chem@cam

Chemistry at Cambridge Newsletter

Spring 2009

Aerosol particles and lung disease

The dynamics of **protein systems**

The changing face of **physical science**

Half a century in Lensfield Road

Former head of department Jeremy Sanders has a new role within the university – he's now head of the school of physical sciences. He tells Sarah Houlton what the job entails

What does the new job involve?

I am responsible for eight departments, which makes up about a fifth of the university's activities – chemistry, physics, earth sciences, material sciences, pure maths, applied maths, astronomy and geography – plus the Isaac Newton Institute for Mathematical Sciences. The school is the layer between the central university administration and the individual departments. In the past, it was mainly a conduit for communication and money between the centre and the departments, but in the past year it's been given a lot more executive authority, so I am officially the budget holder for all those departments, which amounts to about £150m a year.

So is it responsible for overseeing teaching in those departments?

Since last year, the schools of physical and biological sciences have had joint responsibility for the natural science tripos, so all our teaching now officially reports to me and my biological counterpart. Previously, teaching within the departments reported to the university through a pretty undefined route, but it's now got a formal governance structure, and the schools will take strategic charge.

There's a huge education agenda here because in future we will have to ensure there is a better horizontal integration of undergraduate teaching between the individual subjects in the natural science tripos (NST). With geography and maths, which are separate but overlap wiht NST, there are more and more multidisciplinary courses that need to be managed. In addition, there is the 4th year teaching, which is Part III in some subjects, an MPhil in others, and in a few cases it's also the first year of a PhD. In some areas, you can imagine the same lecture course being used for all three purposes. So it all needs to be vertically integrated, as well as horizontally

This may soon lead to the formation of a graduate school for physical sciences, which would oversee postgrad education across the school – admissions, training courses, and all the other non-research functions. That's a big job for the school, and I'm ultimately responsible for it, although I have a newly appointed director of teaching who is responsible for leading the changes.

What about research?

Increasingly, the role of the school is to develop a long-term research strategy, recognising that research funding these days tends to come in larger and larger aliquots. The government, through the research councils, channels a growing amount of its research funding to areas that it deems to be important, be it climate change, energy, health related, or whatever.

And the university needs to learn how to manage these large research initiatives in such a way that we retain the classic Cambridge freedom of the individual to discover the unexpected, quirky, astonishing things that are transformational. That's the big challenge in our local culture. If you look five or 10 years into the future, what's the appropriate departmental structure to enable this? And what's the appropriate management structure to enable it to happen in the best possible way?

There must be other strategic decisions you have to make.

Oh yes – decisions about buildings – which departments should move, and when, and where, and how it is all funded. So I haven't escaped from building work! But the pleasure is that it's mostly long-term thinking. This is actually what heads of department ought to be able to do, but rarely get the time to – spend time with colleagues thinking strategically about where we want to be in five or 10 years and how we go about it, rather than having to spend one's time, as the head of department inevitably does, dealing with day-to-day short-term problems and crises.

And it's not all management stuff: I'm finding it very enjoyable as there's actually more science in it than you might expect! As head of school I am involved in every professorial appointment, so I am exposed to a wonderful breadth of science from cosmology and astronomy to high energy physics, through geography and conservation, nano- and biomaterials with, of course, chemistry at the heart of it all.

Does this give you more time to do chemistry?

The next few months are rather busy as I am also currently a deupty vice-chancellor, overseeing the university's 800th anniversary celebrations until the end of 2009. So at the moment I do very little teaching – you can't do everything! But it I do still make time to see people from my group almost every day, though they do have to have appointments as I can't just drift up to the lab every evening as I used to. I'm seeing as much of my group as I did when I was head of chemistry, and I lik to think I'm able to give them more 'quality' time. I published more papers last year than in any year since 2003! It's hard to have the really big strategic creative chemical ideas now as I don't spend enough time in serious thinking, but when someone gives me results I can see the implications and what the next step should be, because I can draw on more years of experience than I care to admit. And there's still no greater pleasure than sitting with a few of my group and being able to interpret an nmr spectrum better than they can.

CV Jeremy Sanders

Born: London; grew up in Hackney and Wandsworth

Status: Wife Louise is a former biologist. Their son David is an assistant professor of physics in Mexico City, and daughter Deb is a college administrator in Oxford.

Education: Jeremy spent seven years at Wandsworth comprehensive school, then studied chemistry at Imperial College, before moving to Cambridge for a PhD with Dudley Williams.

Career: After a one-year postdoc in pharmacology at Stanford in the US, he returned to Cambridge in 1973 and joined the academic staff in chemistry as a demonstrator. He's been here ever since!

Interests: Cooking (he says he solves all his problems toiling over a hot stove) and music, of the classical variety.

Did you know? Football is not on Jeremy's list of talents. He was last seen on a football pitch back in 1971 playing for the Dudley Williams group against Alan Battersby's group. 'Dudley only had a group of 10, so we all had to play, as did he, to make up 11,' he says. 'I think they would probably have played better with only 10 men – without me!'

Then and now… We've been in Lensfield Road for 50 years, and the building looks a little different these days. Read more on p9!

Chromic cleaning

Dear Editor,
Roger Ward's exhibition, shown in your Autumn 2008 edition, made me (1967-70) feel out of date too!

But where was the large yellow mixing bowl of chromic acid whose role was vital in removing 'intractable tars' from expensive and often hand-blown glassware? No bench was complete without it.

Lab 287 (Steve Quarrie I think) devised the Chromic Frog (a sort of paper boat made of Kleenex) which had to char within half a second for the mixture to be considered adequate. Happy (if rather messy) days.

Dr Peter B Baker
9 Kenilworth Road, Ealing, London W5 5PB

Out of date?

Dear Editor,
Well, thank you for reminding me that the work I did at Cambridge is 'hugely out-of date'. I spent my first year in the chemistry department in Pembroke Street and recall the subsequent move to Lensfield Road as an introduction to the promised land.

Intimations of mortality came some years later when I saw apparatus that I had used in my working life in the Science Museum in London.

Confirmation of the relevance of your reminder is indicated by my favourite page in your admirable journal being on the back.

Yours sincerely,
Roger Duffett

Spit and polish

Dear Editor,
I think I was among the first wave of undergraduates to move from Pembroke Street – where I had spent my first two years doing practicals – to Lensfield Road where everything was pristine.

Benches were cleaned meticulously, I polished on a Saturday morning (as a research student) – something that seemed to be expected!

Yours sincerely,
Bill Collier
Silverdale, 28 Seaton Down Road, Seaton, Devon

chem@cam
Chemistry at Cambridge Newsletter

Contents

Cover

Glass blower extraordinaire Phil Gallego in fiery action

Photograph:
Nathan Pitt and Caroline Hancox

This newsletter is published three times a year by the University of Cambridge Chemistry Department. Opinions are not necessarily those of the editor, the department, or the university.

Editor-in-Chief: Steve Ley
Editor: Sarah Houlton
Photographers:
John Holman, Nathan Pitt,
Caroline Hancox
Editorial Board:
Brian Crysell, Bill Jones,
Jonathan Goodman,
Rosemary Ley, Jeremy Sanders

Address:
Chem@Cam, Department of Chemistry,
University of Cambridge, Lensfield Road
Cambridge CB2 1EW
Phone: 01223 763865
email: news@ch.cam.ac.uk
website: www.ch.cam.ac.uk

Two chairs filled

We've made two new professorial appointments in the past couple of months. First, Clare Grey is to take up the Geoffrey Moorehouse GIbson chair of chemistry. Oxford graduate Clare is currently in the chemistry department at Stony Brook University in the US, and takes up her appointment here in the department in July. Clare studies and develops new materials for batteries, fuel cells and catalysis.

And Professor Shankar Balasubramanian has been appointed as the Herchel Smith Professor of Medicinal Chemistry, a joint appointment with the clinical school. Already a professor within the department, Shankar's work focuses on the chemical biology of nucleic acids.

'I am delighted by the excellent appointments that have been possible to these prestigious chairs,' says head of department Bill Jones. 'The filling of these posts provides great opportunities for the department in the very important areas of energy and medical research.

Homerton's new status

Chemistry teaching fellow Deborah Longbottom holds a joint post at Homerton College, which has just been given permission to apply for a Royal Charter as a full college of the university in its own right.

Homerton was at first exclusively a teacher-training establishment, but it has been accepting students for natural sciences since 2001, during which time the College has established a solid base of fellows in a range of scientific subjects, including Deborah, who joined in October 2007.

The college has been on the Cambridge map since 1894, and its staff and students have been members of the university for more than 30 years. However, as an Approved Society, until now it has been governed by trustees, but now the college – the largest in Cambridge – will become self-governing and take its full place within the university.

'It's a very exciting time to be part of Homerton College,' Deborah says. 'And I'm really looking forward to making a positive contribution in the future.'

Deborah: excited to be part of Homerton as it takes its full place in the university

Matt wins Lilly award…

Matt Gaunt has won the Eli Lilly Young UK Lecturer award for 2008. The award is given annually to a lecturer who has been an independent academic less than five years for their achievements in chemistry. Matt was appointed as a lecturer here in Cambridge in October 2006, with a Next Generation Fellowship funded by Philip and Patricia Brown.

The award involves a cash prize, and Matt has to give a lecture at the Lilly research site in Earlwood, Surrey. 'I was only there to give a lecture last year, so they're going to get another dose of me already,' Matt says. 'I've promised to give them a different talk this time!'

Meanwhile, Matt's very excited that he's just had his first paper in the journal Science. The paper was about Matt's work on substitution reactions on aromatic rings, where the substitution takes place at a position on the ring you wouldn't expect. First year undergraduates learn that if the ring has an electron-donating group on it, the substitution will happen at the ortho and para positions. Matt's found that he can make biaryl compounds where the substitution at the 'wrong' place by using a copper catalyst instead of the more usual palladium.

'We're really excited by these results,' he says. 'We hope that the technique will allow all sorts of organic molecules to be made in a simple reaction that would otherwise take many steps,' he says.

…and Robert a Syngenta prize

Robert receives his cheque from Syngenta's Andrew Plant

Robert Phipps, the PhD student with Matt Gaunt who's working on the project described in the Science paper, has won a prize himself – a Syngenta postgraduate scholarship in organic chemistry.

Syngenta selected about 20 applicants to participate in a three-day assessed workshop at their site in Jealott's Hill near Bracknell. 'It involved activities such as one-to-one interviews with staff, making a poster of your PhD work in 30 minutes before presenting it to Syngenta staff, and group tasks such as retrosynthesis and agrochemical discovery,' Robert says. 'This task was a sort of simulated discovery of a successful agrochemical, but accelerated to fit into a single day.'

In small groups, they were given lead structures and had to make important decisions such as which analogues to make, and what data to request. 'As the data came back, another round of decision-making would be required, and after about five or six iterations, each group presented their final molecule,' he says. 'Following this, the scientist who actually led the discovery of the real agrochemical the study was based on revealed its structure, and the rationale that led to it.'

In the end, six of the participants – including Robert – were selected for the scholarships of £1,000 in cash and a further £1,000 to pay for a trip to a scientific conference.

'I've submitted an abstract for the ACS conference in Washington DC this August,' he says. 'I found the workshop really enjoyable and engaging – and of course it was great to win one of the scholarships.'

Photo: Nigel Luckhurst

800 years in colour

In 1209 a group of dissatisfied scholars left Oxford and settled in a small market town just south of the fens. The University of Cambridge has decided that this event marks its foundation, and so this year we are celebrating our 800th Anniversary. This celebration is quite separate from the fund-raising development campaign.

The theme of the year is Transforming Tomorrow: Cambridge transforms the people who work and study here, and it transforms the world through the ideas that it produces. We opened the year with bell-ringing and a spectacular light show on the walls of the Senate House and the Old Schools. The light show, which was seen by over 10,000 people during three rather chilly January evenings, was a pageant of Cambridge history and achievements. Notable scientific highlights included the DNA double helix, green fluorescent proteins inside cells (pioneered by Roger Tsien, who worked in the Department in the 1970s and shared the 2008 Nobel Prize in Chemistry), and Stephen Hawking disappearing into a black hole. The highlight of the show was a series of sketches by the renowned illustrator Quentin Blake, showing Newton and his apple, and Darwin in the Galapagos.

In July, we will be holding a party in the Botanic Gardens for 10,000 University and College employees and their families, and a few days later a BBC prom concert will be given over to a musical Cambridge festival.

A host of other activities, initiated by staff and students, and sponsored by the 800th anniversary committee, have threaded throughout the year, providing entertainment and education for all ages and interests. A football match between Cambridge United and Oxford United raised over £3000 for Camfed, our charity of the year, which provides educational opportunities for girls in Africa.

All these activities, which are described in much greater detail at www.800.cam.ac.uk, are masterminded by a great team headed by Geoff Morris. I merely chair the steering committee.

Jeremy Sanders

Salt is best in cooking!

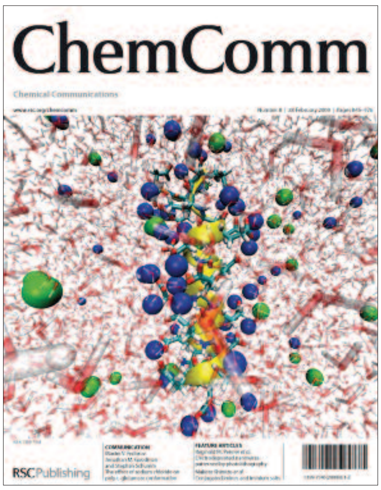
A recent Chem Comm from Jonathan Goodman, and colleagues at Unilever and the Max Planck Institute in Leipzig, was highlighted on the journal's cover, perhaps because of its important culinary implications.

Thanks to some complex molecular dynamics simulations, it appears that salt doesn't just affect food's taste, but its texture as well.

They found that only a tiny amount of salt is needed in an aqueous solution of proteins to have a big effect on their structure. Poly-L-glutamate forms a tight helical conformation in the presence of salt, whereas it stretches out in pure water.

Proteins play an important in giving food its texture, and Jonathan wants to know how they interact with other components of food, such as fat and carbohydrates.

'We want a better understanding of the interactions between proteins and the other components,' he says. 'This may help increase the quality of processed foods.'



Brian enthrals the audience

The second Alex Hopkins Lecture was given by our own Brian Johnson to an appreciative audience of more than 200 people during this year's Science Festival in March.

Alex was a much-loved teaching fellow at Churchill and Fitzwilliam, who was also a mainstay of inorganic teaching in the department. His father John helps us to celebrate Alex's life by supporting an annual lecture, which is supposed to relate chemistry to everyday life and contain an element of humour.

Brian's lecture title was 'Small and beautiful'. He took us on a gentle journey through symmetry and philosophy, before turning to modern catalysis. Starting with the platonic solids and neolithic sculptures based on them, he moved on to the hexagonal symmetry of snowflakes, and Kepler's (possibly apocryphal) realisation that six apples on a table arranged in a hexagon around a seventh might hold the clue to the fundamental organisation of snowflakes. It was to be 300 years before X-ray crystallography confirmed this idea.

The audience spanned the generations, from the children of a member of staff to an enthusiastic 90-year-old pupil in the art class that Brian teaches in his 'retirement'.

Brian, in his unique and apparently spontaneous fashion, drew the audience into his presentation and kept them spellbound. Towards the end, he even managed to introduce some catalytic chemistry from his own research.

Photo: Nathan Pitt

The department is already thinking about next year's lecture. Please send any suggestions for potential lecturers to Jonathan Nitschke (jrn34@cam.ac.uk) or Jeremy Sanders.

■ Science Week was a resounding success again this year, with more children than ever visiting the department to get a taste of what chemistry's all about. There'll be lots more about it in the Summer edition of *Chem@Cam*!

Assessing chemistry research

For much of summer 2008, while most sensible folk were relaxing through the long sunny evenings or were enjoying their latest exciting research results, 16 dedicated members of the chemistry RAE panel were firmly attached to their hot CD readers. Not music, not audio novels, and certainly not raunchy videos, but 4,900 pdf documents containing the 'outputs' submitted by over 1,200 academics in UK chemistry departments.

Each output was read by at least two panel members, which meant everyone read an average of more than 600 outputs, together with pages of statistical data and departmental strategy documents.

Cambridge chemistry contributed Steve Ley and Jeremy Sanders to the panel of wise men – and one wise woman – who rated the research of 31 submissions by 33 universities; Eastchem and Westchem were joint submissions by Edinburgh and St Andrews, and Glasgow and Strathclyde respectively.

Meeting in rain-soaked Lake District hotels or in the sterile environment of the 18th floor of the notorious Centre Point in London, they debated, discussed and eventually pronounced their verdicts. The masochists amongst you can read all the results (and the very carefully written minutes of all the meetings) at www.rae.ac.uk/pubs/2009/pro.

The short summary of Cambridge's results are that we had the largest proportion of 4* (top rated) work. All panel members were, of course, excluded from discussion of any institutions where they had major conflicts of interest.

Jeremy, who chaired the panel, said, 'The RAE panel were a great pleasure to work with: hardworking, well-informed, scrupulously fair and with a good sense of humour to leaven the proceedings. The panel were pleased to see how well UK chemistry has performed over the past few years.

'However, it is extremely frustrating that HEFCE's funding model and the broad spread of scores across the higher education sector generally have meant that chemistry departments in England have mostly ended up with less funding next year, despite their good performance.'

A golden celebration!

December's end-of-year head of department's talk was a little different from normal – it also included talks from Brian Crysell, Tony Kirby, Ian Fleming, Ian Smith and David Watson looking back at the history of the Lensfield Road labs and some of the people who've worked here in the past.

You can read what Brian, Tony and Ian Fleming had to say in this issue – and see photos of the building under construction – starting on page 9. And Ian Smith and David's presentations will be featured in the next issue of *Chem@Cam*. Watch this space!

It was followed by the staff Christmas party – check out the photos on p14.

Presenters in action... Clockwise from the right: Brian Crysell, Tony Kirby, Ian Fleming, Ian Smith and David Watson

Photos: Nathan Pitt

The Corporate Associates Scheme

Arecor
Astex Therapeutics
Astra Zeneca
Asynt
Biotica Technology
Boehringer Ingelheim Pharma
BP
BP Institute
Bristol-Myers Squibb
Cambridge BioTechnology
Cambridge Medical Innovations
CambridgeSoft
Chemical Computing Group
Cornelius Specialties
Dr Reddy's Custom Pharmaceutical Services
GlaxoSmithKline

Thanks to the generosity of the department's Corporate Associates, we have been able to benefit the education and environment for students and staff. For example, the Associates pay for university-wide access to SciFinder Scholar and ChemOffice. They also make significant contributions to the library for journal subscriptions. Moreover, they provide exam prizes, faculty teaching awards and summer studentships, and have recently funded the refurbishment of a state-of-the-art meeting room with teleconferencing and display facilities.

Corporate Associate membership not only provides essential support for the department, but also provides numerous benefits to help members work with us and achieve their business objectives. Members enjoy many benefits through their enhanced partnership with the department, such as:

- Visibility within the department;
- A dedicated meeting room and office for members to use while visiting the department;
- Invitations to recognition days and networking events at the department;
- Access to emerging Cambridge research via conferences, special briefings and various publications;
- Access to the department library and photocopying/printing facilities;
- Regular communications about upcoming events and colloquia;
- Subscriptions to department publications, including *Chem@Cam;*
- Priority notification of and free access to departmental research lectures;
- Ability to hold 'Welcome Stalls' in the department entrance hall;
- Preferential conference rates;
- Free access to the teaching lectures held within the department;
- The full services of the Corporate Relations team to facilitate interaction with students, staff, and other parts of the University of Cambridge to help achieve your corporate objectives.

If your organisation would be interested in joining the Corporate Associates Scheme, then please email Jane Snaith at cas-admin@ch.cam.ac.uk, or call 01223 336537.

Heptares
Illumina
Johnson Matthey Catalysts
Lectus Therapeutics
Maruzen International
Merck Sharp & Dohme
Novartis
Pfizer
Proctor & Gamble
Roche
Sigma-Aldrich
Society of Chemical Industry
Takeda Cambridge
Unilever
Uniqsis

The chemistry of aerosols

Atmospheric aerosols have a big impact on the climate, but they aren't well understood. Markus Kalberer is trying to find out more

Aerosol particles are important in the atmosphere – not only do they reflect and absorb sunlight, but they are also trigger the formation of clouds. Each raindrop forms around a tiny aerosol particle. 'The process isn't very well understood,' explains Markus Kalberer, whose research centres on atmospheric aerosols. 'But aerosols have a huge impact on the climate, and we want to know more about them, and what effects they have on health.'

The chemical composition of these aerosol particles – which are nanometre sized – is complicated. About half of them are inorganic, like ammonium salts, or salt near the sea, and the remainder are organic. 'These are a "soup" of many different chemicals, and more than 10,000 have been identified so far,' Markus explains. 'We're looking at how these organic aerosol particles are formed and what they're made of, and looking at new analytical methods so we can investigate them more closely.'

HEALTH PROBLEMS

Aerosol particles in the atmosphere are thought to have negative health effects and exacerbate respiratory diseases such as asthma. The classic example is the London smog in 1952 when an extra 4000 people died in just one week. Since then, it's been established that there's a correlation between death rate and concentration of atmospheric particles smaller than a couple of micrometres. 'There is most likely a causal connection between the two, but what is so harmful about these particles is not known' he says.

One of the projects Markus is working on looks at the effect of aerosol particles on lung tissue. 'We are collaborating with biologists who look at the biological responses and inflammation that aerosols cause on lung cell cultures,' he says. 'We have built an instrument that allows us to direct aerosol particles onto cell cultures without having to collect them or process them.'

In the longer term, they plan to use the instrument – it's small enough to be portable – in a real world setting, but they're already getting interesting results in the lab. 'We can mimic the aerosols that form outside fairly well,' he explains. 'We flow the aerosols we make through the instrument onto the lung cell culture, which mimics the natural way they are inhaled and deposited on the surface of the lungs. If we'd collected the particles on a filter, extracted them with a solvent and pipetted them onto the cells, we would lose the aerosol nature. It also means that the reactive components of the aerosol, such as radicals and peroxides, remain.'

Photo: Nathan Pitt

That's the instrument they use to test aerosol particles on lung cell cultures on Markus' screen!

Initial results show that the particles do indeed have an effect on the cells – macrophage white blood cells do their job and consume the aerosol particles. The biologists have also looked at whether the macrophages still work after they've taken up the particles, and it turns out their activity is lower so they have been affected by the aerosol deposition. They also found that they release chemicals called interleukins, which is part of the inflammation process.

'It's a good thing there is only a moderate effect – we deposited simulated smog particles, and it would have been astonishing if the cells had just died!' he says. 'So far we've focused on healthy cells, but the next step is to use diseased lung cells – healthy people don't have problems in smog, but those with respiratory problems do.'

He's also using analytical techniques to study the complex mixtures of organic chemicals that make up atmospheric aerosols. Taking just one chemical – alpha-pinene, which is given off by pine trees – and oxidising it with ozone, the result is a mixture of about 400 different compounds. 'If you allow the reaction to carry on for a few hours, then some of the products are acids and di-carboxylic acids, which have very low vapour pressures and spontaneously form aerosols,' Markus says. 'And in the aerosol particle, further reactions take place, so in just a couple of hours all these different compounds are made.'

He's interested in finding out what components of these aerosols could be having an effect on health, and is using analytical techniques to investigate. 'By using mass spectrometry, for example, we can look at how many of the compounds are peroxides or acids,' he says. 'We've developed a method that allows us to quantify the total peroxide content, which is very variable over time. I'd now like to look at the concentration of radicals, which will be challenging as some of them are very short-lived. We have to develop a very rapid method that allows us to sample the air and analyse the radicals before they have had chance to react.'

CV Markus Kalberer

Born: in Basel, Switzerland

Status: His wife Petra is a PE teacher and sports therapist. They have an 18-month-old daughter, Aline

Education: A degree in environmental science at ETH in Zürich was followed by a PhD with Heinz Gäggeler at the University of Berne and the Paul Scherrer Institute close to Zürich. 'His main interest is in discovering super-heavy elements, but he also uses aerosol techniques for analytical purposes, which over the years developed into a research direction involving aerosol processes in the atmosphere and that's what I was working on.'

Career: In 1999 he moved to Caltech for an 18 month postdoc with atmospheric chemist John Seinfeld. He returned to ETH for a habilitation position (a little like a research fellowship) at the end of 2000, and moved to Cambridge as a lecturer last October.

Interests: Spending time with his family, skiing (sadly not in Cambridge!) and travelling.

Did you know? As an undergraduate, he was also interested in geology and spent two summers on a German research ship, sailing from Hamburg to Brazil and western Africa to take sediment cores – a far cry from his current interest in the atmosphere!

The dynamics of protein folding

Proteins fold up into complex shapes and arrangements that are vital to their function. Justin Benesch is looking at the dynamics of the folding process

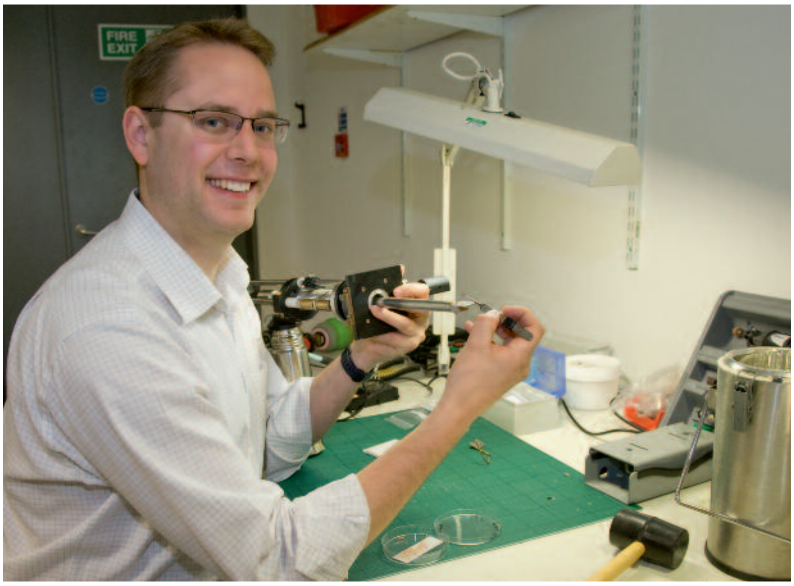


Photo: Nathan Pitt

Proteins are long, flexible chains of amino acids which have to fold up in the right way if they are to work correctly – many diseases are a result of misfolded proteins. One of the ways that nature goes about ensuring the folding process is done properly is by using 'molecular chaperones', which help prevent these errors occurring. A lot is known about how these housekeeping proteins achieve this, but much of this information looks at specific snapshots in time. Justin Benesch is interested in finding out more about what's going on in real time.

'I'm interested in the dynamics of protein assemblies,' he says. 'It's not just the way they put themselves together – do they fall apart again, how do they interact with other assemblies, and what transient shapes do they go through while they are folding? Determining these fluctuations is often even more difficult than determining the structure itself!'

He's using mass spectrometry to look at what's going on with one class of chaperone, the Small Heat Shock Proteins. 'They aren't very well understood at all, but it appears that their dynamics are an essential part of their function,' he says. 'Their structures are very poorly defined because they are difficult to study with conventional techniques, primarily because of their dynamic quaternary structure, but we've found that mass spec is very helpful.'

Mass spec's big advantage over other techniques such as x-ray crystallography or NMR is that it's possible to look at large protein assemblies over a very short period of time. 'Crystallography is the "gold standard" for determining the structure of protein assemblies, but first you have to grow a crystal, which might take a couple of weeks, and it's very hard to trap out intermediate states during the chaperoning process,' he says. 'You might get a snapshot at one point, but not an idea of what's happening in real time. And with NMR, though recent advances have made it hugely exciting in the study of large assemblies, it can still take hours or even days to get a strong enough signal-to-noise ratio, which can hinder getting any information on pre-equilibrium states.'

It only takes a couple of minutes to run a mass spectrum, so it's possible to get information about dynamics. First, the protein is dissolved, and the solution put into a gold-plated glass capillary. It's then sprayed out into the mass spectrometer by pushing it through the capillary with a gas and an electric field, which gives a spray of protein within solvent droplets.

'It's the same principle as spray-painting a car,' Justin says. 'The solvent then evaporates under vacuum, and you're left with naked protein ions in the spectrometer. I remember when I first started learning about the technique I was really surprised that the proteins don't just fall apart in the spectrometer, but you can actually keep huge protein assemblies together in the gas phase like this!'

On a basic level, the information from a mass spec is just a mass, but curiously, Justin says, it can actually tell you a lot. 'In the first instance, the mass is unique. Counter-intuitively, the larger and more complicated it gets, there are fewer things it could be. If you've got a mass of 18 it could be water or ammonia, for example, but if you've got a very big mass of, say, a million, and you know what the constituent units are – which for proteins you do, of course – then you can work out what combinations of those units you could have that would fit with the mass that you measure.'

This, effectively, gives a 'signature' mass for the protein assembly, which means that Justin can look at how it changes over time. 'I'm really interested in the reactions these proteins undergo and the pre-equilibrium states they go traverse,' he says. 'If you mix two protein assemblies together and they interact, you can get information about what is going on. We've mixed two different small heat shock proteins together, and found that they swap elements between themselves. This is easy to spot as the masses we observe for them change, and as we know the masses of the different components we can get an idea of what is changing.'

If you just looked at one protein on its own, then you would never know that these reactions were going on, he says. 'But it turns out they do, and they happen very quickly. We've found that with some disease-related mutations in human proteins this exchange process is much slower. So we have to wonder how important these intrinsic dynamics are to the proteins' function, and we plan to look at this in the future.'

CV Justin Benesch

Born: Vienna, to an East German-Austrian father and an English-Austrian mother. Moved to Switzerland – where his parents still live – aged 5

Education: After an English primary school in Geneva he went to boarding school in England, and then to Oxford to study chemistry. He moved to Cambridge for his PhD with Carol Robinson, at the same time as she made the move

Career: A one-year discipline hopping postdoc fellowship with Carol and electron microscopist Helen Saibil at Birkbeck College was followed by a further postdoc with Carol. He was appointed a Royal Society URF in October 2008

Interests: Unusually for an Austrian, he's a keen cricketer – and plays for the physics department! He also loves cooking, photography and skiing. 'Although I'm pretty anglicised, when there's skiing on the TV I'm completely Austrian,' he says.

Did you know? Justin thinks he may have been involved in the construction of the largest sausage ever made in Cambridge, for his house-warming party last year. It was a Cumberland ring-style sausage, about the same size as a kettle barbecue, and was about 6.5m long unravelled, weighing about 7kg. 'It was very heavy, and it was rather difficult to turn it over!'

Half a century in Lensfield Road

In December, we celebrated our 50th anniversary in Lensfield Road. Brian Crysell, Tony Kirby and Ian Fleming look back at the history of the department, and what it was like in the late 1950s

Above: The old Pembroke Street chemistry building

Brian Crysell on the history

Although chemistry has been taught in Cambridge since about 1682, it wasn't until 1888 that the first purpose built University Chemical Laboratory, in Pembroke Street, was opened. In its day, it was one of the finest in the country. It was lit by gas, and fire precautions were quite primitive. Much work was done during the First World War on chemical weapons research under the direction of Professor Sir William Pope.

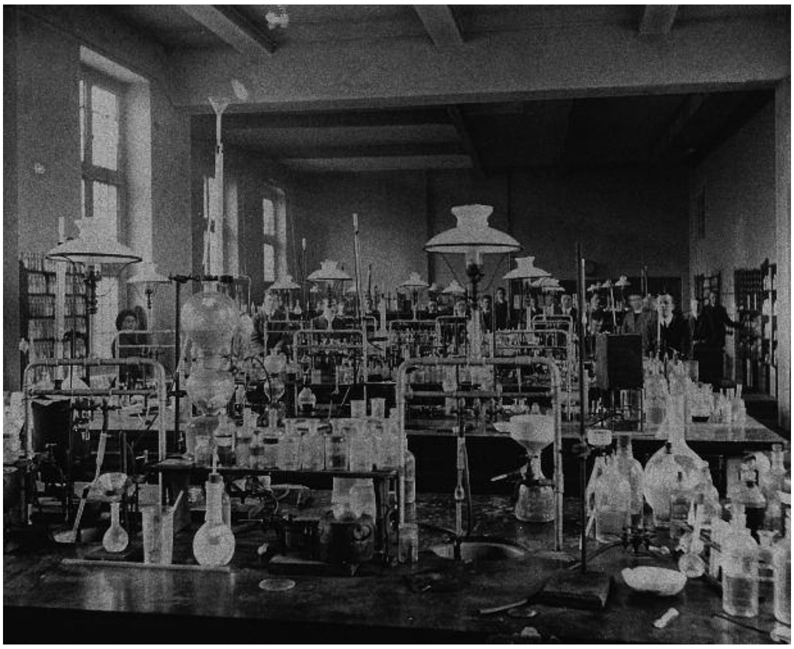
After his death in 1939, it was decided that the appointment of his successor should wait until after the Second World War was over, and a committee should run chemistry in the interim. Several important contributions to the war effort were made in Pembroke Street, including a continuation of the work on gas warfare, photographic emulsions, corrosion and lubricants and also, of course, explosives. One of the least publicised projects was a team working on the separation of plutonium and uranium isotopes as a contribution to the Manhattan Project.

In 1944, Alexander Todd, then professor in Manchester, was invited to accept the 1702 chemistry chair. He visited Pembroke Street and was shocked and disgusted at what he found. Not only had Cambridge become one of the weakest chemistry schools in the country but the laboratory, still lit by gas, was 'a disgrace to any University'. Todd made six conditions under which he would consider the appointment, one of which was that a new laboratory would be built on a new site as soon as possible after the end of the war.

The Lensfield Road estate had been owned by the University for many years. It comprised the villa Lensfield House, and a cottage in quite substantial gardens, and was once home to the architect William Wilkins who had designed much of Downing College, parts of Kings, Trinity and Corpus, and also the National Gallery in London. Although the Scott Polar Institute had already been built in part of the gardens of Lensfield, it was still a large site and much favoured by Todd and the Secretary General of the Faculties.

The architects for the new laboratory, Easton & Robertson, and work began on the site in 1950 with funding from the University and government grants. Steel rationing made progress very slow and the project was completed in four stages over a period of almost 10 years. Stage one, incorporating organic, inorganic and radiochemistry, was completed in 1956, and the move from Pembroke ➢

Below left: the old labs were lit by gaslights; below right: Lensfield House, the villa that once stood on the new site



Above: Excavations on the Lensfield Road site; right: the construction gets under way

Street began. Stage two, physical and theoretical chemistry, was finished in 1958, and the was building officially opened by Princess Margaret on November 6th that year. Stages three and four, the teaching classes and the large lecture room were not completed until around mid-1960, when the old lab was finally vacated.

What is now the Bristol-Myers Squibb lecture theatre was designed as the centrepiece of the new building. Not only was it to be the largest lecture room at that time in Cambridge, but also a cinema, theatre and concert hall. At the back was a fully equipped projection suite for both 16 and 35 mm films. The blackboards and screen could be lowered into a pit to reveal a stage, complete with dressing room facilities off to both sides. The bench at the front could be disconnected from all the services and wheeled out in sections to create an area for a small orchestra.

Sadly, these extra facilities gradually became less used and eventually most of space they occupied was re-allocated. No expense was spared to ensure this room was aesthetically correct, to the extent that the grain of the seats run the same way as the desktops, and each individual seat was reinforced with metal rods to ensure they do not snap when they are sat on!

Tony Kirby remembers

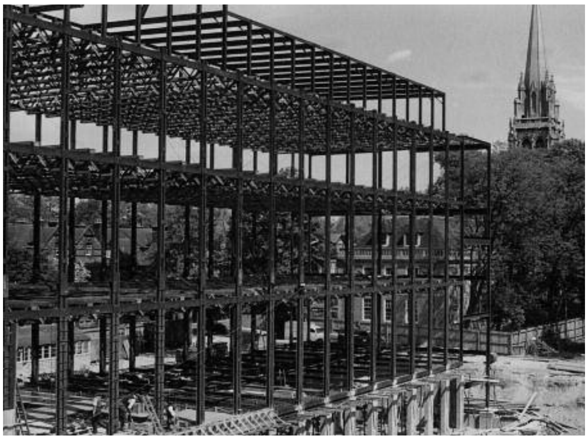
Ian and I came up in 1956, just before the new building in Lensfield Road was completed. Alexander Todd, who arrived in 1944, was crucial in the development of this building and the department, and we still feel the benefits today.

He was very influential in the scientific establishment, which helped in securing the funds to build the new department. Although he never said how much had been spent, the word at the time was that it cost about £4m – rather a lot of money in those days. The story also goes that the Universities Grants Commission were horrified at what they had agreed to, and halved the specifications for any subsequent chemistry departments that were built after the war!

Although the building was officially opened on 6 November 1958, parts of it had been in use to some extent before then, and when we first saw it the construction had still to be completed. The north and south wings were complete, but various parts such as the teaching labs and east wing were yet to be built. The car park was also full of houses – it was very different from how it is today.

Classes were gradually moved from Pembroke Street to Lensfield Road during the late 1950s. The Part I lectures for the Natural Sciences Tripos were still in Pembroke Street in 1957–58, and certainly all the practical classes were still there as the labs in Lensfield Road were not ready. That year Part II classes were taught in both places.

Below: the steel frame that gives the building its strength; right: the labs semi-finished



The building was officially opened by Princess Margaret, who's pictured right with Lord Todd

The teaching itself was also in transition. John Harley-Mason, Malcolm Clark and Peter Sykes were at the vanguard of the new chemistry. The subject was changing in the way it was taught and researched, and we were the beneficiaries of these enthusiastic young people who had been brought into the department by Todd.

Furthermore, he had brought in Harry Emeléus into inorganic chemistry from Imperial College in 1945, and he had made a big impression – as had Christopher Longuet-Higgins as a theoretician. Theoretical was already relatively strong as Lennard-Jones was already in position, originally as Plummer professor of chemical science, and eventually as the first chair of theoretical chemistry in the country.

By 1957-58, the advanced courses for research students were already being taught in Lensfield Road. They had started to move into the new building from 1956, and the change in the facilities was dramatic. The photo of lab 122, where I worked in the 1960s, is particularly interesting – you can see the construction of the roof of the lecture theatre going on outside. We remember it going up very clearly – a very interesting thing to be going on outside your window!

Ian Fleming on the people

I first stepped into the building in 1956, when it was still a construction site. Parts of it were complete, however, and I went through the door to find my supervisor, the sole reason I had to step into the building. David Cohen was working in room 122, and I went there to make arrangements for supervisions, so I saw the building in that state. It was a period of very great change, not only with the new building but also with new ways of teaching chemistry.

In our first year, we had a choice of being lectured to by Bernard Saunders or Barry Kipping, who ran separate courses side-by-side, and your director of studies chose one or other for you; Tony and I both went to Kipping's course.

After two terms of organic, we had one on inorganic chemistry in the Easter term, taught by Alan Sharpe. The difference between the two was dramatic. Kipping taught traditional chemistry – functional group chemistry, starting materials, products and reagents, and nothing in between – no explanations at all. Sharp introduced us to electrons, to s and p orbitals, and we began to see how the periodic table came out the way it did, which was a revelation!

The next year, again, we had very traditional teaching for inorganic from Professor Emeléus or Dr Palmer (there was a choice again). It really was extraordinarily dull, I have to say, with endless information on the chemistry of boron and all the other elements they taught us about.

But then there was another revelation, with Christopher Longuet-Higgins. His goal through the 50s and into the 60s was to get across to the world the importance of molecular orbital theory - thinking about how electrons were distributed and moved as the basis of organic chemistry. And he taught that wonderfully. Although he used mathematics, even I, who had none, was able to follow what he was doing and to be impressed by it. He was a spectacular lecturer who strode up and down in front of the class – just what you're not supposed to do – but people were riveted. ➢

Lab 122 as Tony Kirby remembers it – spot the lecture theatre being built outside the window

We then moved on to what was called the advanced half subject, in which we did more chemistry than had previously been included in the second year. And we had two more lecturers - Peter Sykes, who actually talked about electrons in organic chemistry, showing us how reactions worked, and Alfie Maddock, who showed us that inorganic chemistry was actually very interesting. These were remarkable people who gave us a new view of the subject, and for that reason I went on with chemistry; without the influence of Sharp, Longuet-Higgins, Sykes and Maddock, I would probably have chosen biochemistry instead!

In the third year, we were taught by Alex Todd, who gave us a really first hand account of natural product chemistry, the subject he was most interested in; by John Harley-Mason, who was a modern chemist, in a rather idiosyncratic way; and by Malcolm Clark, who was the single most important individual in my student career as he showed us we could go on thinking about chemistry way beyond what had already been revealed to us.

There was also FG Mann, another traditional chemist. While he was a very clear lecturer, he simply spoke about substrates and products, with no mechanisms. For example, he taught a whole section on benzpyrimidines, which would not be taught like that today, as we teach the generalities of how to think about molecules like this, not specifically about individual structures.

When we started our PhDs in 1959, there were four women in the whole of organic as judged by the photograph – which was pretty typical of those days. What a difference it is today. The other thing is nearly everybody in the photograph has a jacket and tie.

The great thing about this university has been the fact that we've had first class colleagues with whom to talk about chemistry. It was Malcolm Clark who got me, Tony Kirby and Stuart Warren going – we all shared Malcolm as a major input, and it was his way of thinking that infected us.

The year 1962-63 was an extraordinary year - it was the year the Cam froze, and for about a month we could walk on the river. Christopher Longuet-Higgins went skating on the Cam, and one day as he was heading out of the building to go skating, Todd was coming in and said, 'What are you doing? You'll break a leg!' And half an hour later, he was in Addenbrookes. Todd had great predictive powers!

Another major change that was taking place at that time was the introduction of NMR. As an undergraduate, our lectures from Delia Agar on NMR were entirely about the physics of the technique – there was no way we would learn how to interpret an NMR spectrum from them.

So it was a great surprise to me during my first term of research in 1959 when Harley-Mason said to me, when I was puzzling over an unexpected product, why don't you run an NMR? I asked him what it would tell me, and his response was that he didn't know but it was a good idea!

Top: Saunders, Kipping, Sharpe, Emeléus, Palmer, Longuet-Higgins and Sykes;
Above: the frozen Cam

Below: Maddock, Todd, Harley-Mason, Clark and Mann

So I got the NMR spectrum and, of course, I couldn't make head nor tail of it. Compared to modern spectra it's terrible – there's no scale, and the big peaks were internal standards, but it came with a very interesting note pinned to it, saying that there was an ethyl group in my compound. From then on I realised that I had to learn about NMR.

The most dramatic illustration for me of the power of NMR came 18 months later, when Yusuf Hamied was giving a lecture on his research into the aphid pigments. As I remember it, he presented a story in which he was trying to show that the aphid pigments featured two hydrogens on quinone rings, for which there was a chemical test. It was a beautiful lecture, and well performed chemistry that convinced us that the structure he was looking at had two hydrogens like that.

But at the end of the lecture, Norman Sheppard got up from the back and said, 'Yusuf, that was a wonderful lecture and beautiful work, but you've got the structure wrong – I've taken the NMR spectrum of the starting material and the product, and there is no doubt that there's only one H on the ring.'

It didn't take long for someone, probably Malcolm, to show that there was a viable pathway. The lesson we learned was that the chemical test was not reliable, whereas NMR was reliable!

Very shortly afterwards, Dudley Williams came to Cambridge to give us greater strength in NMR and to introduce us to mass spectrometry, and over the years they seem to answer almost everything in the way of structure determination! What a great privilege it was to live through that period of dramatic change.

A couple of issues ago we published a photo of tree surgeons at work in the car park. This prompted retired department photographer Eric Smith to send us this photo he took way back in 1959, when health & safety regulations aren't quite what they are today. Not a job for the faint-hearted, or those with vertigo!

Comings & goings

New Staff
Pawel Paczesny
Christine (Tina) Jost
Asha Boodhun
Judith O'Connor
Susan Smith
Martin McLean

Leaving
Antonia Maria Moya

Tim's beach wedding

Technician Tim Layt got married in February – and went all the way to New Zealand to do the deed. His bride Kirsten Scholefield – who used to work in reception here in the department – is a Kiwi, so they went back to her roots for the wedding. It was a bit of a British invasion – 26 friends and family made the trip to make sure Tim didn't change his mind.

When they got engaged a couple of years back, Tim was adamant that it was going to be at least three years before they got married. But that didn't quite happen. 'It developed its own inertia,' he says. 'People kept asking when the wedding was, and it was easier to say that we had a date…'

The ceremony was held on a beach at Scott's Landing, near Kirsten's home town of Warkworth in the north island. Despite the torrential rain, the wedding went brilliantly, and everyone had a fab time. 'It was the most torrential rain I've ever seen, and it was really funny watching guests running across the beach with umbrellas!' Tim says.

They were in New Zealand for three weeks in total, and had a pre-honeymoon there during which time Tim did his first sky-dive, from 15,000 feet. Kirsten was gutted she couldn't jump too as she had a bad back!

The honeymoon proper was a week of unashamed luxury in the Maldives. 'We were due to fly back at 2.30am on Sunday morning so we wanted a late check-out,' Tim says. 'But unfortunately they were full on the Saturday so it wasn't possible. Instead, they suggested we check out on Friday instead, and spend Friday night and Saturday on the resort's 100 foot fully-catered five-star yacht instead. It was a wonderful surprise ending to our honeymoon.'

After a whole month off, it's a bit of a shock to the system being back in Cambridge. 'Married life is lovely,' he claims. 'Though we have spent most of it so far in five-star luxury! And I'm really enjoying asking people if they've met my wife.'

Snow bride Monika

Monika Czifersky, a postdoc in Oren Scherman's group, got married at the end of March in the Austrian snow. They're both from Vienna and love the snow, so it was the perfect weather for them!

However, there was plenty of potential for disaster as the logistics of where they both were just before the wedding were somewhat chaotic. 'Andreas is still living in Vienna, but he had a job interview at the British Antarctic Survey in Cambridge the day before the wedding!' she explains.

'We were getting married in Vienna on the Friday, so I left Cambridge in the afternoon of the Wednesday, and met Andreas near the airport in Linz to give him my house keys and car keys so he could pick up the car I'd left at Stansted. I then had to drive to Vienna, while he took the evening plane from Salzburg to Stansted.'

On the Thursday while Monika was busy with the last minute arrangements for the wedding, Andreas had his interview, then took the evening plane back to Salzburg, and arrived after midnight in Vienna. 'We were very lucky that everything worked smoothly with the flights!' she says.

The wedding day was sunny and cold, and they held the reception in a mountain hut just outside Vienna, about 1000m above sea level. 'We had much more snow than we expected, but everything went really well. We both love to be in the mountains, we love snow and skiing, hearty soup, snowball fights, and so on. So we tried to include as many of these things as possible into our wedding. Everyone had a great time, and it was an unforgettable day for the two of us.'

They followed the wedding with a week's honeymoon in the Swiss Alps, again with lots of snow. And they also had a bonus wedding present – Andreas got the job!

Fancy a drink?

Nathan Pitt was on hand with his camera to catch some of the faces old and new at last December's staff Christmas party

Left: Alan Battersby and Dick Barton; right top: Sue Johnson and Mike Todd-Jones; right: Tim Dickens and Peter Murray-Rust; right below: Julie Lee and William Prist

Above: David Gillingham and Mike Sleep; above right: John Holman and Sue Harding; right: David Woollard and Ken Veal

Left: Liz Alan, Anne Railton, David Watson and Christine Wilson; above: High fives for Sian Bunnage and Pat Chapman

Last issue's winners

ChemDoku

Another fine response to the ChemDoku puzzle, most with correct answers, plus an honourable mention for Donald Stedman and his wife Hazel, née Cooke, who believed there was a misprint and suggested a change to the puzzle. However, the following all got the correct answer, so hopefully the original version was solvable – either that or everyone else got it wrong.

And correct answers were received from Bill Collier, AJ Wilkinson (who says, is it me – I am 80 – or are your puzzles getting harder? This is the first I have solved for a year or so and I have the impression it was the hardest Sudoku I have ever completed), Jim Dunn, Helen Stokes (who claims ChemDokus are very good fun), Reg Lewis (who says he's from the infamous 1946 class), L Smithurst, CW Haigh, Nick Broughton, Ian Fletcher, John Wilkins, Pat Lamont Smith, Annette Quartly, Julian Langston, Karl Railton-Woodcock, Richard Chambers, Bruce Sargent, Robin Cork, Chris Shorrock, Joanne Castle, John Billingsley, Christian Hill, Roger Duffett, Tom Banfield, David Wilson, Mark Alderton, Raymond Holland, Norman Sansom, Richard Brown, Alison Griffin and Godfrey Chinchen. And the winner is... as chosen by this issue's glamorous assistant (actually my lovely hubby being a random number generator at the end of the phone line)... Norman Sansom. Congratulations!

Chemical crossword

	1 W		2 S	Co	3 Ne		4 Ca	S	5 U	Al
6 Se	I	7 C	He		8 C	Eu	Ta		N	
9 Te	S	La		10 Er	K		Cl		11 Co	12 Re
13 N	Er	Y	14 S			15 C	Y	16 Pr	U	S
Ta		17 Mo	O	N	18 S		19 Sm	O	Th	Er
	20 W	Re	N		21 O	22 V	I	Ne		V
23 P	Ar		24 Ar	25 Se	N	I	C		26 C	At
27 I	N	28 Ca		C		Sc		29 H	Ar	I
Xe		30 Re	31 C	O	32 V	Er		33 As	B	O
La		34 S	U	Nd	I	Al	35 S		36 I	N
37 Te	N	S	Es		Ce		38 Al	O	Ne	

Graham Quartly's latest crossword provided another good influx of entries, without *too* many complaints about the Spanish word and the dance move, although one correspondent thought the latter was most unfair as he is a confirmed *Strictly Come Dancing* avoider! And I think the sports channel 'Setanta' caused a little confusion...

Anyway. Correct solutions came from Bill Collier, Jim Dunn, L Smithurst, Ian Fletcher, John Wilkins (Fiendish!), Pat Lamont Smith, Ian Potts, Julian Langston, Donald Stedman, Karl Railton-Woodcock (who reports that as the UK froze, the temperature in Melbourne hit 45.4°C), Robin Cork (who says the crossword was a big challenge – congratulations to the setter!), John Billingsley (who commented that it's really nice to come across new words), Keith Preston, David Stewart, Roger Duffett, David Wilson, Norman Sansom, John Nixon, Raymond Holland, Richard Brown and Nicola Farrer. And my husbandly random number generator picked John Wilkins as the winner.

ChemDoku gets personal...

Mt	Rf							
		Md	Sg				Rg	
					Fm	Rf		
			Es	Rg			Mt	Sg
		Sg				Cm		
Md	Fm			Rf	Sg			
		Rg	Rf					
	Cm				Bh	Mt		
							Sg	Cm

The return of ChemDoku garnered its usual large crop of entries, so it would seem rude not to provide our loyal readers with another chance to show off their powers of deduction without the benefit of numbers in the grid.

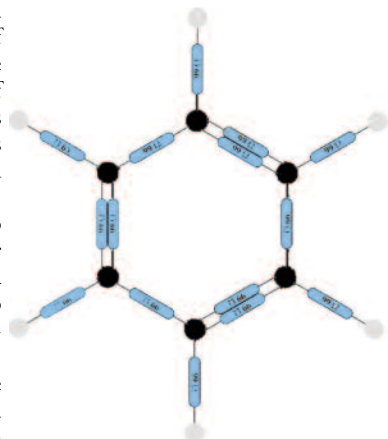
This time, we've replaced said numbers with nine chemical elements named after people – which, of course, means that some of them barely exist, and certainly don't exist in nature. Meitnerium, for example, was discovered when a single atom was created by bombarding a target of bismuth-209 with accelerated nuclei of iron-58.

All you have to do is to arrange the chemical symbols of the nine different precious metals in the grid so that each appears once – and once only – in each horizontal row, vertical column and 3x3 square. Easy!

Benzene resistance

And finally for this issue... a part-chemistry, part-physics puzzle from Graham Quartly. He says that while the problem is based on the structure of benzene, he had been trying to couch it in terms of buckminsterfullerene – but the maths got a bit excessive for that!

And the puzzle is... The trusty chemistry technician at St Anne's was called upon to supply a model of benzene at short notice. As the usual set of atoms and bonds were at home for the apple-weighing problem from a couple of issues ago, she plundered a bag of 99 ohm resistors from the physics department, and hastily soldered 15 of them together to make the familiar hexagonal star, with parallel resistors to indicate the alternate double bonds. What is the effective resistance between diametrically opposite hydrogen atoms?



£20 prizes are on offer for each puzzle. Send entries by email to jsh49@cam.ac.uk or by snail mail to Chem@Cam, Department of Chemistry, University of Cambridge, Lensfield Road, Cambridge CB2 1EW

Never mind the health scares, Grandma – you *know* pumpkin soup needs salt!

UNIVERSITY OF CAMBRIDGE

Chem@Cam is written, edited and produced by Sarah Houlton

Printed by Callimedia, Colchester