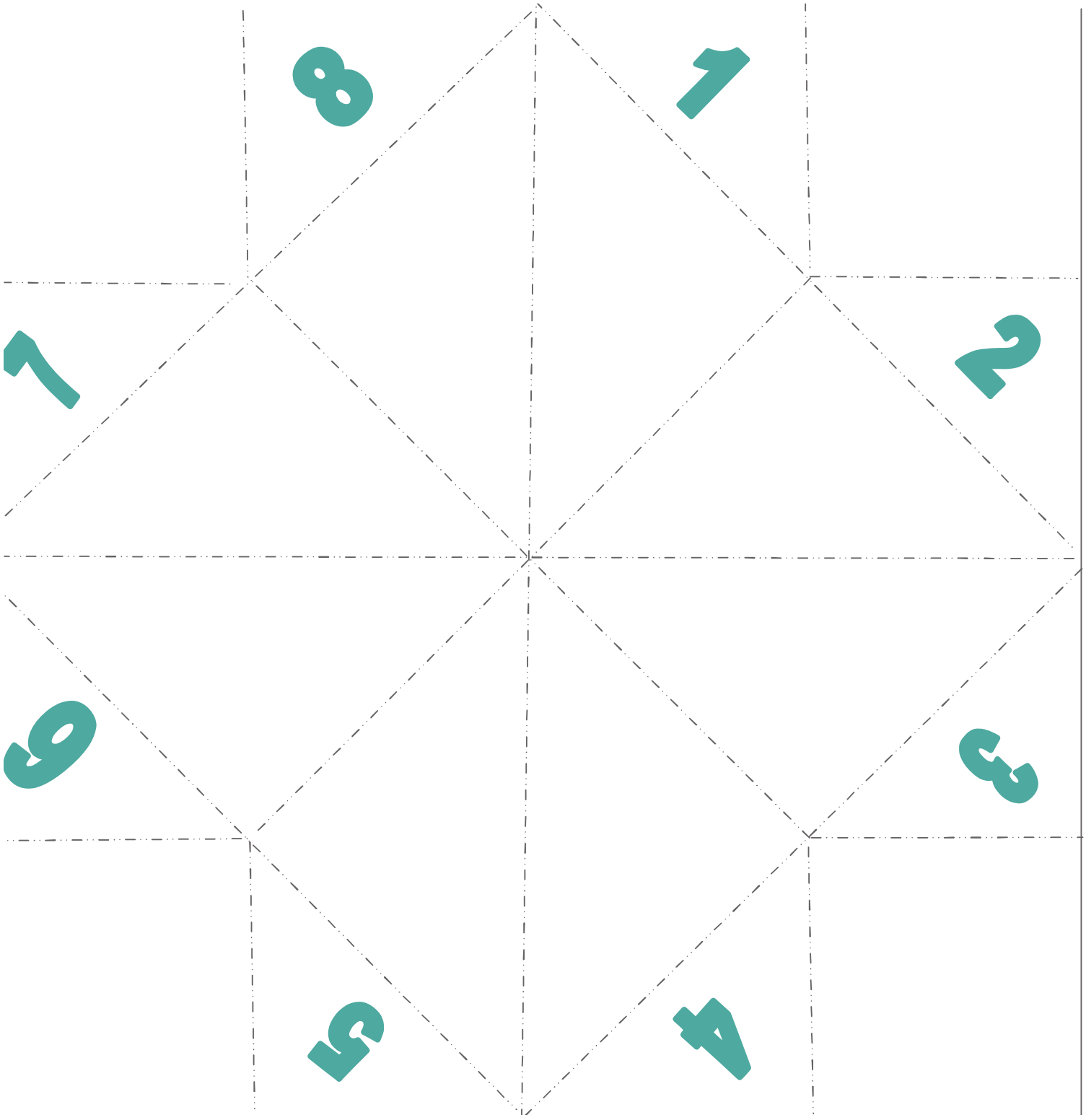

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Fortune Teller How-To Make Your Own

1. Research for some really great biologists in areas of biology that you are interested in. Why not look in your library, or visit our *Biology: Changing the World* website, or our mobile app.
2. Pick 8 biologists, then think of a sentence to describe what they did. On each of the 8 triangles in the centre square, put the name, sentence and a picture for each of your chosen scientists.
3. Think of four topics or themes that link to your scientists—maybe a type of animals or a place.
4. Write these four things on the corner squares and draw a picture to match
5. You are then ready to make and start using your fortune teller! Which scientist will you get?

How do butterflies drink?

This activity demonstrates the principles of capillary action, and explores how butterflies use capillary action to feed.

What's in the box?

3 types of drinking straw – wide, medium and narrow gauge

1 petri dish, sellotape, red food colouring and a felt-tip marker

What do you need?

Water

Try it!

Fill one of the beakers to the top with water (add red food colouring).

Sellotape all 3 straws together so that the bottoms are lined up.

Predict which drinking straw you think the water will rise up the most.

Place them all in the water, making sure they don't touch the bottom. Don't suck! Count to thirty.

Ask your partner to mark on each straw with a felt tip pen where the water reached. Measure the distance travelled.

Note down your result.

Questions to ask

In which drinking straw did the water travel highest?

Try to explain why you think that is.

What might this tell us about how butterflies 'drink'?

Explanation

The water travels highest in the narrow straw. Capillary action works because water is 'sticky'. When water hits the straw, adhesion occurs between the water and the straw surface so the water 'clings' to the straw. If the tube is very narrow then cohesion (where water molecules are attracted to each other) and adhesion combine to lift the water.

Butterflies 'drink' using a long tube-like mouthpart called a proboscis. The drinking straws mimic the butterfly's proboscis 'tube'. Different species of butterfly have different sized proboscises.
A butterfly uses both 'sucking' and capillary action to feed from different food sources.

Extension

Pinch your thumb and forefinger together under water. Remove them from the water, and very slowly pull them apart. You should see a small drop of water 'stuck' there (this tiny gap mirrors the smallest straw). Now, open the gap wider, what happens? Even though water is highly cohesive, it can't stick together in a big straw.

Explore other examples of capillary action in the real world, for example in plants, wax rising up a candle wick or even how paper towels absorb water.

Table

Type of straw	Distance travelled by water (mm)
Narrow	
Medium	
Wide	

Which straw did the water travel highest in?

Why do leaves change colour in the Autumn?

Teacher notes

This experiment will explore what pigments are present in green leaves and why leaves change colour in the autumn.

Learning objectives

- Discover what pigments are present in green leaves.
- Use chromatography to separate the pigments.

Nail varnish remover (acetone) is highly flammable. Ensure room has adequate ventilation, and avoid naked flames.

A teacher could handle the acetone but if pupils handle it then only hand out small quantities.

What's in the box

White coffee filter paper

Small container of nail varnish remover (acetone)

Small transparent beaker, pencil, scissors, cocktail stick

You will need :

- To provide fresh leaves (you could use fresh coriander or spinach or collect leaves)
- **Take care when selecting leaves. Many can be poisonous. Refer to CLEAPSS to check that leaves are safe to use.**
- Put a small amount of acetone into the test beaker (no more than 0.5cm high).
- Hang the filter paper into the beaker so it dips into the acetone (make sure the green spot is above the acetone).
- Now ask the pupils to watch what happens. It may take up to 10 minutes

Pupil notes (30-40 minutes)

This experiment will explore what pigments are present in green leaves and why leaves change colour in the autumn.

Predict

Discuss what you already know about leaves and their colours.

Predict what colours you think will be present in the leaves.

Try it!

Cut your filter paper into a strip roughly 2cm wide and 10cm long.

Draw a pencil line on your filter paper 2cm from one end.

Roll up and pinch a few coriander leaves between your fingers.

Start to rub the leaves into a small dot on the middle of the pencil line (you will need to make sure your leaves are squeezed tightly between your fingers so the dot remains small).

Build this dot of pigment up by rubbing a few times and letting it dry.

Wrap the other end of the filter paper around a pencil so it is secure (or poke a cocktail stick through) – this will allow you to hang the filter paper into the beaker.

Questions to ask

What happens to the filter paper when you dip it into the acetone?

What happens to your green pigment spot?

Why do you think the pigment travels up the filter paper?

Is green the only colour to show on the filter paper?

Explanation

A pigment is a natural colour found in plants. You should see the acetone rise up the filter paper and drag the green spot of pigment with it. You will notice that it separates into green and yellow colours. The yellow colour travels furthest.
Most leaves are green because they contain the pigment Chlorophyll. It is important in photosynthesis because Chlorophyll traps the light energy from the sun to make food for the plant.
Carotenoid pigments are also present in leaves. They are usually brown, orange and yellow colours, and help with photosynthesis as well as protecting structures in the leaf.

During the spring and summer, Chlorophyll usually hides the Carotenoid pigments, but during the autumn Chlorophyll starts to break down and is not replaced. The Carotenoid pigments become more visible, which is why you see the leaves change colour in the autumn.

Extension

Buying fresh leaves and herbs or using dried coriander leaves mean you can do this experiment in winter. During the spring and summer you may wish to collect leaves from trees in your local area. Some leaves will leave a good smudge of pigment on the filter paper, but you may need to cut and crush the leaves up with a pestle and mortar, a bit of sand for abrasion and the acetone to get your pigment for testing. Do different leaves contain different coloured pigments?

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Society of Biology
Charles Darwin House
12 Roger Street
London
WC1N 2JU
www.societyofbiology.org
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