Innovative links across Norfolk

By Phil Smith, Kath Elliott and Helen Banfill

The Teacher Scientist Network (TSN) is an innovative science education charity, hosted by the John Innes Centre on the outskirts of Norwich, a world leading institute for plant and microbial science. TSN takes a 'bottom-up' approach to providing links between local primary and secondary science teachers and real science.

The programme is led by Dr Phil Smith, a scientist for 13 years who received an MBE in the 2008 birthday honours list for "services to science education" which he has credited in part to TSN's success over the years.

"Creating new partnerships is my favourite part of the job, probably because mine was so rewarding", says Phil. The one-to-one teacher–scientist partnerships are teacher-led. TSN currently has over 50 partnerships across schools in Norfolk and north Suffolk. The aims are to make the matches as logistically easy as possible in similar subject areas, with partners who foresee a similar level of commitment.

The key is the induction meeting led by Phil involving teacher and scientist usually meeting for the first-time at the school. "We highlight what works, what doesn't and see how the partners may work together, what specific subject areas the scientist has experience of and how this fits with the curriculum. Even if it doesn't at first, How Science Works often provides an opening.

With heavy workloads facing both teacher and scientist, Phil points this out to partners at the start and uses it as common ground. "A good induction meeting starts with me talking a lot and gradually the conversation is taken over by teacher and scientist with partners encouraged to meet again away from school and really sit down and plan in detail what activities they'd like to run together and how this might work in the classroom.

There is no 'off-the-shelf' formula for how partners work together. TSN rules are simple – the scientist is more than just another pair of hands in the classroom and they are not there to sell their company which is much less of a problem with scientists from academia. Beyond that, anything goes – running practical sessions in topics such a biotechnology (increasingly popular), demonstrating equipment only usually encountered in a book, giving 'frontal' lectures, presenting first-hand cutting-edge data that would take years to reach the text book and assisting with debates into techniques as diverse as nanotechnology and GM crops.

Teachers usually approach partnerships for one or more of three reasons: their own CPD or to gain confidence in teaching science or to enrich their pupils' experience of science. For the scientists the pressure to publish is high and time out in the classroom won't help with the next publication. Or will it? Public engagement is of growing importance within academia with scientists encouraged and supported to come out of their labs to share their passion and enthusiasm with young people and the general public.

Phil firmly believes that only when a scientist can explain their research clearly to 12–14 year olds in

Pictured above, a JIC researcher and TSN scientist talking to pupils during a Soapbox Science session in which students get to meet and hear about life inside and outside the lab.

a way that they will understand will he or she really understand it. Such experiences give PhD students or researchers a wider picture of their research that can aid their writing. Young scientists in many institutions gain PhD credits for such work, and promotions' criteria and merit awards can often be influenced by the scientists' public engagement. However, none of these outweigh the thrill of putting your energies into creating a novel learning experience for young people and being challenged by their questions, thus showing that school science is not so far removed from 'real science'.

TSN also arrange high-quality, subject knowledge CPD delivered by leading scientists from across the UK. TSN's master class programme is extremely well respected and hugely popular since it re-invigorates a teachers' interest in their subject by addressing current developments. Though the courses are not geared too closely to the curriculum, Phil is confident that talented teachers will quickly identify those nuggets they can use in the classroom. For teachers of Triple Science this can be invaluable by increasing subject knowledge to share with enthusiastic and motivated students.

Three years ago, Phil partnered Helen Banfill, Head of Science at Acle High school in Norfolk, with Kath Elliott, a post-doctoral researcher from the Institute of Food Research (IFR). Kath was enthusiastic about getting involved with secondary schools and was willing to travel to Acle, which is about a 25 minute drive from IFR.

Kath says: "I liked working with the pupils; it was great to see them enthusiastic and interested in science." But it has made her justify her work, recognising why what she was doing was important, and what use it could be to society.

This contrasts with life in the lab. "The majority of our time we concentrate on such small aspects of the work," says Kath, "and doing repetitive processes can make it easy to become removed from 'the bigger picture'."

This experience has been so positive for Kath that she has decided to go into teaching, beginning a PGCE at the University of East Anglia in September. And Kath is not alone; one of strongest impact measures is the fact that since the inception of TSN in 1994, almost 20 teachers have entered the profession on the back of their positive partnership experience.

Kath went into school for a block of lessons once per year, visiting the school beforehand to plan

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lessons. In between, she kept in touch by email. Most recently, Kath worked with 25 Triple Science students in Year 11 who were following the Edexcel Biology (B3) topic on biotechnology.

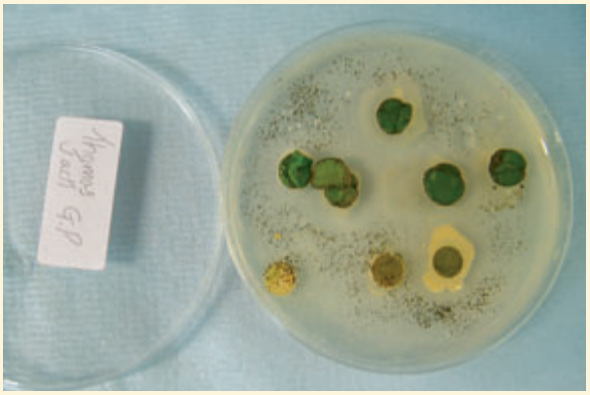
Helen planned and delivered the lessons with Kath exploiting their respective skills. "The input of a scientist made the science seem so much more real," says Helen. "Meeting Kath, who is very much an approachable person has meant students can see that science is not so remote from their own lives after all. And some of the students can imagine themselves working in science now."

Below, a scientist from the Sainsbury Lab at the John Innes Centre performing a 'floral dip'.

Below right, pupil's efforts at aseptic technique, with sterile leaf discs!

The B3 Biotechnology unit includes genetic modification. Over a series of lessons Kath gave the students experience of the techniques used for genetic modification of plants based upon some of her research experiences. The students were set the challenge to evaluate each technique and decide which was 'best'.

We should point out that the students did not actually use real genetically modified (GM) bacteria for the plant transformations. Instead they went through the process, and unknown to the students, Kath 'replaced' the *Agrobacterium* with sterile water/sucrose solutions. At the end of the process Kath transplanted some 'living' plants onto their antibiotic plates – thus giving the impression some had survived and were therefore transgenic!



The visits

Visit 1

The students first sterilised and cut leaf discs from oilseed rape plants and dipped them into a solution of "GM *Agrobacterium*." These were then transferred onto agar plates and Kath took them back to the lab to grow them on in the tissue culture room. Ten days later she returned with their plates.

Visit 2

Kath gave them some of her data to analyse and pictures of what they should have looked like! This showed them how efficient the technique is in the lab.

As a comparison, they then tried the floral dipping technique; dipping *Arabidopsis* plants (so-called rapid-cycling Brassica's) into a solution of GM *Agrobacterium*. Again, Kath took their plants back to the labs to grow them in the greenhouses at the John Innes Centre (JIC).

Visit 3

Kath returned two weeks later with the seeds collected from their plants (hence rapid cycling). The students sterilised these and then plated them out onto agar plates containing antibiotic. Once more, the plates were taken back to the lab to grow.

Visit 4

For Kath's last visit 10 days later, she brought the plated seeds back for the students to count how many had germinated and how many were antibiotic resistant. From this they calculated a percentage efficiency for the technique. They could then directly compare the two techniques in their write up.

Finally, the students visited JIC and saw the plant transformation facility including the gene gun and the tissue culture rooms and the containment greenhouses. Seeing the facilities gave the pupils a much better idea of the real experimental set-up. A couple of PhD students involved in plant transformations gave them a talk about their work, along with the general principles of plant transformation. This was all written up in a report for their coursework.

Kath felt the pupils really benefitted from getting the chance to do some practical work in a topic that is normally taught dry and in an area they see as relevant to their lives. "They all knew about GM from the media and visualising the processes is much easier and more memorable doing it," she says. It gave the pupils an opportunity to talk to a scientist working in the field and the trip to JIC gave them a chance to see 'real-life' science and scientists in action as well as the equipment and techniques they'd learnt about.

Pictured above, scientist Kath Elliott in the classroom.

Finally – in case you're wondering – the leaf disc method is far more efficient (depends on plants but usually >50% transformants) but is far more time-consuming, and requires specialist equipment and a lot of space (you only get five discs per plate and it takes several months of tissue culture to regenerate a GM plant).

The *Arabidopsis* 'floral dip' is not very efficient (~1%), but doesn't take very long in terms of input – a few minutes to dunk plants, which generates thousands of seeds to screen. You can screen 200+ seeds per plate; therefore on average you get a couple of transgenics per plate. The whole process takes less than two months. Unfortunately, you can only do *Arabidopsis* this way because of its rapid regeneration time since it is a model crop as opposed to a commercial crop.

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