SSERC Bulletin

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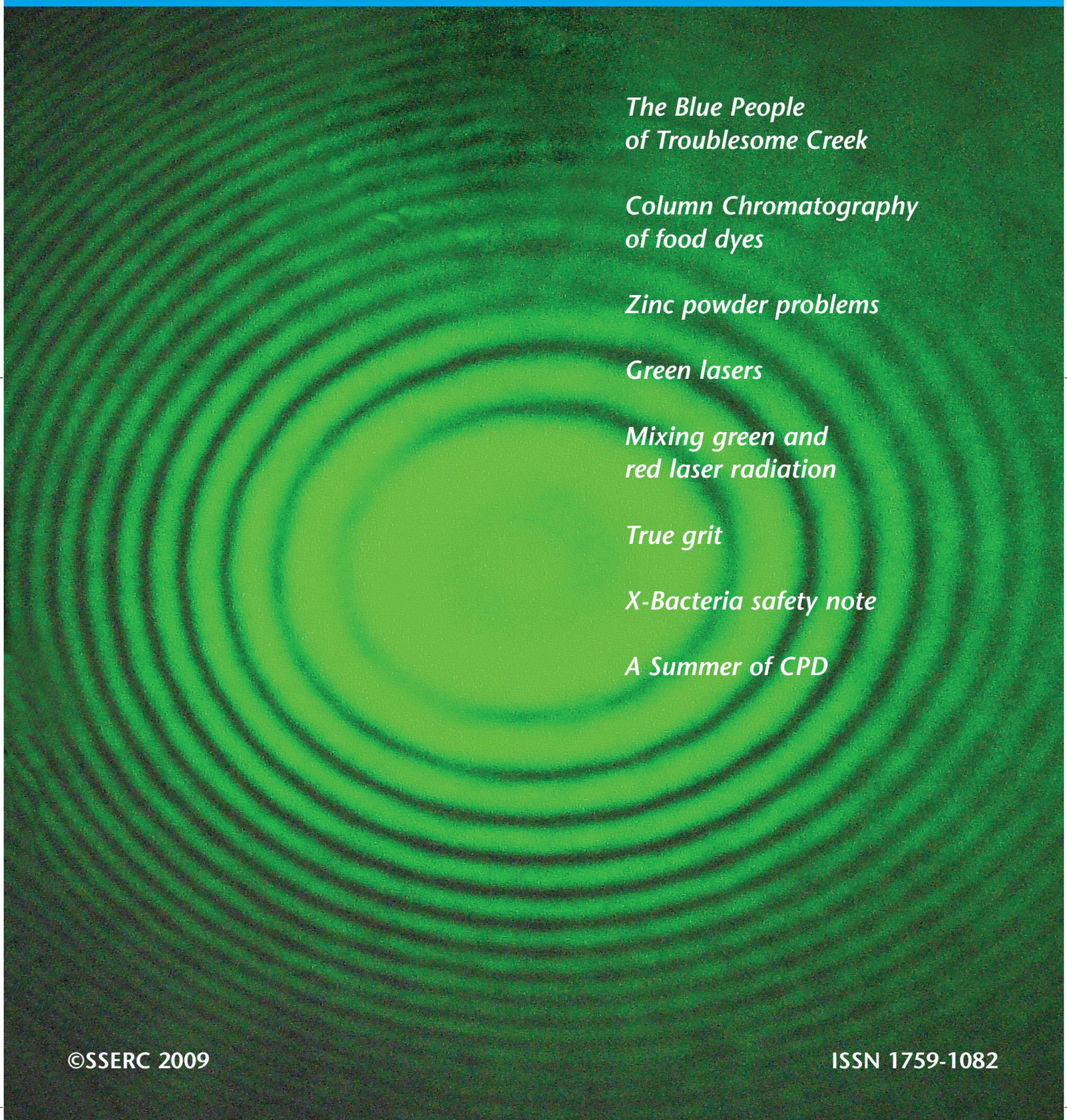
Ideas and Inspiration supporting Science & Technology for all Local Authorities



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The Blue People of Troublesome Creek

Background

The physical sciences are well-resourced in terms of ideas for demonstrations which can be used to support teaching and learning in the classroom [1-5]. Ramette [6] introduced the phrase 'exocharmic reactions' to describe reactions and demonstrations, particularly those in chemistry, which fascinate, allure or delight the observer. Despite their undoubted value as pedagogic aids, collections of demonstrations for use in biology teaching are not widely available. One might argue, therefore, that we need some exocharmic demonstrations for biology. Whilst the example that follows is not new, a minor tweak to the standard experimental conditions used means that we have produced a 'nice' demonstration to support delivery of the biology curriculum.

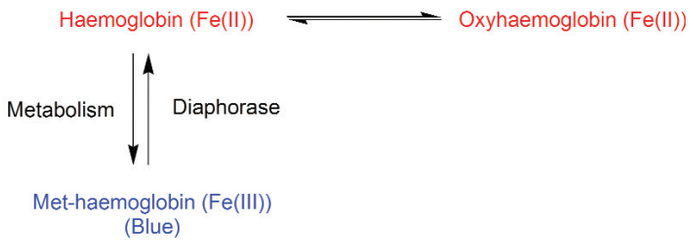
In the early part of the 19th century (1820) a French migrant, Martin Fugate, settled in a small hamlet called Troublesome Creek in Kentucky and married a local woman, Elizabeth Smith. Not much is known about their lives before they met but after their marriage they produced seven children and somewhat remarkably, and not a little worryingly, four of these children had blue skin at birth. As we will see later the affected children were suffering from a recessive disorder which led to a build-up of *methaemoglobin* which is itself blue in colour. One can only begin to imagine the social challenges faced by the family under such circumstances. What is clear is that as a result of their condition, the family was shunned by society and over time this led to a number of consanguineous marriages/relationships (mainly at the cousin to cousin level although it is reported that one of the four 'blue children' married his maternal aunt) with the result that the disorder was confined to a few families.

What are the consequences?

Under normal circumstances the iron atom in haemoglobin (Hb) is in the Fe[II] state. Under those conditions Hb is able to transport both oxygen and carbon dioxide. Oxidation of the Fe[II] to Fe[III], through normal metabolic processes which happen in each and everyone of us, leads to the formation of methaemoglobin (MetHb) which, as stated above, is blue in colour. Accumulation of MetHb leads to a gradual increase in 'blueness' which is most noticeable in the skin and extremities. MetHb is unable to transport oxygen and unless reduction back to Hb occurs, a number of problems arise. Sufferers of the condition are often chronically anaemic since they will have a need to continually replace MetHb with newly synthesised Hb. Additionally, the reduced capacity to transport oxygen around the body may lead to excessive fatigue and lethargy. It is probable that those with the condition would have found physical activity difficult and this may have led to a reduction in income in what would have been difficult financial times.

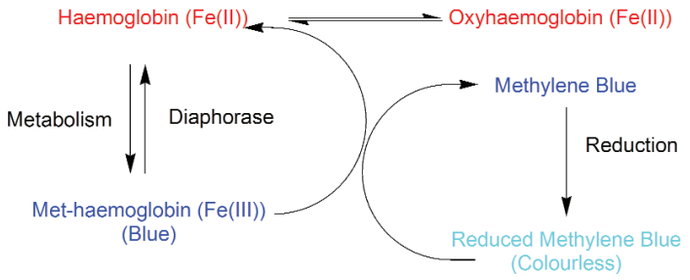
Why is the skin blue?

In the overwhelming majority of people the enzyme *diaphorase* is able to reduce the iron in MetHb to regenerate Hb. The Blue People of Troublesome Creek suffer from a recessive genetic disorder characterised by a failure of diaphorase production and/or its function. The condition leads to the accumulation of MetHb with consequent blue coloration of the skin. A word of caution - there are a number of websites which purport to show photographs of the Blue People of Troublesome Creek but one needs to be cautious since the first ever recorded colour photograph was not taken until 1861 (see http://en.wikipedia.org/wiki/Color_photography). The schematic below summarises the metabolic processes in play:



How is the condition treated?

In the 1960s Madison Cawein, a haematologist at the University of Kentucky, recognised the cause of the condition and decided to offer treatment through injections of methylene blue (MB). There is, of course, something wonderfully counter-intuitive about using a blue 'medicine' to treat a blue condition. The rationale behind the treatment is that to reduce the MetHb requires an electron donor. MB, when ingested into the body, is rapidly converted to a reduced form. This reduced form of MB, which is colourless, can take the place of diaphorase and convert MetHb back to Hb and as a result of that process the MB is oxidised back to its blue form. The MB is then, once more, reduced and is available for reaction with MetHb. Thus:



For each oxidation/reduction cycle of a MB molecule one MetHb molecule is converted to Hb. Once all the MetHb has been removed we finish up with a situation in which the following are present:
Excretion of reduced MB through the urine results in its reaction

with oxygen thereby re-forming oxidised MB. Consequently the urine of those treated turns blue on exposure to the atmosphere - a major side-effect of the treatment.

The Demonstration

The so-called blue bottle demonstration has been reported in the literature on a number of occasions [7-12]. In its 'standard' form a mixture of glucose and sodium hydroxide, in the presence of MB, is allowed to stand for a few minutes after which time the solution goes from deep blue to colourless. The chemical reactions taking place in the bottle need not concern us here but suffice to say that the MB is reduced to its colourless form. The blue bottle is often used in kinetic studies as well as in 'chemical shows' where audiences are often intrigued by the change in colour.

Some years ago Fenster *et al.* [10] suggested that the blue bottle was a good demonstration to use to describe the use of MB in the treatment of the Blue People. Typically one would prepare glucose and sodium hydroxide solutions both of which contained MB. At 'show-time' equal volumes of these solutions are mixed together and the colour change awaited. A minor problem of this approach is that the solution goes colourless rather than back to a pink/red colour as one might expect if Hb (in its Fe[II] state) was present. So, we set about making a minor adjustment to the experimental set-up such that the colour change is blue ➛ pink/red rather than blue ➛ colourless. The following stock solutions were prepared:

- glucose (0.24 mol dm^{-3}) in distilled water
- sodium hydroxide (1.0 mol dm^{-3}) in distilled water (CORROSIVE)
- methylene blue (2.7 x 10^{-2} mol dm^{-3}) in distilled water (Solid MB is HARMFUL if swallowed, if inhaled and in contact with skin. Severe eye IRRITANT.)
- Rose Bengal (1.0 x 10^{-2} mol dm^{-3}) in ethanol.

Into the lid of a Duran bottle (1 dm^3) place 4 drops of the Rose Bengal solution and allow the solvent to evaporate to dryness (at room temperature this may take several hours). Equal volumes (400 cm^3) of the glucose and sodium hydroxide solution are placed in beakers and 4 drops of the MB is added to both solutions. The contents of both beakers are poured into the empty Duran bottle and the lid treated with Rose Bengal is added. The bottle is shaken vigorously making sure that the Rose Bengal is washed from the lid. At this stage the solution will still appear blue in colour but over the next few minutes will change to a pink/red colour mimicking the colour changes described when MB is used to treat the Blue People of Troublesome Creek.

To complete the demonstration it is worth reminding your students that oxidised MB is blue in colour. Of course the Duran bottle now contains reduced MB and exposure to oxygen in the atmosphere will convert MB to its oxidised form (as happens during urination). So the final part of the demonstration is to pour (we recommend from a height of about 50 cm – be careful the solution also contains sodium hydroxide so you should avoid contact with your skin and wear indirect vent goggles) the red/pink solution into a clean beaker (1 dm^3). The solution during this process will turn blue – definitely exocharmic!

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References

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5. Taylor, C. (1988), *The Art and Science of Lecture Demonstration*. Adam Hilger/Institute of Physics Publishing Ltd., Bristol.

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9. Engerer, S.C. and Cook, A.G. (1999), The blue bottle reaction as a general chemistry experiment on reaction mechanisms. *J. Chem. Ed.*, **76**, 1519-1520.

10. Fenster, A.E., Harpp, D.N. and Schwarcz, J.A. (1988), A well-known chemical demonstration to illustrate an unusual medical mystery. *J. Chem. Ed.*, **65**, 621.

11. Vandaveer, IV W.R. and Mosher, M. (1997), The blue bottle revisited. *J. Chem. Ed.*, **74**, 402.

12. Wellman, W.E. and Noble, M.E. (2003), Greening the blue bottle. *J. Chem. Ed.*, **80**, 537-540.

Additional Resources

The Blue People of Troublesome Creek – an article by Cathy Trost based on a publication in Science in November 1982. http://www.rootsweb.ancestry.com/~kyperry3/Blue_Fugates_Troublesome_Creek.html (accessed March 10th 2009).

The Blue People of Troublesome Creek – a PowerPoint file giving background details and the reaction schematics in this article. Available at http://www-saps.plantsci.cam.ac.uk/docs/ppts/BluePeoplepb.ppt (accessed March 10th 2009)

Column chromatography of food dyes

Introduction

Many pupils are familiar with the technique of paper chromatography in its various forms either with inks or food dyes, but few are aware of column chromatography. The idea for trying out this experiment came about as the result of a conversation with an Edinburgh chemistry teacher (thanks Fiona).

This method uses a length of soda glass tubing approximately 20 cm long, or a glass Pasteur pipette as the column. Both columns give very good separation.

The stationary phase is starch and the mobile phase is water. The column is easily packed with a slurry of starch powder in distilled water in a few minutes.

This technique could be used to support learning outcomes **SCN 2-16a** - *I have participated in practical activities to separate simple mixtures of substances and can relate my findings to my everyday experience* and **SCN 3-16a** - *I can differentiate between pure substances and mixtures in common use and can select appropriate physical methods for separating mixtures into their components.*

The ability to show separate dyes in separate containers can show how this technique can recover the constituent parts – a task which is a little more difficult with paper chromatography.

Chemicals

- soluble starch powder
- distilled water
- dry fine sand
- food colouring (ensure there is a mixture of colours in it as indicated by different E numbers)

Equipment

- clamp stand, bosshead and clamp
- syringe, 10 cm^3
- glass tubing, inside diameter 5 mm, approx. 20 cm long
- plastic tubing approximately 20 cm long of internal diameter to fit the syringe and glass tubing
- spatula
- beakers, 100 cm^3, x3
- pasteur pipettes, x3
- stirring rod
- cotton wool

Preparing the column

Prepare a slurry of starch in one of the beakers by adding approximately 4 cm^3 of distilled water to 3 g of the starch powder.

Insert a loose plug of cotton wool in one end of the column. This should be tight enough to hold the stationary medium in the tube but loose enough to allow liquid to pass through it easily.

Clamp the column vertically in the clamp stand and place a beaker under it.

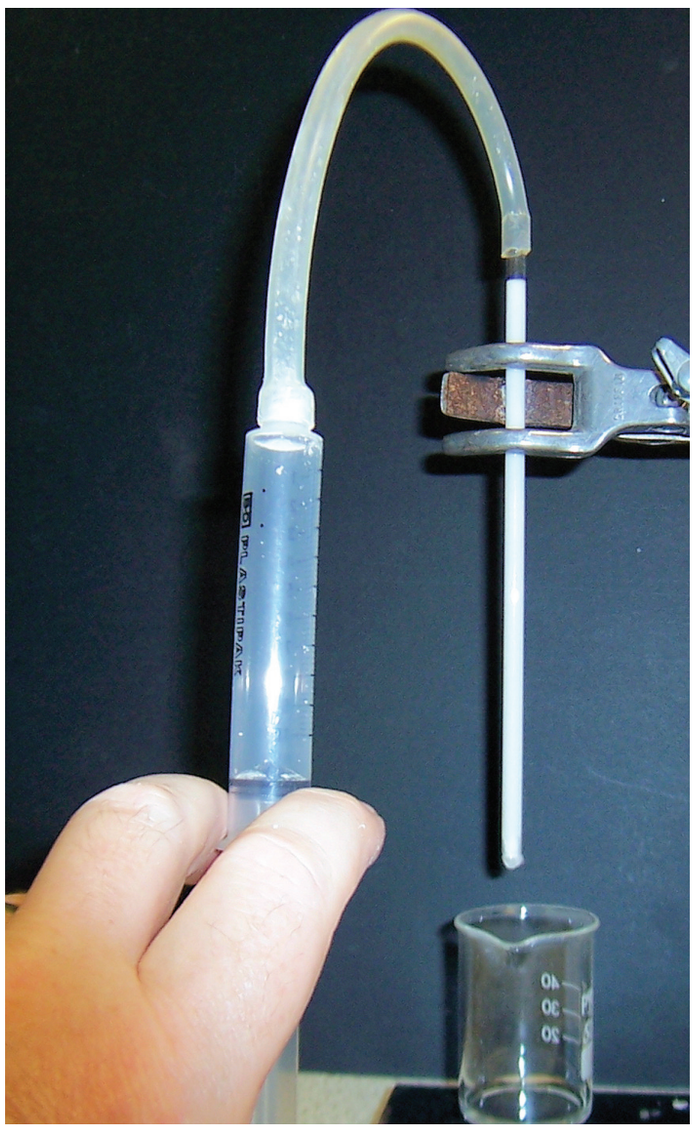


Figure 1 *- Packing the column*

Using a pipette, carefully fill the column with the slurry until it is 1 cm from the top.

Attach the short plastic tubing to the end of the syringe and ensure the plunger is withdrawn.

Attach the other end of the tubing to the top of the column and slowly and gently push in the plunger. The increase in pressure in the column will help to pack the starch and you will see drops of water drain into the beaker. Hold the plunger in for a few minutes until the air pressure in the column reduces. If you release the plunger too quickly the air rushing back into the syringe from the column can disrupt the packing of the stationary starch phase which can lead to uneven separation. Repeat the pressurising 2-3 times more until the column is packed but still damp.

You may also have to add more slurry until the starch is about 2-3 cm from the top when finished. (Figure 1)

Method

The syringe and plastic tubing is used to introduce air into the column to aid the separation of any dyes in the food colouring. Because pressure is used in this way, the colours separate very quickly within minutes and the technique can be called *Flash Chromatography*. Since the system is not sealed, the increase in pressure is never great enough to cause the glass to crack.

Use the second pipette to introduce one drop of the food colouring to the column. Try to pour this carefully down the side of the glass so as not to disturb the starch.

With the plunger withdrawn and the plastic tubing attached to the column top, gradually press in the plunger until you feel some resistance and the dye is forced into the stationary phase. Note: It is not necessary to force the plunger completely in.

Hold the plunger in for a few minutes. When the pressure on the plunger is released, it should remain more or less in position.

Add a few millimetres of the sand to the top of the column.

Remove the tubing from the column and fill it to the top with distilled water (the eluent). Again, try to trickle this down the side of the glass onto the sand so as not to disturb the layer.

Reattach the tubing and pressurise as before until the water has been forced into the stationary phase.

Repeat with further additions of water as required.

We used Super Cook black food colouring from Tesco® which according to the label comprised three separate dyes:

- E102 – (Tartrazine, a yellow coloured dye),
- E122 – (Carmoisine, a reddish coloured dye) and
- E143 – (Green S).

If desired, the addition of more eluent and the pressurisation can be repeated until the colours have been forced through the entire column (Figures 3a & 3b)

After discarding any water which has been forced through, continued application of pressure enables the coloured dyes to be collected in separate small sample tubes. The addition of a few cm^3 of distilled water to these makes the colours more obvious.

If a few cm^3 of each of the dyes are recombined in another small sample tube, the original black colour is reformed. (Figure 4)

The technique can be repeated with other coloured food dyes such as green and blue, which are a mixture of other colours.

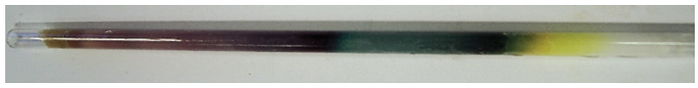


***Figure 2** – The dye started to separate into three distinct bands of yellow, green and red/purple*

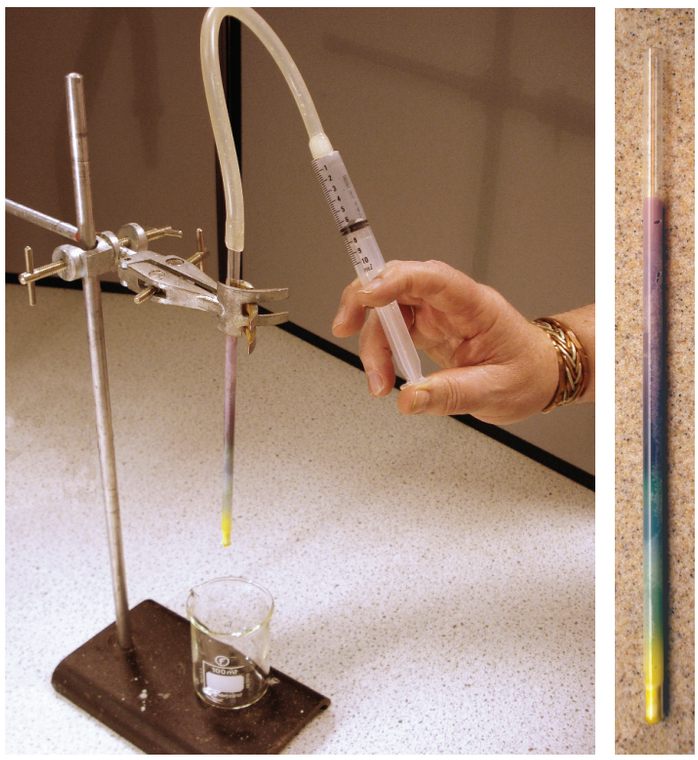
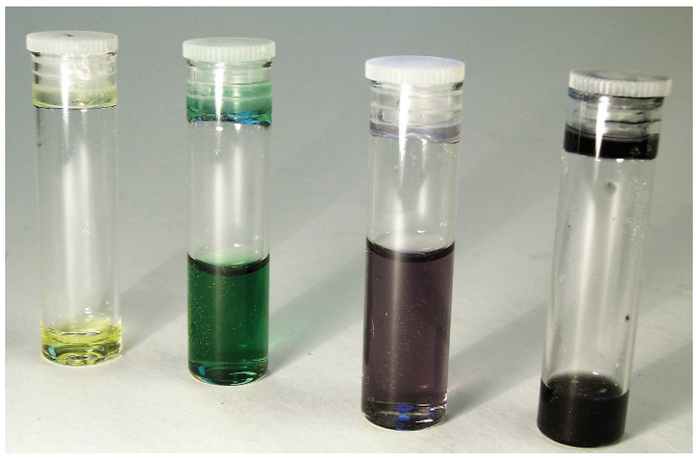


Figure 3a & 3b



yellow *green* *red/purple* *black*

Figure 4

Zinc powder problems

"The zinc/sulphur rocket demo isn't working. We think something is wrong with the zinc powder we just bought. It doesn't look the same as our old stock."

We received several such calls for help from schools throughout Scotland who couldn't get this demonstration to work. In all cases, the common denominator was newly purchased zinc powder.

Having been unable to provide a solution for the schools over the telephone, we contacted the suppliers. They were unaware of any changes to the zinc powder they were supplying but agreed to check on whether the production process had altered. They also sent us samples of the zinc powder they were currently supplying to schools.

The zinc powder we received looked different to our old stock. It was a light silvery-grey powder. Our old stock was darker and dull grey in colour (Figure 1).

We tried a number of experiments with the new and old stock. The experiments only worked with the old stock.

Where to get suitable zinc powder supplies

Scientific & Chemical now supply zinc powder which is suitable for the zinc/sulphur rocket and other demonstrations undertaken in schools.

Zinc powder S&C code 0356/1 - smallest quantity is 1kg/cost £31.68. (Price quoted at 13-07-09)

Acknowledgement

We would like to thank Griffin Education, Scientific and Chemical Supplies and Timstar for their assistance.

Figure 1 *- Old and new zinc powders*

Green lasers

At last, there is an inexpensive Class 2 green laser on the market (Fig. 1). Emitting 532 nm radiation, the device is the laser diode module (LDM) CW532-001 at just €36 from Roithner Lasertechnik, in Vienna.

Writing firstly on safety, any laser bought by a school for lab use must be Class 2. No other laser class other than Class 1 – but not a practicable choice because its power is too low - would be completely safe for use by children. The optical power is kept within the Class 2 limit of 1 mW by a negative feedback mechanism called *automatic power control* (APC). A photodiode inside the LDM monitors the light output, preventing it exceeding 1 mW. Unless there is APC, an LDM-type laser cannot be considered safe. We have already reported on the IOP email forum 'SPUTNIK' that radiation from laser pointers not having APC, although nominally less than 1 mW, can rise to several milliwatts when the laser is fitted with new batteries. That is, the output depends on the supply voltage. This does not happen with APC.

As to how the laser works, radiation at 1064 nm is generated in a neodymium- or ytterbium-based laser. On being fed into a nonlinear crystal the fundamental wave generates a nonlinear polarization wave with twice the fundamental frequency. The output is this second-harmonic, frequency-doubled, plane-polarized radiation at 532 nm. Green light[1].

The beam quality was tested by directing the radiation at a convex meniscus lens and observing the interference fringes caused by reflections off front and back lens surfaces on a screen 3 m distant [1]. The distinctness and regularity of the fringes (Fig. 2) tells us that the beam quality is good.

The laser draws a current of about 200 mA from a 3 V regulated supply. A battery would not be suitable because of this size of current. We therefore recommend the use of a 5 V regulated supply with a current capacity of at least 300 mA.

A chain of three diodes, type 1N4001, should be wired in series with the LDM to drop the voltage from 5 V to 3 V (Fig. 3). Construction details are on the SSERC website.

The laser should be held in a metal clamp, such as a bosshead (Fig. 4). This holds it steady, allows it to dissipate heat and helps to prevent it from being pointed accidentally at someone. Beware that as the metal barrel is electrically connected, internally, to the positive supply, the supply will short should ever a lead from its 0 V outlet touch the clamp stand.

If a school is unable to buy goods from Roithner, being a foreign supplier, they may order through SSERC and we will charge the school at cost, waiting until a batch of requests is gathered to spread the costs of shipping and handling (€35).

Reference

1. *Laser radiation interference: Newton's rings*, Bulletin 191, SSERC, 1997.

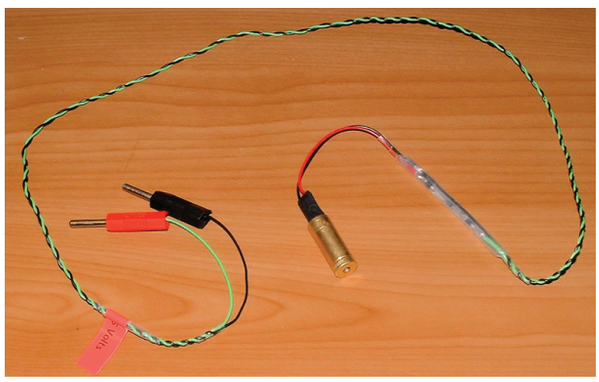


***Figure 1** - LDM CW532-001 fitted with diode chain for 5 V supply.*

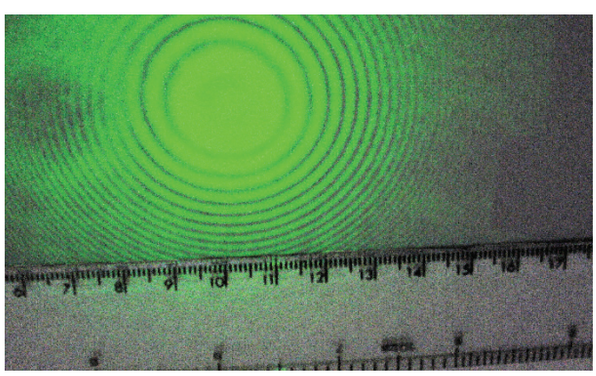


***Figure 2** - Evidence of good beam quality.*

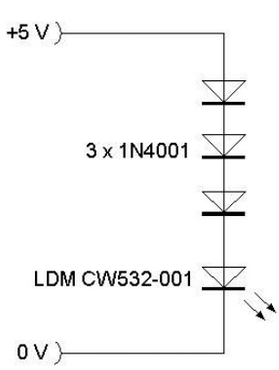


***Figure 3** - Circuit for operating the laser at 5 V.*

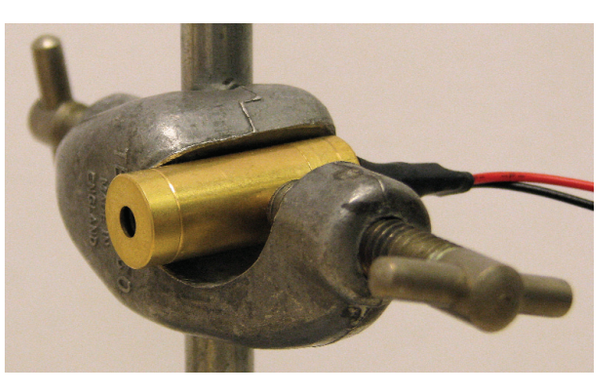


***Figure 4** - Clamp for stability, safety and cooling.*

[1] Radiation at 1064 nm is in the infrared part of the spectrum. Some green lasers have been known to emit infrared, presumably by fault. A Class 2 laser emits visible only.

Mixing green and red laser radiation

The sceptical amongst you, having seen the radiation from green and red LEDs mix, may say that because the spectra of both sources, although narrow band, creeps into the yellow this is what gives the mixture its yellowness. In other words you would assert that the effect is physical rather than physiological, or at least partly so, and you can't be sure what the cause is.

Well then, to put the matter to the test, what you need are two monochromatic sources of green and red radiation. The red source you will have already. It is your standard laser. And green lasers are now available too, at less than the cost of a ticket to watch football. Details on a green laser diode module (LDM) are in the accompanying article in this Bulletin.

The other key ingredient is some LSD. You cannot just shine two laser beams at a white screen, moving one until the spot falls on the other, getting yellow. Laser beams, although small, have a non-uniform cross-section and size. The two superposed will be a messy mixture in which the green dominates because the eye is more receptive to this colour. Rather, the beams must be spread out by a diffuser, the best type of which is LSD[1] (Light-Shaping Diffuser). What's so good about LSD is that the diffuse light is kept within bounds. The stuff we work with has a half solid-angle of 10°. Also almost all the incident light is transmitted. Whereas with an ordinary diffuser much light hitting it is wasted, with LSD most of it is kept in use.

In our colour mixing demonstration, two lasers, one red, the other green, 20 cm apart, are set up pointing obliquely at the white A-4 sized screen, *A*, 50 cm from the lasers (Figure 1). Both beams lie in the horizontal plane 11 cm above the bench and intersect 20 cm from screen *A*. A second low screen, *B*, 11 cm high, is placed where the beams intersect, the beams grazing its top edge. Pieces of LSD are placed in both laser beams about 10 cm from the sources giving superposed semi-circular discs of diffuse radiation on *B* and separate semi-circular discs of diffuse light on *A* (Fig. 2).

If both lasers have the same optical power the patches of green will appear to be much brighter than the ones of red because of the way the eye responds to different colours. The relative response to green (532 nm) is about 90%; orange-red (632 nm), about 25%; and mid-red (650 nm), about 10%. Because of this the mixed light patch is greenish rather than yellow. To turn down the green's brightness, since the radiation from laser diodes is plane polarized, place a polarizing filter between the green laser and LSD and rotate the filter until the mixed light is yellow.

If the polarizing filter is inserted and rotated in either the green or red laser beam, different hues across the red-green spectrum will be seen.

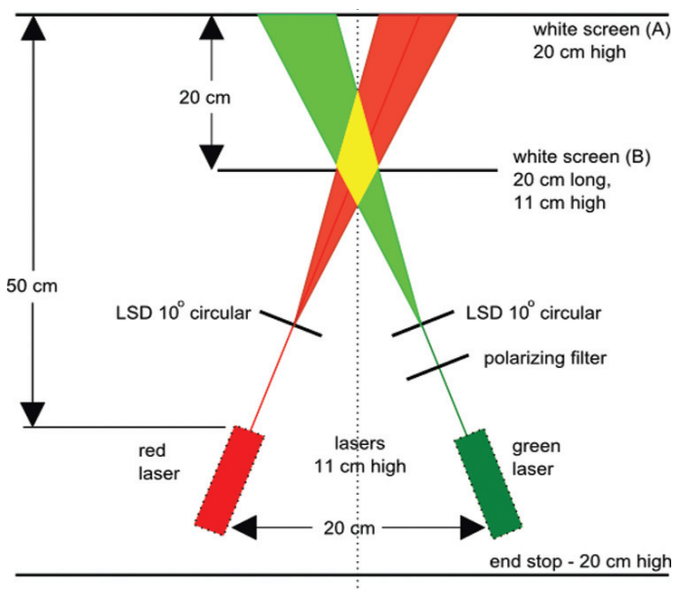


***Figure 1** - Setup for mixing green and red laser radiation (plan view).*

Discussion

This experiment shows that when monochromatic red and green light, of similar brightness with respect to the eye's response to different colours, are mixed, the colour of the combination is yellow. If the red is attenuated, the hue becomes greenish yellow or green; if the green is attenuated, the hue changes to orange or red. We can infer that the perception of yellow, and, indeed, the many hues of colour the eye can make out, is partly physiological, there being no yellow component in the physical radiation we have been working with.

Safety

There is a strong specular reflection off the polarizing filter and there are weaker ones off the LSD. To prevent onlookers being hit, place an opaque screen about 20 cm high as a back stop behind the lasers.

***Figure 2** - Red and green mix giving yellow. The 2 LDMs are held in bossheads in the foreground. The pieces of LSD and the polarizer are in wooden lens supports.*

[1] LSD is available from SSERC at £3.60 a piece. For this application ask for "LSD 10° circular".

As the number of available abrasive types have increased over recent years, the selection and purchase of suitable abrasives has now become a difficult task. Today the term 'sandpaper' is often used to cover any type of abrasive material, of which there are many.

The systems used to classify abrasives based on grit size in Europe and Japan (JIS - Japanese Industrial Standard) are compatible with each other but not the USA (Figure 1). In essence the two systems used are CAMI (Coated Abrasives Manufacturing Institute, the USA based system) and FEPA (Federation of European Producers of Abrasives). There are variations in the grit size between the two systems (FEPA and CAMI) and hence are incompatible. FEPA abrasives are denoted by the use of the letter 'P' before the grit number.

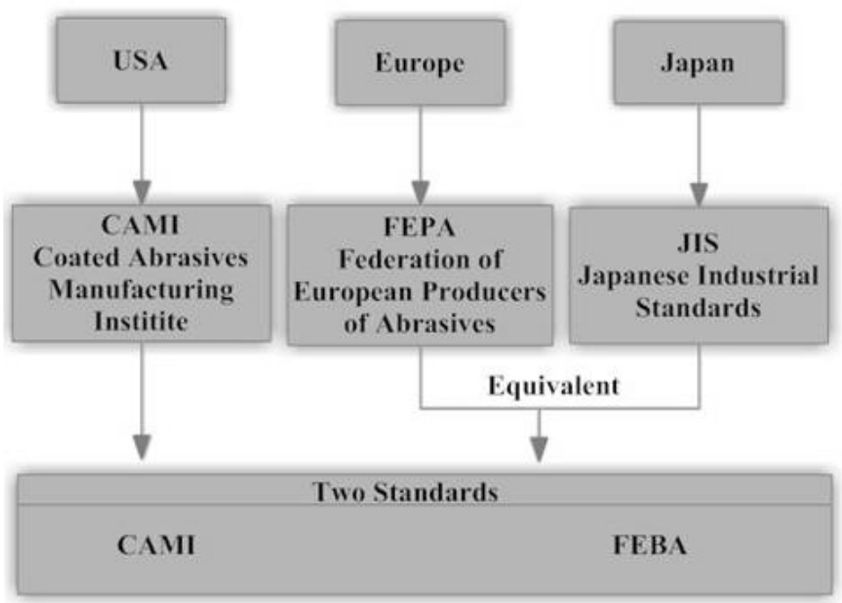


Figure 1 *- Two Standard Systems for Abrasives*

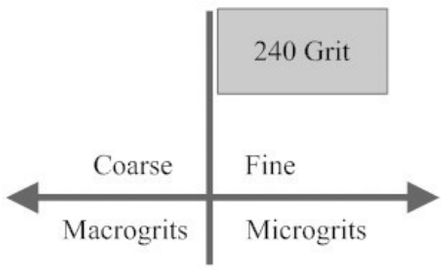


Figure 2 *- Macrogrits and Microgrits*

Figure 2 shows the sub-division of abrasives into two groups, this takes place with reference to the 240 grit. Any material coarser than a 240 grit is called a 'Macrogrit' while anything finer and including 240 grit is called a 'Microgrit'

Grit size varies from P12 to P2500 in the FEPA system and from 24 to 1000 in the CAMI system. A comparison of grit size from extra coarse to ultra fine is shown in Tables 1a and 1b.

Macrogrits

	Extra Coarse	Coarse	Medium	Fine	Very Fine
FEPA	P12, P16, P20, P24, P30	P40, P50	P60, P80	P100, P120	P150, P180, P220
CAMI	24, 30, 36	40, 50	60, 80	100, 120	150, 180, 220

Microgrits

	Very Fine	Extra Fine	Super Fine	Ultra Fine
FEPA	P240, P280, P320, P360	P400, P500, P600	P800, P1000, P1200	P1500, P2000, P2500
CAMI	240	320, 360	400, 500, 600	800, 1000

Tables 1a & 1b *– Comparison of Grit Size*

Mohs' Hardness Scale

Mohs' scale of hardness was devised by Fredrich Mohs (1773-1839), a German mineralogist in 1826. The relative hardness of minerals are grouped into 10 levels of hardness from talc (1) – the softest mineral known to diamond (10) the hardest mineral known. Those in each succeeding group are capable of scratching those in the groups proceeding, for example, an '8' will scratch a '7' mineral, or anything below a seven. Hardness is of obvious interest in abrasives with many materials which we use as abrasives belonging to the upper part of the scale of hardness. For example, emery and garnet are in a range 7.5 to 8.5 with silicon carbide graded 9.25.

***Figure 3** – Reverse of different types of abrasive sheets*

Table 2 shows a comparison table of a number of abrasives.

Abrasive Type	Mohs Scale	Colour	Cost	Comments
Ceramic Aluminium Oxide	9.5		Expensive	Hard wearing; grit size 80-220 available. Long lasting. Recommended for heavy work on timber.
Alumina Zirconia	9.2-9.5		Expensive	Hard wearing, grit limited to 150 or larger, difficult to crush grains for use in finer abrasives. Available in sheets, discs and flap wheels.
Silicon Carbide	9.25	Black		Used wet or dry. Useful on hard lacquers, plastics and some metals. Dark grains can discolour light timber.
Aluminium Oxide	9.0			Tough, can grind metals. Useful for hardwoods.
Emery	7.5-8.5	Dark grey		Used for metal finishing and glass grinding. Can discolour timber due to reaction with tannin. Often creates deep scratches when used on wood.
Garnet	7.5 – 8.5	Reddish brown	Inexpensive	Useful on softwoods. When hand sanding - a better finish is obtained compared to using aluminium oxide abrasives.
Powdered Glass	5.0	Yellow	Inexpensive	Still used in French polishing, although superseded by other abrasives. Hand sanding only.

***Table 2** – Abrasives comparison*

Open and Closed Coats

Abrasives in use can become clogged with resin or sawdust, this is called 'loading' In order to reduce 'loading' problems, abrasives are designed with different covering densities of abrasive particles on the abrasive surface. An 'Open Coat' refers to an abrasive which has only 50-60% of the working surface covered with abrasive grains, this gives an abrasive material which is flexible and less prone to 'loading' problems compared to 'closed coat' abrasives. 'Closed coat' is when the abrasive surface is 100% covered with grit, this makes them less flexible than open cut but also gives increased sanding rate compared to open coat materials.

The X-Bacteria: some additional safety advice

X-Bacteria [1] is a practical kit, funded by The Wellcome Trust, which forms part of the Survival Rivals [2] series of activities to celebrate Darwin Year. These excellent activities, which are available free to schools, enable pupils to examine different aspects of evolution. The dramatic increase in numbers and types of antibiotic-resistant bacteria is a striking and important modern example of evolution which has impact on medical practice and society. The X-Bacteria practical involves allowing two strains of bacteria, each of which is resistant to a different antibiotic, to conjugate. After transferring aseptically to media that contain different combinations of antibiotics, the bacteria are then incubated to look for any that now demonstrate double antibiotic resistance.

Guidance for Scottish schools on the safe use of microorganisms is provided in the SSERC publication, *Biology / Biotechnology Safety in Microbiology: a Code of Practice for Scottish Schools and Colleges* [3]. When practical microbiological work is carried out within this Code of Practice (*CoP*), no additional risk assessment is required. As with many new practicals, X-Bacteria raises some technical issues with regard to 'Health and Safety'. In this article, we would like to address these.

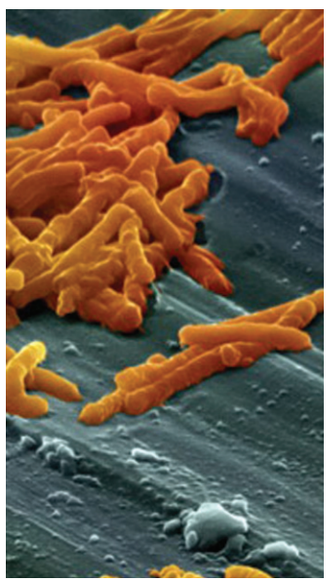
Two strains of *E. coli* are used, HT-99 and J-53R, neither of which are included *per se* in the 'selected organisms' list [4] within the *CoP*. However, do not panic! HT-99 is a derivative of *E. coli* strain B, and J-53R is a derivative of *E. coli* strain K12, both of which are included in the list, so use of the organisms is permitted and there is no need to carry out an additional risk assessment [5].

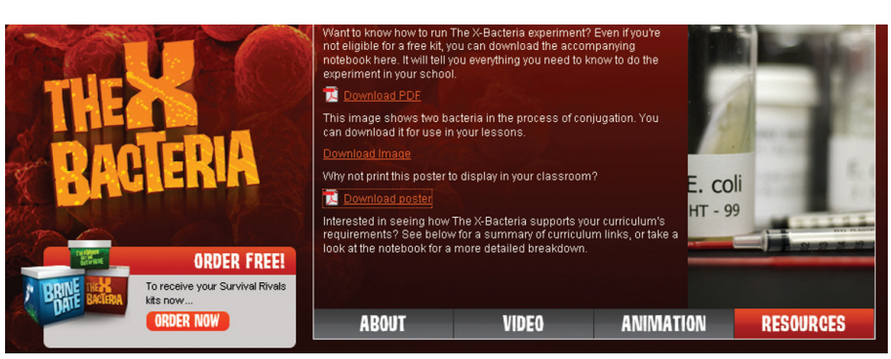
Growth media incorporating antibiotics are required. This is in contrast to the guidance provided in Section 4.32 of the *CoP* which states that '*antibiotics should not normally be incorporated into growth media*'. In the case of X-Bacteria (as is also the case for a number of commercially available bacterial transformation kits), relaxation of this section can be applied providing that:

- appropriate Personal Protective Equipment is worn when making up the antibiotics
- preparation of the antibiotic for incorporation in plates is carried out in a fully functional, approved fume hood
- the guidance in the X-Bacteria manual [6] is followed closely with respect to the technique for dissolving the powdered antibiotic and preparing the plates.

This interesting, relevant and reliable practical allows young people to investigate the horizontal spread of antibiotic resistance between bacteria and to consider the resulting selective advantages conferred to following generations in vertical transfer. There is then significant scope for consideration of the threat to health of this modern, rapid example of evolution.

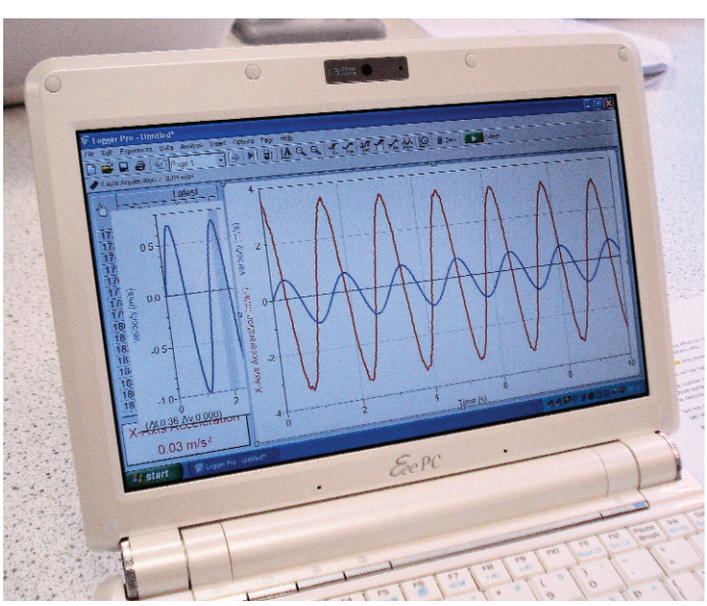
Note: in addition to the above, it is essential that good microbiological practice is observed throughout. (See *Code of Practice* and *Microbiological Techniques Cards* [7])





[1] http://survivalrivals.org/the-x-bacteria/about (accessed 28th July 2009)
[2] http://survivalrivals.org/ (accessed 28th July 2009)
[3] http://www.sserc.org.uk/members/SafetyNet/Microbio2/Main_Menu.HTM (accessed 28th July 2009)
[4] http://www.sserc.org.uk/members/SafetyNet/Microbio2/MOOS/intro.htm (accessed 28th July 2009)
[5] http://survivalrivals.org/content/documents/MicrobiologySafetyDataSheet.pdf (accessed 31st July 2009)
[6] http://survivalrivals.org/Content/documents/TheXBacteriaNotebook.pdf (accessed 28th July 2009)
[7] http://www.sserc.org.uk/members/SafetyNet/Microbio2/Documents/Techniques%20Cards.pdf

A Summer of CPD



"The best things in life are free," sang the Beatles. Though they were unlikely to be precognitively referring to the latest summer schools in biology, chemistry and physics, the words are highly appropriate. Thanks to a partnership between SSERC and the National Science Learning Centre, each of these residential courses incorporated an "RCUK Day". The Research Councils UK have funding to bring teachers and researchers together, funding that provides a £200 bursary for every teacher who attends such a day. The bursary is payable to the teacher's school and in the case of the summer schools, was more than enough to offset the cost of attendance.

First off, around the end of study leave, were the physicists with the IoP Scotland's Physics Teacher Summer School. Taking place at the Carnegie Conference Centre and SSERC's premises in Dunfermline, this event featured a Motion Capture and Analysis day, introducing teachers to wireless motion sensors, video analysis and Edinburgh University Informatics Department's incredible "speckled computing" devices.

Next up, towards the end of term, came the biologists. Their RCUK Day was run in partnership with the Wellcome Centre for Cell Biology at Edinburgh University. Teachers learned about the inner life of a cell, were introduced to fluorescence imaging and worked in the Centre's optical instrumentation laboratory.

Later the same week, chemistry teachers got together at Edinburgh University for their summer school. The SSERC chemistry team has carried out a great deal of work on Grätzel Cells, a type of solar cell that uses dyes extracted from plants. For the chemistry RCUK Day, this was tied to research being carried out at Edinburgh University.

All told, fifty five science teachers took part in the summer schools. In addition to the RCUK sessions, their days and evenings were filled with a diverse range of other activities- moon sketching, bat spotting and making biodiesel being just a few examples.

We started with a quote from a song and perhaps we should end with one too. When asked about future courses, one person's comment on their evaluation form echoed the chorus of Billy Idol's punk classic *Rebel Yell* in simply asking for "More! More! More!" Indeed, there will be more. Look out for four SSERC-run single day RCUK courses in session 2009-2010.