UNIVERSITY OF CAMBRIDGE

Chemistry at Cambridge Magazine

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Experiencing ‘the thrill of chemistry’

chem@cam

Alzheimer’s Adversary: Chris Dobson

Creating purer and better-targeted drugs

Alumni reunion generates fund of memories

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OUTREACH

AS I SEE IT

RESEARCH

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Welcome

In October, I will be making way for a new Head of Department. Whoever takes over will face challenges as we continue to work hard to maintain our world-leading position; I am confident that, as ever, we will rise to the challenge.

This is a great department. Our research is exceptional in its quality, its depth and breadth. Crucially, we have wonderful people – academics, support staff, postdocs, students – who all make huge contributions, enhancing our reputation year on year. Finding funding is, of course, a perennial issue and these pages demonstrate how we use the financial support we receive, which often includes the generous help of our alumni. For this, we are enormously grateful.

Philanthropic donations, for example, support our fantastic annual Open Day in March; at it, the enthusiasm with which children (of all ages!) take part in experiments and demonstrations is heartening to see. What is also noticeable is the enthusiasm with which our student and staff volunteers welcome our visitors and run activities to kindle their interest. It is a great event all round, as the article on page 4 shows.

To coincide with the Open Day we welcomed back to the department some of our alumni who were here 50 years ago and more. It was a pleasure to connect with them and hear their anecdotes about life in the department then and about many of our eminent scientists. (You can read them for yourselves on pages 16-17.) We discovered how the department has changed: we’re a bit less cavalier about Health & Safety issues now than we were then! We can also safely say that we no longer require students to wear top hats during Chemistry practicals, although with suitable sponsorship….

Next month the doors will open to our new Chemistry of Health building, again made possible by generous philanthropic and industrial support, which was essential to supplement government funding. This is a state-of-the-art facility that, amongst others, will house the Centre for Misfolding Diseases – the research team working to advance our understanding of protein-misfolding diseases like Alzheimer’s, Parkinson’s and motor neurone diseases. You can read about some of this work on page 8.

It has been a huge honour to be the department’s Head during this exciting time. I have enjoyed it thoroughly. So many people have helped me that it is impossible to mention them all. However, I must specifically thank my Deputy Heads, James and Nick, for their invaluable advice; Marita and Howard, for all things organisational; and my office staff, Daphne, Klaudia and Chloe for telling me exactly what to do!

John Pyle
Head of Department

Cover photograph taken at Chemistry Open Day by Gaby Bocchetti.

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Chemistry opens its doors

There were bubbles and bangs galore at our Open Day as visitors explored chemistry by creating rainbows in test tubes and constructing batteries from fruit.

The department holds an Open Day every year as part of the Cambridge Science Festival. Visitors can experience the thrill of chemistry, and its importance in our lives, by taking part in experiments organised and run by students and researchers here in the department. "Chemistry began with magic: the alchemists devised complex schemes to hide their wizardry," explained Professor Robert Glen in a specially-created colouring book we were giving out on the day. "But today chemistry is open to all and creating new materials, from better batteries to miracle medicines, to transform our lives."

This year, budding chemists explored the structure of molecules by constructing models of them, and the properties of non-Newtonian fluids (which behave differently when you apply pressure to them) by playing with cornflour slime.

"It's always a very popular day. On average, we have 1,500 visitors," says organiser Emma Powney. One of the big draws is Dr Pete Wothers' – quite literally explosive – lectures. This year's title was 'It's A Gas'. Dr Wothers memorably illustrated his talk about the gases in our atmosphere by blowing up hydrogen balloons and a (model) chicken made from nitrocellulose.

We know from the feedback we receive how much visitors enjoy the event. One mother came from France especially to bring her two teenage children to the event. A primary school wrote to us to say: "Our thanks to the Chemistry department: our children had an amazing day. They were given a glimpse of science at a top university – and loved every minute!" And a student from a secondary school in Leicestershire said: "I learned about 'sublimation' – how solids can turn into gases without becoming a liquid first. I didn't know that could happen until today."

- *We gratefully acknowledge the support of The Walters Kundert Charitable Trust which makes this event possible.*

Cracking a chemical mystery

Schoolchildren turned forensic chemists for a day, conducting experiments to solve 'The Mystery of the Missing Trophy' as they took part in the Salters' Festival of Chemistry we hosted here.

The childen aged 11-13 came from schools across the East of England. They were here for a day of science challenges aimed at encouraging their interest in chemistry. The first competition was set by the Salters' Institute, which supports science education. Working in pairs in our teaching labs, the children had to carry out practical experiments to try and find out who had stolen the Institute's missing Centenary Trophy.

Testing the ink from the ransom note

Supported by some of our PhD students, who had volunteered to act as demonstrators, they conducted test tube reactions on samples of the white powders found on the shoes of the suspects, and used chromatography to test the ink from the ransom note! After a lunch break, they took on the 'University Challenge' set by the department to find out how much iron there really is in a multivitamin tablet. As the iron is contained in a chemical compound, they had to use dilute hydrochloric acid (like the acid in our stomachs) to release the iron into a solution before they could discover how much iron was present by using spectrophotometry.

The students were judged – on their practical work, team work, and logical thinking skills – by representatives from AstraZeneca, Biochrom Ltd and the University of Cambridge. At the end of the day, prizes were awarded to the winning teams.

Children competed to take part

Lorna Bingham, science teacher from Potton Middle School in Bedfordshire, said: "We could only bring a team of four but we had more students who wanted to come. So they competed to be here by taking part in a quiz and doing some practical experiments in the lab in their own time."

And the students from Sawston Village College, who came second in the University Challenge, said they had relished "the practical work", "getting to mix the different chemicals together" and "the calculation we needed to do at the end of the University Challenge."

The young scientists from St Mary's Senior School, winners of the Salters' Challenge.

Beijing's battle for clearer skies

Jones Group

Researchers here are probing urban air pollution in unprecedented detail by using a network of low-cost sensors they developed. Following on from a project at Heathrow, they have been using their technology to study air quality in one of the world's most polluted cities: Beijing.

When you think of the Beijing Olympics in 2008, what do you remember most clearly? The Bird's Nest stadium, or the spectacular opening ceremony? Or the smog that overshadowed the event, making them the 'the most polluted Olympics ever', according to researchers from Oregon State and Beijing Universities who measured particulate air pollutants during the games.

A decade on, Chinese authorities are still working to tackle air pollution in the megacity of Beijing (population: 21 million). But the challenges are many and complex. Man-made emissions from factories, cars and power stations are an obvious issue. "In western countries, mitigation strategies have been really effective in addressing such pollution problems," says Lekan Popoola, a postdoctoral researcher in the Jones group who is taking part in a major international study of air quality in Beijing. "But China is experiencing such rapid industrialisation, they aren't putting enough measures in place to tackle the pollution associated with it."

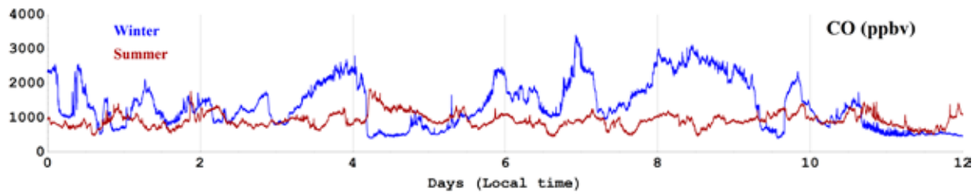
And there are other factors that are more difficult to address, such as the topography of the area: Beijing is surrounded to the north and northwest by mountains that help trap pollutants in the air. There are also natural emissions affecting air quality, like dust and sand that blows in from neighbouring Mongolia.

Lekan is involved in an inter-disciplinary project to measure and understand the range of factors contributing to air pollution in Beijing. The aim is to better comprehend the physical and chemical processes that drive the formation of pollutants, and attribute toxic pollutants accurately to their sources. This should help scientists model and test effective strategies for mitigating ambient air pollution.

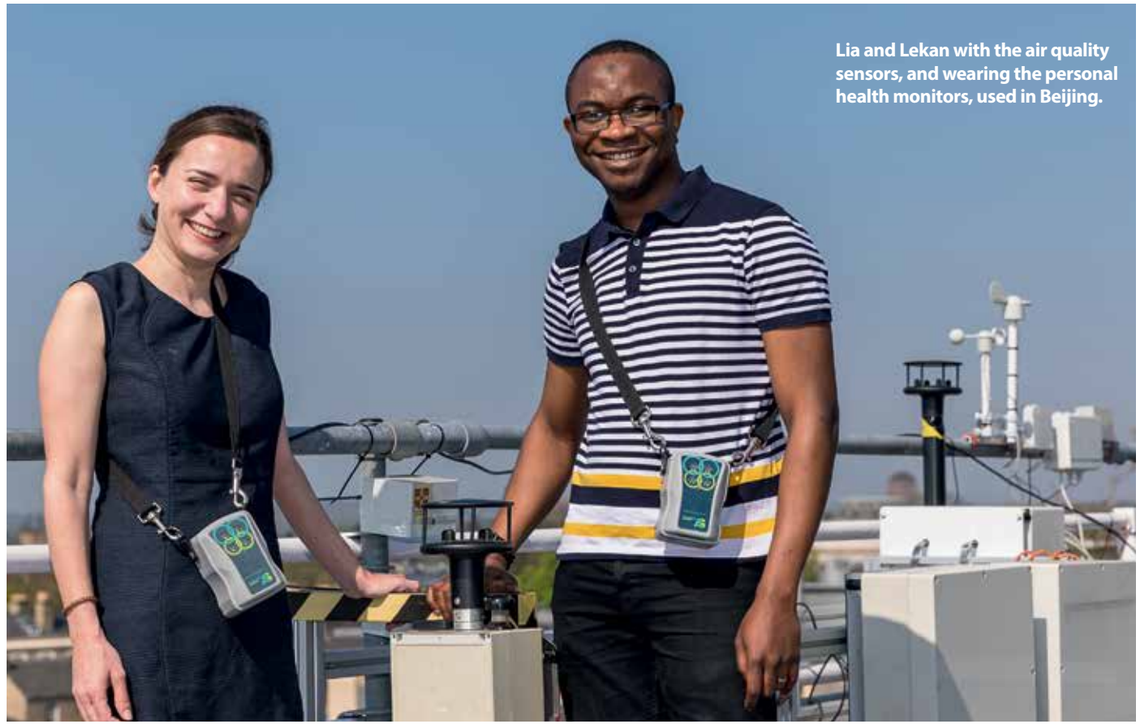
London and Lagos

As a PhD student here, Lekan worked on developing low-cost air quality sensors and using them in cities including London and Lagos. For the current project, he went to Beijing twice – in May and November last year – deploying a network of the sensors in different locations, heights and levels, to build up a detailed picture over time of the city's air quality.

Among other things, the findings show the importance of meteorology and the changing seasons to the issue of air quality. Lekan says: "North China typically experiences dry winters. So, during the winter months, pollutants are being emitted into a stable atmosphere." This has a double-whammy effect: there are more emissions from residential heating coal-fires and power stations in winter and when these emissions are released into the static air, it leads to episodes of smog. But summer, says Lekan, brings problems too. "In winter, you're trying to control toxic emissions like carbon monoxide. In summer, there's an abundance of biogenic sources that can transform other emissions into a high level of ozone (which is harmful to humans if inhaled). So, even though you don't have haze in summer, you do have toxicity linked to ozone."



The blue spikes in Lekan's graph indicate CO levels rising during Beijing's episodes of winter smog while the graph overall illustrates the significant difference in pollution patterns in summer and winter.
Ppbv = parts per billion by volume.



Lia and Lekan with the air quality sensors, and wearing the personal health monitors, used in Beijing.

Harm to human health

And the harm to humans arising from this pollution is what interests Lekan's fellow postdoc Lia Chatzidiakou. With a background in architecture and engineering, she originally came to the UK from Greece to take a Master's in environmentally-efficient building design. When funding became available, she was able to do a PhD here instead and it has led her into this project, where she is researching the links between urban pollution and disease. Lia has been studying two groups of Beijing residents, one in the city's centre and one on the outskirts, aiming to establish detailed links between inhaling pollutants and adverse cardiopulmonary responses.

"As child mortality and infectious diseases have declined markedly, cardiovascular and pulmonary diseases have emerged as leading causes of death in China," Lia explains, "and there is mounting evidence from large-scale epidemiological studies of links between exposure to particulate matter and cardiovascular disease."

However there are some issues with this research: it focuses only on *outdoor* pollution (although people are also exposed to pollution indoors) and also aggregates health outcomes. "This study is much more detailed," she says of her Beijing field trials. "Each participant wore a personal health monitor that allowed us to monitor the levels of pollution they were exposed to. We were also able to monitor their activity levels, as they are important: you breathe in more polluted air running than you do walking, for example. We're now quantifying how much pollution they were exposed to and comparing that with changes in blood pressure, lung function and biomarkers in their blood that show their levels of oxidative stress." The aim is to generate more reliable links between personal exposure and health outcomes, and use the information to inform policy and help people understand how to reduce their health risks.

Cultural issues

One notable finding was that the participants were exposed to more pollution *indoors* than outdoors. "We saw a unique energy use pattern, especially in Pinggu, a semi-rural area on the outskirts of Beijing. Over half the participating households there still use traditional biomass and coal stoves for winter heating and crop residues for cooking over open fires, even though they have access to electricity, because that's what they have always done. It's partly a cultural issue."

Analysis of the findings from Beijing is still ongoing. But the research is already being extended to other developing countries, with work now underway in Dhaka, Bangladesh. "It's even more polluted than Beijing," says Lia, with a wry smile. "Before I went there, I didn't think that was possible."

And Lekan, who came to Cambridge on a Commonwealth scholarship, is starting some collaborations with researchers in his native Nigeria. "Down the line, I'm hoping this technology could be transported back to developing countries like Nigeria where we have some excellent theoretical research – but not enough money to do the practical work," he says.

- *We gratefully acknowledge the support of the Natural Environment and Medical Research Councils, the National Science Foundation of China and the Newton Fund for this research.*

Alzheimer's Adversary

Chris Dobson: "As I See It..."

It was a surprise to Professor Christopher Dobson, when he was studying the "totally innocent" antibacterial protein lysozyme, to learn it had been found deposited in clumps in the organs of some patients at a London clinic. He was intrigued and the puzzle led him into the study of protein aggregation and its relationship to human disease. Over the subsequent 25 years, the work by Chris and his research group, colleagues and collaborators has brought vital advances in our understanding of disorders such as Parkinson's and Alzheimer's diseases – and resulted in new approaches to halting the disorder he views as a modern-day plague.

Alzheimer's disease is a plague.
The best-known plague, the Black Death, was an infectious bacterial disease that devastated Europe in the 14th century. A more recent plague, the 1918-19 outbreak of Spanish Flu, was the biggest pandemic the world has ever seen. Until now...

Alzheimer's disease is a new 'plague', already affecting around 40 million people worldwide, a number predicted to triple by 2050. It's one of a group of non-infectious diseases that terrifies us as it is currently completely incurable, largely untreatable and usually fatal.

We have only known about Alzheimer's disease for a century.
It was first reported in 1906 by Dr Alois Alzheimer. He had a 51-year-old female patient with what we now know was an early-onset form of the disease. Her husband couldn't afford to pay for her care so he agreed that Alzheimer would look after her and in return, Alzheimer could analyse her brain when she died.

As antibiotics, immunisation programmes and improved hygiene have greatly reduced infectious diseases, it's non-infectious conditions – such as heart disease, cancer and now Alzheimer's – that challenge us. In the UK, it already costs £30 billion a year to care for people with Alzheimer's disease. If no treatments are found, the increasing number of people with this disorder will have crippling impacts on society and economy worldwide.

Why is Alzheimer's disease increasing so rapidly?
It is due to the vast increase in the numbers of people living into old age. At 65, our chances of getting Alzheimer's disease are one or two in a hundred. If we live to 85, our chances of getting it are about one in three.

Alzheimer's disease is caused by protein malfunctions.
Everything that happens in our bodies is catalysed or controlled by proteins, of which we have around 100,000 different types. In order to function, most proteins have to fold into specific structures. The cells in which they fold are highly complex environments and sometimes things go wrong. I have spent a lot of my career studying protein folding and we now know many of the general principles involved. More recently, initially because of the observation with lysozyme, I've become very interested in protein misfolding that can give rise to disease. Some such diseases are caused by a shortage of properly functioning proteins, as in cystic fibrosis. Other diseases result because proteins misfold and end up in the wrong place in the body.

And then there is a family of disorders – including Alzheimer's disease, Type 2 diabetes, and Parkinson's, Huntington's and motor neurone diseases – where misfolding causes proteins to clump together, giving rise to intractable deposits called amyloid fibrils. This process abolishes protein function, disrupts organs like the heart and generates cellular toxins.

Proteins naturally like to form these amyloid deposits.
We discovered accidentally that in the laboratory perfectly ordinary proteins can aggregate and form amyloid structures. A postdoc who left his sample of an unfolded protein in an NMR spectrometer over a long weekend discovered, on his return, that it had turned into a gel. We were curious about this phenomenon and found that the NMR tube was full of amyloid fibrils that we then thought were associated only with diseases.

Then a graduate student made the remarkable observation that the amyloid form of proteins can be thermodynamically much more stable than their functional forms. It was a real surprise to discover that many of our proteins would much rather be clumped together as aggregates and that they have an inherent tendency to convert into this state.

"Alzheimer's is a modern-day plague. And it brings much the same fears as the contagions of old: every time someone of my generation forgets a word, we're worried it's the beginning of this dreadful disease..."

The rate of aggregation can be explosive.
We studied the major protein whose aggregation is associated with Alzheimer's disease and found that once a few aggregates form, they catalyse the production of more aggregates in a sort of chain reaction. Tuomas Knowles – then a research fellow at St John's and now a professor and colleague in the Chemistry Department – played the key role in enabling us to work out the mechanism of the aggregation process, a really key breakthrough.

We're looking at the protective mechanisms in the body.
'Molecular chaperones' assist protein folding but we found that they also play a key role in slowing down the formation of these amyloid structures. We're now looking at ways to mimic these natural defence mechanisms artificially and so help protect the body against them for a longer time. My colleague Michele Vendruscolo, also a Professor in the department, has shown that one can design antibodies in a computer that bind to specific regions in the proteins and inhibit the aggregation process.

We're finding ways to reverse the process.
In the recently-established Centre for Misfolding Diseases – that brings together the Dobson, Knowles and Vendruscolo groups and our associates and collaborators – we are developing strategies for combating such protein aggregation. We have found that small molecules, including drugs used to treat other diseases, can inhibit this process in the laboratory and in a model organism, the nematode worm. The hope is it will work in humans as well. And we've found other molecules able to suppress the aggregation of the proteins involved in Parkinson's disease, one of which is now in clinical trials in the USA.

The new Chemistry of Health building will help our work.
We're very lucky to have the new Chemistry of Health Building about to open, thanks to several extremely generous donations that made its construction possible. It will house the labs where we conduct fundamental science, as well as Wren Therapeutics – a drug discovery company founded to take our therapies into human patients.

Preventing and treating Alzheimer's disease and other neurodegenerative conditions are huge challenges. We are, however, confident that this plague will be defeated in due course, just as those plagues affecting humanity in the past have largely been consigned to history.

Absorbing oil from troubled waters

Oil spills threaten aquatic environments and have adverse effects on the environment, economy and human health. Now researchers in the department have helped create a low-density polysulfide that acts like a sponge to soak up oil spills. The new polymer soaks up crude oil or diesel and turns it into a gel. The 'sponge' can then be squeezed to remove the oil, and reused.

Picture: Louisiana Governor's Office of Homeland Security & Emergency Management. Creative Commons.

Dr Gonçalo Bernardes, a Royal Society University Research Fellow here in the department, and his research student Inês S. Albuquerque, worked with a team from South Australia's Flinders University on the joint project. The polymer the team developed has the potential to be less expensive and more sustainable than existing clean-up tools, or sorbents, as it is made entirely from waste: sulfur, which is a by-product of the petroleum industry, and used cooking oil. This makes it inherently lower in cost and sustainable.

Importantly, the product is also safe. Gonçalo and Inês evaluated the new polymers for their potential toxicity and "found they are benign to living cells in general," says Gonçalo. "This is important so that these materials can be used in the field." The researchers are now working with engineers and government agencies to manufacture the product on a larger scale, with a goal of field-testing it over the next year. The Bernardes group is also exploring its potential for biomedical applications, for example, the delivery of drugs.

- *Sustainable Polysulfides for Oil Spill Remediation: Repurposing Industrial Waste for Environmental Benefit*, Max J H Worthington, et al. DOI: 10.1002/adsu.201800024.

Post-match talk sparks pioneering research

Professor Clare Grey's work has just been recognised by the award of a 2018 Royal Society Research Professorship – the Society's premier research award. Clare is one of six scientists who received this prestigious award, which provides long-time support for "internationally recognised scientists of exceptional accomplishments." She joins a colleague here, Professor David Klenerman, as a holder of the award: David received his in 2016.

Clare has spent twenty years seeking to understand the precise chemistry of the rechargeable lithium ion battery and has conducted pioneering research in this field, including building a prototype of a new kind of battery – the lithium air battery – that could make electric cars more energy efficient. Earlier this year, it was announced that she would lead a collaborative Faraday Institution study, with funding of up to £11.9 million, into how environmental and internal battery stresses (such as high temperatures, charging and discharging rates) damage electric vehicle batteries over time.

But as Clare told Radio 4's *The Life Scientific* recently, her research in this field was originally sparked by chance. It was a question asked of her at an academic conference, and conversations with colleagues after a game of squash, that first set her on this path.

She was discussing her work – on how fluorine ions move in solids – at a conference when a Duracell scientist came to talk to her. "He thought I had been talking about lithium (I hadn't the heart to say that it was fluorine) and asked me to look at some battery materials," she told interviewer Jim Al-Khalili. "I wasn't working on batteries then, but that set me on the road to thinking about such things in more detail. I was also playing squash, at the time, with colleagues in a national lab who were working on batteries, and the conversations after our matches were very productive."

This was the mid-1990s, not long after the invention of the first lithium ion batteries for portable electronics. Originally created by Sony for the first rechargeable battery for their camcorders, such batteries went on to be used in mobile phones and laptops. "And versions of it are now moving into electric vehicles," Clare said. But because the technology is now so prevalent, "when people complain about having to charge their batteries they think it's a simple problem to solve," she added. "They don't realise that when you charge a phone battery every day, or an electric car battery once a week, it's the small degradation reactions that happen every time you charge and discharge the battery that ultimately kill it.

"Those are the things that I am interested in understanding, to find out what's going on and work out which are the most important of these reactions and how to stop them."

- Clare Grey's interview on BBC Radio 4's The Life Scientific can be heard on iPlayer at: www.bbc.co.uk/programmes/b09tdr0r

Cambridge chemist wins gold in London

Kim Liu, a PhD student in the department, took top prize at a science competition in Parliament in March. Kim presented his research, which investigates an alternative quadruple-stranded form of DNA, to politicians and a panel of expert judges, as part of the STEM for BRITAIN poster competition. It was judged against 29 other shortlisted researchers' work and came out the winner, receiving the Gold prize (an award of £2,000) and a medal.

Kim said, "I think it's important that scientists communicate effectively with policy makers, and so this was a great opportunity to practise presenting to people from backgrounds outside science, which is often challenging."

The STEM for BRITAIN competition aims to help politicians understand more about the UK's thriving science and engineering base and rewards some of the strongest scientific and engineering research being undertaken in the UK.

Stephen Metcalfe MP *(far right in photo)*, Chair of the Parliamentary & Scientific Committee, sponsors of the chemistry awards, said: "These early career engineers, mathematicians and scientists are the architects of our future and STEM for BRITAIN is politicians' best opportunity to meet them and understand their work."

The Parliamentary & Scientific Committee runs the event in collaboration with a number of STEMM bodies including the Royal Society of Chemistry.

Alumna wins bronze at Commonwealth Games

Hayley Simmonds, who completed her PhD here in 2016, has just won a bronze medal at the Commonwealth Games. The former Gonville & Caius student, who as a Natural Sciences undergraduate used a mountain bike as a cheap way of getting around Cambridge, took bronze in the road time trial, setting a new record time in the process. Not bad for a cyclist who originally took up the sport to lose weight and who was making her Commonwealth Games debut.

Simmonds, who now competes professionally with Team WNT Pro Cycling Team, says she has always been sporty. Her first sporting love was rowing but she dropped out of that to concentrate on her degree. She took up cycling instead to help her combat the weight she found she was gaining.

She competed with the Cambridge University Cycle Club while studying for her PhD in Inorganic Chemistry. She was the most successful female cyclist in the club's history and was also President of the Women's Blues during her time in Cambridge. Hayley became British Women's National Time Trial Champion in 2015 and won the title again in 2016. The Commonwealth bronze is her first major international medal.

As a PhD student she worked under the supervision of Dom Wright, conducting research into the use of main group metals in catalysis as part of an EU-funded project. Professor Wright says: "I'm really delighted to hear of her success."

News

Steve Ley receives Arthur C. Cope award

Professor Steven V. Ley was honoured at the spring 2018 national meeting of the American Chemical Society. Steve has received the Society's 2018 Arthur C. Cope Award "for his exceptional and creative contributions to the art of organic synthesis." This award for achievement in the field of organic chemistry research is generally considered one of the highest honours in the field. Notably, it is the first time that this prize has been awarded to a British scientist working in the UK. He is pictured here at the meeting in New Orleans in March, receiving his award.

John Meurig Thomas papers given to library

Emeritus Professor Sir John Meurig Thomas has gifted us his *Selected Papers*, which have just been published by World Scientific. The volume has been placed in the department library.

A renowned solid-state, materials and surface chemist, Sir John is a former head of the Department of Physical Chemistry (as it then was), a post he held from 1978 to 1986. He went on to become Director of the Royal Institution of Great Britain and of the Davy Faraday Research Laboratories London. He returned to Cambridge as Master of Peterhouse from 1993 to 2002, during which time he carried out much of his research with Prof Brian Johnson. He still pursues research in solid-state chemistry.

His book includes a selection of papers from his work on the Design, Synthesis and Performance of New Solid Catalysts, and on the Initiation and Development of New Techniques for Characterizing New Catalytic Materials, as well as an outline of what he describes as 'my lifetime's scientific journey' and reflections by fellow scientists who have known and worked with Sir John. The department thanks him for his gift.

The Vice-Chancellor comes to visit

Professor Stephen Toope visited the Department of Chemistry in February – his first visit here since he took over as Vice-Chancellor of the University of Cambridge last October. We were very pleased to host him.

Professor Toope has said that in his role as Vice-Chancellor he wants to meet people from across the university. During his visit to Chemistry, he spoke to department members from undergraduate and postgraduate students to teachers, lab technicians and administrators. And he heard about a range of world-class research from our breadth of researchers, including PhD students and postdocs in the early stages of their career as well as more established academics. They shared with him information about some of the innovative work going on here, from synthesis, via electron microscopy, to single molecule spectroscopy.

Professor John Pyle, Head of Department, says: "We were delighted to welcome Professor Toope here. We are very proud of the work of this department and were glad to share with him some of our achievements."

Using self-building cages to save energy

Nitschke Group

Professor Jonathan Nitschke's research into container molecules could help reduce the environmental and economic cost of industrial processes. Sharon Connor reports.

There is a "very strong present and future need for chemical processes that can proceed using less energy," says Professor Jonathan Nitschke. He is describing the urgent problem that his research group's work on supramolecular capsules or 'cages' could help address.

In the US alone, approximately a quarter of the country's entire energy consumption is devoted to industrial processes. And of that, about half is used in separating chemicals into their different components. Refining petroleum, for example, involves a heating process that actually uses up ten per cent of the petroleum itself.

Clearly, this and other separation processes – such as those used to manufacture plastics – are extremely costly, both economically and environmentally. "It would be far better if we could utilise chemical processes that use less energy to do the same work," says Jonathan.

The solution that he and his team are working on involves the design and application of supramolecular structures called 'cages'. These can be created by allowing simple building blocks to self-assemble into complex, functional structures. The cages can then be used selectively to extract the different components of a given feedstock and move them to different physical spaces.

This is possible because the cages vary in size and shape: some are are tetrahedral while others are cubes. But all have a hollow interior that can be used to contain a guest molecule, or 'cargo'. Different-sized cages with different-sized cavities can contain small, medium or large cargoes of varying shape.

The application of certain stimuli to the cages makes it possible to send a small cage with a small cargo off to a different location than a large cage with a large cargo inside it. "Crucially, when you separate the different cages with the cargoes inside them, you are separating the cargoes themselves," says Angela Grommett, who has just completed her PhD in Jonathan's group.

Jonathan's research page on the department website describes a tetrahedal cage created from diamine and aldehyde precursors self-assembling with iron (II) in water. It is able to trap guest molecules highly selectively and the cage can then be opened and the guest molecule released by certain triggers. Applications in drug delivery are another area of interest for this research, as is investigating changes in the reactivity and behaviour of the guest molecules when they are encapsulated.

In the case of petroleum refining, Jonathan describes how a big cage in water that's in contact with petroleum could be used to pull out a desired subset of large molecules, transport them somewhere else and release them. A second cage, designed to host a different size and shape of molecule, could then be used to pull out another subset. Thus the feedstock could be separated into its constituents without using as much energy.

Angela stresses that scalability is a big problem, and that the things they are doing in the lab might not look like the technology that will ultimately develop to solve these problems on a large scale. "The crucial role of academia is to create new ways of thinking that will lead to the step changes in technology needed to save all of the energy currently being used for separations," she says.

"There is a very strong present and future need for chemical processes that can proceed using less energy."
Jonathan Nitschke.

- *This work was funded by an Advanced Grant from the European Research Council (ERC) and the Engineering and Physical Sciences Research Council (EPSRC).*

Jenny Zhang

Women in Chemistry

"As a child in China, my mother's bedtime stories about science - how radios work, how eggs are hatched - had an effect on me. Our new radio would later be found dismantled, and eggs from the kitchen would turn up in bed, buried snugly under blankets..."

The idea of developing more sustainable fuels fascinates postdoctoral researcher Dr Jenny Zhang. She has been working in Professor Erwin Reisner's group on the science of artificial photosynthesis and the development of 'green' solar fuels. Now, following the award of a BBSRC David Phillips Fellowship, she is setting up her own independent research group here.

It was my mother who first got me interested in science.
When I was a very young child, back home in China, she used to tell me bedtime stories that explained the origins of lightning and thunder, how radios work, or how eggs are hatched. This apparently had a profound affect on me. Eggs would regularly go missing from the kitchen and turn up buried snugly under some blankets in bed. Or the new radio would be found dismantled, presumably taken apart by someone who wanted a better look inside...

My PhD research was in medicinal chemistry.
My aim was to design anti-cancer drugs that could penetrate deep into solid tumours. To achieve this, I synthesised a library of novel DNA intercalators and anti-cancer platinum complexes, and studied their bio-distribution and metabolism within 3D-tumour models using a variety of chemical imaging techniques (which had the added advantage of enabling me to travel to many synchrotrons around the world). I was able to arrive at new drug design strategies using this approach.

I value environmental sustainability. That's why I moved into artificial photosynthesis.
My PhD research was highly interdisciplinary and during it, I developed a deep appreciation of how interdisciplinary approaches can breathe fresh ideas into old problems and can often catalyse breakthroughs. Artificial photosynthesis for sustainable fuel development is also a highly interdisciplinary field. And as a research area, it aligns with my personal values about the importance of environmental sustainability.

I came to the department nearly five years ago as a Marie Curie Incoming International Fellow to work on artificial photosynthesis in Erwin Reisner's group. I was excited by the notion that, coming from quite a different background, I would be able to bring unique perspectives into the field. I also liked the idea of being immersed in a new learning experience. It turned out to be more challenging – and at the same time more fulfilling – than I expected.

We're designing new catalytic systems to turn sunlight into 'solar fuels'.
We're interested in turning sunlight into chemical fuels we call 'solar fuels' – sustainable and green alternatives to our current unsustainable and polluting carbon-based fuels. Plants have been doing this for millions of years through the process of photosynthesis. The process is supported by enzymes, so we study enzymes and the reactions that they carry out, and have made a number of prototype systems that can use sunlight to turn sustainable starting materials into solar fuels. We hope this work will help make such fuels available to everyone in future.

To do this, we need to understand the basic biophysics behind many life-sustaining components of nature.
My research interfaces natural photosynthetic systems with synthetic materials and chemical biology techniques to develop the basic science behind artificial photosynthesis. More specifically, I'm wiring photosynthetic enzymes, such as photosystem II, as well as living cyanobacterial cells to high surface area electrodes to study their photoelectrochemical properties.

My Fellowship allows me to develop this line of research independently.
It's the next step for me as it allows me to follow my own vision for my research. My group officially gets underway in July and we will be researching the electron transfer mechanism behind (photo)electrogenic biofilms and how this can be exploited as a source of renewable energy. I'll be supported by a very generous grant that gives me money for two postdocs and the necessary equipment – a very sophisticated, high-tech 3D printer that allows me to print a lot of very different types of materials from live cells to metal.

The Fellowship will also help me build my leadership skills.
It aims to get Fellows on the trajectory to leading our own research groups confidently and successfully. So we'll have a mentor and I'll be able to attend workshops where I can learn about leadership. I really like that this scheme offers not just money but career progression to help me become a leader in science. I feel very lucky to have gotten this opportunity.

I hope my career will lead to the uncovering of many 'unknown unknowns'.
I want to drive creative and high value research – but I want to achieve this whilst also fostering a culture of curiosity and supportive openness in any team that I lead. Like any scientist, I hope my career will lead to the uncovering of many 'unknown unknowns' that would leave a positive impact in the world.

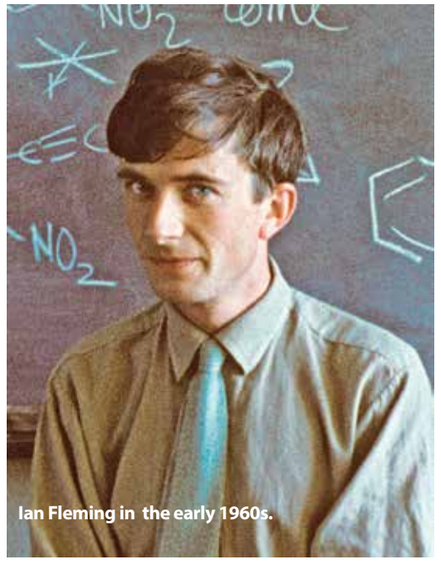
It's important to me that we inspire more students – both girls *and* boys – to choose science.
I still turn up to meetings and workshops where I am either the only female, or one of the few females present. However, this is getting less and less, and I feel that there is a real effort being made by large institutions to be inclusive and lower barriers. The old barriers still exist, but I think women are more courageous than ever in trying to climb over them, and I'm optimistic since I'm aware of how determined women can be.

In the meantime, I think we shouldn't forget about positive action being needed to foster males to challenge their own status quo to become strong counterparts of the future.

A fund of memories

Reunion of pre-1968 alumni

Handling moon rock and meeting inspirational supervisors; conducting explosive experiments and cooking meals over Bunsen burners; enjoying 'lively' conversations in the department tea-room and disposing of chemicals on the roof... When they came to a recent reunion, our alumni had a fund of entertaining memories to share with us.



Ian Fleming in the early 1960s.

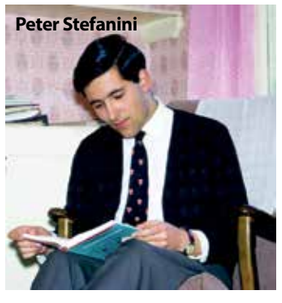

Alumni - including Geoff Royston, Peter Stefanini and Philip Hilton - and their families tour the labs with Deputy Head of Department Nick Bampos.

"I remember all-day practical exams. And being allowed to cook over Bunsen burners. That wouldn't, couldn't, happen now." **Ray Jones** (Trinity, 1967-73).

"I remember handling a small piece of rock from the Apollo 11 moon landing in 1969. It had been sent to Cambridge for a Mössbauer spectroscopy analysis." **Geoff Royston** (Christ's, 1967-70).

"I remember an old boy telling us about his practical entrance exam in 1910 and how – when he observed a colour that identified the cation during a flame test – he immediately put his top hat over the flame (!) so other candidates could not see his test result..." **Clive Bucknall** (Gonville & Caius, 1954-57).

These were just some of the anecdotes we heard when we held a reunion in March for those who had been in the department up to and including 1968. The event coincided with our annual Open Day, so some of our alumni brought their children and grandchildren along with them.


Peter Stefanini

During the day we offered our alumni seats at Pete Wothers' explosive lecture and private tours of the department so they could see what the labs look like now. Later, we held a drinks reception for them followed by dinner in Downing College. It was the first such reunion we have held of this kind but it won't be the last. The alumni who came enjoyed their visit and happily shared their memories with us.

Many told stories of their peers, teachers, technicians and supervisors. **Jarlath Ronayne** (St John's, PhD 1965-68) recalled his supervisor, Dudley Williams, going to the University of California at Irvine as a visiting professor for a year. Jarlath, who is now Tan Sri Jeffrey Cheah Distinguished Professor at Sunway University, Malaysia says: "We corresponded by letter: I sent draft papers to him and they came back covered in red ink. I felt I was not so much pushing back the frontiers of knowledge as pushing back the tide of red ink that came from California! He taught me how to write."

Anne Butland (now Lyon) remembered "Lord Todd (Todd was God!) in the first year of my PhD coming into Lab 122 and booming 'Where is Miss Butland?'. I was not hard to find as I was the only female in this 16-man lab..."


Anne Butland: "Lord Todd was God!"

Meanwhile Emeritus Professor **Ian Fleming** told us how his own supervisor John Harley-Mason "seemed to spend the whole day walking around the Lensfield Road building. He rarely settled in one place, but was frequently to be seen in the corridors. If you needed him," Ian said, "the best thing to do was stay still, as he would come by soon enough."

For others, it was the building that held key memories. **Roger Forder** (Trinity, 1965-71) fondly remembered the Lensfield Road tea-room and the "many lively conversations (and arguments!) in it with other denizens of the organic lab". **Ralph Timms** (St Catharine's, 1961-67) recounted how the roof was used for the disposal of "unpleasant chemicals we no longer had a use for. They were taken to the roof, the sealed vial was placed in an apparatus under a hammer, with a cord attached to a release pin. We retired to a safe distance and pulled the cord; the hammer dropped, the vial broke and reacted with the air in a puff of smoke to be dispersed 'safely' over Cambridge." (*How things have changed: today, unwanted chemicals leave the building rather more appropriately via the chemical waste store.*)

And health and safety issues were a recurring theme in many alumni stories. **Peter Stefanini** (Trinity, 1965-71) told us about the hazards of his PhD research into *Cationic Complexes of the Rarer Platinum Metals*. "It required the synthesis of a chelating ligand and was quite a dangerous procedure as one began with a mole of sodium in liquid ammonia and bubbled phosphine gas through it," he said. "I very clearly remember the first time I did it. It was a Sunday and my supervisor, Dr Mays, turned up to make sure I didn't blow myself up. But as he'd been invited to a pyjama party that afternoon, he turned up dressed in pyjamas..."

"My supervisor turned up to make sure I didn't blow myself up during this hazardous procedure. But he was on his way to a pyjama party, so he was was wearing pyjamas..."

Guest of Honour at dinner in the evening was Professor Ian Fleming. He enthusiastically spoke of his support for the department, telling the audience about how he arrived as an undergraduate at Pembroke in 1956 and never left, spending his entire (very successful) academic career in Cambridge. He then regaled guests with tales of his colleagues (many of whom had taught or supervised the gathered alumni), calling out "Who else do you want to hear about?" before discussing the exceptional – or notorious – talents of the academics named by the audience. It was a convivial end to a very enjoyable day.

- In March 2019, we would like to invite alumni who were in the department in the years from 1968 to 1979, inclusive, to a reunion. More details will follow closer to the event.

Write to us

We are always delighted to receive your emails and letters.

Email your comments to: news@ch.cam.ac.uk
Post your letters to:
Chem@Cam,
Room 142, Department of Chemistry,
Lensfield Road,
Cambridge CB2 1EW

Correspondence

A scientist of great stature, with an extraordinary memory, a fondness for cigarettes – and an occasionally intimidating interview technique. Those were some of the impressions we received when we asked readers for their memories of Lord (Alexander) Todd, former Professor of Organic Chemistry here, who won the Nobel Prize for Chemistry in 1957.

Feats of memory

"Of course, he was *Sir* Alexander Todd when I first encountered him in 1953, the year that I matriculated at Pembroke and the year of Crick and Watson's publication in Nature of the structure of DNA..." So began **Dr David Cohen**'s reminiscence. "My immediate first impression was of his memory when he delivered his lectures on the Nucleic Acids entirely without notes. To my delight, he accepted me as a research student in 1956 with the aim of synthesising oligonucleotides – and showed further feats of memory when he visited me in the lab, as he did daily when he was around. If, say, he wanted me to use a reagent such as dibenzylphosphorochloridate, he could provide from memory the reference to the Beilstein edition, the volume and the page to synthesise it."

Dr Cohen, Emeritus Registrar, University of Keele, adds: "In those days, I used to smoke. Alex would invariably ask me if I had a cigarette and would take the pack and leave it next to him during our discussion..."

Interview technique

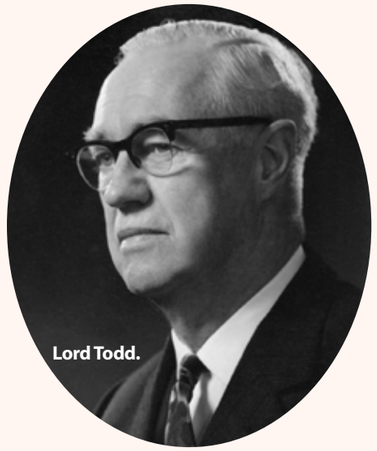
Other alumni remember Todd for different reasons, including his somewhat intimidating interview technique. **David Rand** (Trinity Hall, 1961-67), now Honorary Research Fellow at the Commonwealth Scientific and Industrial Research Organisation, recalls going to see him in the early 1960s to discuss conducting postgraduate research on nucleotides. He found it an unnerving experience. "I entered a room that was surely more befitting a stately home than a chemistry laboratory. Lord Todd, a tall man, was reclining so far back in his chair that I was obliged to converse throughout with the soles of a pair of shoes which rested atop his highly polished desk."

And **Professor Mark Bretscher** (Gonville and Caius, 1958-64), an alumnus who went on to spend almost his entire research career at the MRC Laboratory for Molecular Biology, also recalls an interview with Todd that didn't go quite as anticipated.

"I was at Cambridge, studying Natural Sciences with lots of chemistry, a subject I really enjoyed. In my third year (early 1961), I applied to do a PhD in the chemistry department and had a meeting with Todd in his vast office. He ushered me to sit in a small chair in front of his huge desk and said he understood I wanted to do a PhD in his department: did I have any idea with whom? I said I had chosen Malcolm Clark (who was my Director of Studies at Caius). But Todd told me many students wanted to work with Clark and, were I accepted, I might have to work with someone else.

"I was unhappy with this; I was leaning towards biochemistry when someone suggested I look at Perutz's group in the Cavendish. I had never heard of them, but went along and discovered Francis Crick, who accepted me. When I went back to tell Todd of my move, he became pretty angry. If I went to Crick, he said, I would be "throwing away my career". He suggested that I get a PhD in a "well-founded" subject like organic chemistry and then I could "flirt" with molecular biology. I went to the Cavendish."

Others had different experiences. In an interview with Chem@Cam last autumn, a few months before his death, **Sir John Sulston** (Pembroke, 1960-66), told us how he was accepted into the department as a PhD student by Lord Todd after his original plans – to do voluntary service overseas – fell through. "I came, hat in hand, to the department and was interviewed by Alexander Todd," he told us. "He was austere but amazingly accepting of this 'refugee' with his 2.1."



Lord Todd.

"If I went to work with Francis Crick, Todd said, I would be 'throwing away my career'..."
(Professor) Mark Bretscher

And David Cohen tells us that he enjoyed working for Lord Todd. "In those days, we had to prepare our own supplies of deoxyribonucleosides from herring sperm DNA but the biosynthetic method (published by Alex Todd and two Scandinavian co-authors) had not been able to produce the desired result for some time. My first task was to make it work!

Trial and error

"After a number of failures, I solved the problem serendipitously by the intervention of an American postdoc, Dr. Martin Stempien, who persuaded me to come to lunch in the neighbouring pub just as I had put another batch of DNA onto a waterbath. Returning late, I decided to check the solution by paper chromatography and found the sample totally degraded. This led me to take samples at intervals of 5, 10 and 30 minutes and finally of the starting material. I found that lab's entire supply of DNA (several kilos) was apurinic acid – I presumed from the effect of CO_2 and moist air.

"With a fresh supply of DNA, the process worked perfectly."

Heathrow and air pollution

Last spring, Chem@Cam reported on a new network of sensors that researchers from the Jones group were using at Heathrow to measure air quality. The sensors distinguished between pollutants emitted from the airport and those drifting in from the surrounding area. Some correspondence on this feature was inadvertently omitted from the last issue.

Rachael Webb (née Brooks; Fitzwilliam College 1979-82) wrote: "Professor Jones has determined… that most nitrogen dioxide (NO_2) at Heathrow is not generated by planes but from elsewhere, but his conclusion that pollution should not be a barrier to a third runway does not necessarily follow."

Pollution maps accompanying the article showed pollution plumes from aircraft taxi-ing and taking off, but also, when winds came from the east and southeast, high levels of NO_2 at Heathrow coming from "just north of east - the London plume contributing to pollution at Heathrow airport". As a result, Professor Jones said in the article, even with a third runway, the majority of the pollution would come from non-airport activities.

Rachael disagreed with this view, citing the increase in car traffic as well as air traffic that a third runway would bring. However the Jones Group research paper on this, which is to be published shortly, takes this into account in forming the conclusions that were presented in the article.

Another alumna, **Jenny Wakefield** (née Trubshaw, 1953-1956), found the article "particularly interesting" as she lives "almost under the northerly flight path of planes flying into the airport when the wind is from the west or northwest".

The figures illustrating the article showed measurements of pollution levels as functions of wind direction and wind speed ('WS'), from sensor nodes close to the southern runway at Heathrow Airport. The caption beside the top figures stated they showed the nitrogen dioxide and carbon dioxide levels seen when the wind blows from the east and southeast. Jenny wanted to know what the levels were when the wind was blowing westerly – i.e. from the airport towards London.

In response Professor Jones says: "Actually, the caption underneath the figures should have said '*elevated* nitrogen dioxide and carbon dioxide levels when the wind blows from the east and southeast' – my mistake – and in fact the figures show all wind directions'.

- *Please note: this correspondence is now closed.*

Modifying proteins for more precise drug delivery

Bernardes Group

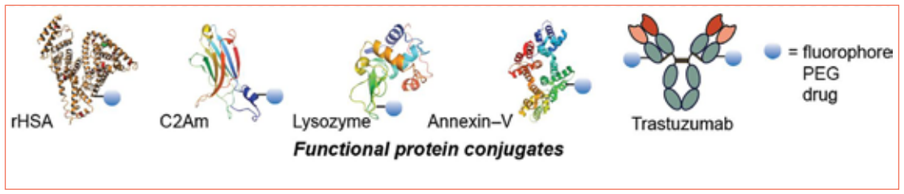
An international team of researchers led by Dr Gonçalo Bernardes in this department has developed a simple yet effective method of modifying proteins that could enable them to precisely deliver drugs to diseased tissues.

The new method mimics the tools found in Mother Nature's own toolbox: it employs chemical reactions to modify the function of proteins such as antibodies – for example, by attaching drug molecules to them so they could be delivered to a specific location. This would make the drugs more effective, and produce fewer side effects, since they can be directed straight to the cancer cells and not to the healthy tissue around it.

The same method is being developed to precisely attach labels to proteins associated with certain diseases so that they can be monitored in patients.

The team's research was published in JACS (Journal of the American Chemical Society) in March and highlighted in publications including Chemical & Engineering News, to Dr Bernardes' delight. "We really want to spread the news about our work," he says. "Our protein-modification technology is cost-effective and easy to apply. We hope it may be used in laboratories round the world to help develop new drugs with improved effectiveness and reduced side-effects for diseases such as cancer."

Scientists have been working for some time on ways to modify proteins in order to attach drugs or other molecules to them for a range of biological and therapeutic applications. But many current methods compromise protein function, while some require highly complex genetic engineering that is "difficult to implement," says Gonçalo. "What we have discovered is a simpler technology that uses a computer-designed reagent and chemical reactions to modify proteins by attaching molecules at a very specific location within the protein's structure.



"We hope our technology may be used in laboratories round the world to help develop new drugs with improved effectiveness and reduced side-effects."
Gonçalo Bernardes

"We can do this very efficiently without the need for any genetic engineering and without interfering with the normal functions of the proteins or the cells."

In nature, modifying proteins at precise locations is a complex process controlled by enzymes. Much research has been conducted into ways of artificially modifying proteins. It has often involved using reagents that react with naturally occurring amino acids called cysteines. But this new method instead targets other amino acids, called lysines, which are much more abundant in proteins than cysteines. Dr Bernardes' team used a computer-designed sulfonyl acrylate reagent that selectively targets only the most reactive lysine in a protein.

In the published research Dr Bernardes and his colleagues – who span the University of Cambridge Department of Chemistry and the Institute of Molecular Medicine, Lisbon – demonstrate that their technology works in five clinically relevant proteins. These include the therapeutic antibody Trastuzumab, which is used in the treatment of breast cancer. The Institute of Molecular Medicine is based in Portugal's largest hospital. "In the paper, we demonstrate our technology on two proteins that the Lisbon clinic is using to image apoptotic tissue (tissue where cell death is taking place)," says Dr Bernardes. "We have also applied it on an antibody that is being used there to treat breast cancer."

The researchers have discovered so far that the technology works when tested in cells. "In *in vitro* tests, we have seen an improvement in the efficacy of the drug by delivering it inside the cancer cells." He adds: "We now want to test it further, *in vivo*, to test that the link between the molecule and the drug is stable and that there is no premature release of the drug before it reaches the tumour."

- *This research was funded by the Royal Society, the Engineering and Physical Sciences Research Council, and the European Commission, including through a European Research Council Starting Grant.*

Maria. J. Matos et al. *Chemo- and Regioselective Lysine Modification on Native Proteins*, Journal of the American Chemical Society (2018). DOI: 10.1021/jacs.7b12874.

Student's award helps model research

Frenkel Group

Winning a Microsoft Azure Research Award has given PhD student Peter Wirnsberger the computing resources to analyse the way particles behave in nanoscale systems that are out of thermal equilibrium. The award offers Peter the facilities for twelve months while he runs simulations of a model that the Frenkel research group devised last year. "It's exciting to have access to these facilities," he says. "The computer simulations are long and expensive to run, requiring up to 200,000 hours' computing time, and the award helps cover the costs of running them. The simulations also generate very large data sets, around two terabytes of data, that are very painful to have to analyse by yourself! The Microsoft Azure cloud computing facilities offer a lot of analysis tools that will really help me when I am analysing all the data."

Peter is running computer simulations on a model posited by the Frenkel group last spring in collaboration with Christoph Dellago of the University of Vienna. Researchers already know how to treat systems in thermal equilibrium (such as the properties of water at constant temperature) theoretically. "But as soon as there is a temperature gradient within a system, such as the gradient between a cup of hot liquid and the air around it, it gets much harder to describe the electrostatic interactions within the system," Peter adds. So when the researchers came up with a theoretical picture of these interactions induced by a temperature gradient, "it was exciting and we now want to do more work to understand it."

The team demonstrated that a pair of heated or cooled colloidal particles in a dipolar solvent behave as if they are electrically charged. "If you heat or cool them, they act as though positively or negatively charged," he explains. "A heated particle aligns the solvent molecules around it, and a heated and a cool particle attract each other (in the same way that a negative and a positive charge attract each other), while two cool particles repel each other. This gives us a very neat picture of what is going on. But the magnitude of the effect is quite small so it's challenging to come up with an experimental set-up where you could easily measure it. That's why we need to do computer simulations before we move on to the experimentation."

Melinda Duer

After completing her PhD here in 1988, Melinda Duer was the first woman to be appointed to a lectureship in the department. She is now Professor of Biological and Biomedical Chemistry. She has led pioneering research into the molecular structure of bone, and the underlying chemical changes in the tissue of blood vessels that cause them to harden as we age, leading to heart disease and stroke.

Why Chemistry?
At my comprehensive school in North Cornwall I enjoyed science and my chemistry teacher suggested I apply to Cambridge for Natural Sciences. I applied, and was sure I wouldn't get an offer. Then I was sure I wouldn't get the grades. Then I was sure I wouldn't be as intelligent as anybody else when I got here. But I made it!

What was it like as the first woman lecturer here?
People often came to my office asking for Dr Duer, assuming that I was 'his' secretary. My 'wife' was invited every year to the Department Wives' Lunch! Fortunately, there is now a completely different mind-set. We still have some way to go, but the Department's involvement in Athena SWAN *(a national scheme to support and advance women working in STEMM subjects)* has had a huge impact on me, both personally and professionally. It helped give me the confidence to apply for a professorship. *(Melinda was appointed Professor in 2015.)*

What is the focus of your research?
The molecular structure of the extracellular matrix: how it drives cell behaviour, how it changes with aging and disease, and how that change alters responses from cells. The British Heart Foundation funds much of my work because we are investigating the underlying chemical changes in the tissue of blood vessels that cause them to harden or 'calcify' as we age, which can lead to heart disease and stroke. I also work closely with Cycle Pharmaceuticals, which is funding work into possible treatments for vascular disease.

How has your work reunited you with a former student?
Cycle was set up by a former student of mine, James Harrison, who after working in the City, returned to Cambridge to set up a small pharmaceutical company on a very different business model from big pharma. Cycle aims to make existing drugs work better for the patient, for example by improving bioavailability. This means more of the drug reaches the system in each dose, so fewer doses are required. James has been a generous funder of my research and Cycle has purchased the licence to the intellectual property rights of some of our results.

They also invest in drug treatments for rare diseases, such as Alkaptonuria. Patients with this inherited genetic disorder lack the enzyme to break down certain amino acids and it causes them severe joint problems and other complications. Nitisonone was a known treatment, but the drug was unprofitable for large pharmaceutical companies to market, so none of them had even sought FDA approval for it. Sufferers were reduced to buying it in its only available form as weed killer! Cycle now manufactures nitisonone for patients in Canada and the US, and is seeking approval for it in the UK.

What first got you interested in biological chemistry?
I was working on how man-made polymers transformed into liquid crystalline phases and whether proteins could form such phases. At that time I owned and rode a couple of horses. There's a lot of keratin in a horse hoof and it gets trimmed every month. So when the funding ran out on synthetic proteins, I was able to study keratin, itself a protein, because I always had a plentiful supply.

Keratin is incredibly robust, stands up year after year to getting irradiated by UV light, muddy water and contaminants, yet maintains a rigid structure with very specific mechanical properties. It's better than anything designed in a lab. That's what got me interested in the whole biological field.

How did you come to study bone?
Horses again. I had a rescue horse that kept suffering leg fractures. I asked a friend who was in charge of Equine Veterinary Medicine at Robinson College [*where Melinda is Deputy Warden*] why some horses seemed to have such delicate bones. She told me nobody knew. I said, "C'mon! People must understand the molecular structure of bone." But when I checked the literature, she was right. There was research on the mineral part, but not on how it interfaced with anything else. Even the study on the mineral component came from the idea that it had to be pure calcium phosphate, but this seemed wholly unlikely. So we started work on that.

Our NMR spectrometer in the department wouldn't allow us to study bone mineral the way we wanted. So we got a small British Council grant that allowed me and a PhD student to use a spectrometer in Berlin. That gave us our first insights into how bone mineral is held in the organic matrix.

Why were such insights so important?
We realised that bone mineral didn't stick directly into the collagen, which is the main protein in the extracellular matrix of bone, but that there was an interface through some sort of functionalised sugar. In fact, the day we got a spectrum on the NMR in Berlin that made us realise it wasn't a protein but a sugar that directed bone calcification was my best moment in science!

That discovery gave me access to grants to start developing this work. *(It was also the start of a research path that led Melinda, in 2016, to identify the sugar as Poly (ADP-ribose) polymerase, or PARP.)*

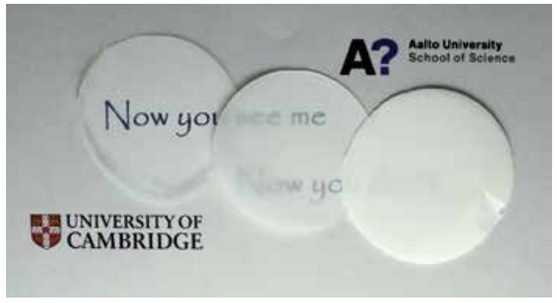
Tell us about the 'heavy mouse' used in your research?
This was our breakthrough. We needed bone cells to study in the NMR, but it became obvious that cells grown in the lab don't necessarily behave the same way as cells in a body. So first we had to find out what real bone looked like in an NMR spectrometer – and that meant getting NMR isotopes into a real bone. We set about growing a mouse with isotope labelling – the heavy mouse – and we were able to measure 2-D NMR spectra from its bones. Those spectra are like fingerprints of the bone molecular structure and they enabled us to grow *in vitro* tissues that had a highly similar structure, at the molecular level, to those in a real animal, to help us understand how the different molecules in the bone extracellular matrix drive cell behaviour. That's what we use now.

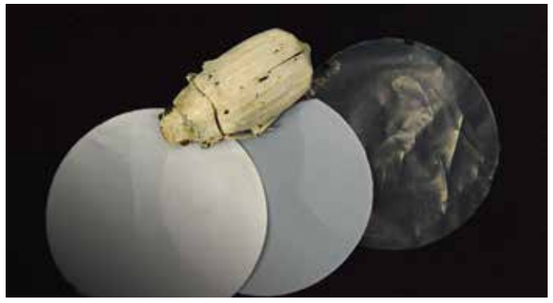
What does your research make you think about the way we should treat disease in future?
There has to be a shift in the paradigm by which we treat people – currently one drug per aberrant cell pathway. That's not a way forward. We've got to think about disease in a whole new way. It's increasingly obvious that most diseases do not have one cause: it's really the whole interplay of many cell pathways, in cancer, multiple mutations. But drugs target only one at a time. We need to think more about correcting the system, not just treating one specific aspect.

Interview by Diane Harris.

Beetles inspire 'super-white' new material

Vignolini Group





The 'super-whiteness' of an Asian beetle has inspired Chemistry researchers to develop a new material "twenty to thirty times whiter than common paper". The researchers say it can help improve the appearance and performance of a range of products from cosmetics to paints.

Scientists in the Department of Chemistry have been studying the 'super-white' Cyphochilus beetle for several years. Intrigued by the exceptional light-scattering properties of its scales, which make the beetle appear to be white even though its body is black, PhD student Olimpia Onelli and her supervisor Dr Silvia Vignolini have been researching ways of creating a material that mimicked these properties.

And as they reported recently in the journal *Advanced Materials*, they have been successful. Inspired by the structures and properties of the insect's scales, and using natural materials, they have successfully created a new material whose whiteness "far exceeds that of common paper". The new material also has the benefit of being ultra-thin. Their work was helped by a collaboration with researchers at Aalto University in Finland.

Lead author Silvia Vignolini, a Reader here in the department, says: "This work paves the way for developing a viable large-scale method for producing white coatings that are sustainable." She and co-author Olimpia Onelli have already patented the material and are now hoping to license it for manufacture in products such as cosmetics.

A survival mechanism

For the Cyphochilus beetle, its exceptional whiteness (in proportion to its size) is a survival mechanism that camouflages it among the white fungi found in its habitat. It has also been of great interest to scientists since it was first noted, by Prof Pete Vukusic at Exeter University, almost a decade ago.

The researchers knew that the key to the beetle's whiteness lies in the interaction of light with its scales. As Olimpia explains: "Our eyes see whiteness when they are exposed to light that contains all the colours in the visible spectrum. In nature, organisms like the beetle produce this effect by having many non-uniform regions of their body – we call them 'scattering centres' – that disperse the light randomly and reflect it back at us from a variety of directions. When all colours are scattered equally well, it appears white."

But they were intrigued by the fact that the beetle's scales produce this effect despite being extremely thin. Usually materials require a certain degree of thickness (typically a few hundred microns) in order to have enough of these scattering centres to reflect the light and make it appear white. The beetle, however, is an intriguing exception to this rule. "The Cyphochilus beetle's scales are extremely thin – just one hundredth of the width of a human hair," says Olimpia. "If you cut a sheet of paper as thin as that, it would be transparent. But the beetle's scales still appear very white."

To find out how the beetle achieves this effect, Silvia and her co-authors used electron microscopy to study its scales. They knew, from Prof Vukusic's discovery, that the scales contain many scattering centres, but this research revealed that the structure works so efficiently because these scattering centres are very densely packed in the scales without being overcrowded.

Overcoming the challenge

It has long been thought that manufacturing an ultra-thin synthetic material that could achieve the same degree of whiteness as this was an insurmountable challenge. But inspired by these findings, the researchers have now made extremely thin membranes that achieve a very bright whiteness despite being only a few microns thick.

This could be of interest to a wide range of consumer goods sectors. Manufacturers have been looking for new ways to enhance the whiteness of materials – from sun creams to toothpaste to paints – without using whitening agents that can affect consumers' health or adversely impact the environment.

As they describe in *Advanced Materials*, the research teams created these ultra-thin membranes using nanoscale cellulose fibres found naturally in wood pulp. This porous membrane material was originally conceived for use as a chemical filter, but the Cambridge researchers studied the way light is carried in it and discovered that it appears extremely white. They then found that by adjusting the size and architecture of the nanoscale fibres within it, they could tweak it to produce different levels of whiteness, from extremely white to transparent.

They achieved this by 'tuning' the porosity of their cellulose material, and adjusting its structure and the packing of the scattering centres within it. They found that when the material has few pores, it does not scatter light so well because its appearance is uniform; when this happens, the material looks transparent. But when a large number of pores are embedded in it, light 'sees' them as variations and is thus scattered, producing a white colouration.

The researchers say the resulting ultra-thin material has a "whiteness twenty to thirty times that of common paper". Additionally, the new material's whiteness also rivals that of materials that have much higher light-reflecting properties but cannot be manufactured in an environmentally sustainable way.

"And the research isn't over yet," says Olimpia. "We are hoping to do further research and to see if we can optimise this material even more."


Olimpia Onelli.

The research was undertaken through a collaboration between Dr Silvia Vignolini and PhD students Olimpia Onelli and Gianni Jacucci in Cambridge, and Professor Olli Ikkala and PhD student Matti Toivonen in Aalto University Finland.

The funding for the Cambridge arm of the research came from the European Research Council and a BBSRC David Phillips Fellowship.

Producing purer drug molecules

Phipps Group

Researchers here have successfully modified a well-known chemical reaction in such a way that it can produce drug molecules in a purer and more effective form.

The new process the researchers developed – which was published in *Science* in April – has the potential to reduce both the side-effects of drugs and the doses patients need to take. It may also cut the cost of producing them and the wastage involved in doing so, says principal investigator Dr Robert Phipps.

Many drug molecules contain a building block called a heteroarene: a ring of carbon atoms that also contains a nitrogen atom. In drug discovery an organic chemical reaction, known as a Minisci reaction, is often used to attach specific molecules to this ring system in order to add therapeutic functions to the drug. Now Robert and two of his postgraduate students, Rupert Proctor and Holly Davis, have come up with a way to modify the Minisci reaction so it can control which of the two enantiomers – the left-handed and right-handed forms – of a molecule it attaches to the ring. This is very important: while both enantiomers of a molecule have the same basic properties, where the right-handed form might produce the desired therapeutic effect, the left-handed form may at best be harmless and at worst cause unwanted or dangerous side effects.

When tested in the lab, and on two existing drugs, the new reaction process selected one of the two possible forms of the molecule up to 49 times out of 50. "To the best of our knowledge," says Robert, "this is the first time a way has been found to make a Minisci reaction selective for one enantiomer over another." And he thinks it may open the door to many potential benefits.

"There are significant implications for pharmaceutical research in the synthesis of enantioenriched molecules – i.e. those that select one enantiomer over the other. It means you could be getting a purer form of the drug molecule because even if the unwanted enantiomer is harmless, having it in the drug molecule dilutes that molecule's efficacy by 50 per cent, so you have to give twice as much of the drug to get the therapeutic effect."

Cutting down side-effects

And in addition, it may also cut down on side-effects, he says. "The often-quoted example of the effects different

Researchers Holly Davis, Robert Phipps and Rupert Proctor.

enantiomers have in the body is the thalidomide tragedy: one enantiomer of the drug molecule helped ease morning sickness in pregnant women but the other enantiomer caused birth defects. Being able to select much more accurately which enantiomer of a drug molecule you are making would be a significant help to pharmaceutical companies working to produce new drug treatments."

Developing the reaction

It was Rupert, a second-year PhD student co-sponsored by GlaxoSmithKline, who developed the reaction under Robert's supervision. He says: "Having something behave for you this early in your PhD is quite rare: I can't really believe the reaction works so well. It would be fantastic if our methodology were developed further and found some real use in the synthetic chemistry community."

Holly, a final-year PhD student co-sponsored by Pfizer, worked on testing the reaction on a series of targets towards the end of her PhD studies. "I really enjoyed the chance to broaden my research experience by being involved in such an exciting project in this up-and-coming field," she says.

When their paper *Catalytic Enantioselective Minisci-Type Addition to Heteroarenes* was published in *Science*, it was picked up by a number of news outlets including *Chemical & Engineering News* and *Phys.org*. There is interest in the research because such a well-known chemical reaction has been used to modify a class of molecules frequently found in drug compounds. On top of that, the new process employs a method that is currently a very active field of research.

Photoredox catalysis, as it is called, is a method for converting light energy into chemical energy and it has led to a resurgence in free radical reactions (i.e. reactions that involve the movement of a single electron, rather than a pair of electrons). Minisci reactions are radical reactions, "and there has been a lot more attention paid to them to recently," says Robert, "because photoredox catalysis has made it easier to carry out single electron chemistry." This is thanks to the fact that LED strips that provide the light have become very cheaply and easily available, and scientists have developed catalysts that are able to harness their light energy and use it to modulate the movement of electrons in a reaction flask.

"But these single-electron reactions tend to be very fast and historically it has been quite challenging to control the chirality – i.e. whether you form a bond with the right-handed or left-handed enantiomer – in them because of their speed," Robert explains. "So actually controlling enantioselectivity in photoredox radical reactions is a very hot topic as there are not many ways to do it. But we have developed a method that I think will gain a lot of attention."

Use in new drug development

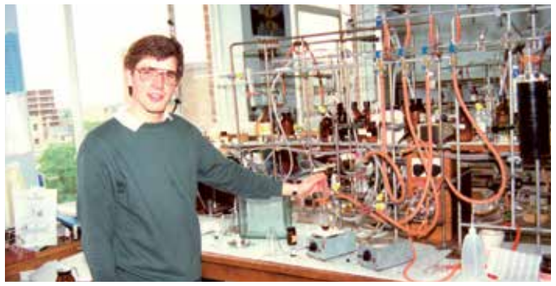
It is a two-step process that employs two catalysts, one taking light from the LEDs and turning it into chemical energy to move the electrons, and the other controlling which form of the enantiomer bonds with the heteroarene. To showcase the way in which it works, the researchers tried it out on two drugs: clofibrate, formerly used to lower cholesterol, and metyrapone, a drug used in diagnosing adrenal insufficiency and treating the pituitary disorder Cushing's disease.

"In the first stage of our research, we tested the process on 15-20 targets that were simple molecules," Robert explains. "But then we tested it on these two pharmaceuticals to demonstrate that it would work on more elaborate compounds." And now that it has done, they hope that others will be interested in trying it out. "We are hoping someone will take it on to the next stage and use the method on therapeutics that are under development," Robert says. "We're keen to get the results out there for people to use."

Rupert S. J. Proctor, Holly J. Davis, Robert J. Phipps. *Catalytic enantioselective Minisci-type addition to heteroarenes,* Science (2018). 360, 419-422 .

The research was funded by a number of sources: The Royal Society, EPSRC, GlaxoSmithKline and Pfizer.

Alumnus returns as Lecturer



An alumnus who studied here with the late Jack Lewis returned in February to give the 2018 Lewis Lectures. Lutz Gade is now a Professor of Inorganic Chemistry at Heidelberg University and a director of its Institute for Inorganic Chemistry. He studied for his PhD here in the late 1980s with Professor Lord Lewis, who is credited with being one of the small group of scientists who led the expansion of inorganic chemistry from its renaissance in the mid-1950s through the syntheses and study of new transition-metal and organometallic complexes. The Lewis Lectures take place annually in the department in his memory.

Professor Gade, who works in the field of enantioselective catalysis, enjoyed revisiting the site of his former lab while he was here, as the pictures above and below show: "It was called 'the Jungle' because it had lots of wiring hanging from the ceiling." Of his supervisor he says: "Jack was by far the most influential person in shaping my career as a scientist and the entire way in which I approach a scientific challenge. He would provide deep insight and always make more suggestions than one person could reasonably follow up!"

He adds: "He was also keen to be kept up-to-date with the latest developments and could develop a contagious enthusiasm for interesting and unexpected research results. On more than one occasion he cancelled a dense schedule of meetings and other commitments in the department or at Robinson College *(where he was Warden)* to spend time to discuss some new crystal structure and its implications..."

Twenty years of Chem@Cam

"Prizes worth £100!" "Fun pages, fun people." "The chemistry of the next millennium." These were among the cover lines when the first issue of Chem@Cam magazine was published in spring 1998.

Twenty years on from this publication's first appearance, while some things have changed (£100 was clearly a more exciting sum in 1998 than it is now), others have not. *Chem@Cam* is still going strong and still "letting people know what we are doing," as then Head of Department Professor Dave King put it in the very first issue.

The publication was set up, he explained, to "tell those in industry that the money they invest is being put to good use, tell those in other universities about our research and elicit their collaboration, and tell the world about the fundamental research we are doing at Cambridge and its implications." Today *Chem@Cam* does all those things while also acting as a channel of communications with our alumni, helping to keep former members of the department in touch with us and each other.

From the scientific to the spooky

In the last two decades, content has ranged from reports on research breakthroughs to rather less scientifically verifiable topics – including, in autumn 2001, suggestions that the building might be haunted. This came via Brian Crysell, an NMR spectroscopy technician and self-appointed historian to the department who has contributed many stories to *Chem@Cam* over the years. When he found news coverage of the accidental death of a labourer in the basement during the building's construction in 1956, it prompted then editor John Emsley to ask if this might account for some of the reported 'strange goings-on' in the basement area, such as "cupboard contents moving of their own accord". But calls for evidence or a photograph went unanswered...

"Telling the world about the fundamental research we are doing at Cambridge and its implications."
***Chem@Cam*, Spring 1998.**

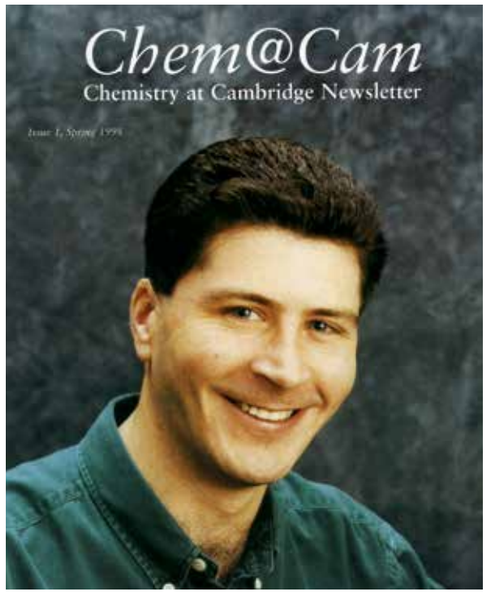
Science writer John was the magazine's inaugural editor. Fundraising for the department was as important an issue then as it is now, he says: in 1997, Dave King and Head of the Organic section, Professor Steve Ley, had set themselves the target of raising £75 million to renovate and modernise the department. Steve Ley brought John in to produce a magazine that would support this effort.

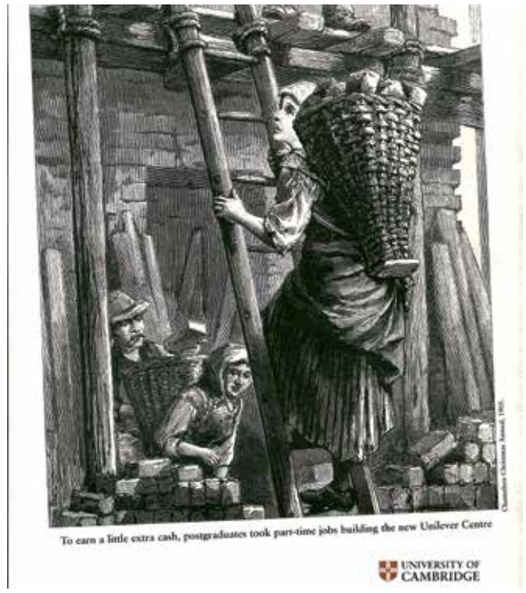
John was initially helped by the public relations advisor, Lord Watson of Richmond, a former presenter of the BBC's Panorama and chairman of the department's advisory board. "At his office in London we discussed the aim of the magazine," John recalls, "and how to appeal to its target audience, namely those in industry, the media, government and alumni, all of whom would be sent a copy. Soon the latter were writing in with their comments and reminiscences, so much so that a 'Letters not forget' column became a regular feature. However, the magazine's pages were mainly filled with news about chemists and their research, the awards they won, and the money the department was able to attract from sponsors."

A visit from royalty

Within a year of its launch, *Chem@Cam* had lots of good news to report. As well as sharing news of research funding, "I particularly enjoyed telling readers that The Guardian had put the department at the head of its league table of UK chemistry departments," John says. He also enjoyed decorating the back cover with old engravings married with topical captions. When the autumn 1998 issue showed a poor girl carrying a basket of bricks up a ladder, John captioned it: *"To earn a little extra cash, postgraduates took part-time jobs building the new Unilever Centre."* The building of the Unilever Centre for Molecular Informatics was a tribute to the success of the fundraising campaign by the department. It cost more than £15 million and *Chem@Cam* was there to cover its official opening, and a subsequent visit to it by then University Chancellor, the Duke of Edinburgh.

When John stepped down in 2002, another science writer moved into the editor's chair. Sarah Houlton had started her career as a research chemist but after a Glaxo-sponsored PhD at Imperial, moved into science journalism. Her first issue included coverage of the Chem@300 Symposium, an





Left: the inaugural issue of Chem@Cam in 1998 featured Ray Freshwater who remains a member of the department 20 years later. Right, one of the engravings that originally adorned the back covers.

event held in December 2002 to mark the 300th anniversary of the 1702 Chair of Chemistry at the University of Cambridge – one of the oldest chairs of chemistry in the world.

'Never read a Chemistry book in his life...'

"The audience were treated to an entertaining talk on some of the more notable 1702 Professors," Sarah told readers, "from the fifth professor Richard Watson, who was appointed (in 1764) despite never having read a chemistry book in his life, to William Pope (appointed in 1908) whose exploits in the field of selenium chemistry filled Cambridge with noxious smells from experiments, carried out first on the roof and then in a local farmer's field." She was quick to add balance to coverage of the role by pointing out: "The importance of the professorship cannot be overemphasised. It was responsible for the formalisation of chemistry teaching and the development of the subject in its own right."

Radioactive contamination

During her editorship, Sarah covered a number of notable events, from the knighthoods in 2003 for Professors Alan Fersht and Dave King, to the arrival in the department of the Melville Lab for polymer synthesis, which after a 10-year wait was finally able to move into a purpose-built facility, thanks to the development campaign's efforts to fundraise for building improvements. *Chem@Cam* went on to catalogue the transformation of the labs where Alfie Maddock had once researched the radioactive isotope protactinium-231 into a gleaming new facility for Professor Clare Grey's group when they arrived in 2011 to carry out research into energy storage.

"Although Alfie's work finished in 1965, it left a legacy of radioactive contamination," Sarah reported, "so before the labs could be refurbished, they had to be decontaminated – a complex process."

Sarah enjoyed her 12-year editorship but it came to an unexpected halt when, while putting the autumn 2014 issue together, she suffered a subarachnoid haemorrhage. "It's rather difficult to craft stories and wield page layout software from an ICU bed," she said later while apologising for the magazine's delayed appearance. She decided to move on. But though the occupants of the editor's chair and its format have subsequently changed (Sarah's successor Carmen Pryce saw it through a redesign that gave it more of a magazine feel), the publication carries on.

As the then Minister for Science, Energy and Industry John Battle said in the inaugural issue, when he wrote to wish *Chem@Cam* well, "Cambridge has produced some of the finest chemists in the world. Their discoveries have helped to create the modern world and contributed greatly to improving the quality of life. I want to ensure you will go on attracting bright young people, inspiring them to make their career in chemistry."
We'd all say 'Hear, hear!' to that.

READ MORE:
Back issues of Chem@Cam can also be read online on our website at www.ch.cam.ac.uk/chem-cam

"Things that go bump in the night: a tap on the shoulder when no-one is there, cupboard contents moving of their own accord. Is the department haunted?"
***Chem@Cam*, Autumn 2001.**

Remembering Alan Battersby and John Sulston

The department has lost two friends following the recent deaths of Professor Sir Alan Battersby and Sir John Sulston.

Professor Sir Alan Battersby FRS, who died in February at the age of 92, was one of the most eminent organic chemists of his generation. He is renowned for deciphering the routes by which complex natural products are built in nature from basic chemical building blocks such as amino acids and sugars. He came to the department in 1969 to take up a Chair of Chemistry. He stayed here for the rest of his career and remained active in the department long after his retirement.

Sir John Sulston (Pembroke, 1960-66) had come here as an undergraduate and stayed on to study for a PhD in organic chemistry. He later went on to share the Nobel Prize for cell lineage research in the nematode worm and lead the UK research in the Human Genome Project. Professor John Pyle, Head of Department, says: "John was a fabulous scientist and we were very proud to be associated with him. His scientific work was recognised in many ways, including by a Nobel Prize.

"He was also a passionate advocate in areas where science and scientists interface with society – not least in arguing the moral position against the exploitation of the human genome for profit and helping keep genomes in the public domain."

Only a few months ago, we were celebrating John's achievements with him. Last October we invited him back to the department to receive our Alumni Medal, which is presented to recipients "for service to the community that has brought honour to the University of Cambridge Department of Chemistry." It was a very happy day and an opportunity for us to recognise the contributions his work had made to society and thank him for them.

Sir Alan Battersby is remembered here by two of his former department colleagues, Ted McDonald and Finian Leeper: "Always known as ARB or 'Prof' to members of his research group, Alan was a great leader who inspired hard effort and loyalty by his own example and by his energy and enthusiasm. The experience of working in the Battersby group provided a solid platform for launching the careers of more than 100 chemists, many of whom went on to make significant contributions in academia and industry."

Alan's research career began with his PhD at the University of St Andrews where "his project culminated in the laboratory total synthesis of emetine, a complex alkaloid that is the active ingredient of tincture of ipecacuanha. This was a significant achievement for a single chemist using the technical tools of the day."

Alan's career progressed through a series of posts at universities including Bristol, where he set out to study the biosynthesis of natural products, and then Liverpool where he continued his quest to map the pathways leading to many complex alkaloids (including the complex indole alkaloids, used in chemotherapy for cancer) in a diverse range of plants, with the outcome that it became possible to classify the majority of newly discovered alkaloids according to their likely derivation.

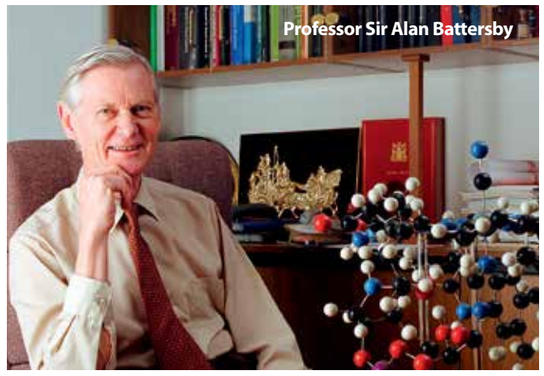
Arriving in Cambridge, he seized the opportunity, with an expanded research team, to tackle a different and potentially more important set of problems. "He began work on the tetrapyrrole pigments, a class of natural products that include the oxygen-binding site of haemoglobin; the chlorophylls; and vitamin B12. In the event, this project could not be solved by existing methods and Alan (with McDonald) became a pioneer in the use of multiple ^{13}C labelling for studying molecular rearrangements; and later, with collaborators Chris Abell and Finian Leeper, of importing genetic approaches to solve biosynthetic problems.


Sir John Sulston, right, receiving the Alumni Medal.

"Great progress had been made on the tetrapyrrole project by the due date for Sir Alan's retirement in 1992 but a little more effort was needed to complete the definition of the pathway to structurally-complex vitamin B12. Fortunately Sir Alan was granted an extension of his research funding, supported by his departmental colleagues, and was able to complete the project at the age of 70 in 1995. Vitamin B12 had for decades fascinated organic chemists with its complexity, including Lord Alexander Todd for whom structure determination was a major project. The total synthesis of vitamin B12 was the crowning achievement of a decade-long collaboration between teams led by Professors Albert Eschenmoser (ETH Zurich) and R B Woodward (Harvard). And now the Battersby group, in collaboration with scientists from the French pharmaceutical company Rhône-Poulenc (now part of Sanofi), had finished mapping out every step in the lengthy biosynthetic route to this important vitamin."

"Alan's achievements were recognised worldwide and awards he received included the Royal Medal and prestigious Copley Medal, both from the Royal Society. In 1992 he was knighted. Alan will be greatly missed by all who had the privilege of knowing him, but his scientific achievements will endure for as long as we remain curious about the chemistry of nature's products."

- A longer version of this obituary appears on our website at: www.ch.cam.ac.uk/alumni/alan-battersby-obituary


Professor Sir Alan Battersby

Linnett Memorial symposium

Instead of our annual Linnett Lecture this spring, we held a symposium instead to honour a scientist who "changed the course of physical chemistry not just once, but several times." At the event here in April, speakers from around the world gathered to remember Professor David Chandler.

The late Professor Chandler, a pillar of the physical chemistry community and former Professor Emeritus of Chemistry at the University of California at Berkeley, is credited with crafting the modern language and concepts for describing structure and dynamics of condensed matter, especially complex systems with disorder and heterogeneity, such as liquids, glasses and biological assemblies.

He had been due to give this year's annual Linnett Lecture. Sadly, he lost his 20-year battle with prostate cancer before he could do so. It was subsequently decided that we would hold a Linnett Memorial Symposium at which speakers would remember the scientist who had so much influence on their work.

They showed what a wide influence he had: delegates came from the universities of Vienna, Munich, Nottingham, Bristol, Denmark, Amsterdam, and the Ecole Polytechnique Fédérale de Lausanne among others, and from fields ranging from computational physics to protein modelling and from software engineering to molecular simulation.

Noticeboard

Awards

Professor Erwin Reisner has won the Royal Society of Chemistry Corday-Morgan Prize for 2018. The Society awards up to three prizes each year for "the most meritorious contributions to Chemistry". Erwin's prize is awarded for the development of solar-driven catalysis with molecularly engineered semiconductors and semi-artificial photosynthesis. His work focuses on advancing the fundamental science of sunlight-driven chemistry, which could help solve the challenge of sustainable energy.

Professor Oren Scherman has also won a Royal Society of Chemistry Corday-Morgan Prize for 2018. Oren's prize is awarded for ground-breaking discoveries in supramolecular chemistry. Oren's work focuses on bringing long chains of molecules called polymers together in a controlled way in water to make hydrogels. These gels can be used for a wide range of applications including slow, controlled release of therapeutics for treatment of diseases such as brain cancer.

Dr Silvia Vignolini has won the Royal Society of Chemistry Gibson-Fawcett Award for 2018. This award is given for highly original contributions to the fields of bio-materials and bio-mimetic photonic nanostructures. Silvia studies how optical structures – such as the iridescence used by many animals for mating or camouflage, or the complex systems that plants use to boost photosynthesis – are made in nature. She uses this to design manufacturing methods for synthetic materials with similar properties.

Professor Clare Grey has been awarded a 2018 Royal Society Research Professorship, the Society's premier research award. It provides long-time support for "internationally recognised scientists of exceptional accomplishments." *(See the news story about Clare's work on page 10.)*

Dr Gonçalo Bernardes has been selected to receive the 2018 *MedChemComm* Emerging Investigator Lectureship for his significant contributions to medicinal chemistry. *(See the feature about his work on page 20.)*

Professor Tuomas Knowles has been awarded the 2017 Raymond and Beverly Sackler Prize in Biophysics "for elucidating physical principles of amyloid fibril formation with important applications in biology and medicine."

Professor Michele Vendruscolo has received the Giuseppe Occhialini Medal and Prize, awarded jointly by the Institute of Physics and the Italian Physical Society, "for having brought physics and biology together in innovative ways to make highly influential contributions to the understanding of the fundamental principles of protein aggregation, solubility and homeostasis".

Dr Jenny Zhang has been awarded a BBSRC David Phillips Fellowship to start her own research group. (*See the 'Women in Chemistry' interview with Jenny on page 14.*)

Peter Wirnsberger has received a Microsoft Azure Research Award, giving him the computing resources for a year to analyse the way particles behave in nanoscale systems that are out of thermal equilibrium. *(See the story on page 21.)*

Books

Dr Stephen J. Jenkins
Reader in Physical Chemistry
Chirality at Solid Surfaces (Wiley, 2018) ISBN: 978-1-118-88012-8

Upcoming events

Sutton Trust Summer School
13-18 August

Alumni event: Chemistry 'Call My Bluff' Wine Tasting
Friday 21 September as part of the University of Cambridge Alumni Festival 2018.
Please save the date!
Details and booking to be confirmed.

Chemistry Showcase Week & Chemistry Networks Industry Showcase 2018
25-28 September
Contact Dr Yolande Cordeaux (yc265@cam.ac.uk) if you would like to be involved in the Chemistry Networks Industry Showcase event.