Cheese

Images and Lesson Plan

Key Stage 2

A bit about SAW....

The Science, Art and Writing (SAW) Trust is an international science education charity that breaks down the traditional barriers between science and the arts. SAW lesson plans use themes and images from science as a starting point for scientific experimentation, art and creative writing.
Using the cross-disciplinary SAW approach, our lesson plans are accessible to individuals of varied interests and learning styles.

The following lesson plan is designed to be delivered across an entire school day but can be adapted into separate sessions.

This lesson plan was designed to be part of the Lunchbox Science series and was developed with support from scientist, Dr Dunkin Gaskin (Institute of Food Research), writer Mike O'Driscoll and artist Théodora Lecrinier.

Dr Duncan Gaskin
Institute of Food Research

A laboratory-based research scientist at the Institute of Food research, over the last 20 years Duncan worked on a variety of projects from improving washing powders and cloning plant genes for improved flavour compounds to developing novel genetic tools for identifying important food poisoning bacteria.
In 2015 his research focused on how and when one of the nastiest of these bacteria produces its toxin.

Duncan enjoys public engagement and outreach events and has been involved in visits, talks and running hands-on activities with school children of all ages and the public. He has even dressed up as an *E. coli* bug!

Cheese

Learning Objectives

This lesson is intended to introduce the process of cheese making.

Core curriculum areas; Science, Maths, English, Art & Design
Other areas that could be linked to; History, Geography

Included in this lesson pack:

- **Lunchbox Science Cheese Lesson Plan**
- **Lunchbox Science Cheese accompanying PowerPoint**

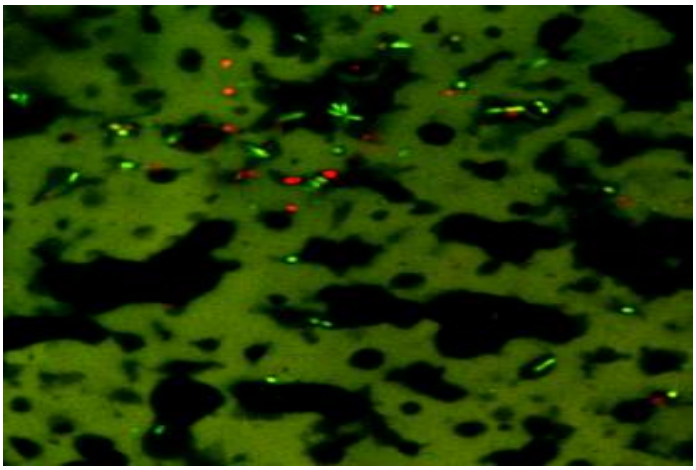
Key vocabulary for the day:

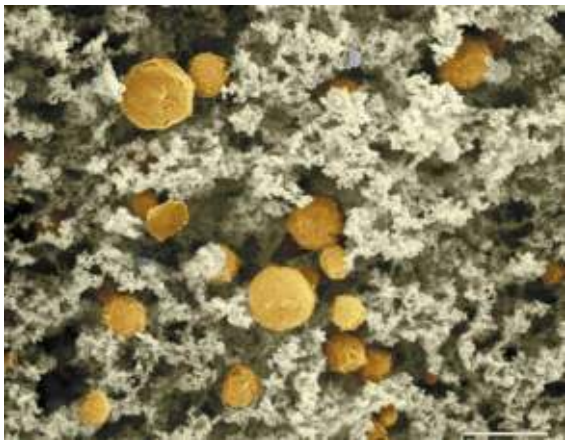
Bacteria	These are living single-celled things that live both inside and outside of other things. Some can be harmful while others are beneficial.	*Curds and Whey*	Products of cheese making. Curd is the curdled solid lumps, whey is the liquid by-product.
Coagulation	The action or process of changing a liquid to a solid.	*Fat*	A naturally occurring, oily substance.
Acidification	The action or process by which you make something more acidic.	*Protein*	An essential part of all living things, especially as structural components.
Pasteurise	A process undertaken to help remove harmful substances, usually with the use of heat.	*Structure*	The construct or arrangement of parts of something complex.
Rennet	Traditional rennet is made from enzymes from an un-weaned calf's stomach, but plant-based rennet is now commonly made from thistle, nettle and artichoke.	*Mozzarella*	A firm white Italian cheese traditionally made from buffalo or cow's milk, commonly used on pizza.

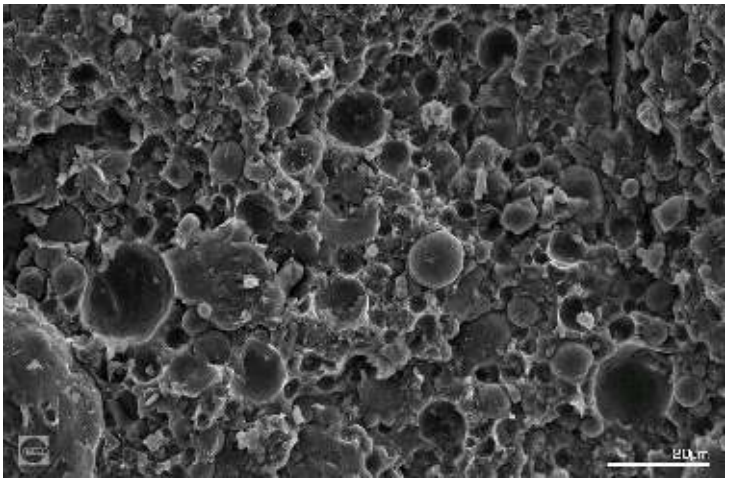
Cheese

Images

- The following images should be used throughout the day to provide a link for the cheese topic.

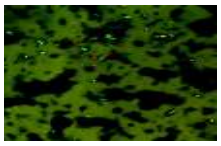






Cheese

1



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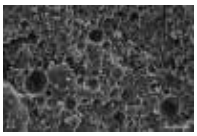

6

1 Before the invention of cooling systems, cheese had to be preserved naturally and so many cheeses contained edible moulds that grew through the cheese and prevented growth of any harmful bacteria or moulds. Blue Stilton is an English cheese that gains its characteristic strong smell and taste from an edible blue mould (*Penicillium roqueforti* and *Penicillium glaucum*).
Coyau / Wikimedia Commons / CC-BY-SA-3.0
https://commons.wikimedia.org/wiki/File:Blue_Stilton_07.jpg

2 Viability staining showing a cluster *Bifidobacterium*-like bacteria cells in Cheddar cheese ripened for 2 months.
By Dr Mark A.E. Auty, Teagasc Food Research Centre, Ireland

3 Whole milk coagulated for cheese production. Fat globules (yellow) were retained in the coagulum for Scanning Electron Microscopy by fixing the curdled milk using imidazole-buffered osmium tetroxide. Two streptococci (blue) from the starter bacterial culture may also be seen. By Miloslav Kalab, Agriculture and Agri-Food Canada. CC-BY-4.0
http://www.magma.ca/~scimat/Cheese.htm

4.Cows eat grass and produce milk for their calves because their young stomach isn't able to digest grass.
Public Domain. By nicoleGOR, Pixabay.
https://pixabay.com/photos/calf-cow-udder-farm-agriculture-4813198/

5 Milk splashing out of a glass captured with a camera using fast shutter speed. Milk is the raw product for any cheese. Milk contains a lot of water with many tiny protein and fat molecules, giving milk its typical bright white colour.
CC-BY-2.0 Tim Fields
https://commons.wikimedia.org/wiki/File:Milk_Splash_created_with_a_Cherry.jpg

6 The structure of cheese using a very powerful electron microscope.
Dr Mark A.E. Auty, Teagasc Food Research Centre, Ireland

The Science Activity (~1 hour and 30 minutes)

Objectives

Key Stage 1:

- Asking simple questions and recognising that they can be answered in different ways
- Observing closely, using simple equipment
- Using observations and ideas to suggest answers to questions
- Measure and record mass/weight and capacity/volume

Lower KS2:

- Asking relevant questions and using different types of scientific enquiries to answer them
- Setting up simple practical enquiries
- Making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment, including thermometers
- Reporting on findings

Upper KS2:

- Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary
- Taking measurements, using a range of scientific equipment, with increasing accuracy and precision
- Recording data and results of increasing complexity

Use the cheese images and accompanying PowerPoint to introduce the children to the science topic and continue with the science activity.

Science Activity: Making Mozzarella

Ingredients (per group):

1 litre full fat milk	(Skimmed or semi skimmed will not do as the fat is needed for the cheese)
30ml lemon juice	(For convenience use supermarket pre-squeezed juice, but if time allows freshly squeezed is more fun)
5ml Rennet	(Lakeland's Essence of Rennet & 5ml measuring spoon)

This activity works best when the milk is at room temperature. We suggest removing the milk from the fridge prior to the session.

Cheese

Equipment (per group):

2 litre plastic pot or jug	(plastic pot capable of holding 1200-2000ml)
1 litre plastic measuring jug	
Disposable plastic or paper cup	
Plastic sieve	(supermarket value fine sieves are fine)
2 Plastic spatulas or spoons	(must be strong)
1 plastic plate	(Disposable paper OK but plastic plate is best)
~500ml ice cold brine	(most supermarkets sell bags of ice-cubes)

An alternative to using a sieve is to use a clean (preferably white) sock, one per group. This allows the children to squeeze the whey from the curds instead of using the sieve. However, as the mixture is heated, we recommend using caution when using a sock as it could become hot!

Equipment (general):

Thermometer(s)
2 x water baths, one at~35ºC and one at ~55ºC
Measuring cylinder or jug capable of measuring ~40ml
At least one microwave, the more the merrier!
A shop bought mozzarella for comparing

Plastic gloves, not essential, but advisable as they will be handling the cheese.

Plastic cool boxes can be used or large stock pans capable of holding the plastic pots containing the milk so they don't float away or fall over with enough water to surround them. Borrow lab water baths from a high school science department or even buy a Sous Vide water bath cooker for approximately £60. You can use just one bath set at ~50ºC, but two is better.

Alternatively, cheese-making kits can be purchased from:
www.thecheesemakerschoice.co.uk

Important: Scientists do not eat their experiments! Professional cheese makers work in clean, sterile environments. They are very careful when handling the cheese so that they don't contaminate it with bad bacteria. The classroom is not really a clean environment and there will be bacteria and mould in the air and on surfaces that could end up in your cheese.

Cheese

Method:

1. Pour 1 litre of milk into your plastic pot.
2. Warm the milk to ~30°C by standing your pot in the water bath
   Check the temperature is reached using the thermometer
3. Take your pot out and gently stir in the lemon juice
4. Return your pot to the ~30°C water bath and **leave for 10 minutes**

<u>The temperature of the water bath should be monitored to make sure it doesn't go above 35°C, or below ~30°C - add hot or cold water to the bath if necessary</u>

? Is the milk changing? Check the colour, the smell and the consistency.

5. After 10 minutes put your pot in the hotter water bath
6. Add ~40ml cold water to your plastic cup and mix in 5mls of rennet
7. Take your milk pot out of the water bath and gently stir in the rennet-water mix
   Return your milk pot to the ~55°C water bath, **leave for 10 minutes**

? How does the milk look now? Check the colour, smell and consistency.

The milk should have **congealed** (become semi-solid).
The jelly bit is called the **curds** and the liquid is called the **whey**.

8. Remove your pot from the water bath and using a spatula, try to push the curds away from the side of the pot. If it doesn't separate from the edge cleanly, return the pot to the 55°C water bath for a further 5-10 minutes
   Remove the pot and use the spatula to test the curds as before.

9. Put the sieve over the top of the 1 L measuring jug.
   Pour the curds and whey into the sieve (or sock) and move the curds about gently with the spatula to allow all of the whey to drain through.
   Keep straining until as much whey as possible has drained off. If the sieve gets blocked tip the mix back into your pot and scrape the mesh clean before repeating.

<u>Record the volume of whey in the jug to work out fat percentage of your cheese later.</u>

Cheese

10. Tip the curds out of the sieve onto your plastic plate. Microwave the curds until hot. (Ideally this needs to be as hot as possible, but not hot enough to burn. Remember the inside of the curd might be hotter than the surface when microwaved).
11. Use the spatula to knead (squash) the curds.
    More whey will separate out so pour it off the plate into the jug.
12. Fold the curds into themselves and repeat the kneading. The curds will become a solid mass and can be kneaded by hand if not too hot.
13. Pull the ball of curds so that it stretches out. Once you have stretched the curds out a few times you can divide the mass into 4 balls.
14. Add some ice-cold brine (salt water) to the plastic pot and drop the mozzarella balls in.
15. Leave for a few minutes and then place the mozzarella on a plate.

? How does your cheese compare to the shop bought Mozzarella?

What is the fat content: <u>We assume there's no fat left in the whey, it's all in the curds.</u>

You started with 1 litre of full fat milk that contains 3.5% fat, that's 35g fat.

Q1. Work out the total volume of liquid you started with (milk & lemon & rennet mix)

Q2. Take the volume of whey collected in the jug away from this.

Q3. Divide the starting amount of fat by the answer to Q2 and times by 100.

This gives you the percentage of fat in your cheese.

Cheese

Activity notes for teachers

Important! We would recommend telling the children that this practical is a science experiment, not a cooking lesson and therefore we will not be eating the cheese we make. Cheese tasting is used later in the day and so the children will get to eat some cheese, but this will be from a shop and will have been made in sterile conditions. It is helpful to inform the class that microbes such as bacteria and fungi are everywhere and circulate in the air. Whilst this doesn't typically cause us any ill effects, we always make sure kitchen surfaces and utensils are kept clean to avoid contamination and so cooking is best done in a kitchen.

1. Pasteurisation

Pasteurisation aims to reduce the number of pathogenic microorganisms by heating the milk for a short time. The milk we buy in supermarkets is already pasteurised and has an extended shelf life.

2. Acidification

The first step in our experiment is to acidify the milk to about pH 4-5. Lemon juice is high in citric acid, which lowers the pH and doesn't alter the flavour of the cheese. Cheese producers use acids or bacterial fermentation to acidify milk on a large scale. A similar but uncontrolled process happens with spoiled milk. Lowering the pH destabilizes the fat globules in the milk so that the proteins begin to interact with each other, forming a gel matrix.

3. Incubation

We incubate the acidified milk at a higher temperature to speed up the process of protein denaturation. Acid and heat change the structure of the milk proteins (protein denaturation) and make them easier to separate during the next step.

4. Making curd

Rennet is a complex of enzymes used to curd milk. A specific enzyme (Chymosin) cuts the milk protein (Casein) into smaller fragments. The protein network can no longer hold the water droplets and separates into curds and whey. A sieve or cloth separates the fat-protein mixture from the water fraction.

Rennet is produced in the stomachs of mammals that obtain nutrients by eating plants and digesting them by fermentation in a specialized stomach prior to digestion, in partnership with specialized gut bacteria. Fermentation is the process by which microorganisms get energy from the environment and these biochemical pathways existed long before we took

advantage of their waste products such as when using yeast for making bread or the bacteria that produce lactic acid to make cheese.
Therefore, rennet for cheese-making was typically sourced from the stomachs of young animals as a by-product from butchers. However, the demand for cheese is too high to use rennet purely from this source and there is also demand for vegetarian, kosher and halal varieties. Rennet substitutes can be sourced from plant and microbes but these enzymes can produce side reactions that lead to undesirable tastes.

Since 1990 industry has used bacteria, fungi and yeast that have been genetically modified to contain the rennet genes from mammals which enable them to produce the chymosin enzyme during fermentation. The chymosin is then isolated from the fermentation broth and the genetically modified microorganism killed to leave a fermentation-produced chymosin (FPC) that does not contain genetically modified organisms. During the cheese-making process most of the chymosin is retained in the whey and at most, may be present in the cheese in trace quantities. According to estimates, between 80 and 90 per cent of cheese in the USA and Great Britain is manufactured using chymosin produced using gene technology. In fact, approval for use exists in almost all western and eastern European countries (except France and Austria) as well as in the USA, reference http://www.gmo-compass.org/eng/database/enzymes/83.chymosin.html.

5. Cooking the curd

Heating the curd to a high temperature in the microwave makes the protein fragments more flexible and creates a mesh of protein similar to a loose ball of wool.

6. Shaping the mozzarella

The final step in our cheese experiment is to shape and lop off a ball of cheese. Mozzarella is kept in brine because it dries out quickly as you will notice in your experiment when you leave the cheese.

Calculating the fat content (optional):

You started with 1 litre of full fat milk that contains 3.5% fat, that's 35g fat.

Q1-Total volume of liquid was 1075 mls (1 L milk, 30ml lemon, 45ml rennet water).

- The volume of whey collected in the jug was 900mls (for example)

Q2-Take the volume of whey collected, away from the total volume 1075-900=175ml

Q3 - The percentage of fat is now 35/175x100=20%

The calculation not only shows how cheese ends up with so much fat, but also allows them to check that their curds have a similar percentage fat as shop bought mozzarella

The Writing Session (~1 hour and 30 minutes)

Objectives

Lower KS2:

- Gain, maintain and monitor the interest of the listener(s)
- Composing and rehearsing sentences orally (including dialogue), progressively building a varied and rich vocabulary and an increasing range of sentence structures
- Read their own writing aloud, to a group or the whole class, using appropriate intonation and controlling the tone and volume so that the meaning is clear.

Upper KS2:

- Identifying the audience for and purpose of the writing, selecting the appropriate form and using other similar writing as models for their own
- Selecting appropriate grammar and vocabulary, understanding how such choices can change and enhance meaning
- Using expanded noun phrases to convey complicated information concisely

The aim of the session is to use the concepts, experiences, images and new vocabulary from the science as a starting point for writing poetry. This gives children a chance to make a personal response using their best, descriptive language to create a first draft. Spelling, grammar and further editing of work can be done later. The following session was developed by Mike O'Driscoll for the Kinsale Junior School project on the theme of cheese.

Spread the science images out on all tables and begin with a short recap on things the children may remember from the science session. Write down any interesting words or facts the children remember on the board and refer to the word bank you created during the science activity introduction. You may want to ask the children how many types of cheese they could name and then ask the class what words they would use to describe the taste of cheese to someone that had never tried it before.

Introduce the children to the idea that they will be writing a poem. Remind them of the type of poems that they may have done previously in class for example acrostic, haiku, narrative poetry etc. We also believe it's important to make them aware that poems do not need to rhyme.

Read one (or both) of the cheese inspired poems to the class.

Cheese

The Big Cheese: Blue Stilton (Mike O'Driscoll June 2015)

I am the big cheese around here
I've been the kingpin for quite some time
I'm a blue-veined number one, son of a gun.
Sitting here just waiting for my moment.
I know they are coming for me soon
With their big curved knives
And their cheese wires
And their crackers and chutney.
If they think it's gonna be easy
Then they got me all wrong
Sure, I've gone a bit crumbly at the edges
Anybody would, sitting here in the cooler alone
In the dark, day after day, week after week,
Just waiting for them to come.
But they'll find out soon enough
I'm stronger, tougher, harder to handle
Than I ever was before.
I can smell my power and strength.
I'm no soft touch, cream cheese kind of guy.
No sirree, I ain't the kind of cheese you stick fruit in.
I'm the real thing. The original.
Extra mature, that's what they call me.
Like I said, I'm the big cheese around here.
Nobody better forget that.
I deserve some respect.
I'm a cheese of distinction.
I got taste, real taste.
When the time comes I'll be putting up quite a fight
Sure, they can cut me
Burn me under the grill
The can grate me to pieces
Smear me with pickles
It doesn't matter what they do
They'll see I can still bite back
Maybe they'll find out they've bitten off
More than they can chew.
I'm ready.
Come and get me,
If you dare!

Cheese

A Visit to the Cheese Shop (Mike O'Driscoll June 2015)

Good morning may I have some cheese,
Tell me, what kind have you got?
Why Sir, I beg don't be a tease
You can see there's quite a lot.

We've hard cheese and soft cheese
We've Cheddar, Cheshire, Leciester, Jark,
We've Wenselydale and look at these
Cheese that glows in the dark!

We've blue cheese and red cheese and cream cheese too
We've got cheese that comes from France
We've green moon-cheese for you
There, now that should make you dance.

So many of our cheeses come from overseas
We've Camemberts and Pont l'Eveques
There's something's sure to please
Why not try this Gruyere? Perhaps some Bleu de Gex?

We've Swiss cheese and Dutch cheese
There's Edam and there's Gouda
We've really got so much cheese
I could hardly shout it louder.

We've mild cheese and ripe cheese
And cheese that's really smelly
Some could bring you to your knees
But still satisfy your belly.

You've really got me started now
There's something I must say
All this cheese comes from the cow
We should thank her every day!

Actually, come to think of it, not quite all.
Some is made by buffalo, or yak, or even goat,
Those taste sensations will not pall
They'll tantalise your throat!

Some cheese you know is full of fat
So be careful when you munch

Cheese

As long as you're aware of that
It's good to eat for lunch.

It's terrific too on toasted bread
A marvellous pizza topping
Once cheesiness gets inside your head
There really is no stopping.
Some people like cheese upon their steak
And others in a sauce
For dessert there's always cheese cake
With strawberries of course!

The cheeseman said in a quieter voice
Sir, I have set out my stall
So kindly please now make your choice.
And I replied, "Yes please, I'll take them all!"

Ask the class after each one, if they like it, what their favourite line is and explain that when writing poetry choosing every single word very carefully is important. Give the children plain paper to jot ideas, word-pairings and to draft lines on. When they feel ready, give them lined paper to write their poem.

Walk around the room supporting the writers and spotting promising lines that can be read out to the class. We suggest allowing approximately 40 mins for the children to work quietly on this.

For the final 15 minutes have the children take it in turns to stand in front of the class to perform their poem. Make sure all are met with applause.

Example poems

Mozzarella Monster *by* ***Aretha****, age 9*

I'm startled when I get a glimpse at these,
Cheddar cheese squishy feet,
Creamy white with turquoise veins
Popping out of the skinny waist,
Kind of stinky crumbly Edam cheese chest,
Slouchy, hung-back Feta cheese arms with disassembling fingers,
Thick, slimy Cottage cheese neck,
Oh but where's the head?
Oops I think I might have eaten it!

Cheese

From Escape the Fridge *by* ***Mollie****, age 8*

I'm the stringy cheese, the stringiest of all.
I'm soft, sweet and long,
On a mission to escape, to escape the cold.
Like the North pole.
Let them know I'm going.
Stilton, Edam.
Don't forget Feta.
All my good friends.
Goodbye.
Open the Fridge,
Let me go.

Super Cheddar *by* ***Anya****, age 9*

Me, Blue Cheese, and my buddy Red Leicester,
We are the worst cheeses in the fridge.
No one messes with us,
No one eats us.
Oh no! Is that Cheddar I see?
He is the nicest cheese in this fridge.
You can run away, you can scream.
But you can't defeat the Cheddar cheese.
They call him Super Cheddar.
He saves the goodie cheese.
We don't stand a chance against Cheddar cheese.
We have no choice but to sit here and mould in the fridge.

The Art Activity – Cheese (~1 hour and 45 minutes)

Objectives

- Produce creative work, exploring their ideas and recording their experiences

Key Stage 1

- To use a range of materials creatively to design and make products
- Become proficient in drawing, painting, sculpture and other art, craft and design techniques
- Evaluate and analyse creative works using the language of art, craft and design

Key Stage 2

- To improve their mastery of art and design techniques, including drawing, painting and sculpture with a range of materials [for example, pencil, charcoal, paint, clay]

Art activity one – Blind taste test

The art session aims to extend the theme of cheese textures with new approaches.

Materials

- Blindfold
- Selection of cheeses (we recommend mozzarella, a soft cheese, Emmental and stilton, dairy free alternatives work well too)

Explain to the children that they can use a range of senses (vision, smell, taste, touch) to fully observe and inspire their artwork.

Have the children work in pairs or groups and take it in turns to try the cheeses.
By excluding their visual sense this enables the children to explore the cheeses without any expectations of how the cheese might feel, smell or taste. After hand washing, have them choose a cheese each and describe it using their remaining senses.

Art activity two – Microscopic Structures

This activity is used to inspire the final piece of artwork.
Show the class the microscopic images 2, 3 and 6. Ask them to use their creativity and imagination to draft out a proposed sculpture using coloured pens and paper, inspired by the structures and shapes they can see in the images.

Art activity three – Clay sculptures

The final learning activity is to build a clay model of the sculpture they drafted, making use of various tools to build in texture, inspired by the combination of the blindfold activity and the microscope images.

Useful links

Organisations

www.sawtrust.org	The Science Art and Writing trust
www.leafuk.org	Linking Environment And Farming

Resources

www.countrysideclassroom.org.uk	Countryside Classroom Resources
www.images.norwichresearchpark.ac.uk	NRP Image Library
www.thecheesemakerschoice.co.uk	Cheese making kits

A new way of looking at the world

www.sawtrust.org