SAPS SCIENCE & PLANTS FOR SCHOOLS

OSMOSIS

No.24 May 2003 www.saps.org.uk

Kew's Millenium Seed Bank Project:
an education opportunity for schools and visitors

The Millennium Seed Bank Project (MSBP) managed by the Seed Conservation Department of the Royal Botanic Gardens, Kew and located at Wakehurst Place in West Sussex, has been described as one of the most ambitious conservation projects ever undertaken. A landmark project of the Millennium Commission, sited at one of the UK's most visited gardens, the MSBP has an important role in educating the public, and particularly children, about the importance of conservation.

Plants are the basis of life on Earth. They trap the energy of the sun to generate oxygen and provide nourishment and other essential living requirements to almost all forms of life, including thousands of mammals and birds, and millions of insects. Worldwide, tens of thousands of plants are used by people for a variety of purposes including food, medicine, fuel, shelter, forage and fodder.

The loss of the Earth's biodiversity is one of the tragedies of our age - once a species becomes extinct, it is lost forever. The significance of this decline is measured not only in terms of the loss of species of potential benefit to humans; the scientific evidence shows that the reduction in biodiversity also has irreversible negative impacts on ecosystem processes, including productivity. The Convention on Biological Diversity (CBD), agreed at the United Nations Earth Summit in 1992, explicitly recognises this link between biodiversity conservation and sustainable development. It is in the spirit of the CBD that the MSBP was conceived.

The Wellcome Trust Millenium Building, a unique structure designed to house the Millenium Seed Bank, as well as offices, laboratories and a public exhibition where visitors can observe MSBP scientists at work

The principle aims of the MSBP are:

- to conserve all of the UK's bankable species by the year 2000
- to collect and conserve 10% of the world's seed bearing flora, principally from the drylands, by the year 2010 (some 24,000 species)
- to develop bilateral research, training and capacity-building relationships world-wide in order to support and to advance the seed conservation effort

One of the most important services offered to MSBP partners is the safe duplication of seed collections at the Millennium Seed Bank. This vital insurance policy ensures that seeds will be stored under the best possible conditions so that they are available in the future to be used for reintroduction, habitat restoration and sustainable use projects, particularly in the countries of origin.

MSBP partnerships have been established in Botswana, Burkina Faso, Egypt, Kenya, Madagascar, Malawi, Mali, Namibia, South Africa, Jordan, Lebanon, Saudi Arabia, Chile, Mexico, USA and Western Australia. Over the last two years 2682 species have been collected and added to the Millennium Seed Bank. Many of these are recognised to have high potential value to people and some are critically endangered in the wild.

continued on page 2...

 OSMOSIS is edited by Erica Clark. Design by Donna Andrews. Artwork by Donna Andrews (page 4) and Roger Delpech (page 6). Science and Plants for Schools, Homerton College, Cambridge CB2 2PH Tel: 01223 507168 www-saps.plantsci.cam.ac.uk SAPS Biotechnology Scotland Project, ICMB, University of Edinburgh, Kings Buildings, Edinburgh EH9 3JR. Tel: 0131 650 7124

MSBP international co-ordinator Michiel van Slageren cleaning seeds of the multi-purpose tree **Moringa oleifera** *with local women in Burkina Faso.*

Combining partners' knowledge of their native floras with the seed conservation skills gained over 30 years by Kew's Seed Conservation Department is the essence of the MSBP. Training and technology transfer are vital components of each of the 16 country projects currently underway. The aim is to offer partners a flexible mix of training opportunities based on individual training needs assessments. Emphasis is placed on in-country training wherever possible, but formal training courses are also offered at the Wellcome Trust Millennium Building. Modules in seed conservation techniques are also delivered to Kew's international Diploma on Plant Conservation Techniques and MSc courses at Birmingham, Sussex and Luton universities.

The MSBP also provides both a focus and the perfect resource for the growing schools education programme at Wakehurst Place.

Higher education students encounter for themselves two forms of conservation management. The Millennium Seed Bank Project demonstrates ex situ conservation operating successfully both globally and nationally whilst the nearby Loder Valley Nature Reserve demonstrates Kew's commitment to in situ conservation. Visiting students gain first-hand experience of the benefits and challenges represented by these two contrasting but complementary strategies.

Primary-aged students are also well catered for. The public exhibition area in the Wellcome Trust Millennium Building provides a wealth of visual and interactive interpretation that engages visitors of all ages. Aided by the large group of specialist Wakehurst teachers and trained volunteers, students are given a wide range of challenging activities to stimulate young minds. The youngest visitors explore 'What's in the box?' on the Seed Bank discovery trolley, where the varied contents promote an understanding of the important role that plants play in all aspects of our life. Next, as children follow the colourful seed bank trail, they can unfold the incredible and varied journeys undertaken by seeds as they travel from plant to underground vault.

An educational visit to the seed bank presents students with a unique opportunity. At one moment they are surrounded by white-coated scientists, working hard on seed banking and research, and the next they can themselves assume the role of young botanists – undertaking investigations into seed dispersal and germination in the Wakehurst mansion laboratory (formerly used by seed bank scientists but now converted for educational purposes).

The MSBP exhibition (sponsored by Orange plc): a resource for visitors of all ages.

Soon teachers will also be able to use an educational version of the very popular 'mini seed bank' kit that was developed by MSBP scientists so that members of the public could process and store garden seeds with the same certainty as professionals. The 'mini seed bank for schools', complete with seeds that can be used to demonstrate the key process of controlled drying as well as germination, will be available for purchase through the Kew website and selected outlets.

Mini seed bank (enquiries to: miniseedbank@kew.org.uk) ÓRGB Kew 2003

More information about the MSBP, and all that it can offer schools education, can be found on the Kew website:
www.kew.org
tel: 01444 894000
e-mail: schoolswp@rbgkew.org.uk

John Adams & Christine Newton
Royal Botanic Gardens Kew (Wakehurst Place)

'I did' or 'It was done' ... some thoughts on scientific writing style

This letter from Sir Robert May (President, The Royal Society), with accompanying introduction from TSNews (Newsletter of the Teacher Science Network), previously appeared in TSNews, issue no 15, Spring 2002. We are grateful to Sir Robert May and to TSNews for permission to reproduce both the letter and the introduction in this issue of OSMOSIS.

"Last year TSN members were asked what they think is an appropriate writing style for a scientific report. Should the style be direct: 'I measured the height . . .', 'We found . . .', or should it be passive: 'The height was measured . . .', 'It was found that . . .'? Which style is appropriate for a research paper? Which is best for children's written work in science lessons? Most thought the passive style is more appropriate for scientists writing research papers and some thought this style should also be used by older school children. Following the TSN survey, an article in the New Scientist (19/7/01) by Rupert Sheldrake put the case for all children as well as scientists to adopt the direct style.

Phone calls to the Examination Boards and the major Scientific Institutions indicated that they are, in the main, undecided in the matter. However, in a letter to the TSN, Sir Robert May, President of the Royal Society, robustly promotes the case for using the direct style:

Dear Mr Chennell

Thank you for sending me a copy of TSN News. I enjoyed the opportunity to see it.

The column, on page 3, about whether one should use the active or passive voice in 'scientific' writing really caught my attention. I was particularly horrified to discover that 'most TSN scientists say that the passive style is more appropriate for scientists writing research papers', and that 'most TSN primary and Secondary Teachers say that they are not sure which style they think scientists should use'. Admittedly, both groups agree that school children should adopt the direct, 'I did', style, although even here we have the loony view that the passive style might be more appropriate for older children. At the risk of going over-the-top, I would put my own view so strongly as to say that, these days, use of the passive voice in a research paper, more often than not, is the hallmark of second rate work.

The two major general scientific journals, Nature and Science, have an interesting history in this regard. For at least the past thirty years, Nature has edited articles that are presented in the passive voice, to transform them into the 'I did' style. To the contrary, until relatively recently, Science remained under the antique delusion that work was more scientific if performed by the impersonal forces of history rather than by real people, and it was in the habit of editing manuscripts to transform them from the active into the passive voice; I had several bitter arguments over this point, over the years. But Science has made great strides in the past decade, becoming (in my view) more fully competitive with Nature in many ways, particularly in its front material. Not surprisingly, a major change has been the switch to editing manuscripts presented in the passive voice to transform them into the active voice. The notion that it is somehow more 'scientific' to suggest that some impersonal, dispassionate actor or whatever did the work - thus conferring more authority upon it - rather that the person writing the report did it him or herself, belong to an older generation. Anyone who writes in this style today simply is not likely to be at the cutting edge.

In short, I believe that Primary and Secondary teachers should, without any reservation, be encouraging all their students - younger or older - to be writing in the active voice. That actually reflects the reality - the students are doing the work - and at the heart of science must be the recognition that it is work being done by people! In the long run, more authority is conferred by this direct approach than by the pedantic pretence that some impersonal force is performing the research!

Yours sincerely
Sir Robert May AC, President, The Royal Society".

SAPS fully supports the use of direct language and the active voice in scientific writing . . . indeed, these words from Sir Robert May encourage us to take a critical look at SAPS material being prepared for publication as well as that already published. I hope that we (SAPS) have not transgressed too often, and that, through our choice of language, we make our writing both accessible and interesting to our readers.

HEAD OFFICE
Homerton College
Cambridge CB2 2PH
Tel: 01223 507168
Fax: 01223 215004

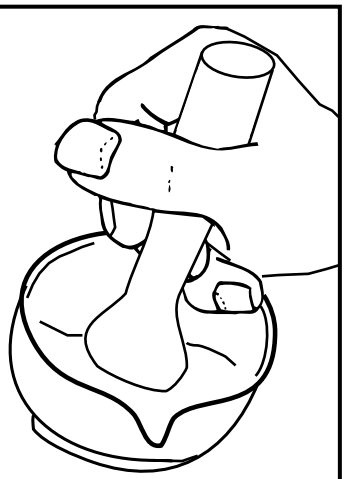
Microscale Investigations with Catalase

Catalase (EC 1.11.1.6) is a widespread enzyme, found in nearly all aerobic cells (animals, plants and microbes). It serves to protect the cell from toxic effects of hydrogen peroxide, generated as a by-product of cell metabolism. It does this by catalysing the decomposition of hydrogen peroxide into molecular oxygen and water.

$$2\ H_2O_2 \longrightarrow 2\ H_2O + O_2\ (g)$$

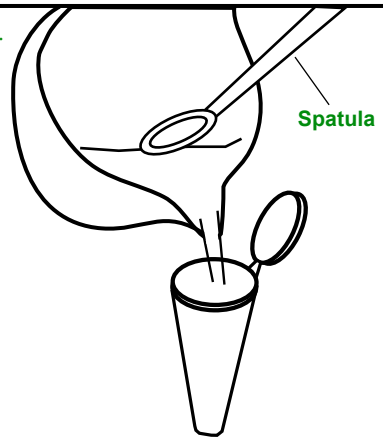
This protocol uses a deceptively simple, yet very accurate method to measure the rate of reaction by collecting the oxygen evolved as a product of the reaction. The whole reaction can be carried out on a very small scale, in a centrifuge tube. An enzyme extract is adsorbed to filter paper discs. These discs initially sink in a hydrogen peroxide solution, but then float to the surface as the oxygen produced gets trapped in the paper fibres. The time taken for the discs to rise is measured.

1.



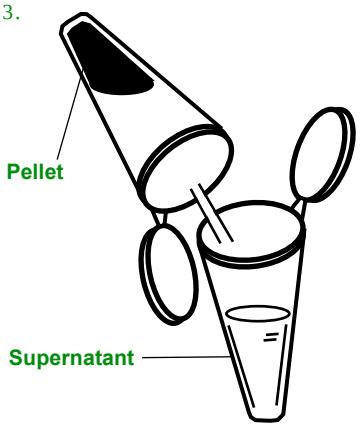
Grind the plant material in a mortar with a small amount of pH7 buffer and silver sand.

2.



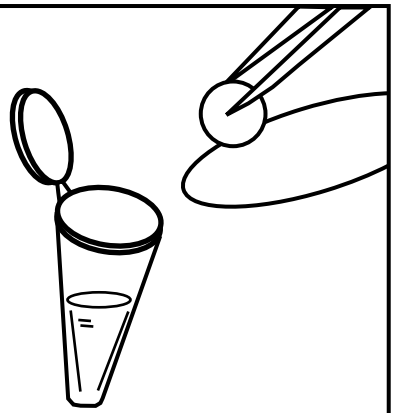
Scrape the paste into a centrifuge tube, and spin at high speed until a pellet is formed.

3.



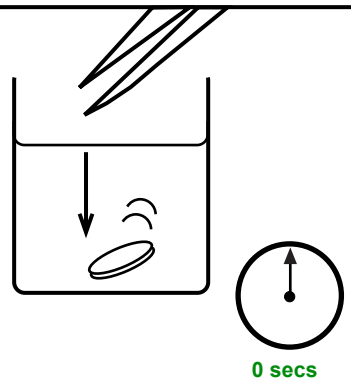
Transfer the supernatant to a clean labelled centrifuge tube.

4.



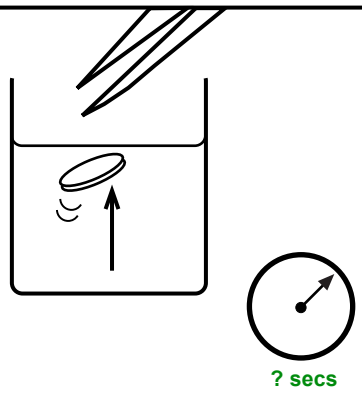
Dip a dry disc of filter paper in the extract and blot briefly on a sheet of filter paper.

5.



Drop the disc into a solution of 1% H_2O_2, at least 1 cm deep, so that it settles on the bottom, and start timing.

6.



Note the time taken for the disc to rise back to the surface of the H_2O_2 solution, and then remove the disc.

It is important to have a clear view of what is happening, so this is best done on the laboratory bench, looking sideways. Occasionally the disc settles at the side, or gets caught on the wall of the vessel - you should remove these discs and repeat the process.

Further notes for teachers and students

The six steps on the Student Sheet provide an outline method that can form the basis of a protocol for investigations with catalase. The comments given here should help you to adapt this method for the particular investigation being undertaken (see below for some suggestions).

Different plant materials contain very different amounts of catalase activity (see table on page 6). In making the extract, try to add only the minimum amount of buffer to make the extract and never use a greater mass of buffer than of plant matter. The critical thing is to get a little clear supernatant in the centrifuge tube (only a tiny volume is used for each test). With a 'watery' tissue you may not need to add any buffer! A very crude method of collecting the enzyme is to hold a disc of dry filter paper in contact with the freshly cut surface of a fruit or vegetable.

The volume of 1% H_2O_2 required depends on the reaction vessel being used (e.g. 5 cm^3 in a small glass specimen tube, or 2 cm^3 in a large Comboplate®* well). Using a depth of <2 cm allows more precise timing. Comboplates® have proven very useful for such investigations, as they are so stable, and provide a series of reaction vessels.

One great advantage of this system is that you can easily do a series of repetitions, simply by removing the used disc from the vessel and then starting again with another disc. There is no need to change the H_2O_2 solution until you have used more than 10 discs in it. There seems to be surprisingly little diffusion of the adsorbed enzyme from the disc fibres into the solution. If reaction times are longer than 2 minutes, you might consider using a more concentrated H_2O_2 solution, and if they are less than 5 seconds, then it might be worth using a less concentrated H_2O_2 solution.

Whilst the method is quick with a microcentrifuge, if you do not have one, you can carry out the technique satisfactorily with a normal centrifuge, but larger amounts of plant material would have to be used. Also, an advantage of using small samples of tissue, is that you can take a series of samples across, for example, a diseased vegetable, and investigate any differences in catalase activity.

If the enzyme extract is going to be kept for some hours, then it would be better to store the tube in a beaker of crushed ice, but remember to warm it up again before use. It will not keep in a fridge overnight!

* Comboplates® are plastic microplates with numerous wells in two sizes, available from:
EDU-LAB, Karoo Close, Bexwell Business Park, Bexwell, Norfolk PE38 9GA (Tel: +44 (0)1366 385777).

Ideas for investigations

Some suggested investigations with seeds and seedlings

- What is the time-course of catalase activity in whole seeds during the germination process?
- Do hypogeal cotyledons have more catalase than epigeal cotyledons - during imbibition and germination, or after their emergence from the soil?
- Do endospermic seeds have more catalase than non-endospermic ones?
- Do any of the following stresses affect the catalase levels of seedlings?
  - flooding (e.g. by extended periods of immersion in water)
  - heat / cold shock (e.g. give heat / cold treatments to imbibed seeds for at least 1 hour)
  - salinity (try watering with sodium chloride solution)
  - shortage of water
  - infection of seedlings with damping-off fungus
- Does hormone treatment (e.g. with auxins, gibberellins, ABA) affect catalase levels?

Some suggested investigations with larger vegetables and organs

- How does catalase activity vary across or along the length of the organ?
- How does catalase activity vary from a healthy to a diseased region?

References

Choinski J.S. , Patterson J.W. (1993) A simple and inexpensive method for studying the effects of the enzyme catalase. Journal of Biological Education 27 (1) 7-10

Delpech R. (2000a) Can you distinguish between ... the living and the dead? Osmosis SAPS Newsletter 17

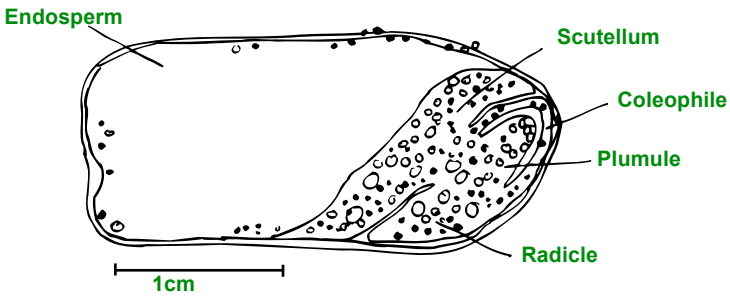
Delpech R. (2000b) Investigating the phenomenon of programmed cell death in maize (Zea mais) seeds Journal of Biological Education 35 (1) 41-44

Lane N. (2002) Oxygen – the molecule that made the world Oxford University Press, Oxford (A superb review of the roles of oxygen, free radicals etc. in the evolution of life and the ageing process – a must for the sixth form library)

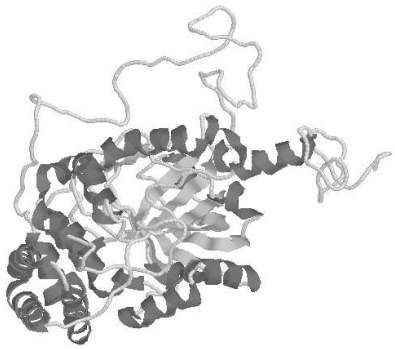
Background information (catalase)

In the mature plant, the catalase protein has a quaternary structure, in that it consists of four similar polypeptide chains (subunits), forming a tetramer (1 subunit = 65 kD). Each polypeptide subunit contains a haem prosthetic group at the active site. Different catalase isozymes can be identified within a particular species, the number of them ranging from 1 in lentil cotyledons to 12 in mustard cotyledons.

You can reveal catalase activity in imbibed and germinating seed tissues quite simply by placing a sliced seed under the surface of a 1% H_2O_2 solution, with the cut surface uppermost. Use a hand lens, or binocular microscope, to detect the production of bubbles of oxygen. Most revealing are sections of endospermic seeds, as the endosperm has undergone programmed cell death (Delpech R 2000a; Delpech R 2000b). The metabolically active embryo and cotyledons should bubble furiously , but the endosperm remains bubble free, except at the borders of the seed, where (in monocotyledons) the living aleurone layer is active. Remember that the oxygen may be trapped for longer in tissues that have smaller air spaces. You can apply this same method to other plant tissues.



Drawing of section of maize seed showing bubbling areas when submerged in 1% H_2O_2 solution



Ramsol image of catalase subunit

The wide occurrence of catalase across the living world means that there are many catalase sequences in the bioinformatics websites that allow information to be collected, and employed to create molecular models, such as the one shown above.

Table to show some fruits and vegetables, with and without significant catalase activity

Catalase activity present			Catalase activity absent
apricots	broccoli	parsnip	apples
bananas	carrots	potato	citrus fruits
cherries	cucumber	radishes	peaches
fresh flowers	leeks	redcabbage	rhubarb
	onions	turnips	tomato
			senescent flowers

Biotechnology Summer School - Follow up Symposium

Over the last 5 years around 250 biology teachers, FE lecturers and technicians in Scotland have attended a week-long residential Biotechnology Summer School at Edinburgh University. Participants have taken part in lectures, laboratory work and industrial visits to update their knowledge and skills in the rapidly advancing area of molecular biology and biotechnology. They have also had the opportunity to consider some of the dilemmas which recent advances have raised.

On 14 November 2002 in Tain Royal Academy, teachers and technicians who had attended a previous Summer School were invited along with some of their 6th Year pupils to attend a follow up symposium. In the morning Dr Gerry Graham from the Beatson Institute in Glasgow and Dr Alison Hill from Cancer Research UK in Dundee described the way in which new technology is impacting on society and the dilemmas which it is raising for people with genetic disease. In the afternoon the participants carried out a genetic engineering practical activity and discussions on genetic disease dilemmas.

Some comments from the day:

- extremely interesting and relevant and great idea to include the students
- looking forward to using the new techniques and dilemmas in the classroom
- Summer Schools and follow up meetings are the best training I've had in 30 years of teaching

These Summer Schools have been hugely successful with places being in great demand. The events are run by the SAPS Scotland Project and sponsored by The Wellcome Trust.

Marjorie Smith, Dollar Academy

My life with plants

Karen Butterworth was once a sixth form student advisor to Science and Plants for Schools. We asked her how she first got interested in plants and how her school and University career led on to her becoming a research scientist at Cambridge.

I first discovered plants at the age of seven. Somebody bought me a Radox 'Grow it for fun' kit for my birthday. This contained not only the seeds of 6 types of herbs, some compost and a (very) mini greenhouse, but it also included THE BOOK. The book was just 3 inches by 5 inches and contained about 30 pages, but this modest piece of literature introduced me to a whole new world and changed my life.

I was amazed at the range of plants it was possible to grow in bits of soil in old yoghurt pots, just from the food we had in the house. I didn't realise peanuts were seeds, but I soon found that they grew into lovely little plants (the salted ones didn't work quite so well!). I hung old carrot and parsnip tops upside-down using bits of string, chiselled out a small reservoir, filled it with water, and watched the leaves sprout, growing first down, and then curving elegantly upwards. I suspended avocado stones over water by stabbing them with cocktail sticks (my parents still have one of the resulting plants, which must be at least 10 years old now). I saved the seeds from chunks of star-fruit, with which I was served once in a restaurant, and smuggled them out wrapped up in a paper napkin. They make fantastic plants, which are almost pet-like (trust me!) because when they wake up in the morning they open out their branches and leaves, and then they fold them all down again at night. Wonderful! And as the battle raged between towels and seeds for space in the airing cupboard, my mum's patience never once wavered.

Almost 10 years later I discovered genetics, and found that plants and genetics made the most excellent combination. At the same time my biology teacher (Stephen Tomkins) introduced me to SAPS, and I became a student advisor on the SAPS committee. It was a great experience for several reasons. I learned about directors, treasurers, secretaries and minutes. I saw how ideas were developed from their inception through to workable classroom protocols. I had my first experience of public speaking as I voiced my own thoughts to a room full of adults, and to top it all I was surrounded by a whole bunch of people who were also mad about plants and wanted to tell the world!

I went on to study Biological Sciences at Oxford. I ended up doing a very general degree because I chose options that interested me, rather than focussing on one area. The teaching was special, and very inspiring. Those three years absolutely flew by. After finals I went to Botswana, where I worked on an integrated agro-forestry project. We looked at water-harvesting techniques for growing annual crops within an orchard of indigenous fruit trees. When I came back to England I moved to Norwich to start my Ph.D., at the John Innes Centre, near Norwich. I studied the genetic control of flowering-time in wheat, which involved a good combination of lab-work, fieldwork and work in the glasshouse. It was tough going, but worth it in the end.

While I'd been doing my Ph.D. I'd become increasingly aware of the growing opposition to genetic modification. It is an area that interests me greatly, and I was keen to get involved in the Public Understanding of Science. Sadly this seems to be an area that people are keen to support verbally, but there is very little funding and few openings. After six months gaining experience in this field at the John Innes Centre, I spent a short time working for the Teacher Scientist Network based in Norwich, and then I moved back to Cambridgeshire.

By this time I was interested in getting back to the lab, and I am now doing a post-doc at the Cambridge Institute for Medical Research. So while I still work in the field of genetics I have now made the switch from plants to people. I am looking into the genetic regulation of immune responses. This is a totally new subject area for me, and it feels good to be learning again. Plants are no longer my work, but they'll always be in my life.

Dr Karen Butterworth

News from SAPS

We hope you are finding your way around the new website structure and that you can now navigate more easily from one part to another.

On the back page of this OSMOSIS you can find news of recent developments aimed mainly at post-16 students, whereas in the Primary OSMOSIS you are given a glimpse into the 'trees and shrubs' website, which has plenty of interest for secondary students and teachers. 'Curriculum links' is already running for the primary curriculum and is now being developed for parts of the secondary curriculum, starting with post-16 specifications. Keep watching - it will come!

Remember to keep an eye on our workshop calendar. We run a range of workshops, mainly for teachers, with some being suitable for teachers of younger pupils and others for teachers of secondary or post-16 students. Visit the website to get a taste of the different workshops we offer - some exciting new ones and still some of the old favourites. Go to the SAPS Home page then 'Courses and kits' then follow the links for further information.

If the published venues and dates are not suitable for you, why not contact SAPS and we may be able to arrange a workshop to help you!

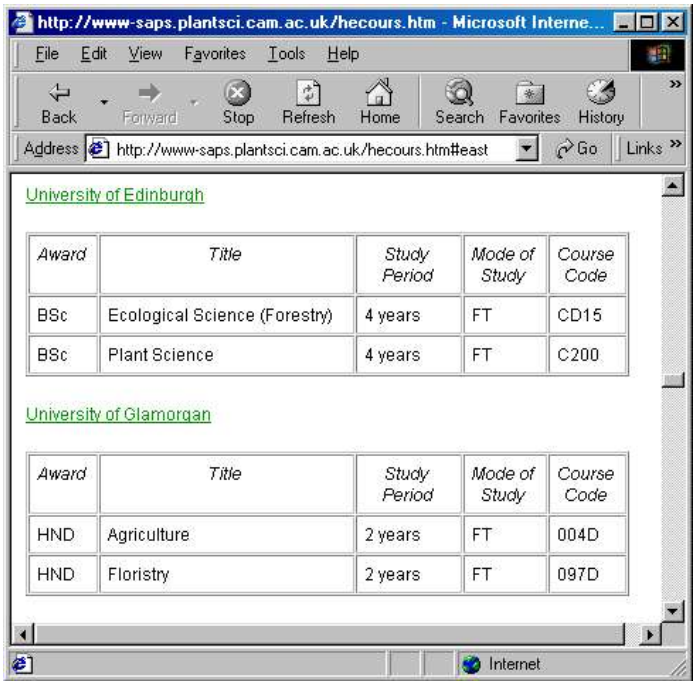
Website Developments

The new SAPS website has been up and running for a couple of months now and we hope that we have ironed out the odd glitches that appeared when we went 'live'. In future issues of Osmosis we intend to feature various parts of the website.

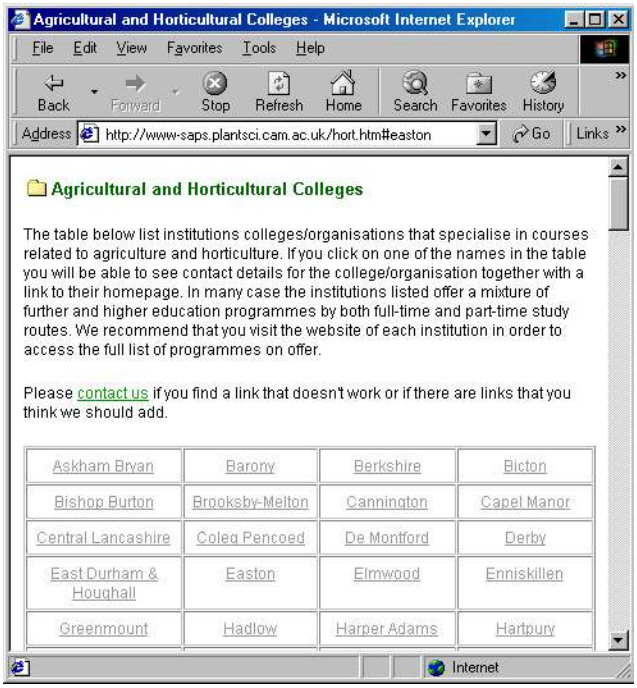
We have introduced a number of new sections on the site and have begun to develop a cluster of 'Student Support' materials. For example, we have produced a list of higher education institutions that offer programmes of study in plant sciences and related areas as well as a list of specialist colleges in the horticultural and agricultural sectors.

For further information visit:
www-saps.plantsci.cam.ac.uk/search_links.htm#9
and
www-saps.plantsci.cam.ac.uk/search_links.htm#ag&hort

Here is a glimpse of what you can find . . .



Links to Higher Education



Links to Agricultural and Horticultural Colleges

We have also gathered together a series of careers resources in biological sciences (www-saps.plantsci.cam.ac.uk/search_links.htm#careers).

We often have requests from teachers looking for ideas for project work particularly for post-16 students. In response to such requests our colleagues in SAPS Scotland have produced a set of six Project Starters (see www-saps.plantsci.cam.ac.uk/prac_starters.htm). Each Project Starter comes complete with Technical Information, Starter Experiment(s), Possible Project Titles and a Resource List. We intend to add further titles in the near future. So why not visit the website on a regular basis to make sure you don't miss anything!

Do let us know if you and your students find these resources useful (e-mail your comments to us: saps@homerton.cam.ac.uk) or if there are similar areas that you would like us to develop.

Paul Beaumont (SAPS)