Activities for STEM

(Science, Technology, Engineering & Maths)

LEAF Education
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Contents

Introduction

How can those of us engaged in farming and countryside education (farm educators and teachers in school) use activities inspired by food and farming to deliver Science, Technology, Engineering and Maths (STEM) subjects?

A conference was held in Hertfordshire at which attendees were able to learn from each other by sharing a variety of resources and hands on activities. The latter are presented in this booklet with thanks to:

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Gerry Blake, Institute of Physics
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Frances Harris, Kingston University
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Egg Science

Many schools hire incubators and hatch eggs in school as part of a life cycles topic. However there are several activities which can easily be organised which help learners understand more about how eggs 'work'.
The two activities here illustrate how to tell if an egg is fresh or not and what egg shells are made of. There is also a diagram of the structure of an egg which learners can see if an egg is broken onto a plate and some FAQs.
LEAF Education Consultants can usually put you in touch with someone who hires out incubators (and in some cases fertile eggs for hatching)
n.b. Anyone handling raw egg should wash hands thoroughly afterwards.

Resources – How to tell if an egg is fresh
Minimum of two eggs – one freshly laid (supermarket eggs are usually very fresh because there is such a sales turnover and poultry farms do not store eggs but move them to shops as soon as possible) and one at least three weeks old
2 empty clean jam jars (deeper than an egg) filled with cold water
2 clean plates

instructions

Put a fresh egg in one jar of water and an older egg in the other.

Egg shells are porous and absorb air. The air sac at the end gradually gets larger as the egg ages. The fresh egg will lie horizontal in the water and the older egg, with larger air space should tilt semi-vertical or even 'stand' upright in the water.

Ask the children why this happens – if they have already looked at the structure of the egg and its shell they may be able to work it out.

Break the eggs onto plates to see if they look the same – fresh eggs have plumper whites, older eggs have flat, watery looking whites.

How does a chicken make an egg?	Eggs form inside the chicken. It takes just 25 hours for an egg to form. The chicken lays a clutch of 5-9 eggs and then has a rest for 24 hours before it starts again.
Why are egg shells different colours?	The shell colour depends on the breed of the bird. For example Marans lay dark brown eggs ; Rhode Island Red eggs are a lighter brown and White Leghorns lay white shelled eggs.
What are *egg* shells made of?	Egg shells are made of calcium (chalk). Calcium dissolves in acid so it is possible to dissolve an egg shell in vinegar.
How old does a chicken have to be to make an egg?	Chicken usually start to lay eggs when they are between 16 and 21 weeks old - depending on the breed of chicken. Chickens can have a 5 - 10 years life span although commercial chickens are only kept on the poultry farm for a year. Chickens moult once a year.
How many eggs can a chicken lay in a year?	Chickens that are kept on poultry farms lay up to 320 eggs a year.
How does the chick get out of the *egg?*	The chick that has grown inside the egg uses a special bit on the end of its beak (called an egg tooth) to crack the shell so that air can get in and it can breathe. This is called pipping. The chick is not ready to hatch out of the egg then but will do so later on, once it has enough air in the *egg* to breathe.
What changes the colour of *egg* yolks?	Yolks are made into a darker yellow colour by the food that the chicken eats. Because some people think that darker yellow *eggs* are tastier, farmers sometimes add things like calendula petals to the chickens' food so they lay dark yellow eggs.
Are brown shelled *eggs* and dark colour yolks better for you and tastier?	The colour of eggs shells and yolks doesn't make a difference in the quality or taste of eggs. Some people think they look better so the supermarkets prefer to pay farmers for brown eggs with darker yellow yolks.
Remember - only the female chickens, also called hens, lay *eggs.* Chicks will only develop in eggs that have been fertilised by a cockerel. Poultry is the word for birds that we get food from: chickens, geese, ducks and turkeys.	

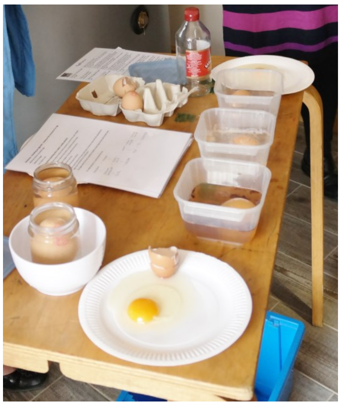
Resources – Dissolving an egg shell – looking at the structure of an egg

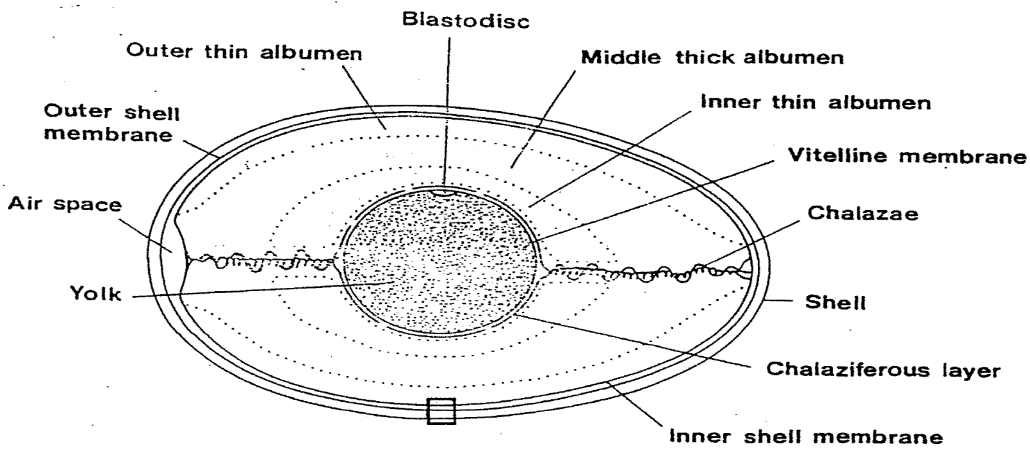
Minimum of four uncooked eggs
Bottle of vinegar
Four plastic tubs

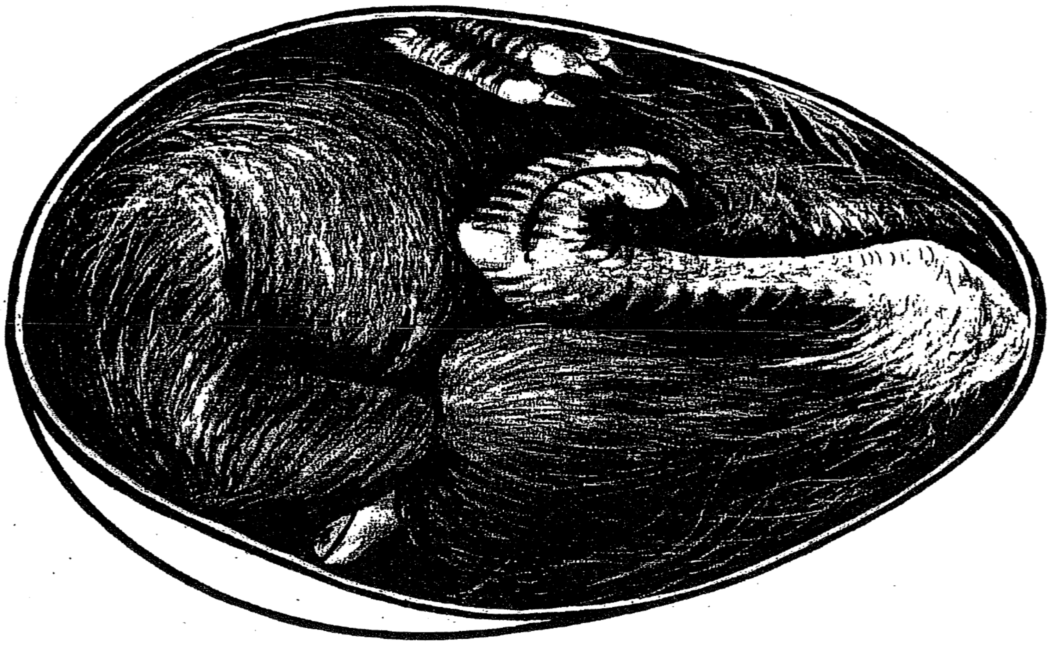
Instructions (warning, this is quite a smelly activity!)
Egg shells are made of calcium which dissolves in acid (in this case vinegar).
It takes about 3 days for the shell to completely dissolve away.
Set one egg in vinegar 2/3 days before the activity.
Set another the next day.
Set a third during the activity.
As the shell dissolves the layers peel away, it becomes quite soft and eventually the egg is just contained in its membrane.
The eggs need to be very carefully handled at each stage as they which break easily.

For older groups it is summarised like this:

Egg shell	+	Vinegar						
Calcium Carbonate	+	Acetic Acid	=	Water	+	Carbon Diox-ide	+	Calcium Ac-etate
$CaCO_3$	+	$2CH_3COOH$	=	H_2O	+	CO_2	+	$Ca(CH_3COO)_2$




Blastodisc
Outer thin albumen
Middle thick albumen
Inner thin albumen
Outer shell membrane
Vitelline membrane
Air space
Chalazae
Yolk
Shell
Chalaziferous layer
Inner shell membrane



Measuring the Thermal Properties of Farmyard Materials

Making sure farm animals are suitably housed throughout the year is key to ensuring their health and welfare. Farm buildings have developed significantly over recent decades to ensure that animals can be kept warm, comfortable, dry, and disease free. There is a range of materials used on the farm which have different thermal properties. This simple experiment will enable children to measure these properties in the classroom.

Resources
Wool; Lollipop Sticks (wood); Straw; 4 x tin cans (empty and clean); Glue; 4 x Thermometers; Record sheet and pen; Kettle and water; Masking tape

Instructions
1. Ensure the tin cans are clean and have no sharp edges around the top. Cover the top rim only with masking tape if there are sharp edges.
2. Using glue, cover each of the tin cans with a different farmyard material so that you have the following: - wood - straw - wool - tin (bare can)
3. Line the cans on a tray and fill each to ¾ full with boiling water.
4. Put 1 thermometer in each of the cans and record the temperature on the record sheet.
5. Take another reading from each thermometer after 10 minutes.
6. Repeat for 1 hour
7. Once all six recordings have been taken, the data can be used to rank the farm yard materials according to their thermal properties.

OPAL Environmental surveys

Open Air Laboratories (OPAL) is a Citizen Science project which has developed ecological surveys to address current environmental research questions. These aim to encourage people to engage with nature and environmental issues while also involving the public in scientific research activities and encouraging them to feel part of a wider scientific community.

Resources and space required
OPAL Citizen Science environmental surveys are available to download at http://opalexplorenature.org/surveys

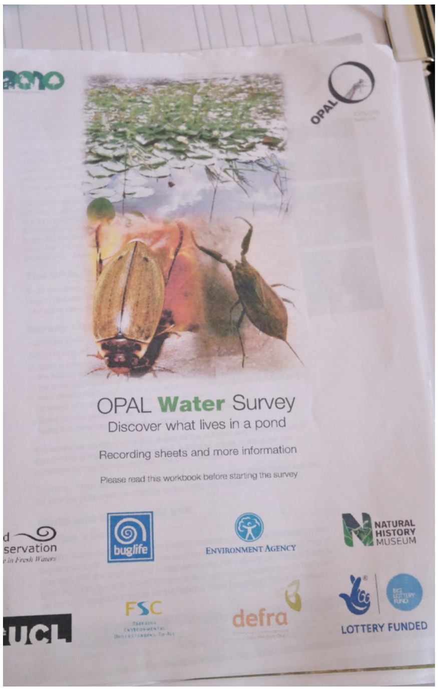
There are seven surveys. Some are more suitable for primary school children than others. “Bugs Count” and the “hedgerow” survey are highly recommended. The soils and earthworms activity is interesting, but children will probably only get as far as digging for worms and looking at them through a magnifying glass. OPAL has now developed a simplified guide to earthworms for use with school children. “Bugs Count” can be done within school grounds, and is quite suitable for urban or rural environments.

“Soils” requires the ability to dig holes in soil to find, count and identify earthworms.

“Biodiversity” involves a survey of a hedgerow, and is suitable for any sort of hedge, whether urban or rural.

Instructions

Excellent instructions are provided with each survey. Be sure to read through several times prior to beginning with children. There are lists of equipment required, health and safety advice, and excellent guides to identify trees, bugs, works etc.
How you use these surveys is up to you. You can just do what the survey pack suggests, or you can use the survey to suit your needs. Teachers can develop activities using the OPAL surveys as a basis. For example, teachers might make a science day of the activity, or a “mini-unit” within the term’s teaching activities. They can be used to make an exciting start to a unit (e.g. habitats). Or they can be used for simple science studies: e.g. comparing the results of the Bug Hunt on wet and dry days, or at different times of the year; comparing the number of earthworms to be found in different areas or soils. For KS2 or older children, the OPAL surveys provide a scientific protocol for ecological monitoring which could be used when developing further science investigation.

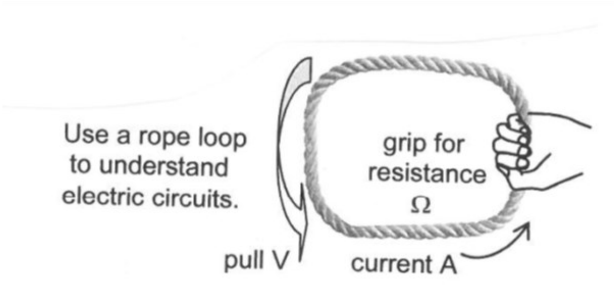


Potato batteries and LEDs

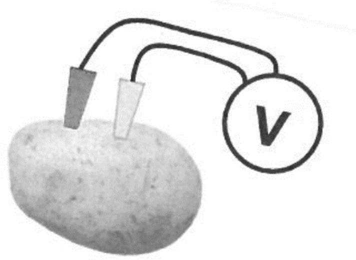
Can a potato battery light an LED (light emitting diode)?
1. Using a variable power unit and a multimeter on the 20V scale, measure the voltage needed to light a red LED.

2. Can a 1.5V AA battery light a red LED?

If not why not?



3. Can a 3.0V AA battery light a red LED?

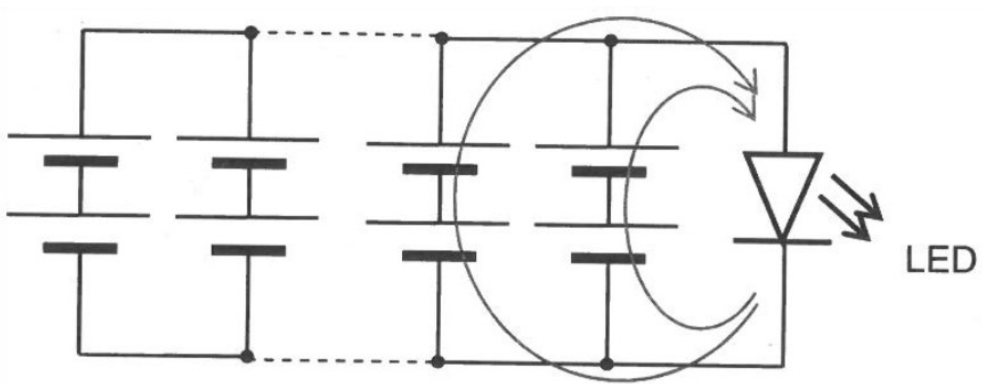


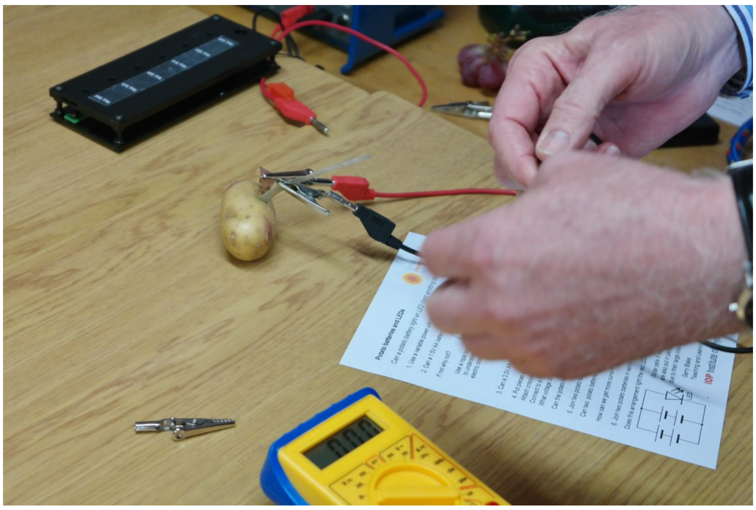
4. Put pieces of copper and zinc into a potato.
Attach crocodile clips. Connect to a multimeter.
Repeat with copper and magnesium electrodes.
Which makes the better potato battery?
Can the potato battery light a red LED? If not, why not?

5. Join two potato batteries in series to increase the voltage.
Can two potato batteries in series light the red LED? If not, why not?

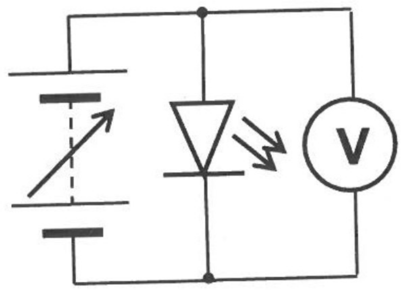
6. How can we get more current? (Clue: blow through straws.)

7. Can you join two potato batteries in series with another two or more in parallel? Does this arrangement light the LED?





Notes:



1. Diodes only conduct one way.
The long leg of an LED is positive.
It needs under 1.1V to light the red LED.
2. No, due to the large internal resistance of the AA battery, which limits the current flowing through the LED.
The larger the grip (resistance) the smaller the current flowing.
3. Yes.
4. Copper (+) with magnesium (–) gives a larger voltage, but it cannot light the LED due to its large internal resistance.
5. No, due to its large internal resistance, which limits the current.
6. Blowing harder would work but be like adding another potato battery in series.
This would increase the internal resistance.
Try blowing through two straws in parallel.
Try blowing the current twice that through one straw.

7. Two batteries in parallel may just light the LED, but four in parallel would be better as it would allow even more current to flow.
Solar cells in series give high voltage but, due to their large internal resistance, are also put in parallel to provide enough current to make devices work.
Extra: Try running a solar motor with the no 7 potato battery arrangement.
Repeat with two solar cells in parallel

Gerry Blake
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Sugar Awareness quiz:
Watch out, watch out, there's sugar about!

We need a small amount of sugar in our diets and we all love a sweet treat now and then - but sugar is also to be found in some surprising foods.
In this quiz children are asked to match some popular, supermarket shelf food products with the sugar quantities they contain. This activity will support food and nutrition projects in school and help in a small way with the work being done nationally to reduce obesity levels through increasing awareness and improvements in diets.
GDA (Guideline Daily Amounts) Sugar:
Adults: about 50g (about 10 teaspoons)
World Health Organisation recommend should be 6 teaspoons
Children, depends on age and how active, but less than 6 teaspoons is the recommendation.

Resources
1 can of "Coke" + plastic bag containing 36g of sugar (label shows only amount of sugar in bag)
Tin of beans – + plastic bag containing 24g of sugar (label shows only amount of sugar in bag)
Tomato Ketchup – + plastic bag containing 4g of sugar for one serving or 88g sugar for bottle (labels show only amount of sugar in bag)
2 Digestive biscuits – +plastic bag containing 4g of sugar for 2 biscuits or 68g sugar for packet (labels show only amount of sugar in bag)
Pot noodle – + plastic bag containing 6g of sugar (label shows only amount of sugar in bag)
Crunchy nut corn flakes – +plastic bag containing 12g of sugar for one 30g serving or 176g sugar for box (labels show only amount of sugar in bag)
Mars chocolate bar (51g) – + plastic bag containing 32g of sugar (label shows only amount of sugar in bag)
4g sugar = 1 teaspoon = 1 sugar cube

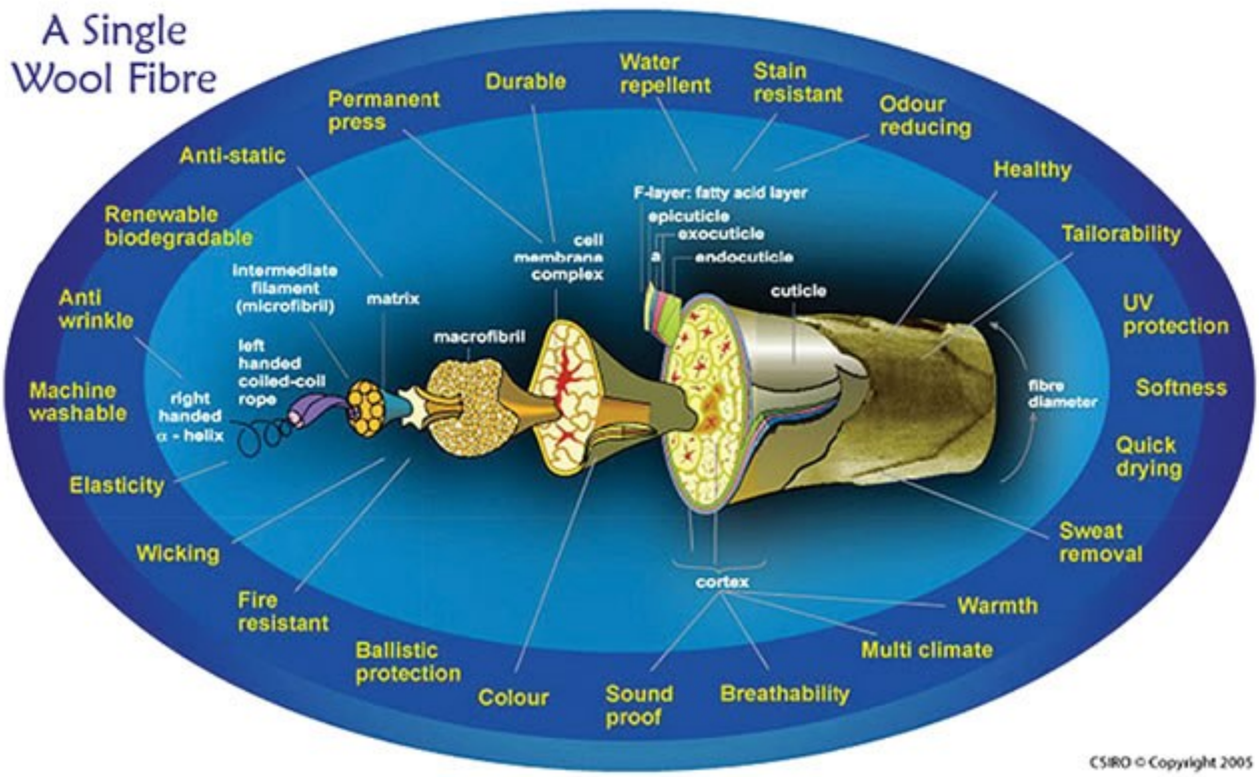
Instructions
The food packets and plastic bags are put out randomly on a table and the people doing the quiz are asked how much sugar they think is contained in each pack and to match the bags to the pack.

In addition:
Ask them to look at the ingredients lists on the pack and check how much sugar they contain.
Add an additional sugar free product (check the label carefully!) and an empty bag.
Have a discussion about why sugar is even added to savoury food products.
Note the difference between Silver Spoon sugar, made with sugar beet grown in the east of England, and other brands, for example Tate and Lyle, made from cane sugar grown in warmer climates. Silver Spoon sugar packets explain how the sugar has been produced.
If you can get hold of a sugar beet (October – March only) try eating some raw, making sugar beet crisps or making sugar crystals (chopping and boiling the beet in water and allowing the resulting liquor to crystallise).

Wool science workshop – making felt

A felt making activity can be found in the LEAF Education Rural Crafts booklet which is one of several resources booklets available on the Countryside Classroom website www.countrysideclassroom.org.uk

Further information about the structure of wool fibre follows.



http://www.soulcomfortsheepskin.com

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LEAF Education

Cuticle On the outside of the wool fibre is a protective layer of scales called cuticle cells. They overlap like tiles on a roof. The exposed edges of the cells face away from the root end so there's more friction when you rub the fibre in one direction than the other. This helps wool expel dirt and gives it the ability to felt. Wool felts when fibres are aligned in opposite directions and they become entangled.

The scales have a waxy coating chemically bound to the surface. This stops water penetrating the fibre but allows absorption of water vapour. This makes wool water-repellent and resistant to water-based stains.

Cortex The cortex – the internal cells - make up 90% of the fibre. There are two main types of cortical cells – ortho-cortical and para-cortical. Each has a different chemical composition. In finer fibres, these two types of cells form in two distinct halves. The cells expand differently when they absorb moisture, making the fibre bend - this creates the crimp in wool. In coarser fibres, the para-cortical and ortho-cortical cells form more randomly so there's less crimp.

Fibre crimp makes wool feel springy and provides insulation by trapping air.

Cortical cell The cortical cells are surrounded and held together by a cell membrane complex, acting similarly to mortar holding bricks together in a wall. The cell membrane complex contains proteins and waxy lipids and runs through the whole fibre. The molecules in this region have fairly weak intermolecular bonds, which can break down when exposed to continued abrasion and strong chemicals.

The cell membrane complex allows easy uptake of dye molecules.

Macrofibril Inside the cortical cells are long filaments called macrofibrils. These are made up of bundles of even finer filaments called microfibrils, which are surrounded by a matrix region.

Matrix The matrix consists of high sulphur proteins. This makes wool absorbent because sulphur atoms attract water molecules. Wool can absorb up to 30% of its weight in water and can also absorb and retain large amounts of dye. This region is also responsible for wool's fire-resistance and anti-static properties.

Microfibril Within the matrix area, there are embedded smaller units called microfibrils. The microfibrils in the matrix are rather like the steel rods embedded in reinforced concrete to give strength and flexibility. The microfibrils contain pairs of twisted molecular chains.

Twisted molecular chain and helical coil Within the twisted molecular chains are protein chains that are coiled in a helical shape much like a spring. This structure is stiffened by hydrogen bonds and disulphide bonds within the protein chain. They link each coil of the helix, helping to prevent it stretching. The helical coil – the smallest part of the fibre – gives wool its flexibility, elasticity and resilience, which helps wool fabric keep its shape and remain wrinkle-free in use.

Metadata *Published:31 May 2010 Copyright:The University of Waikato*

Image from http://www.tafaforum.com/felting-techniques-on-tafa/ Lots of lovely inspiration for felting projects on this forum.
Wool Tops for felt making http://www.worldofwool.co.uk/products/99/dyed_wool_tops_and_fleeces.htm

Further ideas?

FACE is always keen to hear about new activities that help young people to learn in exciting, innovative ways.

If you have any suggestions for STEM related activities, please let us know so that we can share your expertise!

Contact enquiries@face-online.org.uk