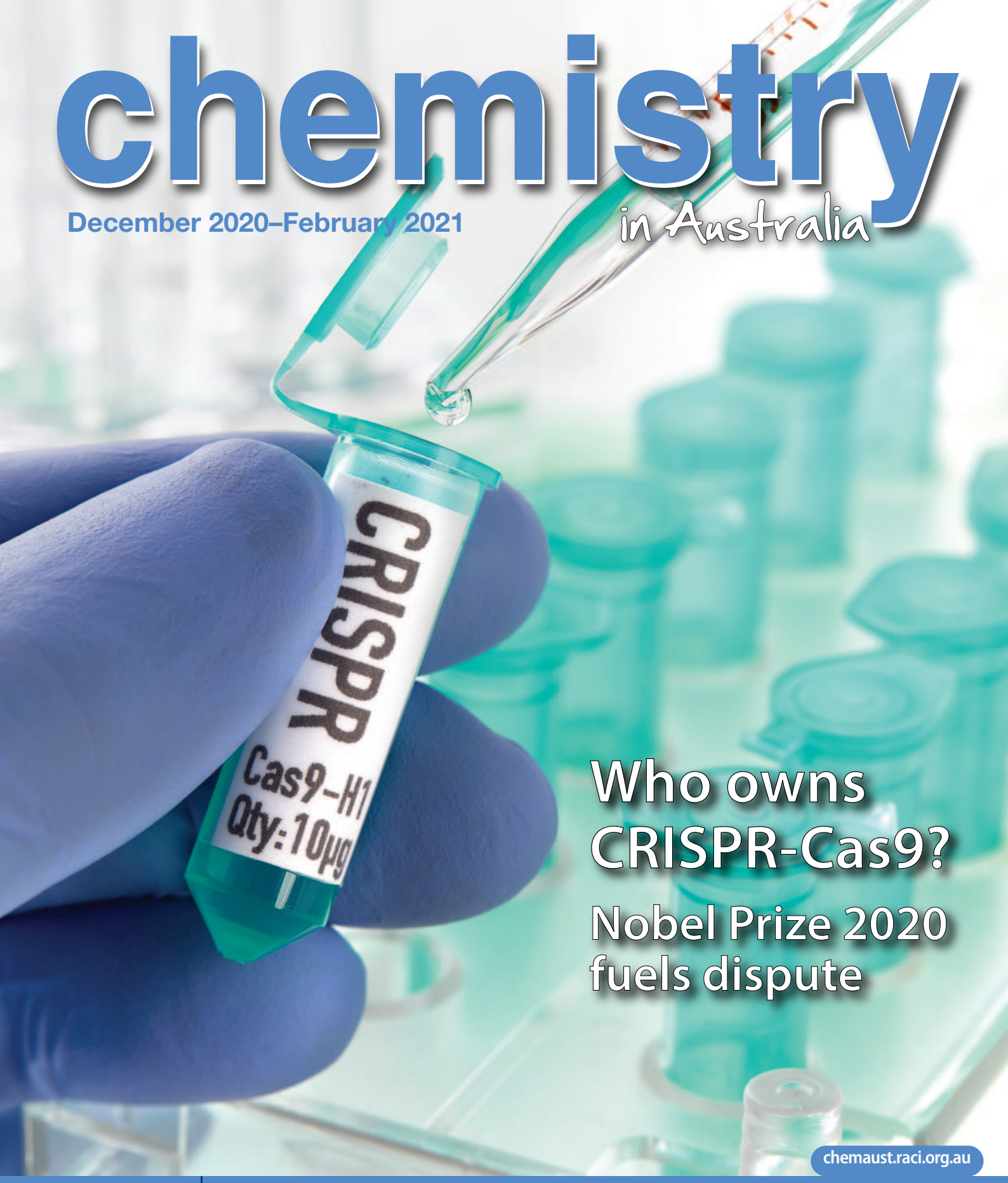
chemistry in Australia

December 2020–February 2021



Who owns CRISPR-Cas9?

Nobel Prize 2020 fuels dispute

chemaust.raci.org.au

raci
ROYAL AUSTRALIAN CHEMICAL INSTITUTE

- Scientific posters: the bigger picture
- RACI National Awards winners
- Science for and in diplomacy

www.rowe.com.au

Online 24 hours 7 days a week, by phone or face to face, we give you the choice.

INSTRUMENTS - CONSUMABLES - CHEMICALS - SERVICE & REPAIRS

ROWE SCIENTIFIC PTY. LTD. www.rowe.com.au

Ajax Finechem · Bel-Art Products · chem-supply · cowie · CHROMACOL · Gilian · KartellLABWARE · SIGMA-ALDRICH · MN · MERCK · METTLER TOLEDO · OHAUS · SIMAX · Tarsons · TPS · Techno Plas · VELP SCIENTIFICA · witeg

A 100% Australian owned company, supplying scientific laboratories since 1987.

South Australia & NT
Ph: (08) 8186 0523
rowesa@rowe.com.au

Queensland
Ph: (07) 3376 9411
roweqld@rowe.com.au

Victoria & Tasmania
Ph: (03) 9701 7077
rowevic@rowe.com.au

New South Wales
Ph: (02) 9603 1205
rowensw@rowe.com.au

Western Australia
Ph: (08) 9302 1911
rowewa@rowe.com.au

Quality System
Quality Endorsed Company
ISO 9001:2015
LIC 10372
SAI Global

REF535

X:\MARKETING\ADVERTISING\CHEMISTRY IN AUSTRALIA

chemistry in Australia

December 2020–February 2021

iStockphoto/Bill Oxford

cover story

Who owns CRISPR-Cas9? Nobel Prize in Chemistry stokes patent dispute 14

The ongoing intellectual property ownership dispute over the CRISPR-Cas9 technology has recently been refuelled by the awarding of the Nobel Prize in Chemistry 2020.

chemaust.raci.org.au

From the President

This is my first President's column and I would like to start by thanking Dr Vicki Gardner for her excellent efforts leading the Institute over the past two years. There are two newly elected members on the Board, so I welcome the new President Elect, Professor Pall Thordarson, and the new Treasurer, Dr Lidia Matesic. I thank the outgoing Treasurer, Dr Matt Sykes, who has served the RACI so very well for a number of years, and Board member Ms Lisa Stevens for her contributions. The new Board appointments arise from elections from the membership and so I also thank the members for their engagement with this electoral process. Elections have definitely been in the news recently, but I am sure that in the case of the RACI we will see an effective and efficient transfer of powers, and the smooth running of the RACI will continue through the transition.

Vicki is the second female President in the RACI's more than 100-year history and under her stewardship the RACI is a more inclusive and equitable organisation, with transparent processes and more open governance. With Vicki as a role model, future RACI presidents, boards, committees and elected officials will continue to reflect our membership diversity and the range of activities where chemists play key roles. The biggest cohort (about 40%) of RACI members are in academia and CSIRO; however, our members pursue chemistry activities in many forms and in many locations. More than half our members come from Victoria and New South Wales, but RACI members exercise their discipline skills in all states and in the remotest locations of the country. Currently, about 30% of members are female. Significantly, this increases to more than 40% for members under 45 years of age and is closer to 50% for the under-35 age bracket. I take this as a positive sign that the RACI of the future will reflect an even gender balance through all elements of its structure and activities.

The future is an important focus for the RACI. Currently, about 40% of our total membership base is under 45, and building a dynamic and enthusiastic cohort of younger members remains a key objective to keep the RACI a vibrant and active organisation. One of the advantages of membership for new chemistry professionals is access to established networks and experienced members. The RACI continues to be strong in this element. Our youngest member is just 18 years old. To balance this, we have two members who are over 100! Our longest serving member is 98 and joined in 1939! We can only marvel when thinking of the changes to the science and applications of chemistry (and to the RACI) they have experienced over those more than 80 years.

... building a dynamic and enthusiastic cohort of younger members remains a key objective to keep the RACI a vibrant and active organisation.

2020's pandemic and political uncertainties make our RACI a different entity from that which existed for much of its more than 100 years of existence. Most COVID-19 induced changes have been accepted with limited complaint and many have been embraced as being of long-term benefit. This is especially true for chemistry education, which now has an increased emphasis on online learning. Some of our new graduate members will not have been exposed to typical face-to-face teaching and will have different levels of hands-on practical skills training. The Board is aware of these challenges and has initiated a process of certification for alternative teaching approaches that some institutions have already put in place and we hope this will be of value to our student and new graduate members.

Steven Bottle FRACI CChem (president@raci.org.au) is RACI President.

chemistry in Australia
chemaust.raci.org.au

EDITOR
Sally Woollett
Ph (03) 5623 3971
wools@westnet.com.au

PRODUCTION EDITOR
Catherine Greenwood
catherine.greenwood@bigpond.com

ADVERTISING SALES
Mary Pappa
Ph/fax (03) 9328 2033/2670
mary.pappa@raci.org.au

PRODUCTION
Control Publishing
publishing@control.com.au
www.control.com.au

BOOK REVIEWS
Damien Blackwell
damo34@internode.on.net

RESEARCH HIGHLIGHTS
David Huang
david.huang@adelaide.edu.au

EDUCATION RESEARCH HIGHLIGHTS
Reyne Pullen
r.pullen@unsw.edu.au

GENERAL ENQUIRIES
Robyn Taylor
Ph/fax (03) 9328 2033/2670
chemaust@raci.org.au

PRESIDENT
Steven Bottle

MANAGEMENT COMMITTEE
Helmut Hügel, Colin Scholes, Madeleine Schultz, David Springer, Richard Thwaites

CONTRIBUTIONS
Contributors' views are not necessarily endorsed by the RACI, and no responsibility is accepted for accuracy of contributions. Visit the website's resource centre at chemaust.raci.org.au for information about submissions.

ISSN 0314-4240 e-ISSN 1839-2539

Chemical oxymoron

I don't receive much in the post these days. Even the bills come electronically. But one day I received two items – the latest issue of *Chemistry in Australia* and a brochure from a well-known wine retailer, whose name I shan't disclose.

The brochure described a white wine on offer as 'having a backbone of fine, chalky acid'. If ever there was a chemical oxymoron, this is it. First we have chalk, known to chemists as calcium carbonate ($CaCO_3$), which is alkaline. Then we have (grape) acid, principally L-(+)-tartaric acid.

Put them together in solution and what happens? Carbon dioxide is evolved and calcium tartrate is formed, which may precipitate over time.

Although it is likely that an early German chemist would have tasted calcium tartrate when first isolated, and recorded its taste, as was the custom, I don't have ready access to Beilstein* these days to discover the chemist's description of the taste.

But it is unlikely to have been *kalkhaltige Saüre* (chalky acid)!

Another reference, *International Oenological Codex* (2015), describes calcium L-(+)-tartrate as tasteless.

Incidentally, winemakers go to great lengths to remove L-(+)-tartaric acid and its salts from wine, especially white wine, by a process called cold stabilisation, to avoid later crystallisation in the bottle, which might offend consumers.

Peter G. Lehman FRACI CChem

* *Beilstein Handbook of Organic Chemistry* (from 1881)

Quarterly magazine: for …

I endorse the decision to make *Chemistry in Australia* a quarterly publication. I see that the magazine continues to bleed money and that readership of the hard copy and online is comparatively sparse, thereby not being attractive to advertising income, nor, sadly, a significant portion of the RACI membership.

During my period on the Board as both President and Treasurer, losses associated with *Chemistry in Australia* were a continual agenda item. Demonstrably, over the past 20 years hard copy *Chemistry in Australia* is less of a service to members than in previous decades. A great pity, but such is the reality of today.

Notwithstanding, I do trust that *Chemistry in Australia* maintains its current high standard, to my mind as high as it has ever been.

David Edmonds FRACI CChem

… and against

What a pity the RACI has decided to cut back *Chemistry in Australia* to quarterly. I thoroughly endorse Peter Lehman's words (September–November, p. 5) and deplore the bumptious reply to his contribution. *Chemistry in Australia* is the prime point of contact with the membership. The initial strategy of charging a premium for hard copy was bound to the same failure as every other organisation going down this track, and, no doubt, has led to loss of membership. People do not have the time or inclination to manipulate a screen image to read a magazine. With a paper copy everybody gets a tangible 'gift' and regular reminder of the RACI. They will probably at least leaf through it.

During my career, I nominated hundreds of chemistry students for membership, who were thrilled when they received their monthly magazine, recognising their acceptance as neo-professionals. Now they will get very little indeed, similarly for members. No hard copy means no real contact means the question of why belong? Were I not an HLM, I would certainly be exploring this question because the answer, for me, is not obvious.

I tried, via the RACI website, to find out exactly what *Chemistry in Australia* costs. I could not find out. Even HLMs cannot penetrate the arcane mysteries of the RACI Board. I was also unable to hunt down any minutes from Board meetings. Maybe my fault? Maybe not. From the published arguments for pruning *Chemistry in Australia* (which, for me, seemingly lack logic, always assuming the Board's long-term aim is to remain in existence), I can only shake my head and wonder who is actually running the show and what their aims are.

R.J. Casey FRACI CChem

Timor-Leste Chemical Society update

Timor-Leste has had only 30 cases of COVID-19, no deaths and no active cases for a few months. This meant that the 70 members of the Timor-Leste Chemical Society (TLCS) were able to meet in Dili on 10 October for their Second National Congress.

They elected their new Board with Professor Samuel Venancio de Sousa Freitas re-elected President. Its members are playing a key role in the economic and social development of Timor-Leste. Samuel is the Dean of the Faculty of Exact Sciences at the National University of Timor-Leste.

TLCS is now an independent society sponsored by the National University of Timor-Leste. It was admitted as a member of the Federation of Asian Chemical Societies in Taipei on 8 December 2019. The Board is now in the process of establishing TLCS as a national legal society. The major impediment to achieving this is the requirement to have US$5000 in their bank account. They have started talking with the Timor-Leste government and various NGOs active in Timor-Leste to raise the funds required. Note that GDP per capita in Timor-Leste is about US$2000 and average salaries about the same, so it will take a long time for the 70 members of the TLCS to save the $5000 themselves.

In 2017, the RACI helped the Friends of Timor-Leste Chemistry raise enough money to enable the Secretary of the TLCS to attend the RACI Centennial Conference. It would be great if we could assist them in raising the $5000.

The development of chemistry in Timor-Leste is hampered by a chronic lack of even the most basic equipment. Attempts by the Friends of Timor-Leste Chemistry to donate spare equipment to Timor-Leste have been thwarted by the COVID-19 pandemic. Let us hope that we can resume work on this project in the near future.

Tom Spurling FRACI CChem and **John Webb** FRACI CChem

Please contact Mary Pappa (mary.pappa@raci.org.au) for further information.

Genetic scissors: a tool for rewriting the code of life

The Royal Swedish Academy of Sciences has decided to award the 2020 Nobel Prize in Chemistry to Emmanuelle Charpentier (Max Planck Unit for the Science of Pathogens, Berlin, Germany) and Jennifer A. Doudna (University of California, Berkeley, USA) 'for the development of a method for genome editing'.

Charpentier and Doudna have discovered one of gene technology's sharpest tools: the CRISPR-Cas9 genetic scissors. Using these, researchers can change the DNA of animals, plants and microorganisms with extremely high precision. This technology has had a revolutionary impact on the life sciences, is contributing to new cancer therapies and may make the dream of curing inherited diseases come true.

Researchers need to modify genes in cells if they are to find out about life's inner workings. This used to be time-consuming, difficult and sometimes impossible work. Using the CRISPR-Cas9 genetic scissors, it is now possible to change the code of life over the course of a few weeks.

There is enormous power in this genetic tool, which affects us all. It has not only revolutionised basic science, but also has resulted in innovative crops and will lead to groundbreaking new medical treatments, said Claes Gustafsson, chair of the Nobel Committee for Chemistry.

As so often in science, the discovery of these genetic scissors was unexpected. During Charpentier's studies of *Streptococcus pyogenes*, one of the bacteria that cause the most harm to humanity, she discovered a previously unknown molecule, tracrRNA. Her work showed that tracrRNA is part of bacteria's ancient immune system, CRISPR-Cas, which disarms viruses by cleaving their DNA.

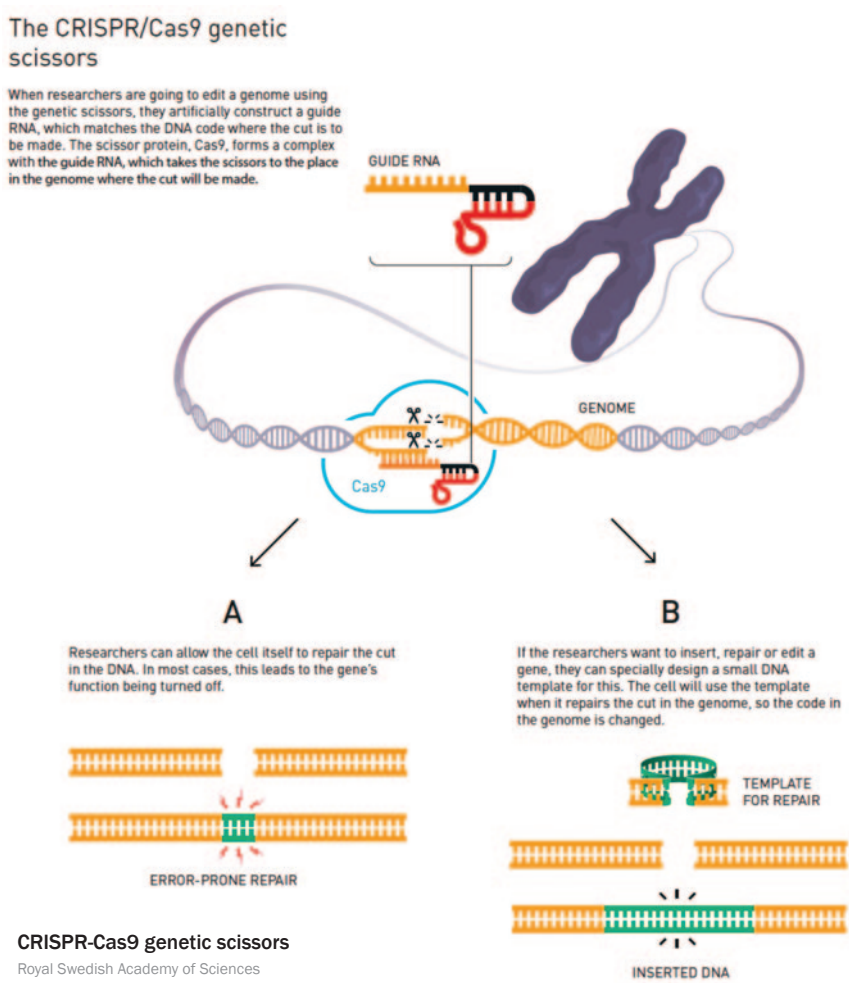
Charpentier published her discovery in 2011. The same year, she initiated a collaboration with Doudna, an experienced biochemist with vast knowledge of RNA. Together, they succeeded in recreating the bacteria's genetic scissors in a test tube and simplifying the scissors' molecular components so they were easier to use.

They then reprogrammed the genetic scissors. In their natural form, the scissors recognise DNA from viruses, but Charpentier and Doudna proved that they could be controlled so that they can cut any DNA molecule at a predetermined site. Where the DNA is cut, it is then easy to rewrite the code of life.

Since Charpentier and Doudna discovered the CRISPR-Cas9 genetic scissors in 2012, their use has exploded. This tool has contributed to many important discoveries in basic research, and plant researchers have been able to develop crops that withstand mould, pests and drought. In medicine, clinical trials of new cancer therapies are underway, and the dream of being able to cure inherited diseases is about to come true. These genetic scissors have taken the life sciences into a new epoch and, in many ways, are bringing the greatest benefit to humankind.

Charpentier was born in 1968 in Juvisy-sur-Orge, France. She obtained her PhD in 1995 from Institut Pasteur, Paris. She is Director of the Max Planck Unit for the Science of Pathogens.

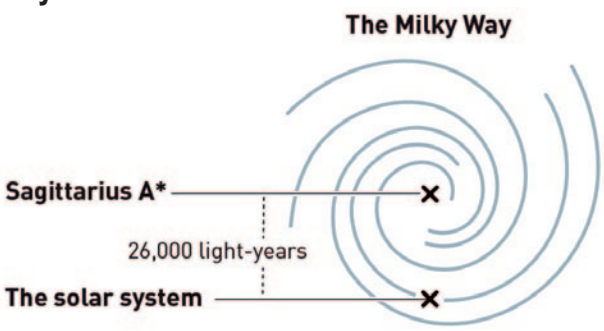
Doudna was born in 1964 in Washington, DC, USA. She obtained her PhD in 1989 from Harvard Medical School, Boston. She is Professor at the University of California, Berkeley, and Investigator, Howard Hughes Medical Institute.



CRISPR-Cas9 genetic scissors
Royal Swedish Academy of Sciences

Other 2020 Nobel prizes for science

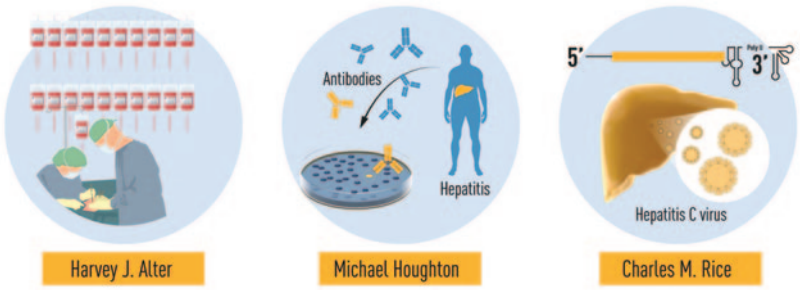
Physics



The Milky Way, our galaxy, seen from above. It is shaped like a flat disc about 100,000 light-years across. Its spiral arms are made of gas and dust and a few hundred billion stars. One of these stars is our Sun.

The 2020 Nobel Prize in Physics is awarded with one half to Roger Penrose (University of Oxford) 'for the discovery that black hole formation is a robust prediction of the general theory of relativity'; and the other half jointly to Reinhard Genzel (Max Planck Institute for Extraterrestrial Physics, Garching, Germany and University of California, Berkeley) and Andrea Ghez (University of California, Los Angeles) 'for the discovery of a supermassive compact object at the centre of our galaxy'.

Physiology or Medicine



The 2020 Nobel Prize in Physiology or Medicine is awarded jointly to Harvey J. Alter (NIH Clinical Center Department of Transfusion Medicine, Maryland), Michael Houghton (University of Alberta, Edmonton) and Charles M. Rice (Rockefeller University, New York) 'for the discovery of Hepatitis C virus'.

BASF launches Infinergy virtual showroom

BASF has introduced a state-of-the-art virtual showroom, which showcases diverse applications and properties of Infinergy®, its expanded thermoplastic polyurethane (E-TPU), as part of its new Empowering Movement brand identity.

'Infinergy has always been synonymous with innovation, pushing the boundaries of chemistry to enhance inventions, such as Dunlop rackets, Adidas Boost shoes, and Ergon Saddles. The new brand identity embodies Infinergy's brand promise, as well as its evolution from being the world's first expanded E-TPU, to being a leader in the high-performance material solutions segment,' said Dr Jens P. Dierssen, Global Business Management, Infinergy.

The Infinergy virtual showroom comprises three areas:

- identity area – presenting the new branding philosophy, this area helps visitors understand how Infinergy empowers movement primarily in three main sectors – footwear, sports and leisure, and flooring.
- showroom area – the showroom showcases successful projects with key partners and customers, such as Maincal, the South American brand, for the launch of its latest Voran line of safety shoes and other renowned brands, such as Elten and U-Power
- resource area – this knowledge area allows the audience to understand new Infinergy innovations, such as the recently launched black beads and mini beads.

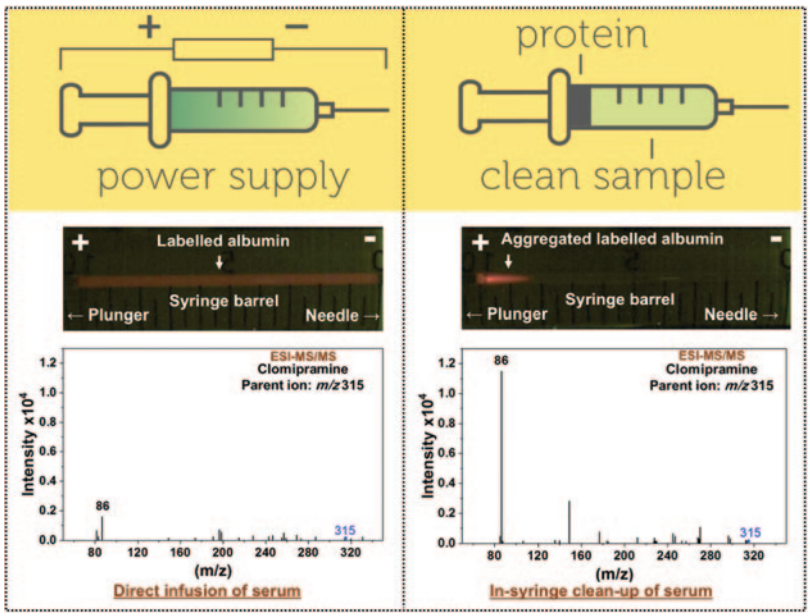
To produce Infinergy, the well-established BASF thermoplastic polyurethane (Elastollan®) is expanded at their German headquarters. Being a particle foam, Infinergy has a low bulk weight, with a density of about 110 kg/m^3 and, after processing on standard moulding machines, a moulded part weight of between 200 and 320 kg/m^3. That puts the new foam somewhere between expanded polystyrene or polypropylene, which are generally lighter, and the heavier elastomeric polyurethane foams.

Alongside its low bulk weight, one of the main features of Infinergy is its excellent recovery behaviour, which is due partly to the closed-cell structure of the foam. This makes it one of the most elastic particle foams currently available on the market.

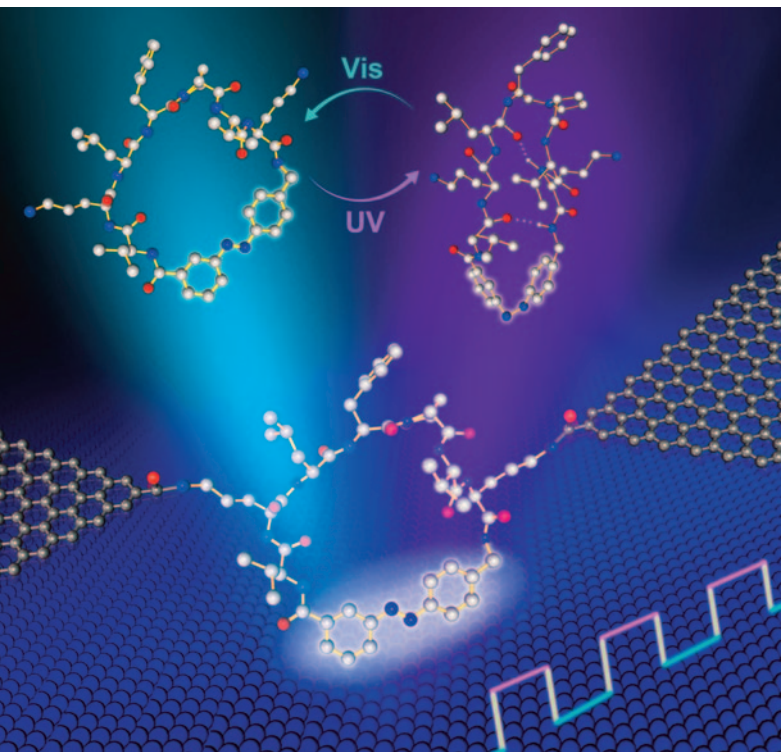
For more information, visit Infinergy.basf.com.

In-syringe clean-up of samples for bioanalysis

Matrix effects can compromise the reliability of electrospray ionisation mass spectrometry (ESI-MS), making sample clean-up critical in MS-based bioanalysis. However, sample preparation is usually the most time-consuming and labour-intensive part of the analytical workflow. Now, an electrokinetic extraction syringe has been developed for the online electrokinetic removal of serum proteins before ESI-MS (Mikhail I.M., Tehranirokh M., Gooley A.A., Guijt R.M., Breadmore M.C. *Angew. Chem. Int. Ed.* 2020, doi.org/10.1002/anie.202006481). The method depends on the migration of charged proteins in serum away from neutral analytes in an electric field, applied using the metallic syringe plunger and needle as electrodes. Under basic conditions, serum proteins are anionic, facilitating their accumulation at the anodic plunger, and subsequently allowing the deproteinated sample to be infused to ESI-MS for detection of basic molecules. Another system was similarly designed for acidic analytes. The proposed concept was demonstrated by quantitative measurement of pharmaceuticals in untreated serum. Signal enhancements of 3.6–32-fold were obtained relative to direct infusion. The measurement capability of the method covered the clinical range of the studied drugs, with limits of quantitation in parts per billion. The method can be used for sample dilution, sample purification, and infusion into MS, which showcases its potential for incorporation in an automated workflow.



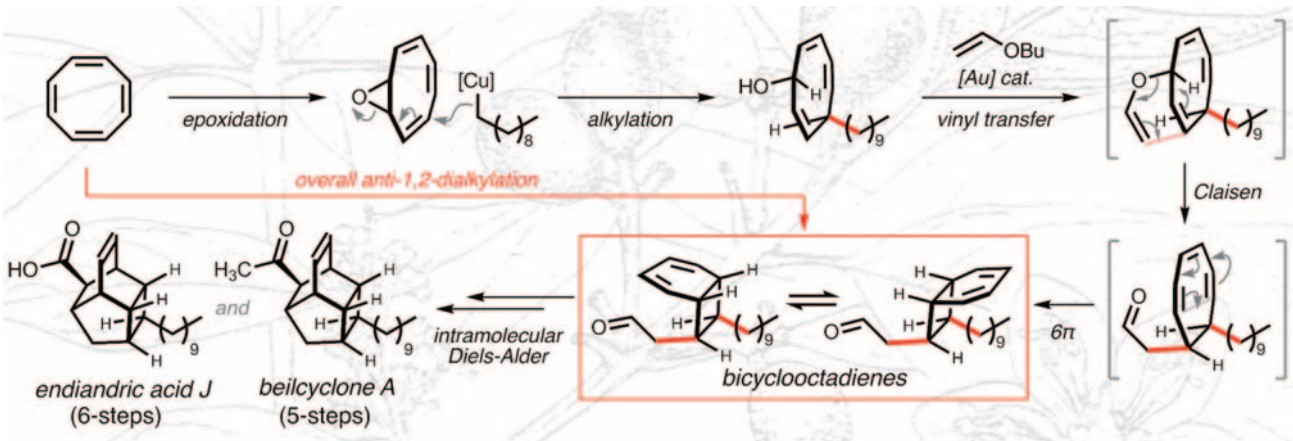
Probing protein dynamics in a single-molecule junction



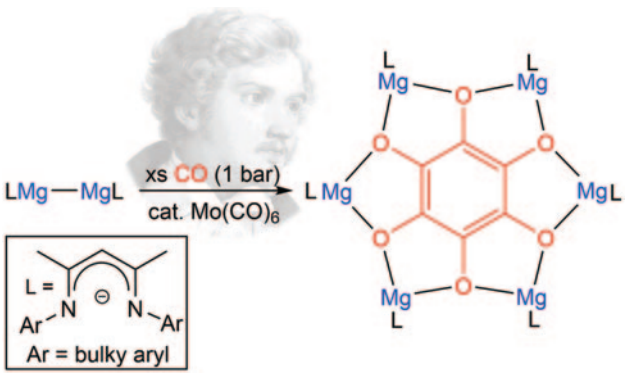
Proteins are in continuous motion, and their structural dynamics is crucial to function. However, the majority of protein structures have been elucidated under equilibrium conditions and provide limited information about their inherent dynamic behaviour. To probe proteins in motion, researchers at the University of Adelaide, in collaboration with researchers at Peking University (China), fabricated a label-free nanodevice comprising a single-peptide junction to measure real-time conductance (Chen X., Yeoh Y.Q., He Y., Zhou C., Horsley J.R., Abell A.D., Yu J., Guo X. *Angew. Chem. Int. Ed.* 2020, doi.org/10.1002/anie.202004701). The single-peptide nanodevice contains an azobenzene photoswitch for interconversion between a well-defined *cis* isomer and disordered *trans* isomer. Real-time conductance measurements revealed three distinct states for each isomer, with molecular dynamics simulations showing that each state corresponds to a specific range of hydrogen bond lengths in the *cis* isomer and to specific dihedral angles in the *trans* isomer. This research provides hitherto undisclosed insights into the structural dynamics of peptides, which may rationally extend to proteins. It also demonstrates the capacity to modulate conductance to advance the development of bio-inspired electronic nanodevices.

Cutting the cascade: a new approach to endiandric acids

The endiandric acids are the first of large family of natural products characterised by a spectacular 8π/6π/intramolecular-Diels–Alder pericyclic reaction cascade at the heart of their biosynthesis. Their compact and stereochemically rich structures have intrigued chemists since their discovery in the early 1980s by Professor David Black of the University of NSW. Nicolaou's original synthetic work has become a classic of biomimetic total synthesis. But all previous approaches require the often challenging and lengthy preparation of linear tetraene intermediates. The Fallon group at the University of Adelaide have recently demonstrated a distinctive new strategy starting from cyclooctatetraene (Yahiaoui O., Almass A., Fallon T. *Chem. Sci.* 2020, **11**, 9421–5). An overall dialkylation of cyclooctatetraene was achieved through an epoxidation, alkylation, vinyl transfer, Claisen rearrangement, 6π-electrocyclisation sequence to give bicyclooctadienes as advanced intermediates. Endgame operations and intramolecular Diels–Alder reactions gave endiandric acid J and beilcyclone A in a total of six and five steps, respectively. This is by far the shortest approach to any member of this family of natural products and heralds renewed exploration of their medicinal properties.



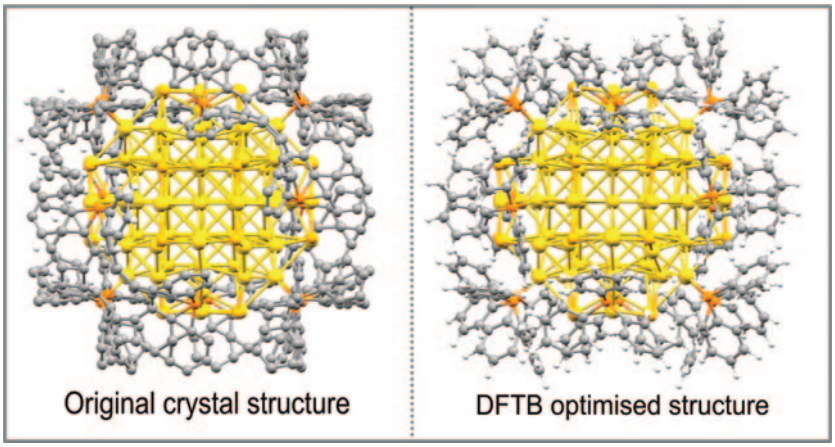
Making arenes from CO



The reductive homologation of CO has been studied since at least 1834, when Justus von Liebig reacted molten potassium and CO gas to give a dark ill-defined solid, 'potassium carbonyl' $(KCO)_n$. More than 100 years later, this solid was shown to contain a mixture of products, including potassium benzenehexolate, $K_6C_6O_6$. To this day, the mechanism of this fascinating reaction is not known, although it has been suggested that transition metal impurities in the molten potassium promote the formation of $K_6C_6O_6$. Now, the group of Cameron Jones of Monash University and his theoretician collaborator, Laurent Maron of the University of Toulouse (France), have shown that cooperativity between reducing magnesium(I) compounds and $Mo(CO)_6$ leads to reductive hexamerisation of CO and the formation of the first well-defined magnesium benzenehexolate compounds (Paparo A., Yuvaraj K., Matthews A.J.R., Douair I., Maron L., Jones C. *Angew. Chem. Int. Ed.* 2020, doi.org/10.1002/anie.202009523). Density functional theory calculations and spectroscopic studies revealed this reaction to be catalysed by $Mo(CO)_6$, thus finally shedding light on the mechanism of Liebig's classical reaction and other C–C bond forming-reactions that use CO as a C_1 feedstock, such as the Fischer–Tropsch process.

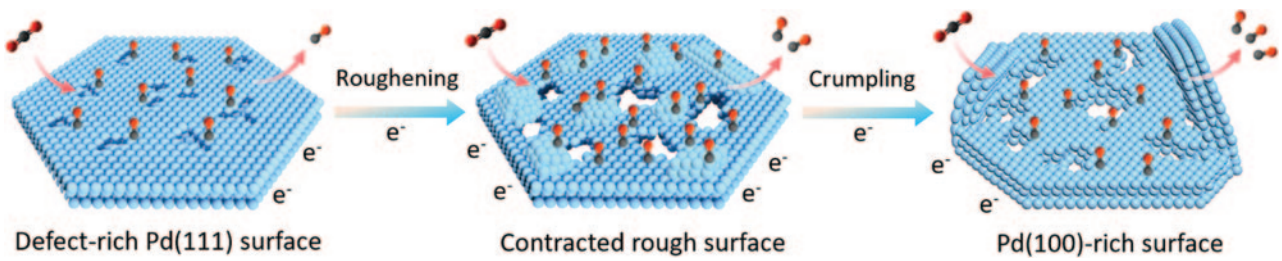
Fast quantum calculations of nanoscale ligand-stabilised metal clusters

Atomically precise, ligated gold clusters have well-defined discrete electronic energy levels that offer unique catalytic properties. Thiolate and/or phosphine ligands are required to prevent aggregation during synthesis. Although density functional theory (DFT) is usually employed to predict and describe electronic, geometrical and vibrational structure, it is limited by computational expense to moderate system sizes. Density functional tight-binding (DFTB) is two to three orders of magnitude faster than DFT, but it requires accurate parameters for all binary interactions between chemical elements, such as Au–S and Au–P; parameters exist for the former but, until recently, did not for the latter. Now, researchers from the University of Adelaide, in collaboration with Oak Ridge National Laboratory (US) and the University of Bremen (Germany), have developed Au–P parameters for DFTB and used them to rapidly compute phosphine-ligated gold clusters, metalloids and gold surfaces (Vuong V.Q., Madridejos J.M.L., Aradi B., Sumpter B.G., Metha G.F., Irle S. *Chem Sci*. 2020, doi.org/10.1039/D0SC04514D). The performance of the new parameters was evaluated for geometries, ligand-binding and cluster-isomerisation energies, ligand-dissociation potential-energy curves, molecular-orbital energies, and far-infrared spectra. The ultimate test was a calculation of the metalloid complex $Au_{108}S_{24}(PPh_3)_{16}$, including correction of unphysical atom positions in the published x-ray crystal structure. A speed up factor of 1500× was found for DFTB over DFT.

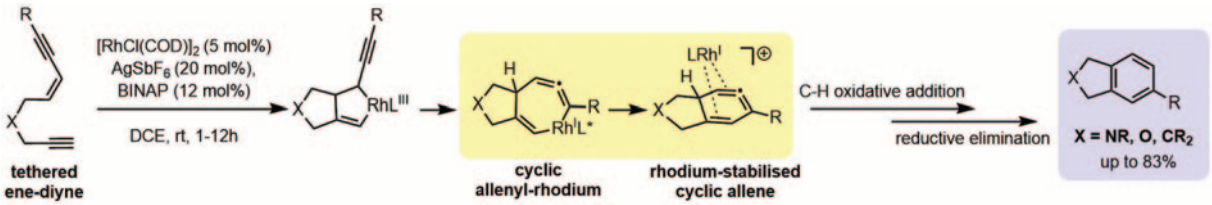


Surface reconstruction of Pd nanosheets during CO_2 reduction

Electrochemical conversion of CO_2 into useful chemicals or liquid fuels is an attractive way to create energy-rich products. Palladium catalysts with intrinsic activity for CO or formate production have great potential in this regard. However, most previously reported Pd-based structure–performance relationships assume that the catalyst active sites remain unchanged during the reaction. But the stability of active sites in Pd nanostructures is not well understood. Now, researchers from the University of New South Wales and Australian National University have discovered a surface reconstruction phenomenon in ultrathin Pd-nanosheet catalysts during aqueous CO_2 electroreduction (Zhao Y., Tan X., Yang W., Jia C., Chen X., Ren W., Smith S.C., Zhao C. *Angew. Chem. Int. Ed.* 2020, **59**, 21493–8). The operating structures on Pd nanosheets under CO_2 reduction conditions were found to be very different from the pristine ones. Pristine inactive basal Pd(111) surfaces can be transformed into crumpled Pd(100)-dominant surfaces with reduced CO binding strength, remarkably promoting CO_2 conversion to CO with high selectivity (>93%). Moreover, this reconstruction results in a size-independent high CO selectivity among Pd nanosheets of different sizes (20, 50 or 120 nm in diameter). Experiments and calculations point to the CO intermediate as a key factor driving the structural transformation during CO_2 reduction. This work highlights the dynamic nature of defective metal nanosheets under reaction conditions and suggests new opportunities for surface engineering of 2D metal nanostructures to tune their electrocatalytic performance.



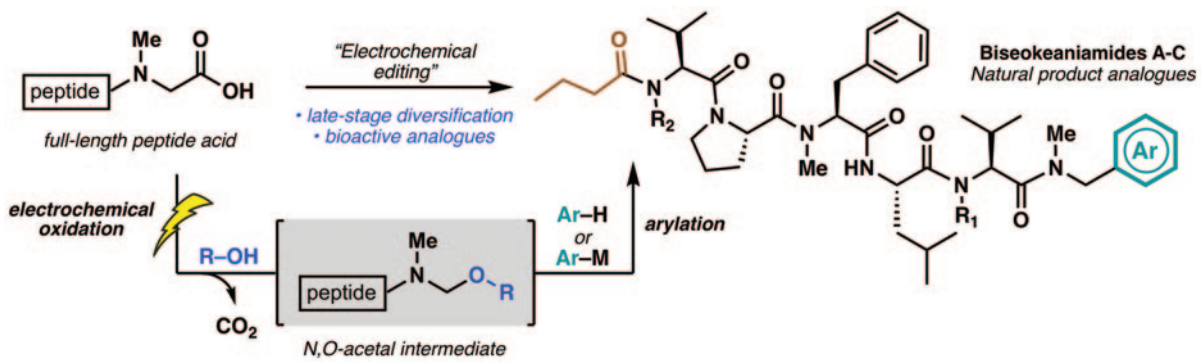
Room-temperature tetrahydro-Diels–Alder reactions via cyclic allenes



Aromatic rings fused to a five-membered heterocycle, such as isoindoles and isobenzofurans, are found in an array of biologically active molecules. There are limited general methods to prepare these heterocycles, but a tetrahydro-Diels–Alder (TDDA) reaction of an *N*- or *O*-tethered polyunsaturated enediyne is a potentially powerful method that could be used. Unfortunately, this reaction has not been deployed in this setting as the thermal variant of the reaction requires very high temperatures and has very limited substrate scope. To solve this problem, Chris Hyland and Stephen Pyne at the University of Wollongong, in collaboration with Alireza Ariafard at the University of Tasmania, have developed a highly efficient rhodium-catalysed TDDA reaction with broad substrate scope that proceeds at room temperature (Thadkapally S., Farshadfar K., Drew M.A., Richardson C., Ariafard A., Pyne S.G., Hyland C.J.T. *Chem. Sci.* 2020, **11**, 10 945–50). Experiments and computation showed that this reaction proceeds via a complex $Rh^{I}/Rh^{III}/Rh^{I}/Rh^{III}$ redox cycle involving formation of an unusual cyclic allenyl-rhodium species, followed by reductive elimination to a rhodium-stabilised six-membered cyclic allene. Subsequent C–H activation and reductive elimination give the final organic products in high yield.

Bioactive peptides via electrochemical editing

Peptide natural products are rich sources of structural and functional diversity. As promising leads for drug discovery, these molecules also serve to inspire the development of new synthetic methods that enable the rapid construction of both natural products and associated analogues. Researchers in the Malins lab at the Australian National University have recently reported the first total synthesis of the biseokeaniamides – a class of structurally intriguing, cytotoxic peptide cyanobacterial natural products—together with an efficient electrochemical approach to bioactive peptide analogues (Lin Y., Malins L.R. *Chem. Sci.* 2020, **11**, 10 752–8). They first constructed the natural product by a concise solid-phase approach before embarking on the development of an electrochemical oxidation–arylation strategy to facilitate the rapid production of analogues. In this operationally simple methodology, direct decarboxylation of the peptide *C*-terminus is triggered by electrochemical oxidation, affording a reactive *N,O*-acetal intermediate that can be engaged with a variety of aryl nucleophiles. The method is amenable to the modification of polypeptide chains and enables the production of modified peptides with enhanced cytotoxicity relative to the natural product, providing promising new bioactive leads for therapeutic development.

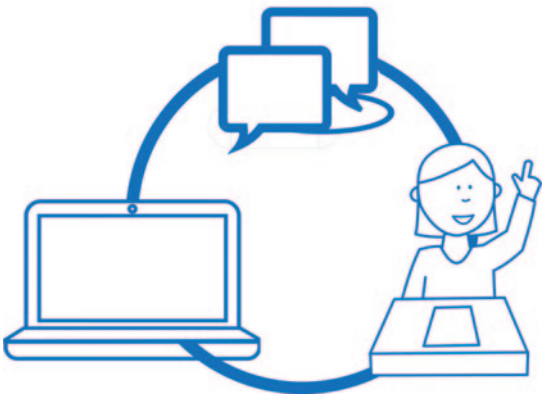


Compiled by **David Huang** MRACI CChem (david.huang@adelaide.edu.au). This section showcases the very best research carried out primarily in Australia. RACI members whose recent work has been published in high-impact journals (e.g. *Nature*, *J. Am. Chem. Soc.*, *Angew. Chem. Int. Ed.*) are encouraged to contribute general summaries, of no more than 200 words, and an image to David.

A most unusual semester

Empty teaching spaces were commonplace as educators around the world adapted their teaching and pastoral care rapidly in response to the challenges brought about by the coronavirus pandemic during the first half of 2020. In this article, the academic members of the Chemistry Education and Communication Theme from the School of Chemistry, University of Sydney, reflect on the challenges and successes over the course of a most unusual semester. They discuss the specific tools and techniques they employed in light of the available literature, across the range of modes in which they teach, including lectures, tutorials and the laboratory. As the challenges for teaching are far from over, they hope their experiences and lessons learned can offer some assistance to others (George-Williams S., Motion A., Pullen R., Rutledge P.J., Schmid S., Wilkinson S. *J. Chem. Educ.* 2020, 97, **9**, 2928–34).

Transitioning to university during COVID



A contribution in the *Journal of Chemistry Education* special edition describes the Monash University first year chemistry team's experience of teaching in semester 1, 2020 in the face of the COVID-19 pandemic. Within one week they went from preparing to deliver a well-planned and developed blended learning experience including face-to-face active learning workshops, small-group tutorials and a wet lab program, to being forced to move the entire program online rapidly. This forced them to improvise solutions in trying circumstances to deliver emergency remote teaching to first year students. The students never had the opportunity to set foot on campus, which raised specific challenges for how to support the student transition to university. The article describes what the teaching and learning delivery consisted of, and how the chemistry team elicited continuous student feedback to respond to their needs throughout the semester. The article also gives insights into both the academic and student perceptions of the semester, and reflects on what was learned and will inform teaching and learning experience in the future (Kyne S.H., Thompson C.D. *J. Chem. Educ.* 2020, **97**(9), 3381–5).

Virtual laboratory classes at Bond University

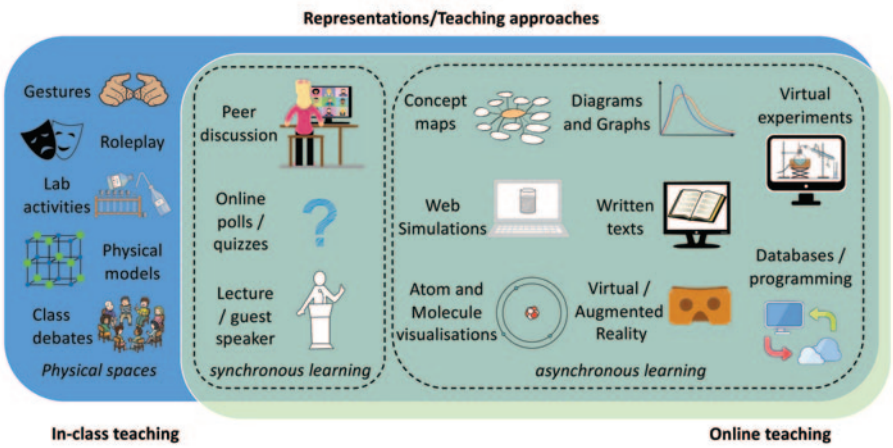
Teaching during the 2020 disruptions of the COVID-19 pandemic has pushed higher education to a new level of technology-enhanced education. The ability for educators to take time and reflect on their teaching and to evaluate the successes or shortcomings of new teaching models is essential. With a rapid response move to remote education late in semester 1, Bond University, like many universities, reacted quickly to the evolving needs of students. This and other issues are discussed in this article (Schweiker S., Levonis S.M. *J. Chem. Educ.* 2020, **97**(*9*), 2863–5). Since this publication, Bond University has moved into a new delivery model with multimodal education at the forefront. The delivery of every class and every assessment needs to be tailored to both online and face-to-face students, while ensuring a quality experience of education. This has resulted in the development of many online resources, and in particular virtual laboratory classes, tailored to our students. Student feedback has been very positive and supportive for our new teaching models.

Converting a physical chemistry unit to online course

The COVID-19 pandemic presents many challenges for society. The lockdown measures that were put in place in Australia during 2020 meant that chemistry academics had to think quickly to convert their units into an online mode of delivery. Many different strategies were implemented across Australian institutions. At the University of Western Australia, a team of academics converted a first-year physical chemistry unit into an online unit in a two-week period (Wild D., Yeung A., Loedolff M., Spagnoli D. *J. Chem. Educ.* 2020, **97**(9), 2389–92). Online conferencing software such as Zoom and Blackboard Collaborate were used for lectures and tutorials. However, the biggest challenge was providing an online laboratory experience. With the help of the technical staff, recordings and photos of experimental observations were made and experimental data was provided to students. Laboratory demonstrators provided online drop-in sessions to help students with data analysis or assessment questions. Students still lacked the crucial technical skills from the laboratory. Therefore, laboratory boot camps were scheduled when the lockdown restrictions eased in the semester break.

Supporting pre-service teachers online

In March 2020, the World Health Organization declared COVID-19 a global pandemic. Responding to this, universities reacted quickly by shifting classes online. Some Victorian academics perceived this shift as a timely opportunity to reflect on how they could develop pre-service teachers' technological pedagogical content knowledge (TPACK) by modelling it in their practice at three universities in Victoria. Through the lens of chemistry teacher educators, they report on this transition as they were faced with redesigning units and methods of delivery for undergraduate and graduate pre-service chemistry teachers. They present these reflections as vignettes demonstrating common themes that emerged from the experiences, including reframing challenges as opportunities, purposeful decision making, explicit modelling of TPACK, and the opportunity to apply knowledge in teaching practice. These themes have been used to develop recommendations for other chemistry teacher educators who may also find themselves reflecting on their TPACK as they support pre-service teachers in an online environment (Carpendale J., Delaney S., Rochette E. *J. Chem. Educ.* 2020, **97**(9), 2534–43).



Compiled by **Reyne Pullen** MRACI CChem (r.pullen@unsw.edu.au). This section showcases exciting chemistry education research carried out primarily in Australia. RACI members whose recent work has been published in prominent chemistry education journals (e.g. *Chem. Educ. Res. Pract.*, *J. Chem. Educ.*, *J. Res. Sci. Teach.*) are encouraged to contribute general summaries, of no more than 200 words, and an image to Reyne.

Who owns CRISPR-Cas9?

iStockphoto/wildpixel

Nobel Prize in Chemistry stokes patent dispute

The ongoing intellectual property ownership dispute over the CRISPR-Cas9 technology has recently been refuelled by the awarding of the Nobel Prize in Chemistry 2020.

BY **BRITTANY HOWARD**

Dr Jennifer Doudna of the University of California, Berkeley (UCB), and Dr Emmanuelle Charpentier, formerly of the University of Vienna and now the Max Planck Institute, are the joint 2020 Nobel Prize laureates in chemistry 'for the development of a method for genome editing'. The announcement of the Nobel Prize in Chemistry 2020 is well-deserved acknowledgement of the significant advances of Doudna and Charpentier in the field of genome editing utilising CRISPR-Cas9 technology. It's particularly momentous when you consider that, previously, only five women had been awarded the Nobel Prize in Chemistry: Marie Curie (1911), Irène Joliot-Curie (1935), Dorothy Hodgkin (1964), Ada Yonath (2009) and Frances Arnold (2018). Also, it is the first occasion on which two women have been jointly awarded a Nobel Prize in any science category.

But there might be more to it: the awarding of the Nobel Prize in Chemistry 2020 may also be considered a political statement of sorts. For almost a decade, UCB has been locked in a patent battle with The Broad Institute ('Broad'), home to another CRISPR forerunner, Dr Feng Zhang, over the ownership of the CRISPR-Cas9 technology. By exclusively attributing the development of a method for genome editing to Doudna and Charpentier, the highly revered Royal Swedish Academy of Sciences has, in the most public of forums, made clear who it considers to be the original developers of the technology.

After initially meeting at a science conference in Puerto Rico in 2011, Doudna and Charpentier bonded over their shared research interest in the CRISPR systems. Charpentier had recently published a *Nature* paper describing the type II system (CRISPR-Cas9). It was to be the start of a collaboration that would culminate in their seminal 2012 *Science* paper, which demonstrated that an RNA-guided protein, Cas9, is capable of reading genetic information on CRISPR sequences and subsequently using that information to identify and destroy viral DNA. Even further, their work showed that the RNA could be engineered to target any gene, highlighting the unique ability of the CRISPR-Cas9 system to act as an elegant tool for precisely adding or deleting specific strands of DNA, effectively editing DNA in vitro.

Zhang, together with his team at Broad, published a subsequent paper in the same issue of *Science*. The paper described the refinement of the CRISPR-Cas9 technology, exemplifying its particular application in eukaryotes. Mere weeks later, Doudna published a paper about the ability of CRISPR-Cas9 technology to edit genes in animal cells.

It is the demonstration of this particular application in eukaryotes that forms the basis of the ongoing claims to ownership rights of the intellectual property encompassing the technology.

In 2012, UCB filed its patent directed to the use of the CRISPR-Cas9 technology for gene editing. The application of the technology in prokaryotes and in vitro was detailed, but the application potentially allowed for uses beyond prokaryotic or in vitro environments.

However, in 2013, Broad filed its patent directed to the use of the CRISPR-Cas9 technology specifically for gene editing in eukaryotes, which was supported by examples of DNA editing inside mouse and human cells. Broad successfully applied for Track One status, meaning its patent application effectively jumped ahead of UCB's application in the examination queue. Consequently, Broad received the first issued US patent to the use of CRISPR-Cas9 technology in gene editing in eukaryotic cells in April 2014. UCB's patent application remained in the examination queue. In essence, despite UCB being the first to file its patent applications, the Broad patent was preferentially issued.

Broad's issued patent represented a highly valuable commodity in the commercialisation of the CRISPR-Cas9 technology in a range of applications in biotechnological, pharmaceutical and agricultural fields.

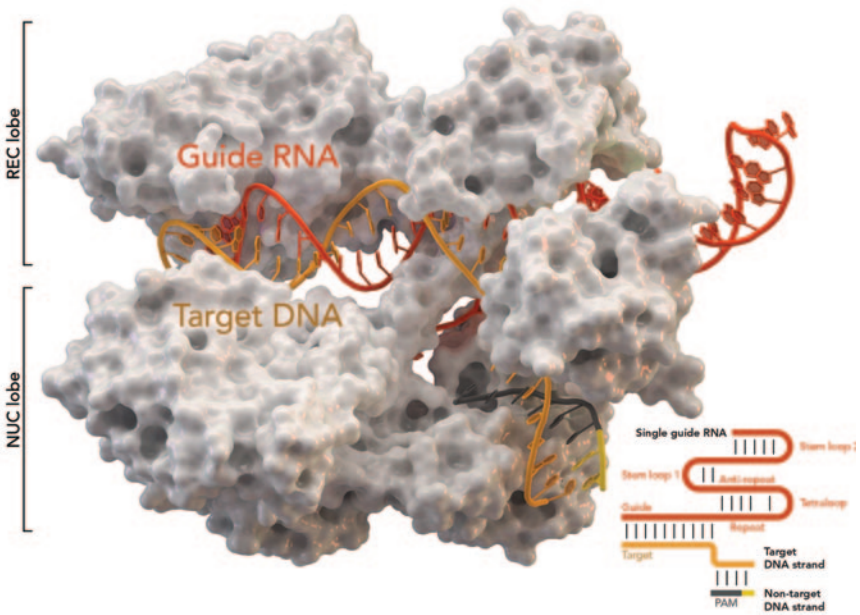
At the time both applications were filed, US patent law was founded on the 'first to invent' principle. This meant that, in the instance of two or more patent applications claiming the same or substantially similar subject matter, regardless of when a patent application was filed, entitlement to the invention flowed to the first to have invented the claimed technology.

A party could challenge an Applicant's entitlement to a claimed invention by filing interference proceedings. The purpose of the proceedings would be to establish which party first invented the claimed invention. Accordingly, to challenge the grant of Broad's patent, UC launched interference proceedings before the US Patent Trial and Appeal Board (PTAB), asserting that Doudna and Charpentier were the first to invent the CRISPR-Cas9 technology. Essentially, they argued that Broad had 'interfered' with UCB's patents in that Broad was not the first to invent the claimed invention.

In its arguments, UCB claimed that Doudna's work acted as a platform for Zhang's work – Doudna had indeed anticipated that the CRISPR-Cas9 technology would find application in eukaryotic cells, and was therefore the first to invent the technology.

In rebuttal, Broad's argument was three-fold.

First, the inventions cannot be considered the same because UCB's is directed to the use of the technology in prokaryotes/in vitro, and Broad's is directed to the use of the technology in eukaryotes. Further, the UCB patent application did not teach how the technology could be adapted from a prokaryote/in vitro environment to a



The crystal structure of CRISPR-associated protein Cas9 (white) from *Staphylococcus aureus*, based on Protein Data Bank structure 5AXW (Nishimasu et al., rcsb.org/structure/5AXW).
Thomas Splettstoesser

eukaryote environment, and Broad argued that it needed to overcome a significant amount of difficulties in order to apply the technology in eukaryotes. Ultimately, it is therefore a different invention from that of UCB's patent application, and therefore Broad cannot be considered to have interfered with UCB's patents.

Second, even if the UCB patent application is considered to extend to eukaryotic applications, Zhang was the first to invent the application of the technology in eukaryotes, having worked on the technology since February 2011.

Third, Broad claimed that Cas9 itself is a naturally occurring protein, and therefore does not meet the criteria of patentable subject matter. In contrast, Zhang's application in genome editing of eukaryotic cells is more than mere discovery, and constitutes patentable subject matter.

Initially, no firm decision as to interference was made by the judging panel. UCB and Broad were therefore presented with three options. On the one hand, if Doudna was found to be the first inventor, UCB would effectively be entitled to Broad's patent. On the other hand, if Zhang was found to be the first inventor, Broad would maintain its issued US patent. As an alternative, Doudna and Zhang could be recognised as co-inventors.

Eventually, the PTAB decided in 2018 that there had been no interference-in-fact. The decision was centred on the finding that UCB's patent application and Broad's issued patent were directed to two, separate inventions. The reasoning for this is that while UCB's application may have suggested that CRISPR-Cas9 could be used in environments other than prokaryotes/in vitro, such as a eukaryote environment, the PTAB decided that it would not have been obvious to do so. That is, Broad's patent application is inventive in its own right.

UCB appealed the decision and, after the latest round, the PTAB found in September 2020 that Broad maintains ownership of its patent. However, the saga remains ongoing, with the PTAB requesting that UCB present additional evidence that it had demonstrated CRISPR-Cas9's application in eukaryotic cells prior to Broad.

The ongoing dispute highlights the potential commercial value of intellectual property. Indeed, many companies have since been founded on the CRISPR technology.

The patent battle is not isolated to the US. Proceedings are also underway in most major jurisdictions, including before the European Patent Office and the Australian Patent Office.

The dispute has turned nasty, extending beyond the US Patent and Trade Marks Office. President and Founding Director of The Broad Institute, Eric Lander, penned a 2015 *Cell* article titled 'The heroes of CRISPR'. Lander subjectively claimed that Broad scientists developed the CRISPR-Cas9 technology, a statement that diminished the efforts of Doudna and Charpentier. Three scientists consequently came forward to dispute several key facts in the article, forcing Lander to later add 'clarifications'. In response, biologist Michael Eisen of UCB claimed the article was 'science propaganda at its most repellent', and was among many to call for its retraction. At an extreme, it was claimed the article was a man's attempt to 'write women out of CRISPR' (bit.ly/3579Ysp). The Twitter hashtag #landergate was born.

The ongoing dispute highlights the potential commercial value of intellectual property. Indeed, many companies have since been founded on the CRISPR technology. Exclusive licenses of the UCB patents have been granted to at least Caribou Biosciences Inc., Intellia Therapeutics, ERS Genomics, Casebia Therapeutics and CRISPR Therapeutics AG. Similarly, Editas Medicine is associated with Broad's patented technology.

Ironically, during this dispute of almost decade in relation to ownership, the commercial value of those originating patents is diminishing. With neither party able to fully capitalise on the originating technology, ongoing scientific work has since established a series of other, commercially relevant, CRISPR systems, including CasX, CasY, Cas12 and so on.

The ongoing intellectual property ownership dispute of the CRISPR-Cas9 technology has undoubtedly detracted from the science at its core – a novel, revolutionary technique for gene editing.

The awarding of the Nobel Prize in Chemistry to Doudna and Charpentier is, undeniably, a refreshing reminder of scientists doing science for science's sake. Doudna and Charpentier, together with their team, have irrefutably made significant contributions to CRISPR-Cas9 technology and the scientific community's understanding of genomic editing. Their research has spurred, and will continue to spur, further innovations in the field.

Brittany Howard MRACI CChem is an Associate at FB Rice. For more about the Nobel Prize in Chemistry 2020, see page 6.

Women awarded the Nobel Prize in Chemistry

2020

Emmanuelle Charpentier and Jennifer Doudna
'for the development of the method of genome editing'

2018

Frances Arnold (with George Smith and Gregory Winter) 'for the directed evolution of enzymes'

2009

Weizmann Institute of Science

Ada E. Yonath (with Venkatraman Ramakrishnan and Thomas Steitz) 'for studies of the structure and function of the ribosome'

1964

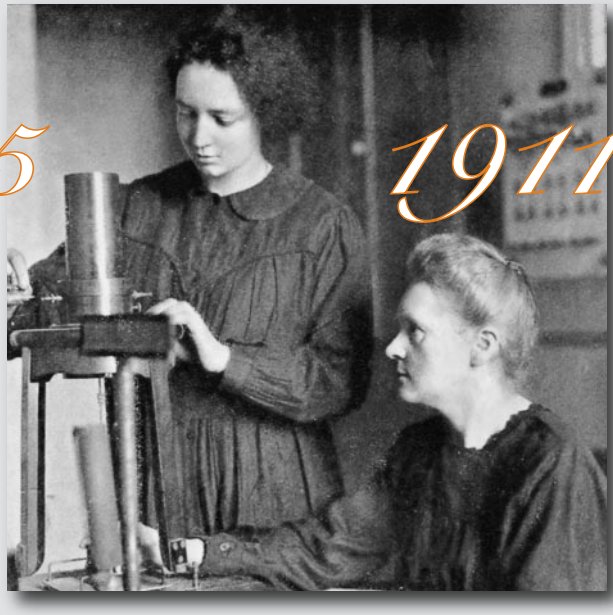
Dorothy Hodgkin
'for her determinations by X-ray techniques of the structures of important biochemical substances'

Godfrey Argent, bromide print, 14 November 1969.
© National Portrait Gallery, London. CC BY-NC-ND 3.0

1935

Irène Joliot-Curie (with Frédéric Joliot) 'in recognition of their synthesis of new radioactive elements'

1911



Marie Curie
'in recognition of her services to the advancement of chemistry by the discovery of the elements radium and polonium, by the isolation of radium and the study of the nature and compounds of this remarkable element'

iStockphoto/Visual Generation

BY **COLLEEN FLAHERTY**

There's a movement for better posters at science conferences. But are they really better? And how does poster push relate to the ongoing campaign for open science?

Hey science, your posters stink. Mike Morrison, a PhD candidate in organisational psychology at Michigan State University, is way too polite to say it that way. But that's the implicit message behind his #betterposter campaign for less cluttered, more user-friendly scientific conference posters.

If you've ever been to the poster hall at an academic conference (typically in the bowels of some big city chain hotel), you know what Morrison's talking about: rows and rows of giant boards alerting passers-by to the newest research in the field. These posters are supposed to serve as jumping-off points for scientists to discuss their work and – as Morrison tells it – efficiently convey new insights to someone navigating the hall in an hour or less.

The typical conference poster, which is long on information and short on design, fails on both points, Morrison says. That's because an eager scientist usually asks if you have any questions before you've even started to read the darn thing, taking up much of that hour. And the tiny print on all the remaining posters makes them impossible to skim before you've got to run off to some panel, interview or meet-up.

'The cardinal sin of every poster I've seen, including the posters I've designed myself, is that they assume people are going to stand there and read our posters in silence for 10 straight minutes, following the order of the sections we've laid out,' he says in a YouTube #betterposter video (bit.ly/3bPFBaQ) that's been seen more than 224 000 times.

Morrison thinks there's a better way, and that it looks like some version of the one shown.

The #betterposter template boils down the conference poster to what Morrison thinks are the essentials: a main finding, in big type and plain language; an 'ammo bar' of data for presenters to use while they're talking to conference attendees; and a 'silent presenter' bar with bullet points introducing the study, its methods and results.

Follow the template and you'll achieve the big three conference poster goals, Morrison says: maximise insight transmitted to attendees, keep it easy to make and include what people 'need to know', not necessarily what's 'nice' for them to know.

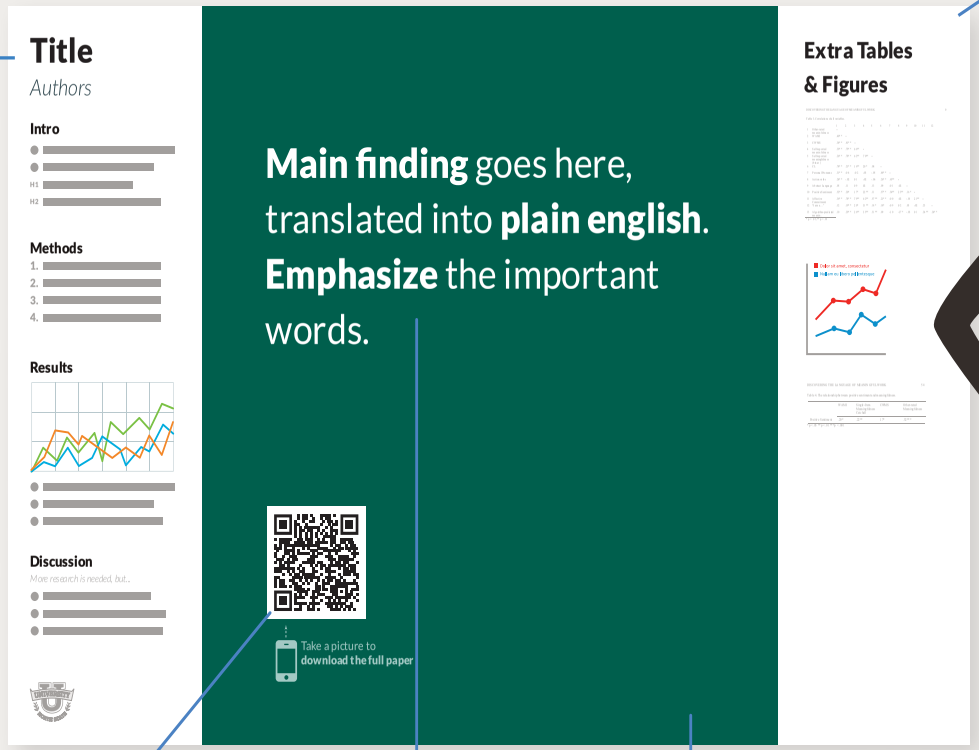
Morrison advises topping it all with a QR code linking to a full version of the study and a copy of the poster. He assures followers that this kind of code

Anatomy of a #betterposter.

Silent Presenter Bar

Concentrated summary of your intro, methods, and results that can be skimmed in 1-5 minutes. Located intentionally far away from the presenter's personal space. For when an attendee wants more detail but the presenter is busy (or they just don't feel like interacting).

WHY: Centralizing and succinctly summarizing the study details in a single column is fast & easy to scan without having to hunt around the poster for each section.



Ammo Bar

For all the figures and tables that you feel like you need to be able to point to if somebody asks you a hard question. Leave it messy! It's just for you to reference.

WHY:

1. Lets you get the worries out of the way, so you can focus the rest of the poster on clearly communicating the need-to-know info to attendees.

2. Keeps the detail you need for questions closest to where you're standing, so you don't have to reach across the poster and block the view.

QR Code to full paper

Point your phone camera at this and instantly download the full paper, a copy of the poster, the presenter's contact details...and/or even the data-set powering the study.

Main finding

The key 'takeaway' of the study is central, translated into plain english. Research on usability writing suggests that casual language is interpreted faster than formal language.

Focus area

Hardly "wasted", negative space maximizes signal-to-noise ratio and helps attendees quickly find the takeaway.

is 'stupidly easy' to make and will better serve conference attendees who take pictures of posters.

The bigger picture

Scientific posters are actually what Morrison calls the 'lowest-hanging fruit' in his bigger agenda to make science more efficient. (He's published another YouTube video of a talk on that topic (bit.ly/359Q9yI).) He thinks it's unbelievable – even negligent – that it takes up to two years to see an article published. And he thinks it's just as bad that information typically sits behind a journal paywall upon publication, instead of being shared freely. In this sense, Morrison is butting up against a culture clash between those who would keep science among institutionally affiliated colleagues and those who believe that science is a public good. He knows that, but he's undeterred.

Morrison's own past as a web developer specialising in user experience makes him especially sensitive to inefficiency. If it takes too long to load something when you're designing a website, it means lost clicks, he said in a recent interview. But in science, it can mean life and death.

'The cardinal sin of every poster I've seen ... is that they assume people are going to stand there and read our posters in silence for 10 straight minutes, following the order of the sections we've laid out'.

'I'm not just talking about curing cancer faster. I'm talking about curing every disease faster. And solving poverty and hunger faster. And reaching the stars faster. Those are the stakes, and that's the opportunity.'

Of the conference poster, in particular – an admittedly small piece of the puzzle – Morrison said, 'It's a bottleneck to learning within science. So if we can improve the learning efficiency of that common design, even by a tiny bit, we can uncork the bottleneck and create massive ripple effects across science.'

Morrison has seen accolades across academe for his design. A simple search for #betterposter on Twitter turns up praise from scientists who have tried it and seen positive results, or from those who plan to. Scientists are trained to be critical, so the response has been 'overwhelmingly positive', he said, noting that some fellow scientists have won 'top poster' nods at their conferences using his template.

Criticism

Morrison also has detractors. Criticism centres on his past assertions that scientists don't think enough about design, because they're not trained designers, as many scientists have previously offered thoughtful suggestions on how to poster design.

Others say Morrison's approach is too extreme.

Teomara Rutherford, assistant professor of educational psychology at North Carolina State University, said recently that the #betterposter movement 'would be great if it got people talking about design and being thoughtful about how design principles could be used for their individual posters, but that's not what has happened.' Instead, she said, 'people have been very quick to adopt an untested format on the recommendation of a splashy video.'

Just as Morrison is predisposed to thinking about the user experience and efficiency, Rutherford – whose research focuses on educational technology – is predisposed to a certain kind of scepticism.

'There are a lot of complaints about ed tech being a solution from outside of education that is often plopped into classrooms and expected to solve all manner of issues,' she said. And many researchers 'now recognise that we first have to understand the needs, experiences and existing skill levels of teachers and students and work with them to find technology solutions that fit within the context'.

In other words, Rutherford wants more research on whether #betterposters are, in fact, better. That discussion has to start with the goals of poster sessions, and with a better understanding of attendees and presenters alike, she said. Morrison has talked about the role of poster design in information retention, for example Rutherford said, but retention hasn't been an aim of any poster session she's attended.

Guessing that the likely goal of a poster session is engagement with scholars who are 'highly knowledgeable and motivated about a very specific topic', Rutherford said they will want to see and talk about data and methods in depth. And while it may be difficult for conference-goers to find the five or 10 relevant posters in a crowded hall, she added, 'we might be able to solve that just with better titles'.

Further research questions on better posters might include, 'How should we present data and text to aid in scientific discussion?' Rutherford said, and, 'What is the flow of a general academic elevator speech about the study and how does the poster layout match with that?'

Morrison said that a recent comprehensive literature review found no evidence for posters' efficacy as a tool for knowledge transmission. He also underscored that the template is based on research on user experience design.

An exit survey of attendees at a

recent conference of all #betterposters found that 68% of attendees preferred even a plain #betterposter layout to the traditional poster design, Morrison noted. Still, he's planning on multiple additional tests and side-by-side comparison of multiple formats at a conference next year. The idea is to see what works best, not just whether the current #betterposter template works.

'It's been tricky to get scarce conference real estate reserved for pure experimenting just logistically, but we now have organisers from virtually every field ready to help,' he said. 'Ultimately, we are planning to test specifically for learning outcomes and attention directly.'

Martin H. Trauth, a geoscientist at the University of Potsdam in Germany who has written about science communication, including the scientific poster, said a poster is really a 'teaser to attract people that are not exactly working in your area. The ones that eventually help you to move forward, because they have some overlapping knowledge and interest.'

To attract that audience, he said, 'your poster needs to be beautiful, with a very short and attractive, meaningful title', something like the main conclusion of the #betterposter design.

'You stand next to the poster, smiling, and you start communicating with your possible future collaborator,' Trauth said. If you're not there, the poster should also work. That's 'why we need content, but not too much, nice and simple'.

Trauth said that he supports a movement towards better posters, 'in principle'. In his graduate course on science communication, for example, he asks students to review 10 posters and guess which won awards. There is a typically little consensus. In reality, all have won some kind of award and none, in Trauth's estimation, is really great. That's in part because awards tend to assess content, not design, he said.

Of #betterposter, in particular, Trauth said that users' examples show that they are still putting too much information on their boards, but now also 'wasting a lot of space on a central statement'. That means there is much less space for 'real content', he said.

Try it first

Morrison's response to his critics? 'Please try it before you knock it.'

'If it's too extreme for you and you find yourself missing certain elements,' he said, 'then add them back for the next conference. Start from scratch and add up. Don't start from everything and boil down.'

Morrison added, 'I can guarantee that you'll learn something about what works and doesn't from trying the #betterposter layout, whether you decide to scrap it or not.'

So far, Morrison has just talked about the need for better posters in science. But many fields outside the natural sciences use posters, too. And academics in some of those fields have previously thought about how to make those posters better.

Colin Purrington, a professor of biology at Swarthmore College who has written about posters, said the design problem is compounded because PowerPoint templates are passed on through departments. There's typically a 'poster person' who has a template that everyone seems to use, he explained. And that poster is 'invariably bad, with 'no emphasis on good design, such as pleasing use of white space and graphics'.

Then, he said, disciplinary societies and conference organisers 'choose one of these dense templates to push onto conference attendees, for decades. The result in most sciences and non-sciences is conferences are full of posters that are unreadable. It's really hard to undo a template in a field once it has been posted on a meeting site. Like a mutation, it's there until the person dies.'

Purrington said that he used to advise adding QR codes to posters, but that the idea didn't really take. In general, though, he said, 'posters in all disciplines would benefit from fewer words and especially fewer logos'.

'I wish conference organisers would just enforce a word limit – 500 words max, for example, might counteract the innate tendencies for academics to overshare. One can always hope.'

Colleen Flaherty is a faculty correspondent for InsideHigherEd. First published at insidehighered.com.

2020 RACI National Awards winners

Leighton Memorial Medal

The academic career of **Paul Haddad** FRACI CChem spanned Australian National University, and the Universities of NSW and Tasmania, where he is currently an Emeritus Distinguished Professor of Chemistry. He served as Dean of Science for 10 years, was Foundation Director of the Australian Centre for Research on Separation Science and Director of the Pfizer Analytical Research Centre.

Paul's research interests cover most areas of the theory and practice of liquid chromatography and capillary electrophoresis, particularly ion chromatography. He has more than 550 publications and three books in these areas and has presented more than 700 papers at local and international scientific meetings. He is a Fellow of the Australian Academy of Science and of the Australian Academy of Technological Sciences and Engineering.

He was editor of *Journal of Chromatography A*, contributing editor for *Trends in Analytical Chemistry*, and an editor of *Analytica Chimica Acta*. He is currently a member of the editorial boards of 10 other journals of analytical chemistry or separation science. He has served as Chair of the Analytical Chemistry Division and the Tasmanian Branch.

Paul has received a number of international awards; a Eureka Prize for Outstanding Research in Safeguarding Australia (as a member of Team Greyscan); the RACI HG Smith and Analytical Division medals, Applied Research Award and Archibald Olle Prize; the inaugural Tasmanian Premier's Scientist of the Year Award; and the inaugural University of Tasmania Vice-Chancellor's Medal for Research Excellence.

Applied Research Award

The research done by Professor **Michael Kassiou** FRACI CChem is interdisciplinary and built around medicinal chemistry and drug discovery. He has a unique and diverse background spanning chemistry, pharmacology, molecular imaging and clinical translation. Kassiou leads an extensive medicinal chemistry program evaluating structure–activity relationships of a number of small molecules that interact with specific targets associated with brain disease. In addition, his innovative use of in vivo molecular imaging, specifically position emission tomography, allows not only the rational design of more efficacious treatments but also the ability to evaluate drug efficacy and monitor disease progression in humans.

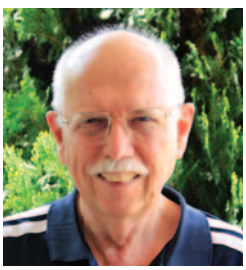
Michael's research program has seen three new compounds progressed to first-in-human studies for the imaging of neuroinflammation in a variety of central nervous system disorders. Also, in the last five years, together with his co-workers, his innovations in small molecule therapeutics has resulted in the formation of spin-off companies Kinoxis Therapeutics, Nexcan Laboratories and ProKardia Therapeutics, which he hopes will provide novel treatments for diseases of the brain.

Michael is Academic Director of the University of Sydney Drug Discovery Initiative, is a Fellow of the Asian Federation of Medicinal Chemistry and the Royal Society of Chemistry, and is immediate past Chair of the Medicinal Chemistry and Chemical Biology Division of the RACI.

Cornforth Medal

Vincent (Eddie) Zwicker MRACI, ECC completed his BSc at the University of Regensburg, Germany, in early 2014. He moved to the University of Sydney on a DAAD scholarship to complete his Honours year in chemistry under the supervision of Kate Jolliffe. In 2015, he was awarded an International Postgraduate Research Scholarship to undertake his PhD with Jolliffe and Elizabeth New, working on novel anion binding motifs, fluorescent sensor arrays for nucleotide phosphates, and fluorescent probes for the detection of phosphatidylserine on the cell membrane surface. After a postdoctoral appointment in the same research groups, he moved back to Germany in mid-2020 where he accepted a role as an application scientist at ACD/Labs.

Distinguished Fellowship



Gary Golding FRACI CChem worked at Queensland Health Forensic and Scientific Services (QHFSS) for 42 years from 1971. During this time, he became the Managing Scientist of all the chemistry laboratories at QHFSS.

Gary completed a Graduate Diploma in Chemical Analysis (QUT), a Master of Science in Analytical Chemistry (QUT) and a Master of Business Administration in Technology Management (Deakin University). He served on many state government committees, including those involved in the assessment of contracts for cleaning chemicals and textiles, drugs and poisons regulation, counterterrorism, and chemical warfare agent analysis.

Gary was a foundation member of a team of volunteer on-call chemists who attended chemical emergencies in Queensland to advise the Queensland Fire and Rescue Service. He received Australia Day medallions as recognition for this activity and in recognition for services to chemistry.

Gary served as president of the Queensland Branch for two years (2007–2008) and was on the Queensland Analytical and Environmental Group for about 20 years with several years as Chair and Secretary. He also served on the RACI National membership committee.

Jenny Sharwood OAM, MACE, FAIE, FRACI CChem has spent a lifetime as a chemistry educator, consultant and author. As well as having taught chemistry for almost 30 years, she has undertaken many writing, reviewing and consultative commissions with the Victorian Curriculum and Assessment Authority, written more than 20 books and many other print and online resources for students and teachers for educational publishers, ATSE and the Curriculum Corporation, and presented at many teacher workshops at conferences.

She is Chair of the Victorian Chemical Education Committee and a lead writer for the Australian National Chemistry Quiz. She recently presented a webinar to more than 1000 chemistry teachers in 12 different countries. She also is a member of the Victorian Branch Committee and of the national education committee, and is actively involved in the Victorian Titration Competition. Jenny has presented many teacher workshops on behalf of RACI and contributed many articles and other resource materials to *Chemistry in Australia* and the RACI website. She has been an invited guest speaker at two Women in Chemistry events and at a virtual luncheon of the Retired Chemists Group.

Jenny was awarded the Medal of the Order of Australia for her services to secondary education in June 2017. In 2019, the Chemistry Education Association named Jenny as the Chemistry Educator of the Year in recognition of her dedication and service to chemistry education for more than 50 years.

Fensham Medal for Outstanding Contribution to Chemical Education

Professor **Richard John** FRACI CChem is a recognised leader in STEM education in Australia, and his influence and contribution spans all levels of education, from pre-K to university.

He is the project lead for the Queensland STEM Education Network – and leads two other STEM education initiatives at Griffith University: the Griffith Science Education Alliance and Science on the GO!

He has more than 60 research publications in international peer-reviewed journals and is a named inventor on two patents and his work has led to the commercialisation of four analytical monitoring systems. He has taught undergraduate chemistry for more than 20 years, is the author of a foundation year chemistry textbook, co-author of two senior-school chemistry textbooks, and author of two early reader series.

Richard has held teaching and research positions at the University of Oxford, the University of Wollongong, the Smithsonian Institute and Griffith University.

Richard is a past Chair of the Electrochemistry Division. He has won numerous prestigious awards and fellowships for his contributions to science and science education. He is the Head of Chemistry and a former Dean (Learning and Teaching) at Griffith University.

H.G. Smith Medal

Courtesy University of Western Australia

The work of Professor **Paul Low** FRACI CChem has criss-crossed boundaries, covering topics from studies of the synthesis and reactivity of metal-coordinated acetylides, vinylidenes and carbon chains, to the chemistry of OLED materials, as well as the structure and dynamics of pheneylene(ethynylene) oligomers. Much of his most recent work has been directed towards studies of electron-transfer processes and conformational dynamics within mixed-valence complexes, and the design of compounds to explore structure–property relationships within single-molecule and 'large area' molecular electronic systems.

Overall, Paul's work is characterised by the application of physical methods and a diverse range of spectroscopic techniques in concert with density functional theory calculations to explore fundamental properties of bespoke molecular systems from the gas phase to solution to ordered monolayer films. The multidisciplinary nature of Paul's studies has led to productive collaborations with many groups across the world, and which continue to drive and expand his research interests.

Paul is at the University of Western Australia. Paul's work has been supported and recognised through the award of major research fellowships from the UK EPSRC (Leadership Fellowship 2009) and the ARC (Future Fellowship 2012). He was awarded a Friedrich Wilhelm Bessel Research Award by the Alexander von Humboldt Foundation (2015) and received a DSc for his work from his alma mater in 2019.

Margaret Sheil Leadership Award

Professor **Danielle Skropeta** FRACI CChem is a highly respected researcher and teacher in organic chemistry, and a leader across the fields of science and medicine. She is committed to gender equity, and equity of representation for Indigenous researchers and knowledge.

At the University of Wollongong, Danielle has been working towards improving equity and diversity across the university. Among her achievements in this area are driving gender-balanced speaking programs that encompass all career stages in conferences she chairs along with assisting participants with childcare options, as well as developing a new student exchange program with Groningen University in the Netherlands, to help future students create global connections when travel pathways re-open.

She has been an active contributor on both the VC's Workplace Diversity Reference Group and as a member of the Athena Swan Self-Assessment Team and speaks at career events for women.

She is a formal mentor in University of Wollongong's Early Career Researcher mentor program, and is passionate about helping students and young researchers to establish their own mentor relationships, by running tutorials on effective mentoring relationships.

Danielle is also involved in Jindaola, an initiative that embeds Indigenous knowledge into the university's curriculum.

Masson Memorial Award

Laura Wait (Student) is a self-motivated and hard-working aspiring scientific researcher with a special interest in biological/medicinal chemistry. She has an intense passion for helping people and solving challenging issues through science.

Laura graduated from the University of Queensland in 2019 with a BSc (Biological Chemistry (Chemistry/Biochemistry)), with Advanced Study Program in Science requirements. She is currently in her Honours year at the University of Queensland, investigating cholesterol analogues as potential drug leads for tuberculosis in the De Voss lab. Outside of university, she enjoys rock climbing and baking.

RACI Educator of the Year Award

Following an undergraduate science/law degree at ANU with first class honours in chemistry (1995), **Madeleine Schultz** FRACI CChem moved to the University of California, Berkeley, for her PhD (2000). She completed her world tour with a postdoctoral fellowship at the University of Heidelberg before returning to Australia.

She has since worked at three Australian institutions as her research focus moved gradually from doing chemistry to improving the teaching of chemistry. Madeleine's educational research explores improved approaches to support students of all ages to learn chemistry through better understanding of student backgrounds, development of scaffolded online modules and explicit use of multiple representations. In parallel with this, she has a strong background in supporting the professional development of chemistry teachers to use best practice for holistic understanding.

Madeleine founded and directs the Chemistry Discipline Network, a community of practice for tertiary chemistry educators. In 2019, she co-developed the UNESCO-funded Periodic Table of Sustainable Elements outreach activities and was part of a team that brought this event to seven disadvantaged schools in rural and remote Victoria.

Rennie Memorial Medal

Lars Goerigk MRACI obtained his PhD in 2011 in the group of Stefan Grimme at the University of Münster, Germany. He relocated to the University of Sydney to work with Jeffrey R. Reimers before becoming a senior lecturer at the School of Chemistry, University of Melbourne in 2014.

His area of expertise is theoretical and computational quantum chemistry with a focus on density functional theory (DFT) for electronic ground and excited states. His developed methods belong to the most accurate in the field. He used them to provide chemists with new insights into how interactions between molecules affect the outcome of chemical reactions, to suggest an improved way to determine biomolecular structures, to enable more reliable predictions of electronic excitation energies, and to make predictions that assisted the development of novel smart technologies. His work has made a large international impact and will influence how chemists will use DFT in the future.

Lars received a 2014 ARC Discovery Early Career Researcher Award, the 2017 RACI Physical Chemistry Division Lectureship, and a 2019 Le Fèvre Medal (Australian Academy of Science).

Nicholas White MRACI was born in the UK but completed high school and his undergraduate studies in New Zealand. He completed his Honours project at the University of Otago working with Sally Brooker on coordination complexes of triazole ligands. He then moved to the University of Oxford to work with Paul Beer, looking at the synthesis of catenanes and rotaxanes containing hydrogen and halogen bond donors for anion recognition. In 2013, Nick moved to the University of British Columbia as a Killam Postdoctoral Fellow, investigating the self-assembly of supramolecular materials with Mark MacLachlan.

Nick was appointed as a lecturer at the Australian National University at the end of 2015. He is currently a senior lecturer at ANU and leads a small research group investigating fundamental and applied supramolecular chemistry, and teaches inorganic chemistry. Outside of work, Nick enjoys nerding out about coffee and music (especially Bob Dylan and Nick Cave), and is a keen runner and rock climber.

Le Fèvre Memorial Prize (Australian Academy of Science and RACI)

Ivan Kassal MRACI develops new theoretical and computational tools for simulating the dynamics of complex chemical systems, especially those where quantum effects make conventional calculations difficult and time consuming. He has designed both algorithms that would allow future quantum computers to dramatically accelerate the simulation of chemical processes as well as quantum simulators, purpose-built devices for solving particularly difficult problems. His methods have been widely used and implemented experimentally, contributing to chemistry and materials science being recognised as the likely first applications of quantum computers. He has also studied the transport of energy and charge in disordered materials that lie at the boundary between quantum and classical behaviour, making them difficult to describe.

Ivan's contributions have included explaining quantum effects in light harvesting (and how to engineer them to improve performance), discovering significant quantum effects in photosynthesis, and clarifying fundamental mechanisms of how organic solar cells operate.

Ivan is a senior lecturer and Westpac Research Fellow at the University of Sydney.

The following members also received national awards: **Mary Fletcher** FRACI CChem (Distinguished Fellowship) and **Lauren Macreadie** MRACI (Rita Cornforth Lectureship).

NSW award: Archibald D. Ollé Prize

Michael Gotsbacher MRACI is an expert in the analysis of biomolecules, with a strong focus on mass spectrometry (MS)-based methods and with a background in synthetic organic chemistry. Michael's research sits at the interface of synthetic and analytical chemistry and medicine. He has a deep interest in investigating molecular mechanisms, with a special focus on bioactive natural products with hitherto unknown modes of action.

He pioneered an MS-fragmentation technique to unambiguously identify native and non-native isomers of bacterial metabolites; and he is currently developing an MS-based imaging method to visualise drug candidates in post-mortem Parkinsonian brain to elucidate tissue-specific spatial distribution and thus better understand their mode of action.

Michael has published in top-tier journals in the fields of chemical biology and medicinal chemistry. His three most recent first-author publications have featured on the front cover of the respective journal – indicative of the high quality and novelty of his work.

The NSW Branch awarded him the Archibald D. Ollé Prize for his 2019 *ACS Chemical Biology* paper 'Reverse chemical proteomics identifies an unanticipated human target of the antimalarial artesunate'.

Michael is presently a research fellow at the School of Medical Sciences (Pharmacology), University of Sydney. Before this, he worked as project chemist in a NATA-accredited lab.

Two PM's prizes for science for RACI members

Professor Thomas Maschmeyer FRACI CChem and Associate Professor Justin Chalker MRACI CChem have received Prime Minister's Prizes for science.

The $250 000 Prime Minister's Prize for Innovation was presented to Maschmeyer (University of Sydney) for his dual work in developing commercially viable processes to recycle mixed plastics and developing a new low-cost battery technology to store renewable energy.

The $50 000 Prize for New Innovators was presented to Chalker (Flinders University) for his invention of a new class of polymers that turn waste plastics into global sustainability solutions. These include a range of materials that can remove mercury from polluted soil and water, help absorb oil from ocean spills, and provide more effective slow-release fertilisers.

This year's awards presentation was held online: industry.gov.au/pmscienceprizes.

Regulatory and Other Requirements in Drug Development

This new article by RACI NSW Pharmaceutical Science Group Treasurer David Edmonds is now available.

Regulatory and Other Requirements in Drug Development describes how, in conjunction with good and comprehensive science, a knowledge of Therapeutic Goods Administration/ regulatory requirements and guidelines at the earliest stages of drug discovery and development should enhance the quality of the drug development.

To access the article, visit bit.ly/3lPSeXH.

New Fellows

Associate Professor **Colette Boskovic** is an inorganic chemist in the School of Chemistry at the University of Melbourne. She obtained her BSc(Hons) and PhD degrees from the University of Melbourne, undertaking research in the field of polyoxometalate chemistry under the supervision of Tony Wedd. Her PhD was followed by postdoctoral positions with George Christou at Indiana University (USA) and Hans Güdel at the University of Bern (Switzerland), both of which involved research in molecular magnetism.

She returned to the University of Melbourne as a lecturer in 2004 to commence her independent career, establishing a research program under the broad umbrella of 'inorganic molecular materials'. Her research interests lie in the fields of molecular magnetism, lanthanoid chemistry, polyoxometalate chemistry, redox-active ligands, inelastic neutron scattering and switchable molecular materials.

In 2013, Boskovic was awarded the Alan Sargeson Lectureship from the Inorganic Chemistry Division of the RACI and in 2014 she received the Dean's Award for Excellence in Research (Teaching and Research), Faculty of Science, University of Melbourne. She was a visiting professor at the University of Barcelona in 2017 and was awarded an Australian Research Council Future Fellowship in 2019.

Boskovic sits on the International Organising Committees of the Asian Conference on Molecular Magnetism and the Asian Conference on Coordination Chemistry. She was a member of the organising committee for the 2016 International Conference on Organometallic Chemistry (ICOMC)/RACI Inorganic Division Conference in Melbourne. Boskovic is strongly committed to increasing the participation of women in chemistry and this year has served as a guest co-editor of the 'Women in Chemistry II' special issue of the *Australian Journal of Chemistry*. She is also the University of Melbourne's representative on the Australian Institute of Nuclear Science & Engineering (AINSE) Council.

Boskovic first joined the RACI as a student in 1994. She is presently the Chair-Elect of the Inorganic Chemistry Division of the RACI, having served as Victorian representative on the Divisional Committee from 2014 to 2019. She has also taken over from Richard Keene as Divisional Archivist. Boskovic has been active in the Victorian Branch's Inorganic Chemistry Group over many years. After winning the inaugural Bruce West Award for best oral presentation at the RACI Victorian Inorganic Chemistry Postgraduate Symposium as a student in 1995, she has been involved in organising this annual meeting on many occasions since 2004.

Professor **Vanessa Peterson** is a senior principal research and neutron instrument scientist at the Australian Centre for Neutron Scattering (ACNS), where she leads the Energy Materials research project, and an honorary professorial fellow at the University of Wollongong. Peterson specialises in atomic and molecular scale material characterization to understand function, particularly using real-time neutron and X-ray scattering.

Peterson obtained her PhD in 2004 from the University of Technology, Sydney, with the neutron scattering group at the Australian Nuclear Science and Technology Organisation. She expanded her neutron scattering research at the National Institute of Standards and Technology's Center for Neutron Research in conjunction with the University of Maryland (USA), before moving to the University of Sydney in 2006. In 2007, Vanessa joined the ACNS, where alongside colleagues she commissioned the two neutron powder diffractometers.

Peterson has focused her research more recently on materials central to sustainable-energy systems, including battery, fuel-cell, and gas separation technologies, and she has pioneered neutron and X-ray scattering techniques to study these systems.

Peterson's research has been recognised by the 2020 Bob Cheary Award for excellence in diffraction analysis for significant long-term contributions to diffraction analysis; in 2019 by the Australian Neutron Beam Users Award for outstanding research and leadership in neutron science; in 2017 by the Society for Crystallographers in Australia and New Zealand's Sandy Mathieson Medal for distinguished contributions to science involving X-ray, neutron or electron diffraction and/or imaging; in 2013 by the NSW Australian Institute of Policy and Science's Young Tall Poppy Award; and in 2011 as a finalist for the Eureka People's Choice Award.

Peterson was appointed to the International Union of Crystallography's Commission on Neutron Scattering (2017), as Director-at-Large of the International Centre for Diffraction Data (2011–2016, 2018–), for which she is also a technical co-regional chair (2010–) and elected Fellow (2011–), as well as past President (2008–2014) and Vice President (2014–2020) of the Australian X-ray Analytical Association. Vanessa holds formal roles on several international facility advisory teams.

Peterson has co-authored more than 160 publications with 6000 citations and has an *h* index of 43.

She is a happy mum, who enjoys roller derby and rock climbing, and helping others as the Marrickville Group leader of the Australian Breastfeeding Association.

Dr **Brad Sleebs** obtained his BSc (Hons, Chemistry) from La Trobe University in 2001. He was awarded his PhD in organic chemistry under Andrew Hughes from La Trobe University in 2005. He then commenced a postdoctoral position in the Medicinal Chemistry group at the Walter and Eliza Hall Institute (WEHI) and in 2018 he was appointed as a laboratory head in the Chemical Biology Division at the WEHI. He has previously held a lectureship in the Department of Chemistry at La Trobe University and currently holds honorary principal fellow appointments in the Departments of Medical Biology and Veterinary Biosciences at the University of Melbourne.

Sleebs' research focus is on the design and utility of small molecules to investigate novel pathways in disease pathogenesis and the translation of these findings towards and into the clinic in partnership with biotechnology and pharmaceutical companies. In the past he was central to the development of an anxiolytic phase II clinical candidate in association with Bionomics Ltd and in the design of a selective Bcl-xl preclinical candidate in collaboration with Genentech and AbbVie, culminating in the FDA approval of Venetoclax for treating chronic lymphocytic leukaemia. More recently, he leads research in partnership with Servier on the design of immune-oncogenic agents and independently with Merck, Janssen and Medicines for Malaria Venture on the development of novel antimalarials.

Academically, Sleebs has published 60 peer-reviewed journal articles in high-impact journals including *Cell Host Microbe*, *Nature Microbiology*, *Molecular Cell*, *Nature Chemical Biology* and *Natural Structural and Molecular Biology* and has more than 2000 citations. Translationally, he is an inventor on 15 patents, 12 of which have been licensed to commercial partners, protecting work on anxiolytics, Bcl-2 inhibitors, HIV agents and antimalarials. He was recently awarded the La Trobe University Max O'Connor Lectureship and the Ellen Corin Centenary Fellowship in Cancer Therapeutics and was an Australian Museum Eureka Prize finalist.

Sleebs commits his expertise annually to the Australian Society for Parasitology Course and has been actively involved with the RACI for the past 17 years. He has have been a long-serving committee member for the RACI Bioactive Drug Discovery Group (Victorian Branch).

Vale Bruce West

23 January 1928 – 17 October 2020

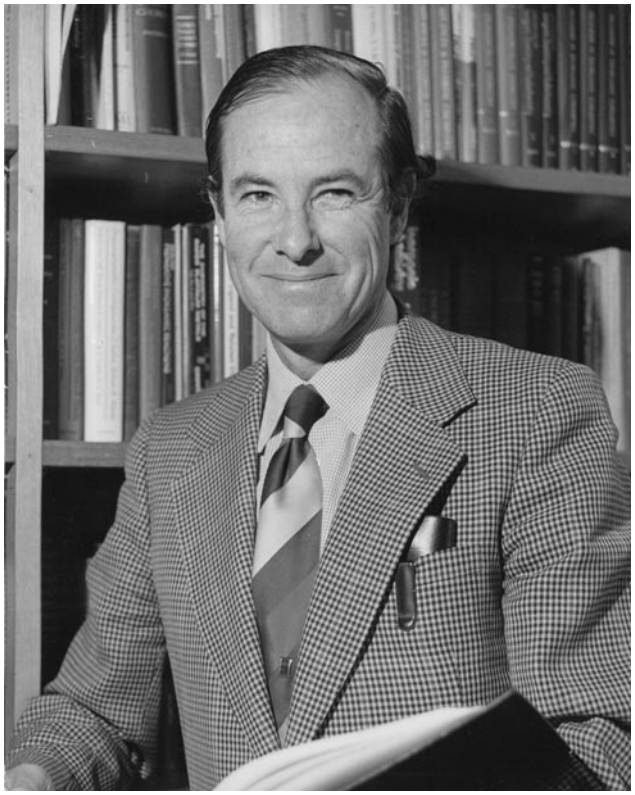
Emeritus Professor Bruce West FRACI CChem, the Foundation Professor of Inorganic Chemistry at Monash University has died aged 92 years, after a long battle with cancer.

At Monash, Bruce built a centre of excellence in Inorganic Chemistry second to none in the southern hemisphere ignited by a fire that had burned since childhood.

Back in 1940, a 12-year-old Bruce watched in wonder as a visiting trainee teacher at his Adelaide school carried out an experiment using Condy's crystals. It was, he later recalled, like watching water being turned into wine. At home he tried to replicate it using his mother's store of potassium permanganate crystals. His experiment failed but it set him on a path to become one of the greatest Australian chemists of his generation.

Bruce came to Monash in 1964 as Professor of Inorganic Chemistry, where he remained for the next three decades. At the time the department was still in its formative years with fewer than 10 academic staff members. He immediately began the task of establishing an inorganic group, which thrived under his thoughtful and creative leadership. His enthusiasm for scholarship and his appetite for new chemical adventures embraced both his teaching and his research, which was characterised by inventiveness and persistence.

His research groups made major advances, particularly in the fields of Schiff base complex chemistry, of which he was a world pioneer, and in the more market-oriented areas of sol-gel technology and metal organic chemical vapour deposition. His work on perfluoroalkyl-organometallic chemistry in the 1955–1980 period was years ahead of its time, coming to later fruition by German chemists in the 1990s. Likewise, his work on polyphosphane and polyarsane chemistry was groundbreaking at the time. He also pioneered Monash's entry into materials chemistry. Bruce and his Monash colleagues were among the first to join in research collaborations with industrial partners and tackle commercially oriented projects. His group was awarded a number of Commonwealth-funded programs in collaboration with Telstra Research Laboratories and BHP involving the synthesis of new organometallic compounds for



Richard Crompton/Melbourne University Archives, IN715

He decided to undertake a PhD, but the problem was that nobody in Adelaide knew enough about the subject matter to supervise his research. So, he supervised it himself.

the preparation of semiconductors. A further special collaboration commenced in 1989 involving the start-up company then known as Silicon Technologies Australia P/L.

As well as a scientist, Bruce was highly regarded for his personal qualities, which included his strong but fair leadership, his thoroughness and attention to detail, his preparedness to tackle less pleasant tasks and his love of the collegiate style of management. He was known for leading with integrity and intellectual distinction. He was an effective mentor, as two former students and two junior appointees rose to professorial status at Monash. Others gained prominence in industry with one becoming Technical and then General Manager of IDT.

Faced by a rapidly growing department, Bruce got heavily involved with the administrative side of University proceedings. He acted as a Member (1966–1982) and Chair (1969–1972) of the PhD and Research Committee; as Deputy Head of the Department (1974); as Associate Dean of Science (1973–1975 and 1986–1988); and as Pro Vice-Chancellor (1976–1982).

Bruce Oswald West was born in January 1928, in Adelaide, South Australia. After his early experiment with potassium permanganate, he rushed out and bought a chemistry set and a few textbooks. His parents' gardening shed became his personal laboratory. His passion led to him studying science at the University of Adelaide, where he graduated BSc in 1949 with first class honours in Physical and Inorganic Chemistry. He started working as a lecturer in the university that same year, due to an unexpected vacancy arising. Despite his lack of teaching experience, his appointment was made permanent a year later.

By this time, he had developed a strong interest in the use of radioactive elements as 'tracers'. He decided to undertake a PhD, but the problem was that nobody in Adelaide knew enough about the subject matter to supervise his research. So, he supervised it himself. His first published paper on exchange reactions with cobalt compounds using radioactive cobalt as a tracer appeared in the renowned journal *Nature* (1950). He was awarded a PhD by the University of Adelaide in 1953.

Bruce realised that if he was to make a career in academia he would have to supervise postgraduate students. Since he did not have the experience of being supervised by a knowledgeable person, he undertook a second PhD, courtesy of a Rhondda Open Research Scholarship at Gonville and Caius College, Cambridge (1953–1955), returning to the University of Adelaide in 1956. He was promoted to senior lecturer (1957) and reader in physical and inorganic chemistry (1962).

In addition to his contributions at Monash, Bruce was elected President of the Royal Australian Chemical Institute (RACI) in 1973, following a period as President of the Victorian Branch of the Institute in 1971. He also played important roles as Chair of the RACI Division of Coordination and Organometallic Chemistry (1970), and as Chair of the Australian Representatives of the Royal Society of Chemistry (1966–1993).

Bruce was awarded the RACI's Burrows Inorganic Chemistry Award (1981) and RACI's Leighton Memorial Medal (1992); the institution's most prestigious award. In 1994, upon retiring from Monash, he was appointed Emeritus Professor. It was a fitting tribute for a man hailed as one of the 'true gentlemen' of chemistry.

Vale Robert (Bob) Douglas Morton

1 June 1943 – 8 November 2019

Bob Morton FRACI CChem was born in Adelaide, schooled locally, before he graduated from Adelaide University in 1964 with a BSc, majoring in Chemistry. He secured his first teaching position at Murray Bridge High School in 1965 and, after marrying his wife Judy in 1967, spent a year teaching in England.

After returning to Adelaide, Bob taught at Unley High, before being transferred to Port Augusta High as a Senior Master, and then Special Senior in Chemistry with a role to travel to schools in the Northern Region supporting science teachers, particularly those in their starting years. The family moved back to Murray Bridge in 1975 where Bob was the Regional Science Advisor and continued his mentoring role. In 1981, Bob was appointed as the Education Department's Chemistry Consultant, before working at the precursor of the SACE board, and Marryatville High School.

Throughout his career, Bob undertook an enormous amount of voluntary work. A long-time member of the South Australian Science Teachers Association (SASTA), he took on the role of president of both SASTA and the Australian Science Teachers Association (ASTA), and was the Education Group Chairperson for both the South Australian Branch and the Chemical Education Division of the RACI.

He was heavily involved with SASTA's Oliphant Science awards and was an instigator in having RACI's Crystal Growing Competition incorporated into the awards. He was consistently one of the judges for the crystal growing entries.

Bob remained on the RACI's Chemical Education Group committee for many years and on behalf of the RACI, he and Judy managed the purchase and distribution of science magazines to schools and libraries across Australia.

In 1998, Peter Schodde wrote an apt description of Bob for the *SASTA Journal* on the occasion of his retirement. 'Bob would be one of the most awarded people in science education across Australia, and justifiably so. He has considerable acumen, and is a canny reader of people and situations. In sum, he is totally genuine – a person of real humanity.'

Bob's contribution to science and chemistry education was enormous and has had a huge influence on chemistry teachers and education in South Australia. He was widely recognised for his contributions through numerous awards, including the SASTA medal, and the ASTA distinguished service award.

He was also deservedly recognised by the RACI, being awarded the Fensham Medal in 2012. In 2009, Bob was made a Member of the Order of Australia for service to science education, particularly chemistry through curriculum development, and as a teacher and mentor through contributions to education and scientific organisations.

Bob Morton presenting a medal to one of the Chemistry merit awardees of 2009 at the ceremony in February 2010.

In retirement, Bob busied himself in a wide range of hobbies and interests, including winemaking, endlessly browsing secondhand books stores, watching his AFL team Essendon, and tutoring year 12 students.

For those who know Bob well, he was a devoted family man, enjoying his grandchildren until the last. Bob is survived by Judy, daughters Catherine and Caroline, and grandchildren Matthew, Harrison, Oliver and Audrey.

Bob's sense of humour was usually subtle and understated. In 1994, following surgery after suffering a heart attack, he penned a letter to the Chemistry Education Group, which included the following:

'I am proud to say that Chemistry has played a significant role in rendering my surgery almost painless and in speeding my recovery. Unfortunately, it also played a part in clogging my arteries in the first place.'

Vale Bob, you have left a great legacy. You will be remembered as a friend, a mentor and a thoroughly good person.

This is an edited version of the obituary published in the *SASTA Journal*. Contributions by Tony Diercks, Lynton Hall and Ian McMahon.

The forest in the tree: how fungi shape the earth

Wild A., illustrator Reed A., created by B. Barr and G. Crocette, CSIRO Publishing and Scale Free Network, 2020, hardback, 48 pp.
ISBN 9781486313310, $24.99

The forest in the tree: how fungi shape the earth is a picture book aimed at readers aged 8–12 that describes the symbiotic relationships between a plant and the fungi and other microbes inhabiting both the forest and the plant itself. Narrating their struggles to survive, and attractively illustrated, the book is firmly grounded in science. Scientific terms are introduced (we are told how to pronounce some of them) and the book finishes with a section explaining many aspects of the science behind the story.

The story is related from the point of view of a mycorrhizal fungus. It begins as a single spore that sends out threads (hyphae) to find a plant to live with, finding one called Broma (a cacao plant, *Theobroma cacao*). The words are simple and quite poetic, while the pictures show more scientific details. For example, the text has a conversation between the fungus and plant while the pictures show and name the molecules (chemical structure and all) they both release.

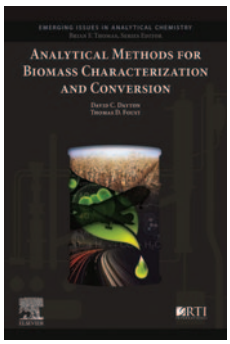
The exchange of sugars (to the fungus) and nutrients and water (to the plant) is established, and the contributions of other microorganisms are introduced. Then the fungus meets and joins others of its kind, creating a whole network throughout the forest – akin to what has recently been popularised as the 'wood wide web'. I like this aspect of the book, which may even educate parents and teachers as to the far-reaching role of fungi in the environment.

A drought provides drama of a sort, but the story on its own is tame compared with many books children in the targeted age range would be reading. However, the book is much more than just the story, and many readers will be sufficiently intrigued by the details of relationships between plants and microorganisms to read on to the science behind the story. These later pages give more background on a wide range of relevant scientific aspects: the key relationships, photosynthesis, cacao plants, the ecological roles of fungi and other microbes, essential processes that support life on Earth, and the impacts of humans and agriculture. There is a glossary of terms and a chart showing the relative sizes of characters, ranging from water molecules to the Sun.

The forest in the tree has been produced by an experienced and knowledgeable team, plus scientific and educational advisers, as part of a four-book *Small Friends Books* series that focuses on microbes and symbiotic partnerships. It is a great way of getting science into children's hands, and heads. CSIRO Publishing also provides teacher notes aimed at years 3–6 science, English, visual arts and sustainability. These notes build on the science presented in the book to make it an even more valuable educational resource.

Margie Beilharz

Analytical methods for biomass characterization and conversion



Dayton D.C., Thomas D. Foust T.D., Elsevier, 2020, paperback, approx. 240 pp.,
ISBN 9780128156056, approx. $155

Analytical methods for biomass characterization and conversion is the latest book in the series *Emerging issues in analytical chemistry* (series editor Brian F. Thomas).

David Drayton is a senior fellow in Chemistry and Biofuels Director at RTI International. He is widely experienced in alternative fuels development to create cleaner, cost-effective energy sources. Co-author Thomas Foust is Professor of Mechanical Engineering at Colorado State University as well as Director of the National Renewable Energy Laboratory's National Bioenergy Center. His specialisations are within the areas of clean energy and bioenergy. Both have considerable experience and seem entirely appropriate to write authoritatively on matters covered in this book.

There are a few good reasons biomass and its use is emerging with increasing importance. Hitherto, biomass has been largely a bit of a nuisance: rubbish to be burnt or dumped in a hole in the ground. In essence, our world runs largely on energy stored in the ground – oil and coal. We use it to generate electricity, to power transport, to make plastics and to power virtually every aspect of our lives. The downside of all this activity is we are consuming a finite resource at an alarming rate while adding extra carbon dioxide (and global warming) to the planet.

Biomass is the product of biosynthesis: taking carbon dioxide and water from the air and photosynthesising them to make sugars, among other organic molecules. So, if biomass can be refined to extract fuels, useful chemicals, biochars for soil and water remediation, or simply incinerated to recover its energy content, then we are on a winner: we have a carbon-neutral, very useful material instead of a disposal problem. We are running out of holes to bury it in, we are running out of time to ameliorate climate change, we are running out of resources and there is a limit to how much compost the world wants! What can be done? Well, utilising biomass would certainly be a good start. Will all this manipulation of biomass not consume energy? Yes, but provided the sun shines and the wind blows and the tides ebb and flow, all will be well. And the supply of biomass is virtually limitless.

This book has been crying out to be written for some years. It is much, much more than a compendium of analytical methods for analysing biomass. In fact, for descriptions of techniques, readers are largely referred to the appropriate American Society for Testing and Materials (ASTM) Standards. The ASTM Standards are the Rolls Royce standards for analysis: follow the methods competently, indeed slavishly, and you will get the 'right' answer (provided there are no loose screws or

nuts operating in the experimentation).

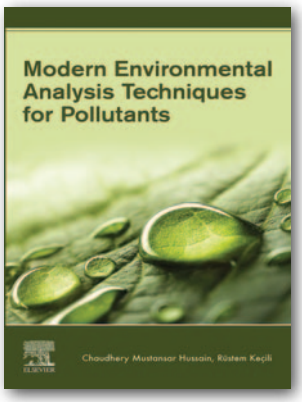
The real strength of this work lies in its comprehensive treatment of the entire gamut of biomass. 'Biomass' is a broad church. It can contain almost any biomaterial you care to think about and in a bewilderingly wide range of compositions. Not surprisingly, then, it can have a wide diversity of treatments to produce myriad useful products. At the very least, it can be burnt to recover energy for heating or electricity generation; it can be low-temperature pyrolysed to produce biochar for soil and water remediation; it can be converted into biodiesel for fuelling transport; it can be converted into bio-aviation fuel (bio-avgas); it can be gasified to create 'producer gas' for domestic and industrial heating as well as a starting material for chemical synthesis; and it can even be steam distilled to extract useful materials. So, the theme of this book is along the lines of defining biomass and how you might establish its physical and chemical properties, followed by what you might be able to make from it, how that can be done on a largish scale, how you might monitor the process and how you might analyse and quality control your product(s).

Yes, the book is certainly about analysis, but it covers a much broader remit than simply considering chemical and physical analysis in that it also covers process and economic analysis.

The chapters of the book are further enriched by interspersing short sections (generally one or two pages) of extra goodies called 'close-ups', which add even more interest to this already superb book.

Overall, this is a splendid book on an area that I feel has an exciting future and can lead to a significant amelioration of global environmental problems. The book is well written and well organised and will give the reader a first-rate sense of the possibilities for biomass utilisation. And it is a great guide to the analysis of biomass. I am absolutely sold on it; every chemist and chemical engineer should read it.

R.J. Casey FRACI CChem



Modern environmental analysis techniques for pollutants

Hussain C.M., Keçili R., Elsevier, 2020, paperback, 424 pp., ISBN 9780128169346, ebook ISBN 9780128169353, $246

Modern environmental analysis techniques for pollutants packs a good deal of interesting and relevant information into a concise package of about 400 pages. The book provides a useful survey of analytical methods, which might be applied to measuring levels of pollutants. Chapters are well backed up with extensive references to original work instancing applications.

Environmental analysis probably divides into two main subdivisions: one looking for high-accuracy laboratory-based analysis and the other about collecting a lot of survey data in the field and possibly with minor compromises to accuracy. The question resolves about whether you are looking for a broad survey of the problem or highly accurate small-scale data. You will find good detail of methods appropriate to each end in this book. In either case, if you do not know where you are going, you are unlikely to know when you arrive. There is a good chapter on quality assurance and quality control.

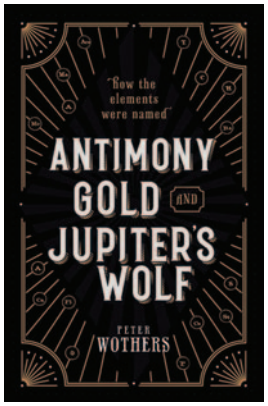
As well as chapters covering 'the usual' analytical methods, there are interesting chapters on, inter alia, applications of nanomaterials, sustainability and green chemistry techniques, and some speculation on the future trends in environmental analysis. My minor quibbles are that neither polarography nor capillary electrophoresis is mentioned.

Analysis is a complex business. The aim is always to provide an answer to a chemical question about a sample of material as a prelude to implementing an action. The entire process begins with getting a sample, preserving it in some way, and then manipulating it to an appropriate form for analysis. Rarely does output of an analysis stand alone: there is need to evaluate its meaning as a prelude to action of some sort, which can include, for example, going round the circle of sample, preserve, prepare, analyse, evaluate all over again. My point is while any half-well-trained chemist should be able to preserve and work up a sample, and modern chemical instrumentation shows high tolerance for nincompoops, as well as an ability to produce more significant figures than pi, if the sample is not 'right', the exercise is a waste of time. Given the title of this book, perhaps my criticism that there is little discussion of sampling is unfair. However, sampling is very, very important (and frequently poorly done) if results are to be meaningful.

Author Chaudhery Mustansar Hussain is an adjunct professor at the New Jersey Institute of Technology, USA, where his interests focus on development of analytical techniques for assessment of environmental samples. He has an interest in the synthesis of nanomaterials for application in air sampling devices. Co-author Rüstem Keçili is from the Department of Medical Services and Techniques within the Yunus Emre School of Anadolu University, Turkey.

This is a well-written, reasonably comprehensive text, with the exceptions noted above. It would make a good teaching text for undergraduate neophytes in environmental sciences. It provides a useful bridge between analytical chemistry and environmental science, with up-to-date references as well as an exploration of the application of nanomaterials and a glimpse of the possible future. Chemists with an interest in environmental analyses will also find it quite relevant.

R.J. Casey FRACI CChem



Antimony, gold and Jupiter's wolf: how the elements were named

Wothers P., Oxford University Press, 2019, hardback, 273 pp., ISBN 9780199652723, approx. $35

Antimony, gold and Jupiter's wolf: how the elements were named is an immensely enjoyable, wonderful and fascinating book. It is a splendidly researched and very readable exploration of historical writings about some of the elements going back to ancient times and the realms of the arcane and recondite. The text is liberally peppered with relevant and apposite wood-cuts from past centuries.

Peter Wothers is a teaching fellow in the Department of Chemistry, University of Cambridge, and Director of Chemical Studies at Saint Catherine's College. Most of the very fine illustrations in the book are from his personal collection. He also obviously has a very fine collection of antique books on matters chemical (and alchemical).

Sometimes the naming of an element is obvious; sometimes it is buried in mystery. But it is always a serious business, often taking years for the combined committee set up by IUPAC and IUPAP to determine.

For example, Pliny described arsenic's external use to eat away protrusions of the flesh, but also that 'taken in honey, it cleanses the throat, and renders the voice clear and tuneful'. Well, possibly, but I think I will stick with my toneless, raucous braying for the time being.

The naming of antimony is somewhat shrouded in mystery. One theory, largely debunked, describes how a German monk, observing a benefit (a weight gain) derived from feeding swine with a dose of an antimony compound, decided it would benefit his entire community and added a goodly dose to their food. Alas, the monks all perished and the material ingested became known as antimony (meaning destructive of monks). In any event, antimony compounds have a long, well-documented history as powerful purgatives. Well to do individuals in the 15th and 16th centuries kept antimony cups, in which a little wine was swirled prior to ingestion. This minimally dissolved the cup but did lead to massive fallings out from the dissolved antimony. Indeed, Captain James Cook had such a cup, auctioned in 2005 for £220 800. Whether this aided his clear passage around the globe, I have no idea. In similar vein, families had 'perpetual pills' or antimony balls to take in binding moments. These were rescued from the resultant effluvium, rinsed off, and reused. They were quite literally, passed down from father to son!

In early times (15th century), metals were believed to grow from seeds. This was a reasonable enough theory for the times. Just as trees and other plants were known to grow from seeds, metals, much more valuable than plants, would also come from seeds that grew into metals and ores below the ground. Seven metals were known at the time (gold, silver, iron, mercury, lead, tin and copper). The number seven had mystical and mythical overtones. There were seven days in a week, seven metals, seven deadly sins and seven planets known in the then geocentric view of the solar system. It is not surprising the metals became associated with particular planets and derived their alchemical symbols from those of their associated planet. While all this might sound like fruit-loopery now, it is important to remember it was high erudition in its era. It all made good sense then and if we now see further, it is, indeed, as Newton put it, because we have stood on the shoulders of giants.

Turning to fire and brimstone (literally meaning 'burning stone' and used in old English to mean sulfur) we meet the Greek for sulfur, *thion*, whence we get thiosulfate ion ($S_2O_3^{2-}$), and thioethanol (ethanethiol), a compound with a stench so foul any release will guarantee your privacy. And all by simply replacing an oxygen in ethanol by a sulfur atom! Is not chemistry wonderful?

Sulfur occurs in nature, but it is frequently derived from pyrites, a yellow mineral of iron disulfide (FeS_2) commonly known now as fool's gold. In ancient Greek, the name derives from *pyrites lithos* or fire-stone. Striking pyrites with a piece of flint causes a spark, and this can be used to ignite kindling to start a fire. This has been known since at least 8500 BCE. Ötzi, the 5300-year-old mummified iceman discovered in 1991 in the European Alps, had on his person just such a flint-and-pyrites fire-making kit. In more recent times, ships discharging high-sulfur crude oil have been known to explode when pyrophoric iron sulfides on the inner hull are exposed to the ullage air as oil is pumped out.

What of vitriol? By the early 1500s, iron sulfate was known as vitriol. If vitriol was heated it gave off SO_3 and SO_2, which when added to water yielded 'oil of vitriol' (H_2SO_4) and 'spirit of sulfur' (H_2SO_3). Similarly, roasting sulfur and other sulfates and sulfides led to sulfuric and sulfurous acids. The capacity to make sulfuric acid remains an indicator of national status.

This book is a totally enjoyable experience. The writing, referencing and content is top-notch; the illustrations are splendid; you can buy it for about $35 on-line; and I guarantee any chemist will greatly enjoy it, from cover to cover. But, what of Jupiter's wolf? Well, buy the book and see! The only hint you will get from me is that it has something to do with tungsten.

R.J. Casey FRACI CChem

Science diplomacy – where chemists make a difference

Chemists have always been central in assisting their governments with many complex diplomatic matters. The interface between science and diplomacy is captured in the term 'science diplomacy', which even has its own Wikipedia definition: 'the use of scientific collaborations among nations to address common problems and to build constructive international partnerships'. Climate change, ozone depletion, the storage and security of chemicals, and the elimination of chemical weapons are all issues where chemists and their specialised knowledge are vital to creating sustainable solutions. Professional societies such as the RACI have a vital role to play in supporting chemists to contribute to these pressing international issues.

It's now almost 10 years since the UK's Royal Society and the American Association for the Advancement of Science met to clarify what is meant by science diplomacy and to stimulate further development of this field. They described three different aspects of science diplomacy: science in diplomacy (informing foreign policy objectives with scientific advice), science for diplomacy (using science cooperation to improve relations between countries) and diplomacy for science (facilitating international science cooperation).

Science in diplomacy: The chemistry of the atmosphere is fundamental to our understanding of the world's climate and our climate future; chemists were also critical in the debates about the ozone layer and the development of the Montreal Protocol, on substances that deplete the ozone layer. The safety and security of chemicals such as ammonium nitrate became global news recently with the explosion in Beirut harbour. A further example is the development of the Chemical Weapons Convention (CWC) where Australian chemists worked closely with the Department of Foreign Affairs. The RACI provided strong support to government in this process. Many Australian chemists made vital contributions to the programs of the Organisation for the Prohibition of Chemical Weapons (OPCW), the organisation set up to implement the CWC. The RACI kept its members informed through a series of articles in *Chemistry in Australia* over several years about the CWC and OPCW activities.

Another form of science diplomacy is the appointment of scientists into diplomatic positions in embassies abroad. Australia made its first such appointment to the High Commission in London in 1926, followed by Washington (1941), Tokyo (1971) and Moscow (1976). Their duties included recruiting scientists and gathering information about technology and industrial developments and policies in their host countries. Many of these appointees were seconded from the scientific staff of CSIRO until responsibility for the positions was transferred in 1981 to the public service.

Diplomacy for science: Gaining access to international research facilities often requires diplomatic support. Such facilities include telescopes, high energy beam accelerators such as CERN in Geneva and various synchrotrons. Generally, these arrangements for international access have been negotiated through diplomatic channels.

Science for diplomacy: The RACI's many international connections are outlined in the Institute's Centenary Book published in 2017. Many Australians have contributed significantly over decades to the International Union of Pure and Applied Chemists (IUPAC). The RACI took the opportunity to help start the Federation of Asian Chemical Societies in 1979, becoming one of the 11 inaugural members. Specialised groups have also become engaged with Asia, such as the Asian Federation of Medicinal Chemistry, while mention can be made of the Pacifichem conferences and the activities of the two Australian learned science academies (AAS and ATSE). Individual chemists have contributed to these networks of connections through research cooperation and international conferences.

Overall, the high reputation of Australian chemistry in the international arena reflects positively on the nation's international image. In this way, chemists strengthen Australia's 'soft power' and Australia's attractiveness to international audiences. Unlike hard power, based on military capabilities, soft power refers to the appeal of a country to others and, since its enunciation in 1990, has become increasingly recognised as an important asset in diplomatic matters.

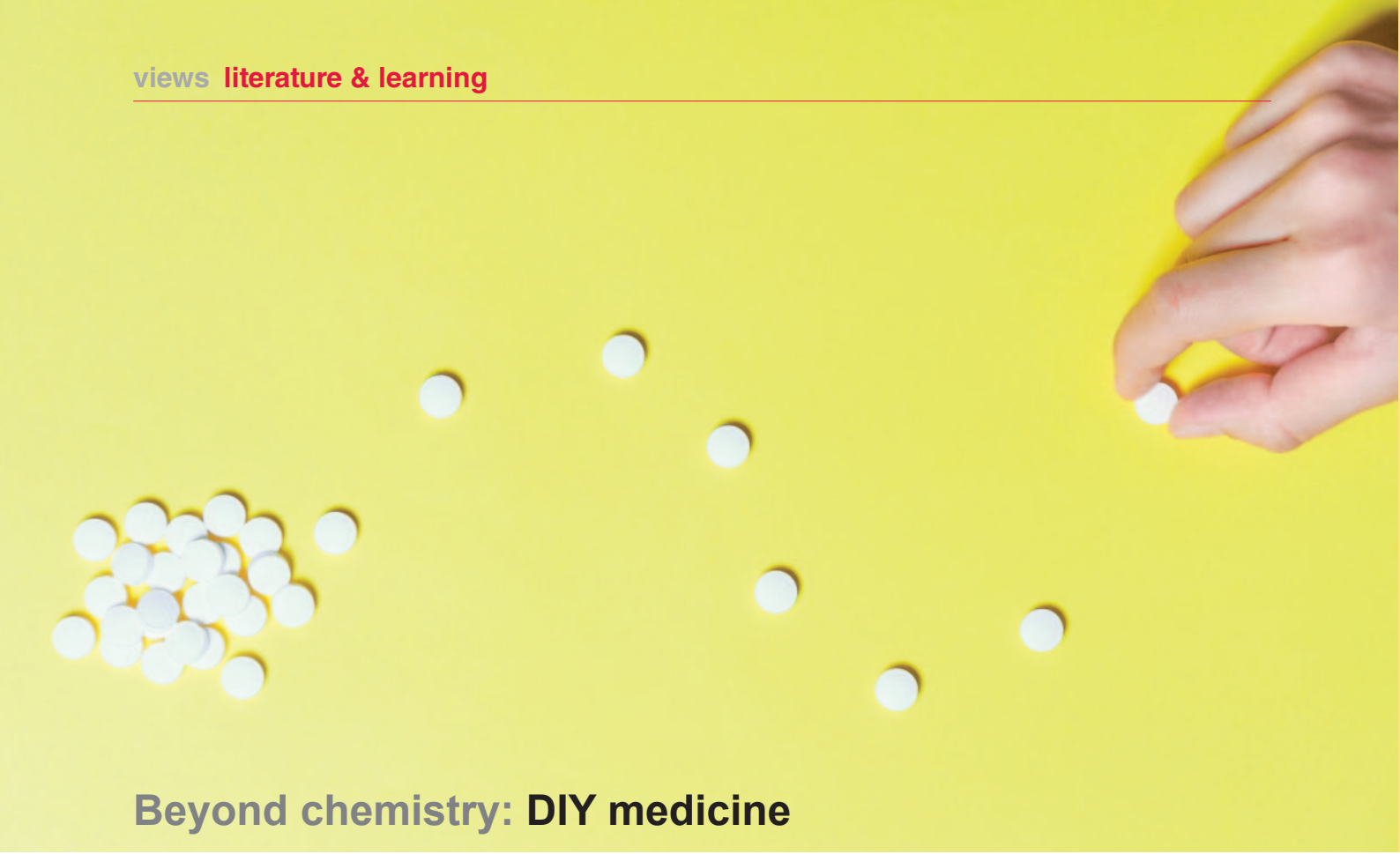
Not all activities fit exactly into one of these categories of science diplomacy. Some can be more than one type at the same time. An example is the Sesame synchrotron in Allan, Jordan. The synchrotron in Jordan was created under international auspices, namely, Unesco, bringing together as member countries Cyprus, Egypt, Iran, Israel, Jordan, Palestine and Turkey. This is definitely an unexpected group of countries to be involved in a cooperative venture. Clearly it required considerable diplomatic effort to be established (and thus is an example of *diplomacy for science*). Sesame's web site also states that one of the goals is to build scientific and cultural bridges between diverse societies, that is, to contribute to a culture of peace (and so is also an example *of science for diplomacy)*.

Australian chemists and their RACI have already made wide-ranging contributions to the diverse activities where science and diplomacy interact. As the world pivots towards an uncertain and complex future, it is important that these contributions continue.

John Webb FRACI CChem, **Tom Spurling** FRACI CChem and **Greg Simpson** FRACI CChem

Further reading

Davis L.S., Patman R.G., *Science diplomacy: new day or false dawn?* World Scientific, 2015.
Krasnyak O., Ruffini P.-B., 'Science diplomacy', *Oxford Bibliographies*, 2020.
Spurling T.H., Webb J.M., *Chem. Int.* 2018, January–March, pp. 10–14; *AsiaChem* 2020, vol. 1(1), November, pp. 68–71.



Beyond chemistry: DIY medicine

Many of us in Australia are exponents of do-it-yourself (DIY). But have you heard of the Open Insulin Project, the Four Thieves Vinegar Collective or the Open Source Pharma Foundation? I hadn't until I read a piece by Margaret Talbot in the 25 May issue of *The New Yorker* and followed up with some desk research of my own.

Over time, dozens of these DIY movements have sprung up, predominantly in the biological sciences, including genetics, microbiology and synthetic biology. Perhaps, this is because DIY chemistry, which has a longer history, fell into disrepute when some practitioners strayed into illegal activities, making recreational drugs in clandestine laboratories for the street market, which can only be deplored. Talbot suggests the emergence of DIY-Bio in places such as Cambridge, Massachusetts, and the San Francisco Bay area in the US can be attributed to their proximity to flourishing centres of biotech at the time.

The Open Insulin Project was initiated by computer scientist Anthony Di Franco in Oakland, California, in 2015, with the objective of countering the rising cost of synthetic insulin, which must be injected daily by millions of people with type 1 diabetes, all over the world. Talbot called these activities 'biohack' and 'pharmaceutical code breaking', which most readers would recognise as unlawful. Di Franco doesn't hide the fact he sees the group as part of the biohacking community.

On its own admission, the Four Thieves Vinegar Collective 'is an anarchist biohacking group' founded in 2015 by professor of mathematics Michael Laufer. The Collective's mission is to develop ways for individuals to manufacture their own medications – 'This will save hundreds of thousands of lives', Laufer has (modestly) claimed.

Laufer came to prominence in 2016 when he released instructions on how to make an EpiPencil, a cheap epinephrine injector, which imitates the much more expensive Mylan EpiPen, used for emergency treatment of anaphylaxis. Subsequently, Four Thieves has released instructions for building an Apothecary MicroLab, a DIY device Laufer claims can be used to synthesise a variety of medications. The Collective has been able to sidestep action by the regulators because they do not make or sell anything.

The Open Source Pharma Foundation is a somewhat different kettle of fish. It plans to use open source principles derived from the software industry. This not-for-profit foundation originated in India and has offices in Bangalore and Paris. It aims to develop affordable new therapies in areas of greatest health need, to discover new (pharmaceutical) drugs and a new way to discover them. There is no suggestion of code breaking or hacking.

As early as 2006, a paper in *Nature Reviews* entitled 'Can open-source R&D reinvigorate drug research?' attracted wide attention and was followed by meetings in London (with World Health Organisation involvement), Italy, Germany and France. In 2019 and 2020, meetings were also held at the Harvard Global Health Institute, establishing an important US connection.

The Foundation continues to receive funds from the Tata Trust, an Indian philanthropic organisation, which also supports the Tata Council of Scientific and Industrial Research Open

Source Drug Discovery (India) Fellowships to students and young researchers. It focuses on tuberculosis and diseases endemic in under-privileged countries.

All of these movements have common threads running through them. First and foremost they are counter-culture movements, i.e. ones whose values and norms of behaviour differ from those of mainstream society. Apparently, in human societies a few individuals have always sought to operate outside normal boundaries – to do their own thing. But when it comes to medicines, I think it is a bridge too far.

Consider now the discovery and development of new medicines. Ultimately, only those products that are proven to be safe and efficacious can be registered, prescribed and sold. It is a lengthy and expensive undertaking. DIY medicine appears to want to circumvent the established protocols and processes, even with the best of intentions, by allowing them to be put into the hands of individuals, who have no relevant training or experience.

The inference is that, somehow, the medicines will be cheaper, making them accessible to patients, who might otherwise not be able to afford the prices new, effective medicines command. It should not be necessary to explain to professional chemists that the discovery and proving of a new medicine is a long process, full of technical challenges, and increasingly expensive – these days often costing upwards of a billion dollars. It is reasonable that manufacturers of medicines should, given extremely low success rate of pharmaceutical R & D, be able to recover their costs, in order to remain viable. The government regulatory agencies, such as the Food and Drug Administration (USA) (FDA), European Medicines Agency, Therapeutic Goods Administration (Australia) and others, are there to protect us all, by setting and upholding extremely high standards. Anyone who has experienced an FDA inspection will have no doubt about this!

Regulatory agencies on occasion allow patients with life-threatening illnesses access to new remedies that have not completed full testing, because the remedies have shown early indications of efficacy, are potentially lifesaving and their use is urgent. But these are the exception rather than the rule.

When DIY Medicine first emerged in the early 21st century, some of the movements were at best naive while others were possibly on the verge of dangerous. They seemed to openly ignore patents or hoped to find a way around them. Laufer is said to be convinced that providing lifesaving medication to any who need it justifies violating intellectual property rights of the pharmaceutical companies that own the IP.

According to Talbot, the Open Insulin Project planned to use protocols lifted from published papers to produce insulin using genetically modified organisms, as the established manufacturers do. Others believe that making small batches locally, sufficient to fill a few prescriptions, is the way to go, but that ignores both the benefits of scale in containing manufacturing costs and in meeting the demanding quality requirements for medicines.

Thankfully, as the DIYs have matured, so too has their thinking and ambitions. Some have redirected their efforts towards medical hardware and diagnostic tests, rather than trying to make medicines. More trained professionals are joining their ranks, emphasis is being placed on safety, and laboratory induction programs have been introduced. A Sydney DIY, Biofoundry, has added environmental science to its portfolio of activities, while an online global community of volunteers, E-Nable, is using 3D printers to make low-cost body parts and prostheses, and since the pandemic, face shields.

So, what can we expect from DIY medicine in the future? Many argue that these DIY movements are good because they expand participation. My view is that the anarchists and hackers will fall by the wayside. There is no place for them. Some of the practitioners Talbot interviewed for her article seemed to me to have given rather feeble reasons to justify their existence and activities. Democratising and demystifying the underlying science may appeal to those on the *outside*, but the solution for them is to study the science that will allow them to come *inside*, because any real benefits will be derived only from using the underlying science to discover new and better medicines.

The one to watch is the Open Source Pharma Foundation. However, a problem it faces is that unlike the software industry, in which open source material is rife, the pharmaceutical industry is antithetic – a proprietary culture of confidentiality, patents and licensing. I would prefer to see it remain that way.

Peter G. Lehman FRACI CChem

Biljana Cvetanovic

Peter's learning list

Biofoundry, Sydney, NSW, https://foundry.bio.
Counter-culture movements, https://en.wikipedia.org/wiki/Counterculture.
E-Nable, https://enablingthefuture.org.
Four Thieves Vinegar Collective, https://fourthievesvinegar.org.
Munos B., Can open-source R&D reinvigorate drug research?, *Nat. Rev. Drug Disc.*, 18 August 2006.
Open Insulin Project, https://openinsulin.org.
Open Source Pharma Foundation, https://www.ospfound.org.
Talbot M., The rogue experimenters, *The New Yorker*, 25 May 2020, pp. 40–9.

Steel yourself: spilling a patent's 'secret sauce' is a must

The obligation to 'spill the secret sauce' and describe an invention in full detail when filing a patent application is fundamental to the 'Quid pro quo' of the patent system. In return for making an invention that is potentially beneficial to society, the patentee is given a 20-year monopoly by the Government to commercialise it. At the end of this period, however, others are free to use and improve on the invention, and they should be able to do so because the patentee is supposed to have described everything that needs to be known to perform the invention.

Subsections 40(2)(a) and (aa) of the *Patents Act 1990* require that the patent specification 'disclose the invention in a manner which is clear enough and complete enough for the invention to be performed by a person skilled in the relevant art' and 'disclose the best method known to the applicant of performing the invention', respectively.

The sufficiency requirement (s40(2)(a)) means that the patent specification must describe the invention in enough detail for a hypothetical 'person skilled in the art' (e.g. an unimaginative chemist, much like myself) to perform anything falling within the scope of the claims, using only the disclosure in the specification and the 'common general knowledge', perhaps with some routine trial and experimentation thrown in if needed. The best method requirement (s40(2)(aa)) means that the patent specification must include a complete and full description of the best way to perform the invention known to the inventors at the time the patent application is filed.

These two requirements are closely interrelated and, for some inventions (typically those relating to simple mechanical subject matter), describing the best method can also satisfy the sufficiency requirement. Unfortunately, this is rarely the case for patents relating to chemical subject matter, as chemical reactions can often produce surprises and principles of general applicability are not so easily found. Patents for inventions in the chemical technologies are therefore much larger than patents for mechanical inventions.

The importance of these provisions of the *Patents Act* was highlighted in a relatively recent court decision. BlueScope sued Seoul-based Dongkuk Steel for infringement of various claims of two patents relating to steel strips coated with an Al–Zn–Si–Mg alloy. Dongkuk manufactures alloy-coated steel strip products, sold by third parties in Australia. Although Bluescope had patents for this technology, the judge deemed all of the relevant patent claims invalid, and they were revoked. What went wrong for BlueScope?

Bluescope Steel Limited v Dongkuk Steel Mill Co., Ltd (No. 2) [2019] FCA 2117

In 2009, BlueScope filed patent applications for methods for coating steel strips with a particular Al–Zn–Si–Mg alloy. The coated steel strips were intended primarily for roofing products, so corrosion resistance was very important. Si is an essential component of the alloy because it apparently prevents excessive alloying between the steel substrate and the molten coating in the hot dip coating, and promotes the formation of an adherent coating. Mg is an essential component of the alloy because it apparently provides an improved protection at cut edges due to it changing the nature of the corrosion products formed. In their marketing material, BlueScope claim that the magnesium improves galvanic protection by 'activating the aluminium, resulting in a tougher protective coating that's more resistant to scratches and scuffs encountered during construction'.

A problem with these alloy coatings, however, is that Mg_2Si forms during cooling and, if it forms in certain regions of the coating (especially near to the surface), a phenomenon called mottling occurs, which makes the coating aesthetically unappealing. Further, the Mg_2Si can also form relatively large particles compared to the coating thickness, which present a corrosion risk.

BlueScope's invention involved applying the alloy coating on the steel strip in a manner that reduces Mg_2Si formation, or at least ensures that that any Mg_2Si which does form is not at the surface. In simplified terms, one of the ways the distribution of Mg_2Si in the coating could be controlled was to minimise variations in coating thickness. Indeed, the main patent claim defined the invention by this result, where passing the steel strip through the alloy bath results in a coating having a variation in thickness of:

> … *no more than 40% in any given 5 mm diameter section so that the distribution of Mg_2Si particles in the coating microstructure is such that there is only a small proportion of Mg_2Si particles or substantially no Mg_2Si particles in the surface of the coating.*

Given the importance to the invention of minimising coating thickness variations, one might expect that a specific technique or techniques that could be used to keep the variations under control would be described in the specification. However, this was not the case and the specification simply stated:

> … *the applicant found that short range coating thickness variations could be very high, and* special operational measures *had to be applied to keep the variations under control.* [author emphasis]

In evidence during the trial, BlueScope submitted that four particular operational measures that could be used to control coating thickness variations were known to them at the time the patent application was prepared (in 2009), but that they had not actually tested any of these. Indeed, it took until about 2013 to commercialise this invention, using one of the operational measures known to them in 2009. BlueScope argued that these operational measures were, however, part of the common general knowledge and that there was therefore no need to provide a detailed description in their patent specification.

Dongkuk Steel, of course, disagreed and argued in court that

operational measures for controlling coating thickness variations of Zn–Al-based coatings were not part of the common general knowledge. Further, Dongkuk argued that even if operational measures that might achieve this function were known, the use of the word 'special' in the patent would confuse a person skilled in the art and they would not have understood 'special operational measures' to be referring to known operational measures, let alone the particular operational measures BlueScope knew to be the best method of performing the invention.

Horrific amounts of evidence were produced by both sides, which the judge methodically worked through in his 239-page decision. I can only imagine the cost of this litigation. In the end, the invention was deemed by the court to meet the sufficiency requirement because the judge found that the evidence indicated that a person skilled in the art, using their common general knowledge and the teachings of the specification, would have been able to perform something falling within the scope of the invention.

Unfortunately for BlueScope, however, the court found that the evidence did not establish that some of the operational measures known to BlueScope for controlling coating thickness variations were part of the common general knowledge. Further, even though some of the operational measures were found to be part of the common general knowledge, the court was not persuaded by BlueScope that the person skilled in the art would know which of these operational measures were the best operational measures to perform the invention.

As the judge quite brutally put it:

> *Notwithstanding that BlueScope knew of the best method of performing the alleged invention as at March 2009, it did not disclose it in the specification as at the date. Rather, it confidentially used the best method commercially from 2013 whilst simultaneously benefiting from the statutory monopoly. In the circumstances, all of the asserted claims of the 257 Patent are invalid.*

Thus, referring to 'special operational measures' being required to control variations in the coating thickness (and hence the Mg_2Si distribution in the coating), but without providing any guidance about such measures, resulted in the BlueScope patent failing the best method requirement. This was found to be the case even though some operational measures that would control coating thickness variations were known in the art. The judge also made the point that this would still be the case even if the expression 'special operational measures' had not been used.

The upshot of this court decision was that patent claims which were otherwise valid (the court found them to be novel and inventive) were revoked. So, the moral of this story is that, when preparing a patent application, never give in to the temptation to skimp on any detail. You need to shake the bottle to get the last little bit of secret sauce out, and then leave it upside down for a while, in case there's some left.

Andrew Jones MRACI CChem is Principal of Foundry Intellectual Property.

Water, oil and cling – it's a surface thing

iStockphoto/malirka

The kids are home for the holidays and you want something interesting and educational for them to do – but no stinks or bangs please!

Why not go for surface chemistry? The suggestions here are simple and safe, and the surface science behind them has extremely wide industrial and domestic applications.

Why are plastic bags so pesky to open?

Why do the two sides of new freezer bags stick together and how do you pull them apart so that they can be filled? Enter Johannes Diderik van der Waals.

The van der Waals force is a (generally attractive) force between molecules (and atoms). It is very weak, except at very short distances. It is a force, not a bond like an ionic or a covalent bond. It is this force that holds the individual polymer molecular chains together to form the macroscopic plastic solid such as polythene. To pull the sides apart, you generate a static charge by friction, rubbing the outsides together up and down. Provided the humidity is not too high (which interferes with static electricity), the similar charges repel and, hopefully, the bag opens.

If not, you might try wetting your fingers to stick lightly to each side of the bag to pull them apart.

The first method is generating static electricity;* the second method is a force that holds the plastic to your *wet* finger.

There are plenty of examples of static effects. The success of the second method –wet fingers pulling the sides of the bag apart – is not often discussed. Tear a small piece of aluminium foil (1 × 2 cm). Place a drop of water on it and then lift and touch it with your finger. It holds tenuously. Metals don't hold static (much).

The wet patch formed between your fingers and the plastic freezer bag causes strong adhesion. To move away, the surface area of liquid would need to increase and this is resisted. The ultimate explanation has to do with Laplace's equation.

Repeat the aluminium levitating experiment but use a *small* drop of *oil* instead of water. It still works (although probably not as well).

This adhesion holds sand grains together so you can build sand castles; it supresses dust during construction and mining. It can be very strong. Try parting two flat pieces of wet glass by pulling.

How does clingwrap cling?

What does Google tell us how the clinginess works? Many answers attribute it to 'static'. But the adhesion can't be static. Same charges repel.

We can wash out the static idea because *wet* clingwraps work just as well.

Given the slightest opportunity, clingwrap, unlike plastic bags from rolls, clings furiously to itself.

Clingwraps cling better to metal (a conductor of electrons) and glass, but they reject the embrace of plastic utensils.†

So what is in clingwrap and what makes it work? A good start is to up look some patents. Try US4367256A and US5006398. A huge range of clinging agents are incorporated

*Two good resources for teachers: www.education.vic.gov.au/school/teachers/teachingresources/discipline/science/continuum/Pages/electrostatics.aspx http://people.virginia.edu/~ral5q/classes/phys6263/fall15/Lab01.pdf

†Glass picks up a positive static charge. In water, things are quite different. Glass reacts, releasing hydrogen ions and has a negative (zeta) potential. Thus, glass washed with a cationic detergent (positive hydrocarbon tail) becomes hydrophobic and greasy. However, as we saw, static plays no role in clingwraps clinging.

Small drops (or small bubbles) have high curvature and thus high surface energy (or high internal gas pressure).

but they are all 'oily' and their clinginess depends on liquids in contact coalescing to reduce their surface area (as seen above with your wet fingers opening the freezer bag).

Why does oil spread over water, but water does not spread over oil?

Spreading occurs when the overall surface energy is reduced. Thus, a low-surface-energy liquid will spread over a high-surface-energy solid (or liquid) because it increases the amount of low-energy surface and reduces the amount of high-energy surface. Overall, surface energy is reduced.

Figure out 'what liquid wets what solid' – trying both water and oil on various surfaces – and see whether theory matches the practice.

So a rough rule would seem to be that the more readily water wets a surface – i.e. the lower the contact angle and the flatter the puddle (due to the force of gravity, the surface tension and the density of the liquid) – the better the clingwrap should stick.

Where there is no overall lessening of the total surface energy, there will be no incentive to cling. This fits with the observation of plastics rejecting the clingwrap's embrace. Vegetable oils would be expected to wet most surfaces except Teflon, silicones and tungsten carbide.

Teflon magic

Drop a tiny amount of detergent onto a tablespoonful of water in a cool Teflon frying pan. This proud up-sitting non-wetting globule of water has a reversal of fortune and spreads itself instantaneously.

Why does drawing on a foggy window leave a picture? And why does it come back after the window has dried and fogged up again?

Starting to wear a mask because of COVID-19, I found that my glasses kept fogging up. Then I had a close look at a fogged-up bathroom window on which I had scribbled.

The fogged section has a myriad of tiny droplets spread fairly evenly on the surface; the written section has large globules separated by large sections of clear surface. The act of writing causes an 'instantaneous' transition.

Small drops (or small bubbles) have high curvature and thus high surface energy (or high internal gas pressure). Where possible, the high-energy water surface minimises by coalescence. For connected bubbles, the slightly smaller one blows up the slightly larger, until the internal pressures are equalised by equalising the surface curvatures of both bubbles, the smaller one almost flattened (see 'Bubble politics', *Chemistry in the marketplace*, 6th edn, p. 50).

The ghost of your past drawing comes from not cleaning the mirror thoroughly, leaving fatty, soapy material on which the next lot of water vapour can nucleate.

Ben Selinger FRACI CChem is Emeritus Professor of Chemistry at ANU.

Surface energies of some kitchen utensil materials

Material	Surface energy (mJ/m^2)
Teflon	19
Tungsten carbide	20
Silicones	24
Vegetable oils (peanut, safflower, sunflower, olive as well as that oily 'sticking agent' in clingwrap)	33–35
Polythenes	approx. 35
Acrylics	3040
Aluminium alloys (surface is often modified to add adhesion when coating, to reduce adhesion when cooking, and to aid cleaning)	36–65
Titanium nitride/carbide (e.g. Scanpan cookware)	36–37
Ceramics (varies a lot)	41–46
Stainless steel	70 (sometimes 30–40)
Water	72
Glass	83
Anodised aluminium	170
Aluminium	840
Cast iron (before cooking oil has been pyrolysed onto surface)	1520

Rapid responses to smoke taint

In the May 2012 grapevine column, Geoff Scollary summarised what was then known about the impact of bushfire smoke on grapes and wine. Since then, the frequency of bushfires has increased, with the 2020 summer fire season affecting many Australian grape-growing regions. More recently, US grape and wine producers in Oregon and California have had to manage the effects of fire and smoke. Professor Kerry Wilkinson from the University of Adelaide is a lead researcher of 'smoke taint' and provides an update here.

Early research identified volatile phenols (and their glycoconjugates) as chemical markers of smoke taint, developed analytical methods for their quantification, and investigated the sensory impact of grapevine smoke exposure on wine. Factors affecting the intensity of smoke taint, including the timing and duration of smoke exposure, fruit maturity at harvest and skin contact time during fermentation, were also established.

More recently, research has sought to understand the accumulation of smoke-derived volatile phenols in grapevine leaves and fruit, in glycoconjugate forms, including an apparent delay between the 'disappearance' of volatile phenols and the 'appearance' of volatile phenol glycoconjugates in grapes after exposure to smoke, which could result in smoke taint being underestimated prior to vintage.

Current research efforts focus on developing rapid methods for detecting and quantifying grapevine smoke exposure and strategies for ameliorating smoke taint.

Most grape and wine producers rely on commercial laboratories for compositional analysis to determine whether fruit is smoke tainted. When multiple regions are simultaneously affected by fires, as happened in Australia during the 2019–20 growing season, and more recently in California and Oregon, demand for analysis creates sample backlogs and significant reporting delays are experienced. This undermines decision-making prior to vintage and highlights a need for rapid diagnostics. Commercial sensors that measure particulate matter concentrations can be used to monitor the occurrence of smoke exposure in the vineyard. The absence of smoke gives industry confidence to proceed with harvest, and when smoke is detected, the density and duration of smoke exposure informs the need for chemical analysis of fruit. Spectral sensors are also being evaluated as rapid methods for quantifying grapevine exposure to smoke and could provide options for in-field applications using unmanned aerial systems (drones) or even optical berry sorting in the winery. Spectral analytical techniques (e.g. Fourier transform, near- and mid-infrared spectroscopy) may enable rapid screening of smoke-affected grapes, to prioritise those samples in need of more detailed compositional analysis by GC-MS and LC-MS/MS.

In the vineyard, various protective sprays (e.g. anti-transpirants, grape 'sunscreen' and even a synthetic phospholipid cuticle 'biofilm') have been evaluated as strategies for mitigating exposure of grape bunches to smoke. Unfortunately, many of these sprays actually facilitate the uptake of smoke and, therefore, exacerbate the problem. Where promising results have been achieved, these strategies still rely on sprays being applied to grapevine foliage before smoke exposure, which may not be feasible, depending on the proximity of the fire to the vineyard (i.e. because of the inherent OH&S risks).

An in-canopy sprinkler system used to alleviate heat stress by 'misting' the grapevine bunch zone during heatwaves was evaluated as a strategy for mitigating smoke adsorption by grapes, in a manner akin to how rain cleanses aerosol pollutants. However, misting during the application of smoke to grapevines did not significantly influence the sensory perception of smoke taint in the resulting wine. Previous attempts to 'wash' smoke-affected grapes (with water, aqueous ethanol or milk) did not affect the concentration of smoke taint marker compounds, demonstrating their rapid diffusion into berries. However, trials are underway (in California) to determine whether washing ash from grapes might prove beneficial.

The amelioration strategies identified a decade ago (i.e. adding activated carbon or using nanofiltration and solid phase adsorption to remove smoke-derived volatile phenols from wine) remain the most effective strategies for amelioration to date, and are still used by wineries to treat smoke-tainted wine. However, novel adsorbents and treatment processes are being evaluated, including molecularly imprinted polymers, ozonation and distillation, and a recently funded Cooperative Research Centre Project, led by Cassegrain Wines in collaboration with the University of Adelaide and several industry partners, will continue to explore strategies for ameliorating smoke taint.

Smoke taint remains an ongoing challenge for grape and wine producers around the world. Australia is world-renowned for expertise in the science of smoke taint, but as fires have continued to affect global wine regions, researchers from Canada, the US, Chile, South Africa and Europe have strengthened efforts to overcome the impacts of bushfires on grape and wine production.

Kerry Wilkinson (kerry.wilkinson@adelaide.edu.au) is a professor of oenology at the University of Adelaide – a role that enables her to combine her passions for wine education and wine research. Her primary research interests concern the chemistry of grapes and wine, but she is best known for her research into the impacts of grapevine exposure to bushfire smoke.
https://researchers.adelaide.edu.au/profile/kerry.wilkinson

Still some X about X-rays

In late 1927, the Commonwealth of Australia placed an order with the Belgian Radium Society for 10 grams of the radioactive substance, at a cost of £100 000. There was some opposition from people who thought it should have been sourced from the Australian Radium Corporation, but it did not have stocks on hand from its Mt Painter mine, and there was a sense of urgency, brought on by demands for its use in the treatment of cancer, so we settled for material ultimately coming from the Belgian Congo.

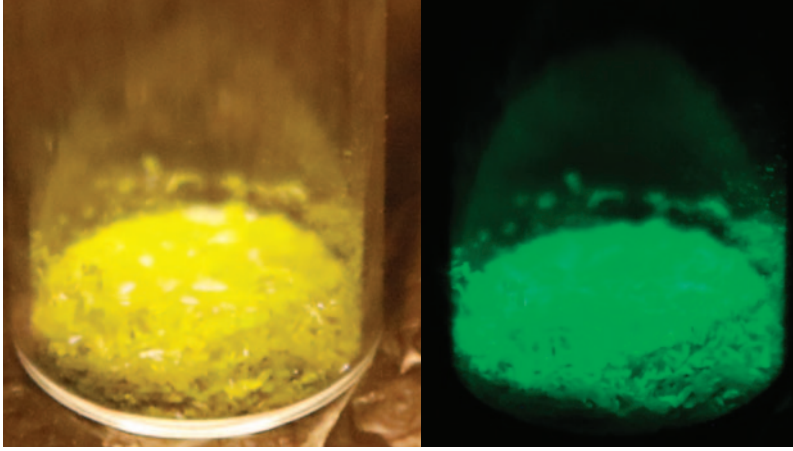
Several batches of tubes containing the 'hot' substance arrived in Melbourne over the next few months. Armed guards accompanied them from the ship to the vaults of the Commonwealth Bank until the Health Department could take delivery of them. A Commonwealth Radium Laboratory was established, in conjunction with the Department of Natural Philosophy at the University of Melbourne, where the Professor of Physics, T.H. Laby (1880–1946), had already established an X-ray laboratory for the Commonwealth.

Following the Australian Cancer Conference in 1935, these two sources of radiation were brought together in the Commonwealth X-ray and Radium Laboratory and a building was constructed for it on the Parkville campus. The officer in charge was Cecil Ernest Eddy (1900–56), whose research with Laby had involved X-ray fluorescence (XRF). Eddy had followed the trail of other Laby MSc graduates, going to Cambridge to work with Rutherford in the Cavendish Laboratory, but he didn't like it there and preferred to continue his studies in Melbourne where he was awarded the DSc in 1930. His biographer described him as a man who was 'good company and enjoyed a beer with friends'.

In 1999, the by-then Australian Radiation Laboratory merged with the Nuclear Safety Bureau in the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), occupying a site at Yallambie in Melbourne's northern suburbs.

Once X-rays were introduced into medicine, it was realised that the dose of radiation was important, and various schemes were introduced for ensuring that the patient received the Goldilocks ('just right') amount.

A major contribution was made by French physician and mycologist Raymond Jacques Adrien Sabouraud (1864–1938), who early in the 20th century was using X-irradiation to treat ringworm infections. His dosimeter consisted of cardboard discs (known as pastilles) covered with barium platinocyanide $Ba[Pt(CN)_4]$ (barium tetracyanoplatinate). This is the substance that led Wilhelm Conrad Röntgen (1845–1923) to deduce that invisible rays were being produced in his electrical experiments and causing fluorescence of a nearby screen coated with the platinum compound. Sabouraud realised that the platinum salt showed reversible colour changes when irradiated with X-rays, from yellow-green through yellow, orange and brown, then back again when the irradiation ceased. The colour of a test pastille was compared with standards prepared with measured amounts of radiation.



Barium tetracyanoplatinate under normal light (left) and fluorescing under UV light (right). Zheng Zhao, Southeast University, China

George Gabriel Stokes (1819–1903), who introduced the term 'fluorescence', observed in 1853 that the crystalline solid shows bright green fluorescence but is inactive in solution. It became a common component of optical experiments, hence its presence in Röntgen's laboratory. More recent researchers attribute a number of its optical properties to Pt–Pt interactions within the crystal lattice, where tetracyanoplatinate anions are stacked face-to-face. Despite modern interest in this substance, the chemistry of its reversible colour changes remains a mystery. It is spectacular stuff, as you can see from the photographs, one under normal light and one under ultraviolet, kindly provided by Dr Zheng Zhao of Southeast University in Nanjing, China.

This tale started for me on a lazy afternoon spent in a library that overlooked part of the University of Melbourne campus, where I noticed a building being demolished. On the campus map, it was labelled 'old radiation lab' and I realised that it was the old X-ray and Radium Laboratory. While I watched, the demolition waste and the machinery were being checked with a counter, and I was just in time with my camera to see the worker's feet being checked, as you can see in the accompanying photograph.

Ian D. Rae FRACI CChem (idrae@unimelb.edu.au) is a veteran columnist, having begun his Letters in 1984. When he is not compiling columns, he writes on the history of chemistry and is an editor of *Historical Records of Australian Science*.

RACI 2022 National Congress: Save the date

You are invited to join us for the RACI National Congress, Sunday 3 July to Friday 8 July 2022, at the Brisbane Convention and Exhibition Centre, Queensland.

The theme for the 2022 National Congress is 'Chemistry: Catalysing solutions to global challenges'.

The congress will include a high calibre of national and international chemistry professionals, showcasing the latest breakthroughs in our discipline and exploring new opportunities for collaboration.

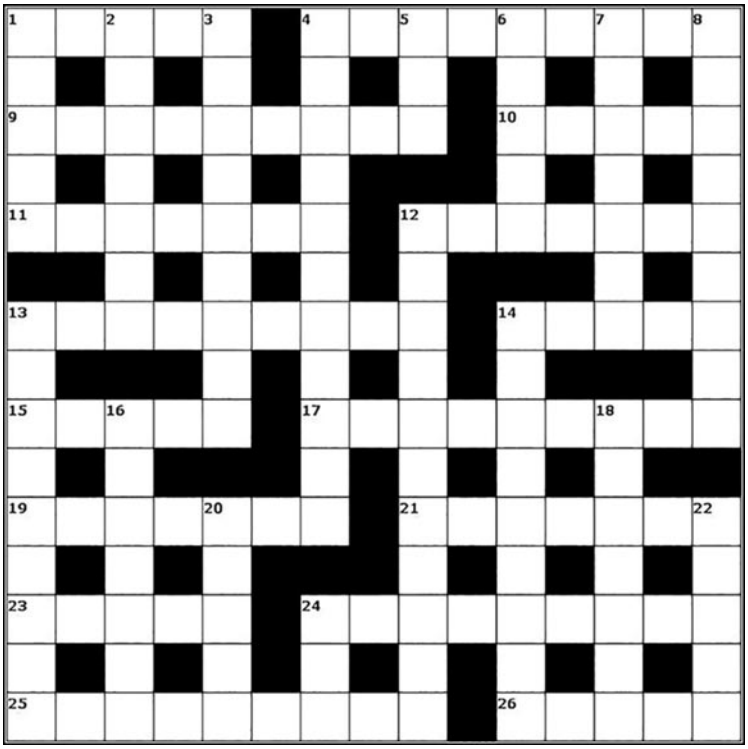
Thinking of attending?
Register your interest at **raci2022.com**

Like to attend with a discount?
Become an RACI member at **raci.org.au**

Interested in being a sponsor?
Download the prospectus at **raci2022.com/sponsorship**

Please save the date and we hope to see you there!

Kind regards, RACI 2022 organising committee



Across

1 Supports jobs. (5)
4 Basic Ti/Ir/N_2 compound, that's intentional. (9)
9 Enact iron reaction to make tin, perhaps?! (9)
10 Unattainable model. (5)
11 Lots use offbeat dissolved matter. (7)
12 Vanadium a sure bet for Spooner radiation health unit. (7)
13 Resolve to put off extract. (9)
14 Presents fellow over in that Na symposium. (5)
15 In that way cap state. (5)
17 Heats oil to start making $LiSC_6H_5$ and CH_3SNa, perhaps. (9)
19 Quit holding carbon in an energetic state. (7)
21 Sounds like still water for this cyclic di-ester. (7)
23 Took a load off indium fabric. (5)
24 Five elements are needed. (9)
25 Portrays planting of seeds over the bed. (9)
26 Renewable energy returns in neutral osmium system. (5)

Down

1 Contracts three elements. (5)
2 Just one line for this piece of clothing. (7)
3 Wet parts. Teed off! (9)
4 Anodises its product by bombarding with charged particles. (3-8)
5 Smear salt. (3)
6 I am extracting $RN=CR_2$. (5)
7 Female subject came to pass illicit bar. (7)
8 Phlegmatic time with pans for condensing vapours. (4,5)
12 Silica seeps away and concentrates in one area. (11)
13 Ceased hanging on to press which broke up and took off in all directions. (9)
14 Strange shapes detected compounds. (9)
16 Assembles Spooner's finds. (7)
18 Minor radical held in titanium container. (7)
20 Forenotice held up powder. (5)
22 Mathematician detected looking after machinery. (5)
24 Two elements get up and go out. (3)

Graham Mulroney FRACI CChem is Emeritus Professor of Industry Education at RMIT University.
Solution available online at Other resources.

THE TRIPLE QUAD THAT SURPASSES ALL EXPECTATIONS

Whether you are leading a research laboratory or simply carrying out cutting edge research, you know firsthand how important it is to have access to the right instrument for your analysis.

The PerkinElmer Qsight® LC triple quad LC/MS/MS family can provide your lab with outstanding sensitivity and reliable performance even with the most challenging matrix.

It's What's Inside That Counts

Two sources are better than one
Maximize output from a single injection by collecting data from two independent sources (ESL/APCI).

High sensitivity and even higher productivity
Reduce chemical noise and maintenance time while simplifying sample preparation with our StayClean™ technology.

Go with the flow
Improve ions transmission efficiency with our Laminar Flow ion Guide™ - no axial electrical fields are necessary.

See how easy it is to switch
Near-simultaneous detection of positive and negative ions without high-voltage switching with our Unifield Detector™.

Choose from our 3 models:

Qsight 400, QSight 200, and QSight 100

QSight® Triple Quadrupole & LX50 UHPLC

LASSalesAU@perkinelmer.com 1800 033 391 www.perkinelmer.com/QSight

PerkinElmer®
For the Better