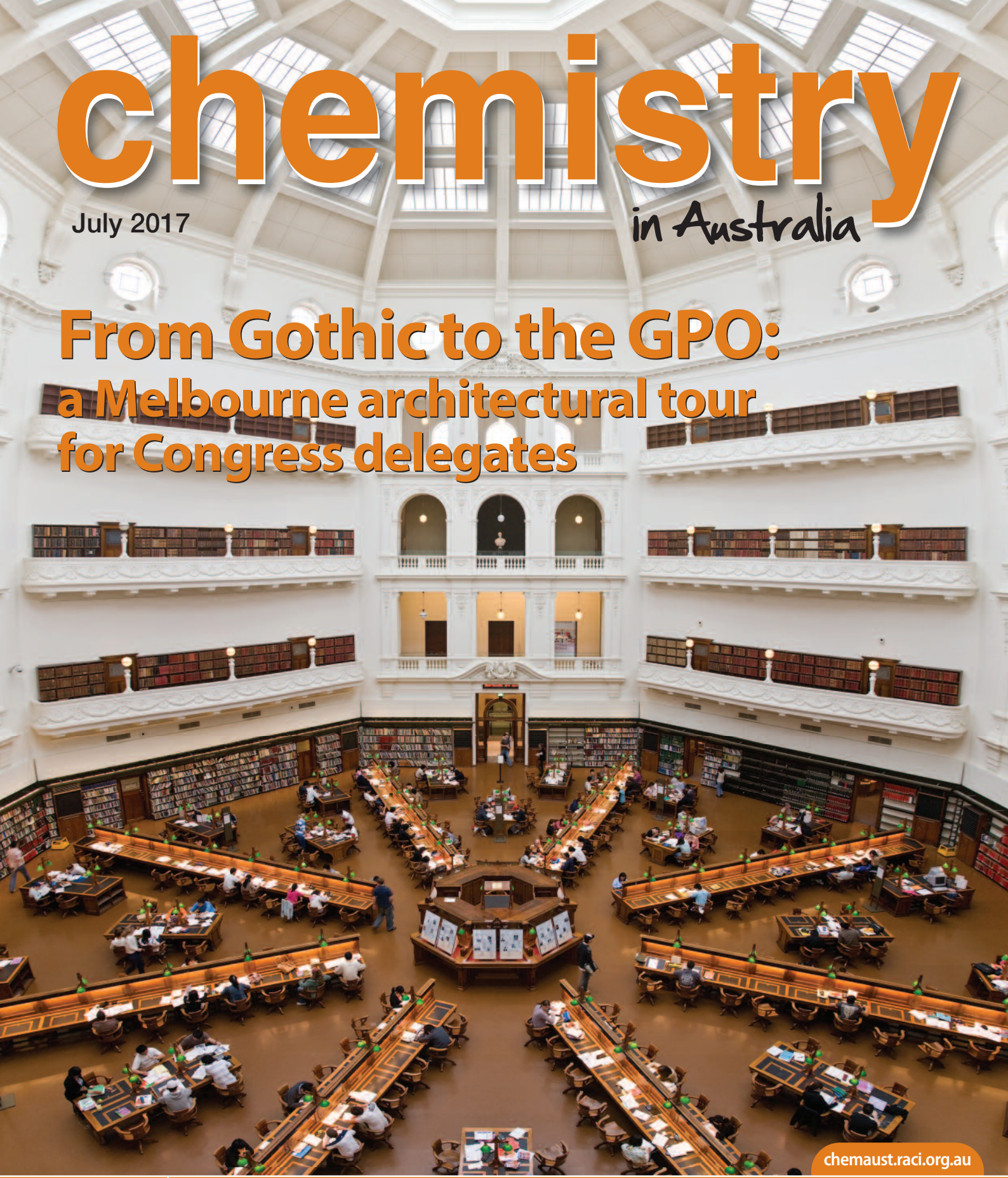
chemistry in Australia

July 2017

From Gothic to the GPO:
a Melbourne architectural tour for Congress delegates



chemaust.raci.org.au

- The declining art of scientific glassblowing
- Andrew Holmes celebrates RACI's centenary and 50 years of membership
- Peter Doherty on marching for science

Come and meet us at RACI Centenary Congress

SCI - Where Science meets Business

Tuesday 25 - Thursday 27 July 2017,

Melbourne Convention Centre, Melbourne Australia

SCI (Society of Chemical Industry) is a unique learned society established in 1881 to work at the interface of science and industry.

The SCI Seminar will appeal to scientists from industry and academia, who are looking to understand how to commercialise their technology and ideas and offers excellent case studies of how to succeed in taking lab discoveries to the marketplace. This three day seminar showcases prominent speakers from industry, academia, patenting and publishing.

Programme highlights include

Global perspectives: global trends in the chemistry using industry and the impact of Brexit
Policy: how does policy affect innovation and entrepreneurship: a NZ perspective
Funding: the role of venture capitalists in start-ups
Where science meets business: a showcase of case studies
IP and licensing: IP creation, protection, preservation, licensing agreements
Patenting & publishing: the role of patenting and publishing in protecting and promoting innovation

About SCI

Established in 1881, SCI has been led by eminent scientists, inventors, and industrialists such as Viscount Leverhulme, who established Unilever, Ernest Solvay, the founder of Solvay and Nobel prizewinner Sir William Ramsay, who discovered the Noble Gases.

The Australia International Group aims to offer a variety of activities such as lectures and seminars, plant visits, dinners and other social events to provide networking opportunities for its members. Key activities are the Plant of the Year Award (below) and annual Student Prizes to encourage excellence in undergraduate chemistry and chemical engineering students. The Committee meets monthly, usually over dinner in south Melbourne, and is actively looking for new members to play an active role in developing what we affectionately call the 'Antipodean Group' of the Society.

Register today: conferences@soci.org, www.soci.org/events

SCI
where science meets business

Get your chemistry quick smart

Visit us online today!

chemaust.raci.org.au

chemistry in Australia

iStockphoto/Kursad

chemistry in Australia

July 2017

cover story

A short city tour of Melbourne

Trevor McAllister leads the way between some of Melbourne CBD's great buildings.

22

The State Library of Victoria's La Trobe Reading Room as viewed from the fifth floor. It comprises four landscape photos combined vertically. David Iliff/https://creativecommons.org/licenses/by-sa/3.0/deed.en

RACI Centenary Congress: an opportunity to celebrate

Founded in 1917, the RACI is the oldest scientific or technical professional society in Australia. This month we are hosting one of the most exciting activities as part of the Institute's celebration of our first 100 years – the RACI Centenary Congress. As members read this column, many will be preparing to travel to Melbourne to participate in the many and varied activities associated with the Congress. Some members and delegates may well be reading this while they're immersed in the Congress program. For Congress delegates who don't normally receive a copy of *Chemistry in Australia*, I offer a particular welcome. I hope you enjoy perusing this edition of our monthly magazine. I look forward to meeting with as many Congress delegates as possible over the week of celebrations.

Speakers include Nobel laureates, Australia's Chief Scientist and a wide range of international leaders in chemistry research, education and policy development, as well as captains of industry.

The Centenary Congress is the largest scientific and technical meeting ever organised by the RACI, with approximately 3000 delegates attending over five days. The Centenary Congress is an opportunity to celebrate the contributions that chemistry has made to Australia's, and the world's, social, economic and intellectual advancement over the past century as well as to look forward to the challenges and opportunities in the century ahead.

The Centenary Congress brings together the RACI National Centenary Chemistry Conference, incorporating the 17th Asian Chemical Congress, and seven international conferences all under one roof. This structure allows the Congress to cover all of the major areas of the chemical sciences. All delegates to the Congress will be able to satisfy their diverse interests across the chemical sciences by being able to freely move between any and all of the parallel meetings.

The quality of the technical programs is first rate. Speakers include Nobel laureates, Australia's Chief Scientist and a wide range of international leaders in chemistry research, education and policy development, as well as captains of industry. Scientific sessions span the spectrum from creating new knowledge through to translating our knowledge of chemistry into innovative new technologies that enhance our quality of life.

To encourage scientific discussions in less formal environments, special attention has been paid to the Congress social program, with a welcome reception, several conference dinners and social functions coinciding with the various poster sessions. Additionally, with many tours on offer in and around Melbourne, delegates will be able to enjoy the cuisine, wines and unique flora and fauna of Victoria. I am sure that all delegates will enjoy a stimulating and pleasant Congress, from both the scientific and the technical points of view.

It has been a pleasure and a privilege over the past three years to serve as the Chair of the Congress organising Committee. However, this Congress has come together as the result of the hard work and dedication of a large number of colleagues. The diverse technical program has been developed under the leadership of Chairs of each of the Partner Conferences as well as the technical Divisions of the RACI. The logistics have been managed by a talented team of professionals from ICMS Australasia under the stewardship of Emma Bowyer. However, I pay particular tribute to the tireless efforts of our CEO, Roger Stapleford. Roger has been the driving force behind almost every aspect of the Congress's organisation. His creative thinking is first class, and his eye for detail is exceptional.

I look forward to the RACI Centenary Congress being a platform from which the RACI will contribute to society for the next 100 years.

Mark Buntine FRACI CChem, Centenary Congress Chair

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

PRODUCTION
Control Publications Pty Ltd
science@control.com.au
www.control.com.au

BOOK REVIEWS
Damien Blackwell
damo34@internode.on.net

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

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

PRESIDENT
Peter Junk FRACI CChem

MANAGEMENT COMMITTEE
Sam Adeloju (Chair) Sam.Adeloju@monash.edu.au, Amanda Ellis, Michael Gardiner, Helmut Hügel, Colin Scholes, Madeleine Schultz, 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

Equations in maths and chemistry

I noted with interest Kieran Lim's report (May, p. 40) on the difficulties many students have with the mathematical aspects of chemistry. Some years ago, a colleague and I explored this issue (Fensham P.J., Lui J. *School Science Review* 2001, vol. 83(302), pp. 57–62), and so I can add a few other sources of this problem.

Chemistry textbooks rarely comment upon or explain the use of the symbol → in a chemical equation in contrast with the familiar = symbol used for equations in mathematics. Furthermore, many teachers simply start by introducing the equation expressions for chemical reactions, which include the symbol →, without discussing how different chemicals can be added, to produce yet further different chemicals, when in mathematics adding *x* apples and *y* oranges does not lead to anything new.

We found that in German mathematics, the two symbols are in use. The symbol = is used, say, for 6 + 4 = 10, meaning the quantity on the left side is equal to the quantity on the right side. The symbol → is used in 6 + 4 → 7 + 3 to indicate that, if you add 4 to 6, you can produce new numbers, 7 and 3, which is a process many Australian students will have practised in their early stages of their learning about numbers.

We also found that while teachers can usually assume ratio and proportion have been taught and understood in mathematics before they are required in chemistry, the use of these concepts in even the simplest quantitative calculations of a chemical reaction is considerably more complex and needs very careful teaching.

Peter Fensham FRACI CChem

'Your say' guidelines

We will consider letters of up to 400 words in response to material published in *Chemistry in Australia* or about novel or topical issues relevant to chemistry. Letters accepted for publication will be edited (no proof supplied) for clarity, space or legal reasons and published in print and online. Full name and RACI membership type will be published. Please supply a daytime contact telephone number (not for publication).

Publication does not constitute an endorsement of any opinions expressed by contributors. All letters become copyright of the Royal Australian Chemical Institute and must not be reproduced without written permission.

Send letters to editor@raci.org.au.

An oenological jibe at an Aussie in the Trentino

Being a regular reader of Geoffrey Scollary's Grapevine articles and being of Italian descent, I was most pleased with his 'Italian bubbles for summer' article in the December 2016/January 2017 edition (p. 40). Its review of the wines from different Italian regions brought back memories, as I'm sure it did for many, of past and recent trips to Italy and the experiences with its most convivial people.

I was particularly chuffed that the wines of the Trentino region (far north-east corner of the country) were mentioned, it being from where my father's side of the family hale. When I was visiting the area recently, I stopped for a wine tasting, after which I purchased some fabulous wine in gorgeous gold-label bottles (presentation as you know is important!).

During the purchase I did mention that I was from Perth, Western Australia, to which the winemaker jokingly replied that it was about time that we bought some of their wine, since they had bought copious amounts of wine from our Margaret River region! Just goes to show that Australian wine is making an impact.

Alf Larcher FRACI CChem

RACI members and U3A

These comments follow on from an earlier article in November 2016 (p. 26) titled 'Science in the Third Age'.

I wrote to several high schools in Dubbo, New South Wales, before Science Week in August 2016 offering to give illustrated talks with samples on any topic they wanted me to cover. I especially mentioned the new zirconium/rare earth mine and gold mining in the Central West, pollution, etc. Of the two schools that replied, they were too busy with their programs. If it is not possible for chemists in Science Week to visit schools, we need another approach.

My suggestion is to work with the senior citizens attending U3A in this country. I am taking a class for two hours a week at U3A in Dubbo this year. The topic is 'Caring for the Environment'. I will cover the new zirconium/rare earth mine near Dubbo, gold and coal mining, pollution problems and other topics that interest the class.

Informed senior citizens may then be able to help educate other family members and friends. The people who have turned up to register for this year are very interested in the future of Australia.

Chris Owens FRACI CChem


EPA Victoria

First Chief Environmental Scientist for Victoria

The Environment Protection Authority (EPA) Victoria has appointed Dr Andrea Hinwood as Victoria's first Chief Environmental Scientist. An Associate Professor at Edith Cowan University and a sessional member of the State Administrative Tribunal of Western Australia, Hinwood commenced her new role on 1 May. She has previously worked with EPA Victoria in chemical and contaminated land management. The appointment was announced by EPA Victoria CEO Nial Finegan in March. According to EPA news, Hinwood will 'provide advice to EPA's leadership team and other senior decision makers, including the Minister for Environment and Victoria's Chief Health Officer.'

The need to provide community with health advice was a driver in completing my PhD in environmental exposure and continues to inform my community-based research and engagement.

Dr Andrea Hinwood, EPA Victoria (quoted in EPA news)

Nuclear fuel in the spotlight

The evolution of and influences on public opinion about nuclear fuel use in Australia need to be revisited, according to a review of the South Australian nuclear fuel issue in Canberra in April. The Canberra meeting, a symposium organised by the Energy Change Institute of the Australian National University in collaboration with the Academy of Science, ATSE and Engineers Australia, reviewed the report of the South Australian Nuclear Fuel Cycle Royal Commission.

The Royal Commissioner, the former Governor of South Australia, Rear Admiral Kevin Scarce, framed the symposium with a summary of the Royal Commission's findings, followed by a series of panel discussions on topics involving key stakeholders in industry, government, research and relevant organisations.

Given that social licence to operate was a key theme in all aspects of the nuclear fuel cycle, the symposium recommended that expertise in the humanities and social sciences be engaged to study the evolution and determining factors for public opinion on nuclear issues in Australia. This could be facilitated, it said, by conducting an Australian Council of Learned Academies (ACOLA) research project on the 'social licence to operate' on nuclear fuel use.

ACOLA's predecessor organisation, the National Academies Forum, published a major report, *Understanding the formation of attitudes to nuclear power in Australia*, in 2010. That report recommended a national, longitudinal program of research on attitudes to energy and climate change policy.

ATSE

… the Symposium recommends that expertise in the humanities and social sciences be engaged to study the evolution and determining factors for public opinion on nuclear issues in Australia.

Excerpt from Nuclear Fuel Cycle Symposium communique

Don’t relax drug approval process, experts warn

iStockphoto/negodina

Experts are warning that moves to deregulate the US drug approval process could see a flood of unproven and even harmful new drugs enter the market that could threaten human health.

The warning follows a speech to Congress by President Trump in which he said the US Food and Drug Administration’s drug approval process was ‘too slow and burdensome’, and where he promised to ‘slash the restraints, not just at FDA but across our government.’

Trump’s claims reinforce comments he made in January to pharmaceutical industry executives, where he said: ‘We’re going to be cutting regulations at a level that nobody’s ever seen before’, adding that up to 80% of regulations could be slashed.

In an editorial in *Nature* on 29 March, three experts said moves to deregulate the drug testing and approvals system will harm health everywhere, not just in the US, and that such moves will also stifle innovation and waste patients’ and taxpayers’ money.

One of the letter’s authors, Professor John Rasko from the University of Sydney and Royal Prince Alfred Hospital, said Trump’s argument is consistent with a history of neoliberal economic thinking that claims regulatory agencies are systematically biased towards excessive caution, and that the burden of testing a drug’s efficacy before it comes to market outweighs the benefits.

‘They argue that potentially harmful drugs can be identified quickly after they go on sale’, said Rasko, ‘and that the FDA runs an overly stringent system that withholds or delays safe and effective drugs from patients.’

These arguments are wrong, he says.

‘The most extreme proponents of deregulation say the market should be the sole arbiter of utility: if a medicine sells well, then it must, therefore, be safe and effective.

‘A more moderate version of this argument says reliable information on safety and efficacy can be collected after a drug is on sale, through observational studies or using biomarkers.

But Rasko and his co-authors, policy researcher Douglas Sipp and health economist Christopher McCabe, say relaxing the FDA’s regulatory system will subject patients to drugs that may be toxic.

They point to the iconic example of thalidomide – a 1950s drug prescribed for nausea during pregnancy – that caused more than 10 000 birth defects worldwide.

‘Even in the past dozen years, initially promising drugs, such as torcetrapib (for reducing cholesterol and heart-disease risk) and semagacestat (for improving cognition in people with Alzheimer’s disease), were found to cause harm only after they had been tested in large, mandatory trials – effects that were not seen in the smaller trials’, said the authors.

Another problem with deregulatory arguments is the issue of safe but ‘useless’ drugs.

‘Untested drugs can be reasonably safe but provide no benefit’, said Rasko, ‘and unregulated markets are hopeless at sifting out these “futile drugs”. We only have to consider the multibillion-dollar industries in homeopathy and other pseudo-medicines to see this.

‘These ineffective pills and potions are a massive waste of money and provide false hope to millions of people worldwide. What’s more, for progressive diseases such as cancer or multiple sclerosis, if a doctor were to prescribe a drug that didn’t work, she’d be giving a disease a free pass.’

Meanwhile, the current regulatory system is working well, said Rasko and his colleagues.

In January 2017, the FDA released a report identifying 22 products that were initially promising but disappointed in later-stage clinical trials: 14 for lack of efficacy, one for lack of safety, and seven for both reasons.

Rasko said it’s important to consider how far we have come thanks to regulatory agencies like the FDA, and what’s at stake right now as President Trump considers appointing a possibly radical new FDA commissioner.

‘The 1938 US Food, Drug, and Cosmetic Act required only that drugs demonstrate safety’, he said. ‘In 1962, new legislation demanded that marketed drugs also go through well-controlled studies to test for therapeutic benefit.

‘More than 1000 medical products were subsequently withdrawn after reviews found little or no evidence of efficacy. The free market that existed before 1962 revealed no connection between a drug’s ability to turn a profit and its clinical usefulness.’

The same is likely to be true of any future deregulated market, the experts warn in *Nature*.

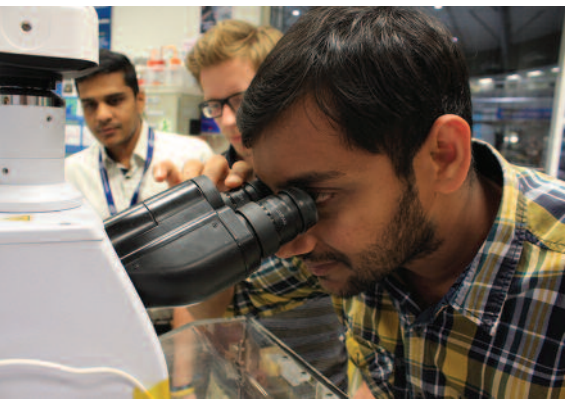
‘Patients and doctors must have access to reliable information to make educated and ethical choices.

‘But reliable information costs money and no one will invest in producing good-quality evidence if they can make the same profit on a drug or technology without it.

‘Rigorous clinical studies are still the best way to learn whether a drug works, and regulation is essential to ensure that these studies are conducted.’

University of Sydney

IR insights into carbon fibres



Left to right: Nishar Hameed, Maxime Maghe and Srinivas Nunna on the Australian Synchrotron Infrared Spectroscopy beamline.

Infrared (IR) imaging technology at the Australian Synchrotron, developed specifically for carbon fibre analysis, has contributed to a better understanding of chemical changes that affect structure in the production of high-performance carbon fibres using a precursor material.

A research collaboration led by Carbon Nexus, a global carbon fibre research facility at Deakin University, Swinburne University of Technology and members of the Infrared Microspectroscopy team at the Australian Synchrotron, has just published a paper in the *Journal of Materials Chemistry A* (2017, issue 16), that identified and helped to explain important structural changes that occur during the production of carbon fibres.

The research was undertaken to elucidate the exact chemical transformation occurring during the heat treatment of polyacrylonitrile (PAN), which produced structural changes.

The majority of commercial carbon fibres are manufactured from PAN but there has been an imperfection that occurred during production that affected its material properties.

Because the conversion of PAN to carbon fibre did not occur evenly across the fibre, it resulted in a skin-core structure.

Manufacturers want to prevent the formation of the skin-core structure in order to enhance the strength of the fibres.

The research, led by Dr Nishar Hameed, provides the first quantitative definition on the chemical structure development along the radial direction of PAN fibres using high-resolution IR imaging.

'Although it has been more than half a century that carbon fibres were first developed, the exact chemical transformations and the actual structure development during heat treatment is still unknown.'

'The most significant scientific outcome of this study is that the critical chemical reactions for structure development were found to be occurring at a faster rate in the core of the fibre during heating, thus disrupting the more than 50-year-old belief that this reaction occurs at the periphery of the fibre due to direct heat.'

A multitude of experimental techniques including IR spectroscopy confirmed that structural differences evolved along the radial direction of the fibres, which produced the imperfection.

The difference between skin and core in stabilised fibres evolved from differences in the cross-linking mechanism of molecular chains from the skin to the core.

The information could potentially help manufacturers improve the production process and lead to better fibres.

'Using a technique called attenuated total reflection (ATR) to focus the synchrotron beam, the IR beamline allowed the research team to acquire images across individual fibres, to see where carbon–carbon triple bonds in the PAN were being converted to double bonds,' said Dr Mark Tobin, Principal Scientist, IR, at the Australian Synchrotron, who is a co-author with Dr Pimm Vongsvivut and Dr Keith Bambery.

'Previous IR studies have been conducted on fibre bundles and powdered fibres, while we were able to analyse the cross-section of single filaments.'

To acquire detailed images of the fibres, which are only 12 micrometres across, the IR team modified the beamline for the experiment using a highly polished germanium crystal to focus the IR beam onto the fibres.

Lead author Srinivas Nunna received a postgraduate research award from the Australian Institute of Nuclear Science and Engineering (AINSE) to support the study.

First published at www.synchrotron.org.au.

American and Korean Chemical Societies collaborate to recognise advancement of science

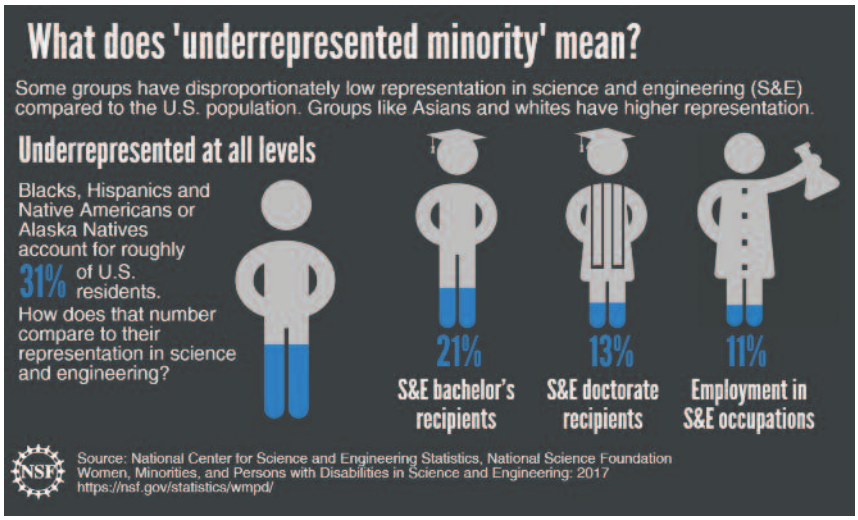
The American Chemical Society (ACS) announced in April a three-year collaboration with the Korean Chemical Society (KCS) to recognise outstanding contributions by distinguished scientists in Korea. The collaboration includes an annual award and a symposium.

The new ACS–KCS Excellence Award – sponsored by Chemical Abstracts Service, a division of the American Chemical Society – honours a scientist working in Korea who is excelling in the field of chemistry. The recipient is selected by KCS and receives a cash award, three-year complimentary access to SciFinder and a three-year ACS membership. The award will be presented annually during the KCS spring meeting.

For 2017, the ACS–KCS Excellence Award recipient is Dr Sukbok Chang, a director of IBS, a professor at KAIST and an associate editor of ACS *Catalysis*. Chang is being honoured for his development of catalytic systems that enable highly selective and efficient C–H functionalisation of low reacting molecules. He received his award on 20 April.

American Chemical Society

Women, minorities and persons with disabilities in science and engineering report



The US National Center for Science and Engineering Statistics announced in January the release of the 2017 *Women, minorities, and persons with disabilities in science and engineering* report, the US government's most comprehensive look at the participation of these three demographic groups in science and engineering education and employment.

The report shows the degree to which women, people with disabilities and minorities from three racial and ethnic groups – black, Hispanic and American Indian or Alaska Native – are underrepresented in science and engineering (S&E). Women have reached parity with men in educational attainment but not in S&E employment. Underrepresented minorities account for disproportionately smaller percentages in both S&E education and employment.

Key findings include:

- The types of schools where students enrol vary among racial and ethnic groups.
- Since the late 1990s, women have earned about half of S&E bachelor's degrees. But their representation varies widely by field, ranging from 70% in psychology to 18% in computer sciences.
- At every level – bachelor's, master's and doctorate – underrepresented minority women earn a higher proportion of degrees than their male counterparts. White women, in contrast, earn a smaller proportion of degrees than their male counterparts.
- Despite two decades of progress, a wide gap in educational attainment remains between underrepresented minorities and whites and Asians, two groups that have higher representation in S&E education than they do in the US population.
- White men constitute about one-third of the overall US population; they comprise half of the S&E workforce. Blacks, Hispanics and people with disabilities are underrepresented in the S&E workforce.
- Women's participation in the workforce varies greatly by field of occupation.
- In 2015, scientists and engineers had a lower unemployment rate compared to the general US population (3.3% versus 5.8%), although the rate varied among groups.

For more information, including access to the digest and data tables, see https://nsf.gov/statistics/wmpd.

National Science Foundation

Next phase for smaller electronic devices

Researchers have made a technological breakthrough that will help unlock the next phase of creating smaller everyday electronic devices such as mobile phones and laptops.

In a paper published in April in *Nature Communications* (doi: 10.1038/ncomms15056), researchers report the creation of a diode out of a single molecule, which will help continue the downsizing trend of electronic devices.

Diodes, which are responsible for directing electric currents in most common electronic devices, allow currents to flow in one direction while blocking currents in the opposite direction.

Lead researcher Dr Nadim Darwish, from Curtin University's Department of Chemistry and Curtin Institute for Functional Molecules and Interfaces, said the physical limit of current computing power had been reached because today's conventional technology was limited to allowing only the printing of millions of diodes on silicon chips, not thousands of billions of diodes.

'While we are not the first to have created single-molecule diodes, this diode is much smaller and more efficient than any previously reported. Using this technology, we can fit more than ten thousand billion diodes onto a 1 cm^2 area of a silicon chip, which will help make it easier to develop even smaller everyday electronic devices in the future.' Darwish said.

Co-author Dr Simone Ciampi, also from Curtin University, said the team of researchers was now focused on increasing the mechanical stability of the diodes, to ensure it worked to open up a range of exciting technological possibilities for modern electronic devices.

The paper was co-authored by researchers from the University of Barcelona and the University of New South Wales.

Curtin University

Australia's next oil boom might just come from plants

Sorghum bicolor **is widely used as a feedstock and biofuel.**

Research by CSIRO now makes it possible to produce oil in the leaves and stems of plants as well as the seeds. This promises to be a game changer in the global production of renewable oils. US-based company Amfora and CSIRO have signed an agreement that will advance development and commercialisation of the technology to produce energy-rich feed for livestock.

In some plants, the research team has been able to get around 35% oil content into vegetative tissue, the same amount as in many oil seed crops.

CSIRO Chief Executive Dr Larry Marshall said the work demonstrates the capacity of Australian researchers to develop innovative solutions for global industries.

'It is estimated that in 20 years' time we will need 50% more plant-based oils just to meet the nutritional needs of a global population, and there is also a growing demand for renewable biofuels', Marshall said.

Amfora will use the technology to develop oil content in the vegetative tissue of corn and sorghum, meaning they can market a feed for dairy farmers that does not require them to purchase additional oils, such as tallow or cotton seed, to supplement feeds.

Dairy cattle require around 7% fat in their diet to produce milk. If their feed already contains this fat in the form of oil, then this means less agricultural land is needed to produce feed and fewer greenhouse gas emissions are produced from feed production.

CSIRO

World's most spoken language is 'Terpene'

Research by microbial ecologists from the Netherlands Institute of Ecology has demonstrated that two very different groups of micro-organisms use fragrances to communicate with each other, the most common type being terpenes.

In only one gram of soil billions of micro-organisms are thriving, so that makes many 'speakers'. On top of that, this 'chemical communication' will probably work for many other life forms as well. This is what the research team discovers in *Scientific Reports*, a relatively new journal from the Nature family (doi: 10.1038/s41598-017-00893-3).

The researchers have demonstrated that bacteria and fungi respond to each other. In other words, they can hold conversations. Group leader Paolina Garbeva explained, '*Serratia*, a soil bacterium, can "smell" the fragrant terpenes produced by *Fusarium*, a plant pathogenic fungus. It responds by becoming motile and producing a terpene of its own.'

The researchers established this by studying which genes were switched on by the bacterium, which proteins it began to produce and which fragrance.

'Such fragrances – or volatile organic compounds – are not just some waste product, they are instruments targeted specifically at long-distance communication between these minute fungi and bacteria.'

But how widespread is this language of smells? Pathogenic soil fungi such as *Fusarium* also have an effect aboveground, where they make plants sick. Can they communicate with those plants? Garbeva said, 'We have known for some time that plants and insects use terpenes to communicate with each other. But we've only just begun to realise that it's actually much wider. There is a much larger group of "terpene-speakers": micro-organisms.'

Fungi, protists, bacteria, and even higher animals. Terpenes act as pheromones, which makes them a regular ingredient of perfumes. So it's likely that the language of terpenes forms a vast chemical communications network indeed.

Terpenes are by no means the only volatile organic compounds that are in for a good chat. The researchers found others as well: in the soil, for instance. Garbeva's PhD student Ruth Schmidt, the first author of the article, added, 'Organisms are multilingual, but 'Terpene' is the one that's used most often.'

Who knows, maybe without realising it we are native speakers too?

Netherlands Institute of Technology

Students get a taste for brewing

Paul and Natasha Holgate have taken their beer-making knowledge to campus.
Chris Hopkins

Brewer Paul Holgate is quite emphatic. The new subject he helps teach at the University, 'An introduction to beer styles', does require students to swallow, not spit.

'It's the only way', he says. 'The only way! This is what we do in beer judging to understand style and a beer's characteristics. To get the full hop or bitter sensation on the back of the tongue, you need to swallow the beer.'

The higher the percentage of hops, the more bitter the beer, but students need to keep in mind that bitterness can be off-set by the sweetness of malt, which helps determine a beer's flavour and style. Tasting the beer will tell a drinker all about that.

'An introduction to beer styles' and 'Sensory analysis and principles of brewing' – two breadth subjects introduced this year by the Faculty of Veterinary and Agricultural Sciences – cover a fair bit of beer-making and drinking territory, with help from Paul and Natasha Holgate, of Holgate Brewhouse in Woodend, 70 kilometres north-west of Melbourne.

Paul is a guest lecturer in the highly popular 'Beer: theory and craft' subjects, which teach a range of skills to would-be beer-makers. It's a chance for students to learn about a fast growing industry from real-world professionals.

For the Holgates, the subjects mark a return to their old stomping ground. The couple met in the University's chemistry library in 1987. Both were chemistry majors (BSc(Hons) 1989), who went on to work in the chemical industry before Paul decided to take his enthusiasm for home brewing and turn it into a business.

The couple moved to Woodend and began selling beer they made in a backyard shed. Eventually, they left their corporate careers to concentrate on their passion. The timing was perfect.

By 2002, when the Holgates bought an old hotel (circa 1896) in Woodend's main street, interest in the craft-brewing movement, which had begun in the US and Britain, was taking off in Australia.

It has been portrayed as a kind of grassroots rebellion against the dominance of big, multinational brewers. Paul says 'craft brewing', a term that has been bastardised by big breweries, requires time, attention to detail and quality ingredients.

It has proved to be a winning formula for Holgate Brewhouse, which has since expanded to a restaurant and hotel, with a showroom and beer discovery centre in the works. The Holgate brews sell in bars, pubs and outlets across Australia.

Subject coordinator Dr Charles Pagel, a lecturer in veterinary and agricultural sciences and an avid home brewer himself, says the study of craft brewing fits well with other University subjects in wine-making and viticulture.

'Breadth subjects allow students to learn about something they're interested in from outside the core disciplines of their degree', he says. 'Many of the students I have talked to are interested in the recent rise of the craft-brewing movement, and are keen to learn more about brewing and even to get their hands dirty and have a go themselves.'

Dr Pagel says enrolments in the subject have been high, prompting him to move classes to a bigger lecture theatre and to add more practical sessions. Students will learn the skills to brew good-quality beer, with additional lectures in biochemistry, agriculture, sustainability and marketing.

Meanwhile, Paul and Natasha's daughter, Emily, is now at the University studying a Bachelor of Arts. She has yet to say whether she will follow in her parent's beer-brewing footsteps.

'I think she would know a lot more about beer than regular kids her age,' says Paul. 'We'll wait and see. Let her enjoy uni first.'

By Jeni Port. First published in *3010 Melbourne University Alumni magazine*, unimelb.edu.au.3010, issue 1, 2017.

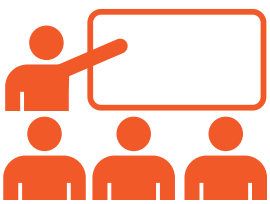
RACI2017 Centenary Congress

The oldest scientific or technical professional society in Australia, the Royal Australian Chemical Institute celebrates their centenary, at RACI2017 in Melbourne at the Melbourne Convention & Exhibition Centre 23-28 July 2017.

RACI Must Dos

Be social. Mingle in amongst old friends and make new ones. Celebrate the Centenary and enjoy yourself.

This novel congress concept involves all of the partner conferences running concurrently during the week allowing delegates to access sessions across a wide variety of chemistry disciplines.



CHEMISTRY – ADDRESSING

- 2 Nobel laureates
- 9 Congress plenary speakers
- 334 Keynote/Invited speakers
- 62 participating countries
- 2979 abstract submissions
- 1575 oral submissions
- 1404 poster submissions

1917 - 2017 100
raci
National Centenary Conference

17ACC
17th Asian Chemical Congress & 19th General Assembly of FACS
23-28 July 2017 Melbourne Australia
Chemistry addressing sustainable development and other challenges of the 2020s

6th Asian Conference on Coordination Chemistry
ACCC6
24-28 July 2017 I Melbourne, Australia

AHeDD 2017
Asian Hub for e-Drug Discovery Conference
Computers in Drug Discovery
26-27 July 2017
Melbourne Australia

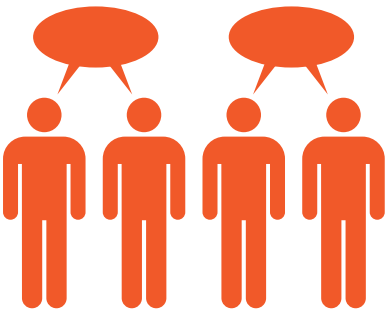
Melbourne | 23-28 July 2017

Download the App from the Congress website.

Attend the Academic Sharp Brain

- 10 intelligent minds will pitch their ideas
- Panel of experts vote for the idea
- Knowledge investors will compete by offering bigger dollars
- Intelligent minds and knowledge investors will bring the idea to the marketplace

Join the conversation #RACI100

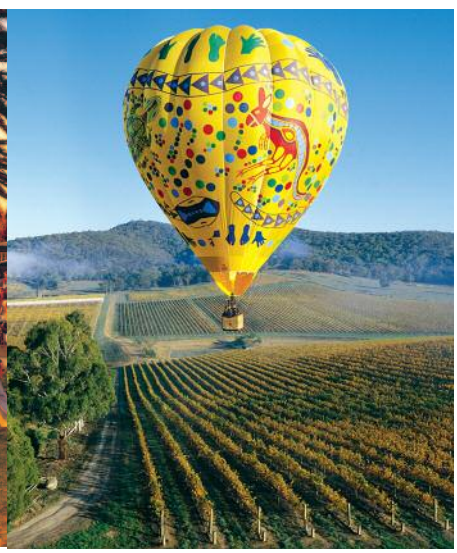


Plan ahead, create your own itinerary and make contacts with other attendees.

chemeca CONFERENCE
26 JULY 2017
MELBOURNE AUSTRALIA
ACADEMIC SHARP BRAIN

Consult with your colleagues and make valuable connections. Speakers, sponsors and exhibitors and attendees alike are experts in their field.

SUSTAINABLE DEVELOPMENT AND OTHER CHALLENGES OF THE 2020s



23-28 July 2017 | Melbourne

raci 100

Centenary Congress

REGISTER NOW
www.racicongress.com

AIMECS2017
23-26 July 2017 | Melbourne Australia
Chemistry in Drug Discovery, Design & Development

Carbon 2017
23-28 July 2017
Melbourne Australia

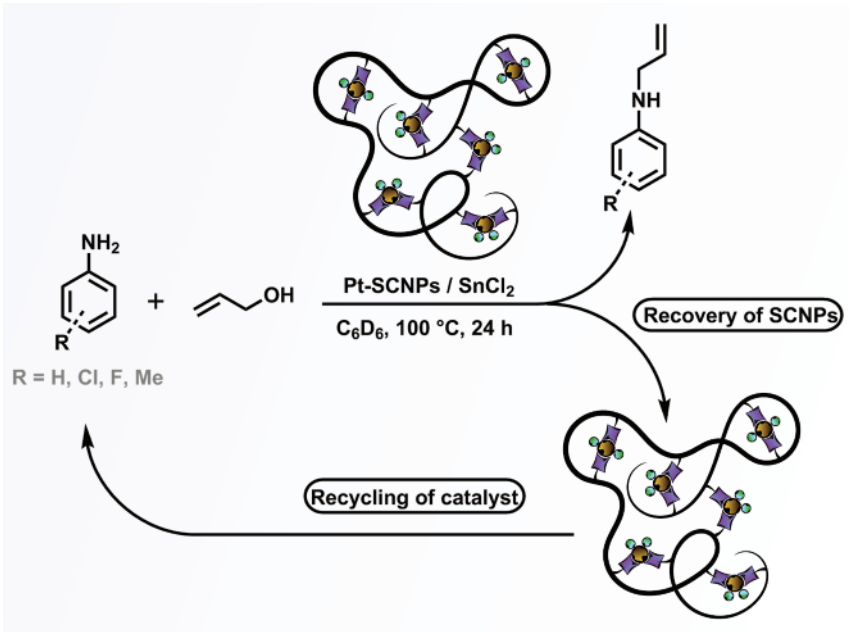
chemeca CONFERENCE
23-26 JULY 2017
MELBOURNE AUSTRALIA

GSC8
8th International Conference on Green and Sustainable Chemistry
23-26 July 2017 | Melbourne Australia

18th TETRAHEDRON SYMPOSIUM
Asia Edition
24-26 July 2017
Melbourne, Australia

Stable, recyclable catalysts using single polymer chains

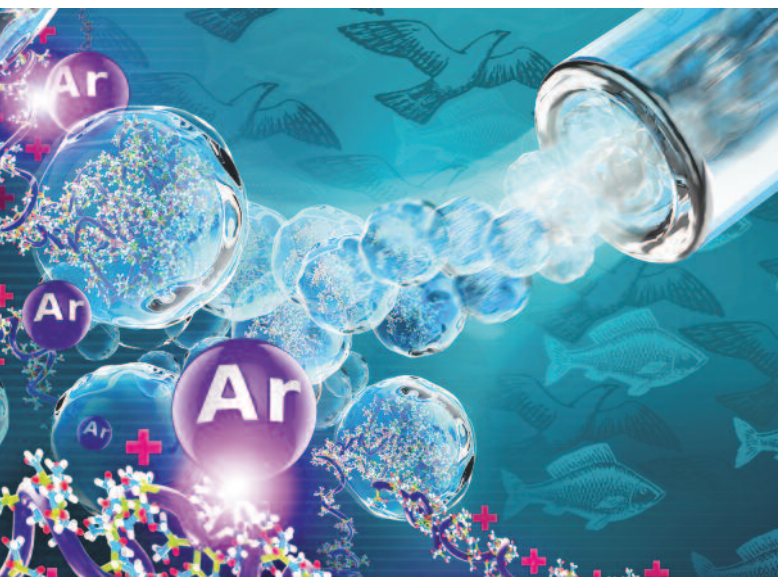
The research teams of Christopher Barner-Kowollik and Peter Roesky at the Queensland University of Technology and Karlsruhe Institute of Technology, Germany, have pioneered a new macromolecular catalyst by embedding transition-metal catalytic centres into folded single-polymer chains (Knöfel N.D., Rothfuss H., Willenbacher J., Barner-Kowollik C., Roesky P.W. *Angew. Chem. Int. Ed.* 2017, **56**, 4950–4). Critically, the team was able to demonstrate for the first time that the folded polymer chains retain their original shape during catalysis and can be readily removed from the reaction mixture by a simple precipitation procedure and recycled. The team demonstrated the stability of the shape of the single-chain nanoparticles (SCNPs) via light-scattering, NMR and chromatographic methods. Remarkably, the folded single-chain macromolecular catalysts showed similar activity to a reference homogeneous metal catalyst, opening a new door to the design of advanced macromolecular catalysts. The



field of catalysis based on precision-made macromolecules folded into well-designed catalytic nano-environments ultimately aims to achieve the selectivity of naturally occurring catalysts such as enzymes, but with significantly enhanced stability and tailored specificity. The team envisages being able to construct a wide array of metal-containing single-chain folded systems for catalytic applications, providing a significant improvement over existing homocatalytic reactions.

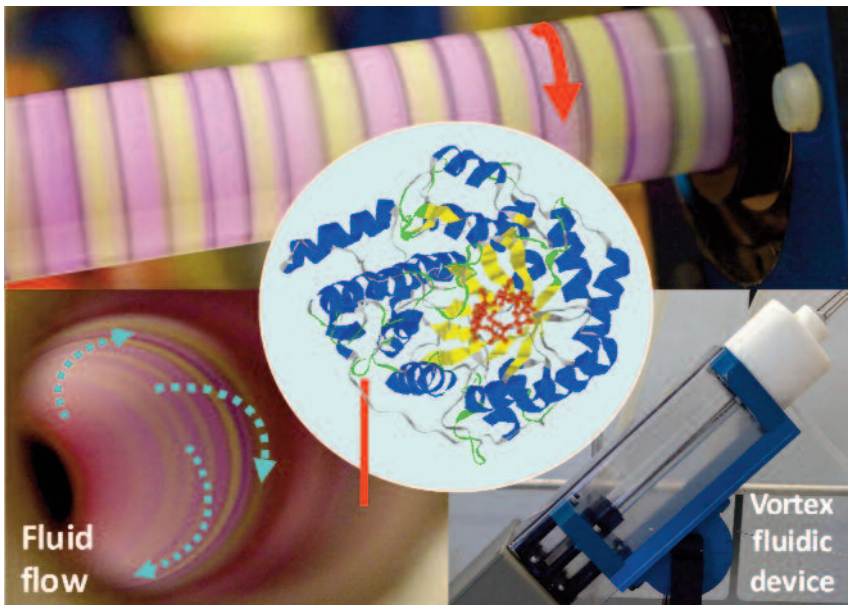
Turning proteins into the strongest known acids

University of New South Wales chemists have produced the strongest organic acid, demonstrating that protein ions in high charge states can protonate molecules and atoms that are



normally considered inert, such as argon and nitrogen, at room temperature. Such protein 'superacids' are >10 kJ/mol more acidic than H_2F^+, the primary acidic component of fluoroantimonic acid and strongest acid on record (Zenaidee M.A., Leeming M.G., Zhang F., Funston T.T., Donald W.A. *Angew. Chem. Int. Ed.* 2017, doi: 10.1002/anie.201702781). Protein sequence analysis is primarily achieved by mass spectrometry and proteins with more charges can be more readily sequenced than those with fewer charges. By forming highly charged protein ions, proteins can be nearly completely sequenced from the mass spectra of single charge states for proteins up to 66 kDa. The previous limit for such experiments was 10 kDa (which covers <5% of human proteins). Because these highly charged protein ions are >375 kJ/mol less basic than the components of electrospray ionisation solutions, this research resolves a longstanding debate in the literature about how protein ions are formed in electrospray ionisation. This finding could change the way that mass spectrometers are designed – by modifying the ion source to reduce proton transfer, even higher charge states can be generated to yield significant performance gains.

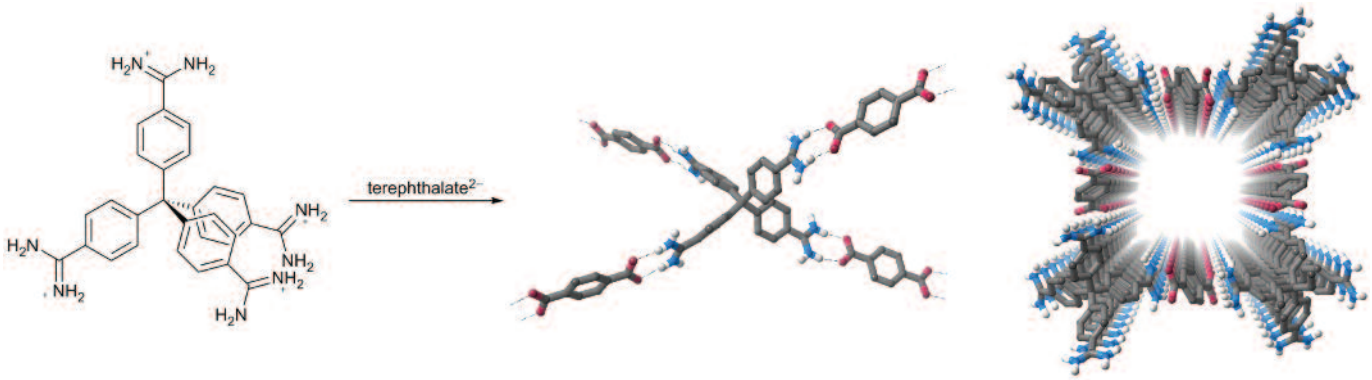
Rapid protein purification and surface tethering for continuous flow biocatalysis



Enzymatic assembly lines have evolved over eons to synthesise a vast range of bioactive compounds. Inspired by the possibility of performing assembly line syntheses in the laboratory, a research team at the University of California, Irvine, and Flinders University in South Australia have developed a facile method to purify and attach enzymes to the surface of the glass tube in a vortex fluidic device for use under continuous flow conditions (Britton J., Dyer R.P., Majumdar S., Raston C.L., Weiss G.A. *Angew. Chem. Int. Ed.* 2017, **56**, 2296–301). Six proteins were purified and immobilised in only 10 minutes to create a 'reaction-ready' system suitable for at least five days of continuous flow processing. The proteins included tobacco *epi-aristolochene synthase*, which is particularly difficult to purify and work with due to its propensity to aggregate; it was attached via a His_n epitope fused to the protein's terminus. As multi-step transformations become increasingly popular in continuous flow synthesis, the authors aim to use the new method to determine what beneficial attributes rapidly immobilised proteins can yield and whether it is possible to create chemoenzymatic assembly lines outside of the cell for the eventual synthesis of compounds vital to human health.

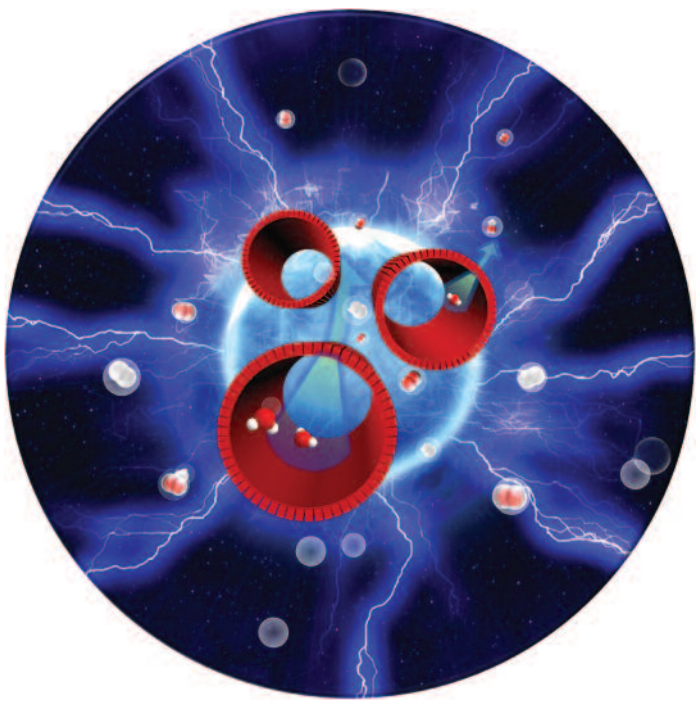
Switchable supramolecular frameworks in water

Anions typically form quite weak supramolecular interactions, particularly in competitive and/or protic solvents. But now researchers at the Australian National University, in collaboration with colleagues at the University of Adelaide, have demonstrated that anions can be used to assemble porous supramolecular framework materials in water (Morshedi M., Thomas M., Tarzia A., Doonan C.J., White N.G. *Chem. Sci.* 2017, **8**, 3019–25). The materials were assembled by charge-assisted hydrogen bonds between tetratopic amidinium receptors and terephthalate anions. Impressive selectivity was observed during the synthesis as no frameworks were obtained if a range of other anions was used in place of terephthalate (namely halides, nitrate, sulfate or isophthlate). Two forms of the framework were prepared: one containing a network of connected pores, and another containing smaller discrete pores. The researchers showed that these were the kinetic and thermodynamic forms of the framework, respectively, and that it was possible to switch between the two in response to stimuli. Furthermore, the frameworks could be disassembled and rapidly re-assembled in response to acid–base triggers, suggesting that related materials could be used to selectively bind and release guests.

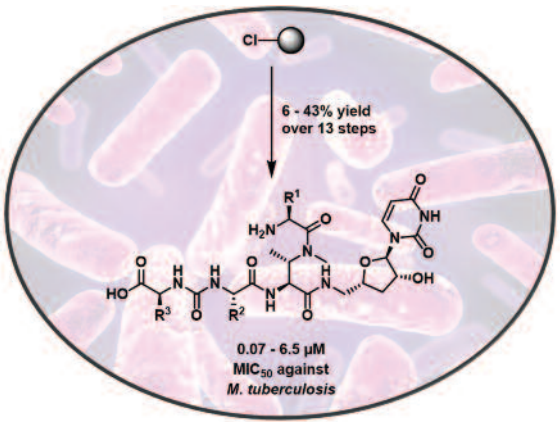


Hollow microtube arrays for efficient water electrolysis

Electrochemical water splitting is a key process in sustainable energy technologies, but the electrochemical activity and durability of electrocatalysts must improve and their cost reduced for this process to be commercially viable. Engineering well-defined micro/nanostructures through a rational synthesis strategy is one way to achieve this goal. Recently, Professor Shizhang Qiao of the University of Adelaide and co-workers have developed an electrochemical sacrificial-template strategy to prepare hollow Co_3O_4 microtube arrays featuring interesting hierarchical structures for electrocatalytic water splitting (Zhu Y.P., Ma T.Y., Jaroniec M., Qiao S.Z. *Angew. Chem. Int. Ed.* 2017, **56**, 1324–8). $CoHPO_4$ microrods with low stability in alkaline media were employed as templates for the Co_3O_4 microtube arrays, which were produced by anodic bias treatment. The resultant arrays could be used directly for electrocatalytic water splitting with high activity and remarkable stability, even surpassing the combined performance of precious metal IrO_2/C and Pt/C benchmarks. The impressive performance is related to the considerable surface area, hierarchical porosity and hollow structure, ensuring abundant active sites and exceptional mass transfer. Owing to the readily scalable synthesis, material availability, and excellent performance, this work paves the way for the exploitation of three-dimensional and free-standing electrodes with well-structured morphologies and adjustable chemical compositions for high-efficiency water electrolysis or photolysis.



Exploiting nature in the fight against tuberculosis



Tuberculosis (TB) is a major global health burden, with two billion people currently infected with the microbe that causes it, *Mycobacterium tuberculosis*. In 2015 alone, TB was responsible for 1.8 million deaths worldwide. Perhaps most concerning is the rapid emergence of drug-resistant *M. tuberculosis* strains, which means that new TB drugs with novel modes of action are desperately needed. A multi-disciplinary team led by researchers at the University of Sydney has recently reported a new class of anti-mycobacterials derived from the sansanmycin family of natural products, which has previously been shown to possess activity against *M. tuberculosis* (Tran A.T., Watson E.E., Pujari V., Conroy T., Dowman L.J., Giltrap A.M., Pang A., Wong W.R., Linington R.G., Mahapatra S., Saunders J., Charman S.A., West N.P., Bugg T.D.H., Tod J., Dowson C.G., Roper D.I., Crick D.C., Britton W.J., Payne R.J. *Nat. Commun.* 2017, **8**, 14414). A library of over 30 natural product analogues was synthesised via an efficient solid-phase strategy, from which key structural features required for anti-mycobacterial activity were identified. Lead compounds exhibited nanomolar activity against *M. tuberculosis* and were exquisitely selective over other clinically relevant bacterial strains. The team subsequently determined that the antimycobacterial activity of the compounds stems from inhibition of the enzyme translocase I (MurX) involved in peptidoglycan biosynthesis. MurX has yet to be exploited as a TB drug target and so these natural product analogues serve as an exciting starting point for the development of a novel TB drug.

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.*, *Chem. Sci.*) are encouraged to contribute general summaries, of no more than 200 words, and an image to David.

Would you publish in a 'Chemsitry' journal and who is Stefania?

What do you think when you receive an exhortation to publish in 'an academic, online peer-reviewed journal' that has the stated objective 'to publish quality research that undergoes a thorough scrutiny process'? But their thorough scrutiny does not extend to spelling 'chemistry' correctly! Not much, I imagine.

We are all getting daily invitations to submit to or review for new 'journals', and this seems to paint a picture of an explosion of new journals. The most annoying issue here is that we are being asked to contribute to journals that have no relationship to our area of expertise.

Additionally, the deluge of invitations to give keynote presentations at a myriad of dubious conferences is a new worrying trend. A salient example is when a colleague of mine at the University of Western Australia was issued with a cordial welcome to be the chair/speaker in the conference theme 'Snack Food and Sweet Food, Baking Food' on the basis of a recently published paper entitled 'Sandwich and half-sandwich metal complexes derived from …'. Clearly an amusing faux pas, but one begins to wonder what has driven the equivalent of the Nigerian email scam.

This phenomenon of predatory publishing has been the subject of a fascinating study by a Polish group who created the identity of fake scientist Anna O. Szust and applied on her behalf to the editorial boards of 360 journals (see *Nature*, **543**, 481–3, also the subject of an article in the *New Yorker*). Szust's academic record was constructed to be inadequate and not of the standing to be approached for editorial board membership, but that did not hinder her appointment to 48 of those journals. In fairness, quite a number rejected her application on these grounds; perhaps some of them recognised that 'Szust' was Polish for fraud.

Most of these predatory publishers seek to profit from the fees that are requested for publishing in their so-called journal and their continued proliferation suggests that a significant proportion of people are taking up the offer. What's driving the phenomenon? I imagine the ever-increasing scrutiny of academic performance has driven unsuspecting academics to try and accumulate the tokens required to remain in their jobs. In a world where a keynote invitation to an international conference is promotion currency, such offers would be tempting. Thus, unqualified metrics have driven the phenomenon of predatory publishing and the proliferation of dubious conferences.

The over-reliance on metrics such as *h*-index and journal impact factor, while easy to measure, is misplaced. Such instruments are rather blunt and lack the agility required to effectively indicate quality and even, perhaps, impact.

It used to be said that the one good thing about being an academic chemist was that our conferences were held in nice places. Now you have to be very careful where you register. I regularly get conference invitations from Stefania, the latest being 'Seventh Joint International Conference organised by Institute of Research Engineers and Doctors' and I haven't the heart to tell them that I am not an engineer. I'd like to be able to tell you how to spot a predatory journal and a bogus conference but the scams are becoming sophisticated, unlike the recent one when advertising its Advanced Synthesis and Catalysis Sessions, which suggested that chiral pharmaceuticals were created by enantioselective catalysis defined as 'synergist hilter kilter amalgamation'.

The question we face is whether these predatory journals are a clear threat or simple ruses that are easily spotted and should therefore be disregarded. Perhaps there should be a return to a register of predatory journals, which was once online, compiled by University of Colorado librarian Jeffrey Beal. The only answer, in my view, is good science published in respectable journals. We all know which they are.

George Koutsantonis FRSC, FRACI CChem, Co-Editor-in-Chief, *Australian Journal of Chemistry*
(george.koutsantonis@uwa.edu.au)

RACI's first 100 years

An inspiring chemical history

To celebrate his 50th year as an RACI member and the Institute's centenary, Andrew Holmes reflects on some great Australian chemistry over the past century.

At the time that the Royal Australian Chemical Institute celebrates its 100th anniversary in 2017, I shall have been a member of the organisation for 50 years, and I think that is something to celebrate.

I decided to list some of the luminaries of the late 19th and 20th century that I would like to 'invite back' to the 100th anniversary dinner celebration. One could start with the early giants recognised in the field of chemistry in Australia (in those days, nearly always men).

Sir David Orme Masson was the first professor of chemistry at the University of Melbourne and the founder of the (Royal) Australian Chemical Institute in 1917. It would be interesting to ask him whether his vision had been fulfilled and what he would expect today of the modern RACI. Masson worked closely with his mentor Sir William Ramsay (of Bristol and later UCL). They were very interested in the classification of the inert gases (and whether they should be assigned to a special group in the periodic table), and Masson

introduced the 'flap model' of the periodic table that is so eloquently discussed in Ian Rae's* article in the 2013 volume of *Historical Records of Australian Science*, vol. 24, issue 1 (June 2013). Masson classified hydrogen above fluorine in group VII and I believe that version of the periodic table was extant in at least one lecture theatre in my early undergraduate years at the University of Melbourne.

Other notable dinner guests would be the chemists who were the foundation chemistry Fellows of the fledgling Australian Academy of Science in 1954. These include physical organic chemist Raymond J.W. Le Fèvre, agricultural chemist James A. Prescott, and physical chemist A.C. David Rivett (Masson's successor at the University of Melbourne before he moved on to lead what is now CSIRO).

The next wave would include inorganic chemist John S. Anderson, spectroscopist Noel Bayliss, organic chemist Arthur J. Birch, chemical physicist A. Lloyd G. Rees, and surface chemist Ian Wark. Mineral chemistry research was extremely strong in Australia, and the froth flotation process developed by Wark and his colleagues for extracting elements from crude ore has gone from strength to strength, most recently under the leadership of Graeme Jamieson who was awarded the inaugural PM Prize for Innovation in 2015. Thinking of the menu for the dinner we would certainly wish to have a fish course. Sir Ian Wark was famous for a popular commercial fishing fly called the 'Dr Wark' that he developed from a Norwegian design that made him the most productive trout fisherman on the Big River.

Most senior academic chemistry appointments in the early days in Australia involved individuals who had been trained abroad. With one or two exceptions the majority came from the UK. Archibald Liversidge was an early appointee to the Chair of Chemistry at the University of Sydney, Robert Robinson was the inaugural professor of Organic Chemistry from 1913 to 1915, and according to Ian Rae's 2005 (vol. 52) article in *Ambix* the contributions of Eustace Turner and George Burrows created the important development of organo-arsine compounds as ligands in coordination chemistry that spawned a number of generations of successful chemists from Sydney. Rae has drawn attention to the fact that Edward Rennie was the first Australian-born chemist to hold a chair in chemistry in an Australian university.

Other notable dinner guests would be the chemists who were the foundation chemistry Fellows of the fledgling Australian Academy of Science in 1954.

The Shine Dome, home to the Australian Academy of Science, in Canberra.
Bidgee/CC BY 3.0

In the late 1930s, the University of Sydney produced a number of very distinguished chemists who went on to illustrious careers in the UK. Arthur J. Birch and Rita Harradence shared the University Medal and they together with John Cornforth (who subsequently married Rita and in 1975 was awarded the Nobel Prize) all went to Oxford to study for the DPhil under Robert Robinson, supported by scholarships from the Royal Commission for the Exhibition of 1851. Other notable contemporary chemists were Allan Maccoll and Ronald S. Nyholm, who both held chairs of chemistry when I studied for the PhD at University College London. Birch returned to Australia to hold the Chair of Organic Chemistry at Sydney before being lured to Manchester. He ultimately returned to found the Research School of Chemistry at ANU

*I am grateful for stimulating discussions with historian of science Ian Rae (an organic chemist), who is co-editor of *Historical Records of Australian Science*.

Chemistry Building, University of Melbourne.
HistorygroupZRZ/CC BY 3.0

as a foundation Chair with David P. Craig (also then at University College). Nyholm was also expected to join them, but evidently changed his mind and remained in London.

The PhD degree was introduced in Australian universities in the mid-1940s. Until then, Australian researchers either finished their research with a masters degree or went abroad (largely to the UK) to complete a doctorate. In his 1999 article in *Historical Records of Australian Science*, vol. 12, issue 3, Ian Rae describes the experiences of some 159 Australian chemists who earned a UK doctorate between 1945 and1965. He reports that by 1954 the number of homegrown doctorates exceeded those that were earned abroad. I consider myself as being at the tail end of that mass migratory experience. As an undergraduate at the University of Melbourne, I was largely unaware in those early days of the opportunities for PhD research. I was passionate about chemistry and probably chose science as a degree because I thought qualifying as a medical practitioner would take too long. Little was I to know that it took me even longer to obtain a tenured academic research appointment.

The University of Melbourne in the early 1960s had benefited from the appointment of the organic chemist Lloyd Jackman, an Australian who was recruited to Melbourne from Imperial College. Jackman was a specialist in nuclear magnetic resonance and introduced modern physical and mechanistic organic chemistry to the lecture courses as well as attracting a strong and talented cadre of research students who have subsequently made an impact at home and abroad, helped by Jackman's influence in placing then in strategic postdoctoral positions. There were not many women in teaching positions, but those that were there were extremely influential. Emily Stephenson ran the teaching labs with a rod of iron, and I learned so much from her. She taught us among many things how to use the old-fashioned water aspirator. To this day, I will always turn a water tap full on, and then back half a turn to prevent the washer swelling up, closing off and jamming. Valda Macrae became the official departmental historian and was deeply loved and admired by all who knew her, and Joan Radford was extremely influential in the area of chemical education.

In those years in the mid-1960s, the RACI thrived. I believe there were close to 6000 members and the membership was dominated by those who worked in industry. Many of the larger chemical companies had a significant research laboratory in Australia and often this was located in Melbourne. How different the situation is today, with fewer members and barely any major chemical company doing research in Australia. This is our challenge in the era of the National Innovation and Science Agenda. Much research is being carried out in small start-up companies and in small and medium enterprises (SMEs). Today, we must find ways to connect the research base in chemistry with these end-users, many of whom are unaware of the opportunities available and for whom the cost of funding such research is beyond their ability. This is where the government can assist. A fundamental aspect of the NISA should be a systematic program, funded by government, of connecting research provider with end-user. The challenge I pose to the members of RACI is how we draw new members from industry into the organisation to try and establish some of the impact and influence that RACI can exert on behalf of the discipline of chemistry in the community. As well as enjoying the company of the giants of the previous century at our centenary dinner, I would include entrepreneurs and business angels to re-establish the strong engagement that obviously existed in the past.

Towards the end of my Masters research in Melbourne when

Many of the larger chemical companies had a significant research laboratory in Australia and often this was located in Melbourne. How different the situation is today ...

In the late 1930s, the University of Sydney produced a number of very distinguished chemists who went on to illustrious careers in the UK.

University of Sydney, University Commemoration Day ('Commem') through streets, 1937.
Sam Hood (1872–1953)/State Library of New South Wales

Lloyd Jackman was lured to Pennsylvania State University, I was encouraged to apply for a scholarship to the UK. I was fortunate to be awarded a Shell Scholarship to study for the PhD degree with Franz Sondheimer at University College London. Sondheimer had moved from Cambridge to London the year I joined him. He was tremendously wealthy, owing to his early involvement with the company Syntex that developed the first female oral contraceptive, first in Mexico and later in Palo Alto. Arthur Birch and Gilbert Stork were consultants to Syntex. Sondheimer was a brilliant steroid chemist, but is probably best know for his invention of the 'annulenes' – the cyclic conjugated homologues of cyclobutadiene and benzene respectively.

It was an exciting time to be in London at the end of the 'swinging sixties' but depressed a little when PM Harold Wilson devalued the currency and told us that the 'pound in your pocket will still remain the same'.

Working with Sondheimer was exhilarating, and many of his group had the opportunity of then going on to do postdoctoral work with the very best chemists in the world. In my case, it was the opportunity to work with Alber Eschenmoser at the ETH-Zürich on the end steps of the total synthesis of vitamin B12. This was supposed to be a partnership with R.B. Woodward's group in Harvard, but in reality it was a race that was pretty much a dead heat.

By the greatest good fortune, I was offered an academic appointment as a demonstrator (assistant lecturer) in Cambridge. There I worked with some of the most intellectually able academic chemists in the world as well as having the privilege (and the challenge) of teaching undergraduates who were far more able than I in chemistry, with the result that I had to learn fast. We had outstanding research students who did excellent research. In fact, one of the professors of physical chemistry once said to me 'If you can't succeed as an academic researcher in Cambridge, there is something wrong and you shouldn't be here!'

The message I've taken from my Cambridge experience is to always keep an open and enquiring mind and be willing to take the calculated risk to embark on a new project, possibly in partnership with someone who is an expert in a different discipline. In my case, with physicists, we were lucky to be involved in developing light-emitting polymers for flat panel displays. Here in Australia we have been doing the reverse, printing large area flexible solar cells. In addition we have had a fabulous journey with Tony Burgess and his colleagues in the Ludwig Institute and now the Walter and Eliza Hall Institute in identifying key proteins in intracellular signalling in colon cancer cells.

My recommendation to young researchers is to move about – to other institutes and other countries, and to bring back your experience to apply it here or elsewhere to advance the essential body of scientific knowledge that will empower society to be innovative and productive and to provide an economy that is a little bit more advanced than one that relies on extracting our wealth from the Earth's crust.

Andrew B. Holmes FRACI CChem is at the School of Chemistry, Bio21 Institute, University of Melbourne.

A short city tour of Melbourne

Trevor McAllister leads the way between some of Melbourne CBD's great buildings.

If you're a congress participant from out of town, then welcome to Melbourne! Please forget the tourist slogans 'Marvellous Melbourne', coined by a visiting English journalist in the 1880s, and 'The world's most liveable city', a trite assessment by the business travellers of the *Economist*. Come with me, instead, on a personalised journey through a select part of the city where I have lived for 48 years.

Just board the northbound 109 tram outside the Congress Centre, which will take you across the river. On the other side of the river, you pass on the left the place where the first settlers (from Tasmania) landed on 30 August 1835 – now called Enterprise Park, after the name of their ship. After a block, the tram will turn right into Collins Street.

Three blocks along Collins, you pass through the 1880s banking district, of which the Gothic Bank, on the left at the corner of Collins and Queen, is the most remarkable, designed by William Wardell, one of Melbourne's leading 'Gothic Revival' architects. The financial boom of the 1880s led to a great crash in the 1890s, but it has left us these amazing buildings. Get off the tram two intersections further, near Swanston Street. Take the pedestrian crossing to the left and then cross Swanston Street to the Melbourne Town Hall. The Town Hall itself is a fairly typical neoclassical

building of the 19th century. Its foundation stone at the corner was laid by the then Duke of Edinburgh in 1867 (the second son of Queen Victoria). For many years, the auditorium was the home of the Melbourne Symphony Orchestra until the new Arts Centre was built across the river in 1982.

Turn and look back across Swanston at one of the most remarkable buildings in Melbourne, the Manchester Unity. This marvellous example of Art Deco 'Commercial Gothic' was designed by Marcus Barlow and opened in 1932. The narrow vertical lines of the windows, the terracotta tiled façade and the tower are reminiscent of the Chicago Tribune building of 1927. One of Melbourne's most select apartments is located in the tower. Next to the Manchester Unity is the Capitol Building, also inspired by the Chicago style, by the architect Walter Burley Griffin in the 1920s, when he and his wife Marion Mahoney were living in Melbourne and designing the Commonwealth capital, Canberra. From 1901 to 1927, the capital of the Commonwealth of Australia was in Melbourne.

Cross Collins Street to the corner of Swanston and Collins, the site of one of our planning failures, the so-called City Square. This unpromising space was once the site of the magnificent Queen Victoria arcade, which was demolished in a notorious act of civic vandalism in 1960. It and the Regent Theatre remained empty for decades, under a building union ban, until a deal was done to restore the theatre and build the Westin Hotel, which now overlooks the rather meagre Square. Note the statue of Burke and Wills, the two explorers who perished in the north Queensland outback in 1860.

Walk south along Swanston towards Flinders, pausing to look across at the Nicholas building, a 1920s building in the 'Commercial Palazzo' style. Alfred Nicholas was a St Kilda pharmacist who was given the right to manufacture aspirin in Australia during the 1914–18 war against Germany, when the Bayer patents had been expropriated as enemy property by the government of Billy Hughes. Some of the Nicholas fortune went into this building, designed by Harry Norris. It has a lovely arcade roofed in art deco glass tiles. Continue to the intersection with Flinders Street. St Paul's Cathedral is on your left, built in 1890 but replacing a church of the 1840s. Overcome any religious prejudices you may have and go inside to enjoy the stained glass windows, made in England by Clayton and Bell in 1887.

Turn and look back across Swanston at one of the most remarkable buildings in Melbourne, the Manchester Unity.

Manchester Unity Building.
Stephen Bain/CC BY 3.0

When the timetables of the various train lines went electronic, on screens inside the station, it was proposed to remove the clocks, but an outcry caused the authorities to relent.

Flinders Street Station illuminated for the 1954 Royal Visit. Public record Office Victoria/CC BY-SA 2.0

Diagonally across the intersection is Flinders Street Station, which has many legends attached to it, one being that the design was a mistake, originally intended for Bombay (now Mumbai). But this remarkable example of 'Edwardian Baroque' is firmly fixed in Melbourne's social history. The clocks under the arch have been a meeting point since its opening in 1910. When the timetables of the various train lines went electronic, on screens inside the station, it was proposed to remove the clocks, but an outcry caused the authorities to relent. Cross Flinders to Federation Square, created in 2001 (100 years after the federation of the colonies to form the Commonwealth of Australia). The conservative citizens of Melbourne did not like the modern architecture of the square when it opened, but they have grown used to it, and it has become the genuine city square that Melbourne had lacked since its foundation in 1835. The colours of the angular metal pieces of the façade mimic the colours of older stone facades in nearby buildings on Flinders Street.

Continue over the river, across Princes Bridge, to the Arts Centre on your right, cross to the National Gallery of Victoria (1968), go inside past the famous water wall to the Great Hall at the back of the entrance lobby and enjoy another stained glass experience, the ceiling of the Great Hall, a modern design by the local artist Leonard French. You need to lie flat on the carpeted floor to appreciate it properly. Unlike the thin, leaded, medieval type of stained glass in St Paul's, these 'windows' are of coloured slabs of glass, a style called dalle de verre by the French glassmakers who introduced it in the 1930s. This ceiling is one of the greatest stained glass works in the world.

Take the tram or walk back over the Princes Bridge, get off at Young and Jackson's Hotel (1860) and turn left into Flinders Lane where you will come on Centre Place on the right, and Degraves Street on the left, two of the most photographed laneways in the city with many al fresco cafes. Turn right and go through Centre Place and the Centre Walk building to Collins Street. Take the pedestrian crossing, turn left at the other side and walk along to the Block Arcade. This gem of an arcade, a copy in miniature of the Galleria Vittorio Emmanuel in Milan, dates from 1890, and with its tessellated floor and high windowed Victorian shop fronts is probably the most photogenic of Melbourne arcades. On the right is the Hopetoun Tea Rooms, which were started by a

charity chaired by the wife of the governor of the day, Lady Hopetoun, and are eternally popular. Walk through Block Arcade to the rotunda where the arcade turns left, and take the small laneway on your right, which will allow you through to Little Collins Street. Cross the street to the Royal Arcade (1867). The tiled floor and Victorian shop fronts, plus the clock with the Gog and Magog statues, make this a strong competitor with the Block for the title of most loved arcade in the city.

Turn back into Little Collins Street, and turn left to Swanston. Take the tram or walk left along Swanston Street for two blocks to the neoclassical portico of the State Library of Victoria (on the right). The forecourt in front of the library (dating from 1856) is one of the great gathering points in the city, and the start of many demonstrations (I confess to have been in quite a few in recent years). The empty forecourt, on a Sunday morning in 1960, was the location of the last scene of the quietly grim *On the Beach* movie (directed by Stanley Kramer and starring Gregory Peck and Ava Gardiner) about the end of the world after a nuclear war. So dull was Melbourne in those days that Ms Gardiner is reputed to have said 'It's a great place to make a movie about the end of the world'. We trust that her ghost has returned to view a very different city! You should take time to enter the library and go to the La Trobe Reading Room, one of the great library domes of the world.

Return along Swanston Street, walking or taking the tram one stop to Bourke Street. Cross Swanston to the Bourke Street Mall. This pedestrianised strip was the subject of a typical Melbournian stand-off in planning in the 1980s. As a result, the Tramways, being the most intransigent of the parties, managed to maintain the running of trams though the mall. Avoiding these, walk along to the 1930s Myer Emporium, another example of 'commercial gothic'. Alongside, on the corner with

The Royal Arcade. Diliff/CC-BY-SA-2.5

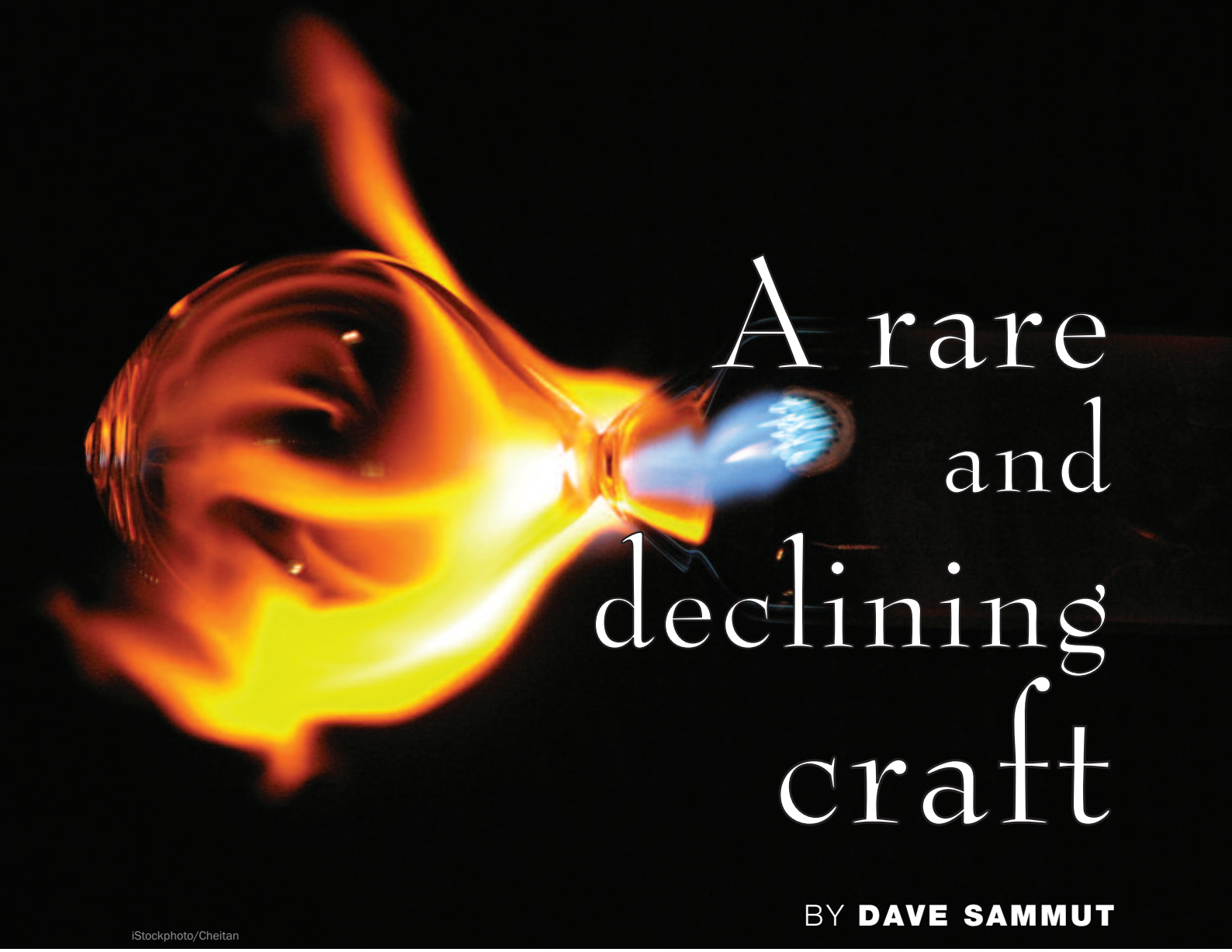
Elizabeth Street, is the General Post Office (GPO, 1867–87), forgotten now but once the point of telegraph communication with the rest of the world. It is also remembered as the sad location in 1880 of the death of the artist S.T. Gill, the famous goldfields sketcher, who drew the often reproduced 'Doing the Block' of the fashionable class parading in Collins Street.

And this is where you can catch the 96 tram, proceeding west to return to the Congress Centre on the river.

Trevor McAllister FRACI CChem
trevormc@internode.on.net is retired and enjoying life after science as a tour guide at the Melbourne Museum and the State Library of Victoria.

What's on in July in Melbourne

- Theatres and exhibition tour, Arts Centre Melbourne, www.artscentremelbourne.com.au/whats-on/2017/tour/theatres-and-exhibition-tour
- *Brave New World* art exhibition, National Gallery of Victoria www.ngv.vic.gov.au/exhibition/brave-new-world
- 'Changing face of Victoria' tour, La Trobe Reading Room, State Library of Victoria, www.slv.vic.gov.au/whats-on/changing-face-victoria-tour
- Laneway tours, www.meltours.com.au/tours/laneways
- Run Melbourne, http://events.solemotive.com/run-melbourne-about
- Scienceworks museum, museumvictoria.com.au/scienceworks
- Screen Worlds, Australian Centre for the Moving Image, www.acmi.net.au/events/screen-worlds



A rare and declining craft

BY **DAVE SAMMUT**

iStockphoto/Cheitan

'A bench all down one wall contained a selection of glassware apparently created by a drunken glassblower with hiccups, and inside its byzantine coils coloured liquids seethed and bubbled.' Terry Pratchett, *Eric*

The art of professional glassblowing pre-dates the Enlightenment. And the ground-breaking scientists who first attempted an orderly understanding of the world (July 2014 issue, p. 22) performed many of their experiments in glassware custom-made for this work.

According to the American Scientific Glassblowing Society, glass first appeared in Egypt as far back as about 1500 BCE, used to glaze tiles. But it was a luxury item, and took almost another two millennia to spread to common items, both socially and geographically. It was only less than a thousand years ago that we first invented a reliable way of keeping the rain out of our homes, while still admitting the light (see box).

Glass remains an ideal material for modern scientific experimentation. Inert to most substances and transparent, glass can be fashioned into a near-infinite variety of vessels and implements. It is so ubiquitous in application that it forms the fundamental trope representing the archetypal chemical laboratory.

Yet the artisanal glassblower, like the cooper or the farrier before him (or her), today practises a craft that is in decline. Although still essential for bespoke and advanced glasswork, the role of the professional glassblower is threatened. In the 1970s and 80s, wet chemical glassware represented the majority of work for professional glassblowers. This has been largely displaced by cheap imports of lower-quality catalogue glassware. And this,

A solubility cell. Brandon Scientific Glassblowing

in turn, is leading to chronic underinvestment in the next generation in the craft.

Today, there are fewer than 30 members of the Scientific Glassblowers Society of Australia and New Zealand (SGSANZ). A generation ago, almost every major scientific institution in Australia had a dedicated glass workshop. With the recent closure of ANU's new facility (after only a few years of operation), the association could now only point to Queensland University of Technology and the University of Melbourne remaining.

Part of the challenge is that there isn't enough work in Australia to support the full-time creation of bespoke pieces. The scientific glassblower needs a core of routine work to survive. Mike Brandon of

A window into history

The humble window offers a great view into the evolution of glass making techniques.

European windows were small, draughty and covered in oiled parchment (knock carefully!) or cloth. But Venetian glassblowers first worked out a method to make flat glass: blow a closed cylinder, cut the ends off, then cut the cylinder lengthwise – the cut glass could then be heated to sag to flat sheets. Over time, the glass cylinders could be made up to 2.4 metres long and around 30 centimetres in diameter, and this came to be the dominant window glass production technology in the 19th century.

New World glassblowers later worked out a second method: they spun molten glass on the end of a pipe, using centripetal force. The 'crown glass' discs could be as large as 1.5 metres, but were commonly much smaller, and could be cut into relatively small squares when cool. At the centre was a distinctive 'bull's eye' piece that are now collectors' items.

The Pilkington process, invented in the UK in the 1950s, produces continuous sheets of flat glass that are made by floating molten glass on a pool of molten metal, typically tin. Via simple gravity, the molten metal naturally forms a completely even, horizontal surface for the production of consistent glass sheet of even thickness. Common furnaces are 9 metres wide and 45 metres long, and can contain more than 1200 tonnes of glass at 1200°C. And modern understanding of annealing and layering processes means that we can imbue strength and resilience to the glass, so that its less likely to break, and less likely to cause injury if it occurs. It's all really quite clever.

Ammonia neutralisation apparatus.
Brandon Scientific Glassblowing

The modern scientific glass workshop is much more sophisticated than just furnaces and tongs ...

Brandon Scientific Glassblowing, Vice President of the SGSANZ, creates high vacuum stopcocks for his bread-and-butter work, primarily for export markets. Other glassblowers mix their time between scientific and artistic glassblowing, or run their shops as a hobby.

Brandon was generous with his time in talking about the state of the craft. Starting as a trainee in New Zealand in 1981, Brandon worked for the DSIR (the equivalent to our own CSIRO). Coming from a chemistry background, this knowledge has served him throughout his career to provide a context and understanding for the pieces he produces. Brandon was trained by a member of the British Society of Scientific Glassblowers, but was introduced to both American and German influences in his craft.

He moved to Australia to take up a job at the University of Tasmania in 1989, and in 2008 set up his own company. His enthusiasm for his craft is evident. 'I love what I do. I enjoy the variety of work, having to do research work and work for industry, agriculture, aquaculture and the arts. I've done all sorts of weird and interesting work over the years. It is a great craft to be lucky enough to be in.'

But there are few students taking up the craft. Apprenticeships are long – at least five years. Brandon says that they're expensive for the master, and challenging for the apprentice. It is very difficult, he says, when it is likely that every single piece that the apprentice produces in the first year will be discarded. That's costly in labour, the master's time and materials, and requires a great deal of fortitude as the apprentice learns the craft.

The British Society of Scientific Glassblowers is the primary certifying authority for Australian and New Zealand glassblowers, with a certificate of competence taking a minimum of three years to attain (probably much longer) across a variety of work. And this requirement for varied experience poses another challenge to apprentices as the work dries up.

The modern scientific glass workshop is much more sophisticated than just furnaces and tongs (what Brandon refers to as 'pot workers'). Brandon says 'We're mainly ''lamp workers'', working at a bench with a lamp [a flame], fabricating scientific glass instruments from tubing and rod. And we use instruments like

glassblowing lathes designed to work the materials, with specialised burners – not like a normal engineering lathe'.

'You could be working something very fine and intricate to something large. I've worked with oxygen probes down to microns in size, up to reaction vessels up to 100 litres. In my workshop I can work a very wide range.'

But a workshop requires a substantive investment, and with no apprentice to take over from Brandon in the later years of his career, he is concerned that one day his workshop will need to be broken up, and his specialist equipment separated and sold for a fraction of its value.

The key for preserving the craft, according to Brandon, is to think locally as a scientific community. 'At Australian universities, a student can buy whatever they like off the internet. There is no control, no loyalty to Australian suppliers. If the universities and the research labs gave their local industry a second thought, it might be enough to give support to warrant investing in the future. Any scientific community still requires our skill set.'

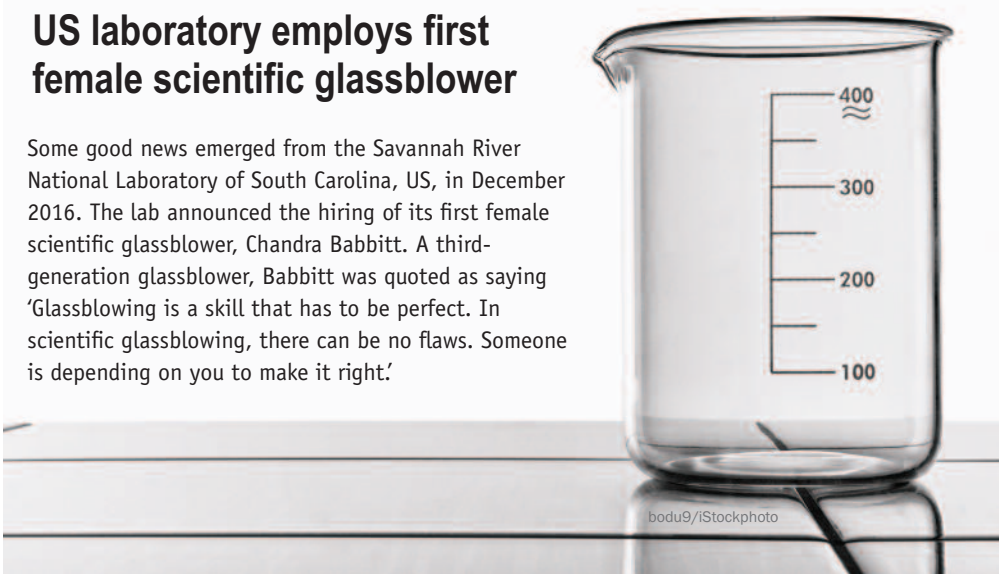
Brandon says: 'The craft is in its senior years, no doubt. But there's always going to be a demand there. Science changes all the time, so therefore the demands on your glassware will change. But without some sort of acknowledgement that the craft needs to continue by the people who make the decisions … it's up to Australia to support its local industry or there won't be a glassblower out there to do one-off jobs.'

Dave Sammut FRACI CChem is principal of DCS Technical, a boutique scientific consultancy, providing services to the Australian and international minerals, waste recycling and general scientific industries.

A jacketed sparging vessel. Brandon Scientific Glassblowing

US laboratory employs first female scientific glassblower

Some good news emerged from the Savannah River National Laboratory of South Carolina, US, in December 2016. The lab announced the hiring of its first female scientific glassblower, Chandra Babbitt. A third-generation glassblower, Babbitt was quoted as saying 'Glassblowing is a skill that has to be perfect. In scientific glassblowing, there can be no flaws. Someone is depending on you to make it right.'



bodu9/iStockphoto

Science Meets Parliament 2017: a cost–benefit analysis

If you're a scientist who works in a publicly funded role, then Science Meets Parliament (SmP) is about your continued survival. Government policy and attitudes towards science matters greatly to your employment and ability to attain grants. It's thus no surprise that SmP is seemingly swamped with the best and brightest from this sector. For both the employing organisations and the individuals concerned, attendance at SmP has potential long-term benefits. But what about the private sector?

I started my career as a publicly funded researcher, but after seven years I left to join the private sector (23 years ago) due to government policy changes affecting funding at the time. As an industrial consultant who founded his own company 20 years ago and has a very broad-based experience servicing clients across all sectors of industry (private and public), I recognise that many fellow industrial experienced colleagues would have some well-justified reservations about events such as SmP.

Those in the private sector familiar with obtaining government funding (whether through sole supplier status, preferred supplier tender panels or open tenders/contracts) know that it is the program managers and project managers who ultimately decide selection and consequent commercial outcomes. Politicians are not generally of any commercial interest whatsoever. Neither are senior and especially executive level bureaucrats/technocrats.

The format of SmP makes it highly unlikely to result in any direct personal or corporate gain to anyone in the private sector. A half-hour meeting with a parliamentarian is not a particularly effective platform for seeking any specific or even general lobby endpoint. This raises the question: 'Why attend?'.

This year, approximately 200 highly selected delegates and 70 parliamentarians (out of a total of 226; approximately 30%) attended SmP. The organisers of SmP (STA) effectively controlled proportional representation by the manner that they allocated delegate numbers among their member organisations (the vast majority of whom are government, public research and academia). As a general (affiliate) member of STA, RACI sent two delegates (1% of delegates) to represent the entire spectrum of the chemical profession (public and private). This year, STA extended to also include two delegate slots for indigenous women and up to a maximum of 10 delegates from industry (other than those via its members).

The only direct interaction was (if opportunity allowed for direct conversations) at the Gala dinner (where most tables had one parliamentarian) and any scheduled nominal 30-minute meeting(s) planned for the next day. As noted by some attending parliamentarians, it's a sad indictment on the extent of the absent 70% of politicians who either had no interest or calculated no political benefit from being seen with some of the finest scientific minds in the nation (both established and up and coming stars). While some may well have had good reasons for not attending, the more likely case is that most (if not all non-attenders) viewed SmP as a political liability or of no value to themselves. This also raises the question of why the 30% of parliamentarians who did attend showed up.

As scientists, especially industrial consultants, we strive to be situationally aware at all times and to test any hypothesis or conclusion we derive from those observations with the view to filter out hype, misdirection and presentations in order to uncover the underlying objective truths. We observe first, think later, then test. But we always observe carefully first because otherwise we are liable to only see what was expected or crafted for our consumption. It's vital not to forget that, especially when a sense of occasion and pomp and ceremony are added to the mix.

It can't be overstated because of the many instances of incongruity I witnessed. Whether in presentations, speech or as part of discussions, what was said may have been true (in part or whole), but it was always seemingly incomplete. Thus it was appropriate to test the underlying intent, integrity and completeness of what was said.

Everyone who attended SmP likely had their own motivation for doing so. Mine was to get industry into the conversation. In particular, it was to highlight the concept that science (and in particular industrial science) can positively contribute creative and viable solutions to political and economic issues across most, if not all, portfolios.

The simple fact is that the reality in Australia has been a continuing trend over the last few decades of closure and downgrading of many chemical and related industries. The result has been that consulting and employment opportunities within the private sector have significantly deteriorated. The trend continues unabated (despite any political talk to the contrary) with many companies closing, shrinking or simply being uneconomically viable to continue for much longer. Political speech about jobs is the mainstay of politics yet manufacturing has been thrown on the scrapheap by successive governments

As noted by some attending parliamentarians, it's a sad indictment on the extent of the absent 70% of politicians who either had no interest or calculated no political benefit from being seen with some of the finest scientific minds in the nation (both established and up and coming stars).

of either party. Scientists are ubiquitous in society and yet do not vote as a collective bloc and so are a largely ignorable and invisible part of the electorate.

My scheduled parliamentarian was the Hon Richard Marles MP, Shadow Minister for Defence. The meeting was very enjoyable and seemed mutually so. I found him quite nuanced and focused. Clearly very intelligent and thoughtful, he weighed each sentence and response with care to understand and analyse on the fly with considered responses.

I tested intent. When I asked him 'What can we do for you?', his response was 'Scientists should engage more in politics'. Drawing on the entire conversation plus presentations made throughout SmP, it became apparent that the underlying driving political need was to have scientists provide politicians with credible backing for pre-existing policy platforms (that may have had no prior scientific input).

RACI delegate Dr Motty Sobol at Science Meets Parliament 2017.

During conversations, I created on the spot an example of a new product of potential use in his portfolio, using relatively simple technology and cheap, easily sourced materials from businesses in his electorate of Geelong that could be conducted using known existing capabilities within CSIRO and DST Group. Further, the products could have applications outside of his portfolio and could form the basis for exports of value-added high tech.

Despite interest during our discussions, diligent follow-up resulted in no response.

The particular example I created is immaterial. The value lay in demonstrating that solutions can be created at will that are viable, economical and within capabilities and utilise public researchers in a way that can boost the economy.

Serendipity played a major role in the days when I conducted clinical cancer research so it was oddly fitting in how it played a role at SmP. An accidental meeting at the Gala dinner produced the potentially best outcome. Late in the evening, I noticed a person sitting alone a few tables away and joined him. We spoke at great length in general conversation that flowed easily and enjoyably. It turned out to be Senator Chris Ketter and the end result was an invitation for a future meeting and a link to make a submission to a senate select committee inquiry on funding of cancer research for cancers with low survival rates (a topic very close and dear to me). I submitted a contribution that I hope ultimately results in getting significantly better outcomes for patients with low survival rate cancers.

In terms of cost–benefit, participation in Science Meets Parliament costs are fairly inconsequential relative to long-term gains for the profession. Chemistry is vital and underpins the performance of the economy directly and by supporting other scientific and engineering disciplines. Politicians need to be reminded of this fact at every opportunity.

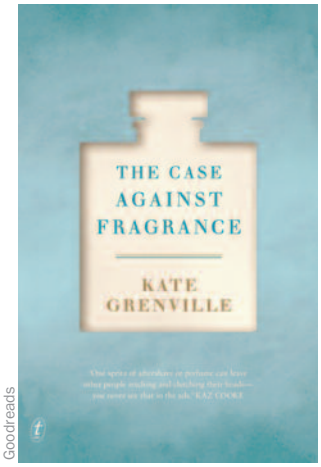
In terms of improving the impact factor for protecting public research funding, SmP is likely a good vehicle. In terms of representing science, it is skewed in favour of public-funded researchers and organisations.

Those seeking any gold or glory out of attendance will very likely be sadly disappointed. The highest probability is that the business cards you freely handed out have most likely found their way into recycling bins long before you even made it back to the airport, let alone any further. The politicians had a very brief PR window and their attentions are now on far more pressing matters. Fellow delegates have returned to their own lives and continued those unabated and the memory of you is most likely fading rapidly, to be extinguished by the passage of time and focus on more pressing matters closer to home. The moment has passed and life has moved on. But this is not to say there is no benefit from attendance.

Even with the most diligent follow-up, the chances of anything tangible eventuating are slim and nebulous. Serendipity may occur but can't be relied upon. The greatest success you can have at SmP is in the experience itself and the impact (if any) that it may have left on the parliamentarian you interacted with.

For the sake of the profession as a whole, I highly commend SmP and strongly encourage future participation by both public and private sector RACI members.

Dr Motty Sobol FRACI CChem. Visit www.raci.org.au/raci-news/science-meets-parliament-2017-the-raci-experience for a general overview of SmP 2017.



Goodreads

Something smells off: Kate Grenville's *Case against fragrance*

Grenville K., Text Publishing, 2017, paperback, ISBN 9781925355956, 208 pp., $24.99

Scents, fragrances, perfumes. These words transform the mere concept of odours into something more evocative. Fragrance is intimately linked with our memories and feelings.

For me, the heavy smell of eucalyptus is forever associated with summer. A waft of its scent and my mind brings up the feeling of heat and the buzzing of cicadas. Kate Grenville shares a similar reminiscence of her mother's perfume in her latest book, *The case against fragrance*.

So why a case against? As Grenville writes, 'Surely only a weirdo wouldn't enjoy the smell of flowers and pine forests?'

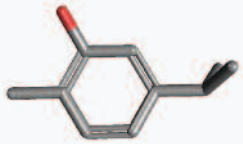
But consider those to whom fragrances bring blinding headaches, asthma attacks and allergies. Something like a third of all Australians have adverse reactions to fragrance, with nearly 8% so severe that the people involved have lost work days.

Grenville builds the case that fragrance is having a significant adverse impact in modern society through personal anecdote and peer-reviewed research. On the way she takes us through the multitudinous things that fall under the term 'fragrance': how we perceive it, who regulates (or fails to regulate) its components, who tests it for safety, and how we can share the air together, fragrance fans and foes alike.

Readers may be puzzled. We have been using fragrances for thousands of years: how could something so ubiquitous be harmful? Surely we would have noticed before now? But let me remind you that we used toxic white lead as a cosmetic for centuries before realising its harms.

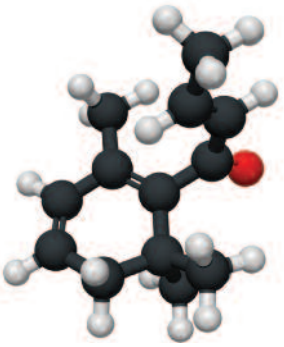
Grenville points out that many of the natural essential oils that form the basis of fragrances have adverse or toxic effects that have only recently been recognised. The properties that make the chemicals in fragrances able to vaporise easily and stimulate our sense of smell also mean that many are highly reactive and able to stimulate immune reactions.

One example is carvacrol, the chemical that gives oil of oregano its distinctive scent. It can also chemically react with proteins to stimulate an immune response. β-Damascenone, whose chemical structure looks like an industrial hazard, is a natural compound found in rose essential oils and Kentucky bourbon (it is safe at fragrance concentrations, but can cause allergic reactions). 1,8-Cineol, which is part of the distinctive smell of eucalyptus, can cause liver damage if you consume enough of it.



Carvacrol, the chemical behind oregano's odour.
Ian Musgrave

Grenville shows that with modern processes, fragrances are more available than ever before. Whereas in the past perfumes were expensive items used only occasionally outside those well-off, fragrances are now everywhere, not only in perfumes but in air fresheners, detergents and laundry liquids to name a few places we find them.



β-Damascenone, found in roses. And Kentucky bourbon.
Ian Musgrave

The rise of synthetic fragrances has the advantage of low cost and less need to use animals. (We no longer need to extract musk from the glands of civets.) But this ubiquitous use and higher concentration of fragrances means that more people are exposed to fragrances for longer than ever before.

Grenville smoothly charts this rise, and the regulatory and safety issues. Fact-dense and extensively referenced, the book is a delight to read and never gets bogged down. I may be biased, of course, by my love of chemistry.

While some of the science has been simplified, the book generally conveys the sense of it correctly. I particularly salute Grenville for working through the labyrinth that is Australia's National Industrial Chemicals Notification and Assessment Scheme (you can find the NICNAS section on cosmetics here). The issue of regulation is a thorny one, given the current mood of government is for less, but the book gives a good walk-through of the regulatory and testing issues. Anyone who can write about NICNAS without inducing somnolence is a master indeed.

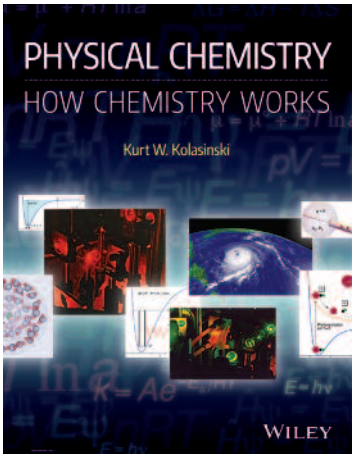
While the issues around fragrance and headaches, respiratory issues and allergies are well documented and supported, the issues around hormone (or endocrine) disruption are less clear. There is evidence that high concentrations of some of the essential oils that make up fragrances (and other non-odoriferous components that go into fragrances) can activate hormone receptors. But these compounds are hundreds to thousands of times weaker than our natural hormones.

Grenville gives diethyl stilboestrol (DES), used in therapy, as an example of how endocrine disruptors can affect health. But DES is very potent, hundreds to thousands of times more potent than the weak hormone mimics in fragrances and cosmetics. This could give people a misleading impression of the risk associated with fragrances. We've seen similar discussions about phthalates found in cosmetics.

Statements such as, 'We know about the dangers of endocrine disruptor bisphenol A in our plastic water bottles', are unhelpful because they are basically untrue, based on exaggeration of risks.

Nonetheless, the issues around other risks, regulation and fragrance in the workplace are well developed and thoughtful. Read *The case against fragrance* and you will never think about fragrance in the same way again. If you have been suffering fragrance in silence, you will know you are not alone.

Ian Musgrave, senior lecturer in Pharmacology, University of Adelaide. First published at theconversation.com.



Physical chemistry – how chemistry works

Kolasinski K.W., Wiley, 2016, paperback, ISBN 9781118751121, 744 pp., $134.95

Physical chemistry has been defined as: 'The futile attempt to fit the universe to $y = mx + c$'. This remains my favourite description of physical chemistry. My new second favourite is found in *Physical chemistry – how chemistry works*: 'The role of physical chemistry is to tear down mirages of explanation in order to construct the machinery that results in fundamental understanding'. In this book, author Kurt Kolasinski, whose research interests in surface science straddle physical chemistry and chemical physics, constructs this machinery with a focus on statistical mechanics. Many books on physical chemistry could easily be divided into two stand-alone halves with nothing much to connect them, but Kolasinski always has one eye on statistical mechanics as the essential link between thermodynamics and quantum mechanics.

Kolasinski's ferocious love of his subject matter shows through on every page. He has a distinctive voice which – while not everyone may appreciate it – I found to be clear, imaginative and entertaining. He does not shy away from complicated derivations, or leave vital parts of them missing. I was pleased to find him a stickler for IUPAC definitions; he includes numerous links to IUPAC publications, especially the physical chemistry *Green book*.

The exercises are numerous, frequently interesting and grounded in real-life problems. These have obviously been constructed with care, not tacked on as an afterthought. Both the Latrobe Valley and the Ashes are mentioned in them, indicating that the author is not completely unaware of our continent.

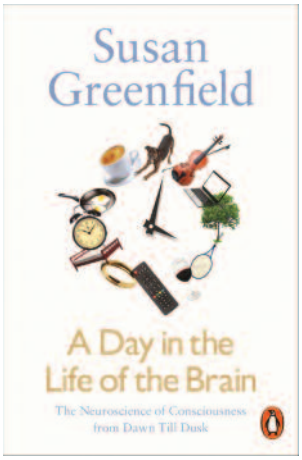
There are many figures in the book that are well thought out, describe something interesting, and that I haven't seen a hundred times before in other physical chemistry textbooks. Colligative properties, overpotential and hyperfine splitting are all illuminated by figures different from any I have seen before. On the other hand, there are quite a few figures reproduced from publications of variable quality that would have been better adapted and redrawn.

Many points are illustrated with examples drawn from recent research, especially in Kolasinski's field of surface chemistry, and in general these examples are more inventive than usual. For example, the Carnot cycle – usually the dullest few pages in any physical chemistry textbook – was discussed using the example of a hurricane, which made it awesome.

The main problem I found with the textbook as it stands was a lack of internal connections. At times, it seemed as if the book was designed to be disarticulated into separate chapter readings meant to stand on their own. When the Sackur–Tetrode equation reappears in Chapter 8, for example, there is no citation of its previous appearance as equation 6.127, and if you think 'Hmm, where exactly did I see that equation before?' and look in the index, you won't find it. There are numerous places – unavoidable in a physical chemistry textbook, which must always leap with some degree of arbitrariness into a meandering stream of interconnected knowledge – where something is mentioned in passing as more-or-less assumed knowledge when it will be properly introduced later in the book; yet very rarely was there a word from Kolasinski letting the reader know that this possibly unfamiliar concept would be elaborated on in such-and-such a chapter.

But all in all, this is the best new general textbook on physical chemistry I have seen for a long time, and I am seriously considering adopting it for several of our teaching units.

Chris Fellows FRACI CChem



A day in the life of a brain: the neuroscience of consciousness from dawn till dusk

Greenfield S., Penguin Random House, 2016, paperback, ISBN 9780141976341, 199 pp. $10–20

Who isn't curious about what it is to be human and have independent thought? 'What is consciousness?' is still the 'hard question' according to psychologists, neuroscientists, philosophers, theologians and the like. What is consciousness?

Susan Greenfield's book *A day in the life of a brain: the neuroscience of consciousness from dawn till dusk* delivers an interesting read in just nine chapters and a total of 199 pages, serving as a short foray into offering an explanation for the human experiences of consciousness. The catchy title looks into the 24-hour period of the life of one family (a father, a mother, an adolescent and a mother-in-law). One day in the life of this family affords Greenfield the opportunity to digress to a diverse range of topics such as mental illnesses (depression, schizophrenia, dementia, Alzheimer's disease and Parkinson's disease), ages and stages of babies, adolescence and adults, as well as learning styles (visual, auditory or kinaesthetic), the psychology of colour, and even animal consciousness.

Baroness Susan Greenfield CBE is Professor of Synaptic Pharmacology at Lincoln College, Oxford. As a neuroscientist, Greenfield has written several books about the brain. *A day in the life of the brain* is a sequel to *The private life of the brain*. In this latest book, the chapters are appropriately named: In the dark, Waking up, Walking the dog, Breakfast, At the office, Problems at home, Dreaming, Overnight and Tomorrow.

Greenfield establishes an interdisciplinary approach for her central supposition of a meta assembly that gives rise to a moment of consciousness. Phenomenology (a subjective approach using philosophical discussion) and physiology (an objective approach using neuroscientific techniques) are intertwined to offer a way forward into thinking about consciousness. The constant analogy used throughout the book is that the size of the stone (cognitive factor) and the force with which it is thrown (intensity of the stimulus) into a pool, the viscosity of the puddle (availability and concentration of various modulators), the frequency with which subsequent stones are thrown – the extent of the ripples from the impact – combine to determine the degree of consciousness at any one moment.

According to Greenfield, conscious experiences may be mindless (consisting of small neuronal assemblies) or more meaningful (consisting of larger neuronal assemblies). As a novice in this area, I am not convinced by Greenfield that human consciousness has been elucidated.

But Greenfield offers explanations for what it means to lose consciousness or to be unconscious. And it was interesting to think about whether a foetus is conscious at 4–5 weeks. Her book reads like a review of conscious research with many references made to scientists of note from around the world such as Crick and Koch, Oliver Sacks, Friedrich Neitschke, and Hebel and Wiesel to name a few. As well, references are made to leading philosophers and psychologists through the passage of time. 'Snapshot' studies are presented as well as results of longitudinal studies.

Scientific techniques mentioned included voltage sensitive dye imaging used to detect brain activity over milliseconds, fMRI used for activity of the brain measured over seconds, functional electrical impedance tomography by evoked response (fEITER) for short time scales and non-invasive brain activity interpretation, and EEGs and a bispectral index were referred to in the measured effects of anaesthesia.

There were many interesting facts that I would like to be able to call upon in any trivia competition. For example, there are 100 billion changeable neurons that make up your brain, hearing is the last sense to cease functioning under general anaesthetic and the first to re-awaken, the loss of sense of smell is the earliest sign of Alzheimer's disease, humans with normal vision are able to appreciate a staggering 2.3 million discernable colours, and donkeys sleep for 3 hours a day while armadillos sleep up to 20 hours!

So in just a couple of hundred pages, *A day in the life of the brain* covers the disciplines of philosophy, psychology, neuroscience and physics, as 'consciousness' is explored. How the 'water' of the objective brain events is transformed to the 'wine' of subjective consciousness is not fully answered. Susan Greenfield discusses variations of consciousness, attempts to disentangle different terms related to consciousness and proposes a way forward to resolve the 'hard question' using an easy reading, narrative style. Best that you read this one for yourself and form your own opinion!

Alison McKenzie

Am I an inventor?

Corrine Porter, Patent Attorney, FB Rice

I was included as an author on a scientific publication but have just discovered that I was not included as an inventor on a patent application filed before the paper was published. Why am I not an inventor?

Authorship and inventorship are not the same thing. For scientific publications, an author is usually someone who has contributed to the work presented in the paper. They may have designed and/or performed the experiments, supervised the person performing the experiments, analysed the data, prepared the manuscript or contributed reagents or money. Authors are sometimes included as a matter of professional courtesy.

In contrast, inventorship is a legal concept. This is a complicated area of law and inventors are determined on the basis of their involvement in the development of the inventive concept. Unfortunately, there is no one-size-fits-all definition of inventorship because the laws on inventorship vary depending on the country. Accordingly, a person may be considered an inventor in one country but not in another. In Australia, the key question is whether the person has made a contribution to the invention. This requires identification of the nature of the invention and the inventive concept followed by an assessment of a person's contribution to the invention. The latter can be assessed in a number of ways.

1 Did their contribution have a material effect on the final invention?
2 Was their contribution part of a collaborative effort?
3 Did the person contribute to the 'conception of the solution' to a problem solved by the invention?
4 Did the person have a general idea of what was required but another person put the idea into effect?
5 Would the final concept of the invention have materialised without the person's contribution?

Typically, not all authors on a publication will be an inventor. A person is not an inventor if they simply funded the research or contributed reagents. A person is not an inventor if the work was routine or carried out under the direction of others. For example, a research assistant who prepares a new drug according to a reaction scheme proposed by their supervisor would not be an inventor because they were merely following the directions of their supervisor. In this situation, their supervisor is the inventor. However, if the research assistant actively contributed to the development of the new drug by proposing the reaction scheme used or varying the drug to enhance its efficacy, then the supervisor and research assistant are both inventors.

It is important that the correct people are named as inventors on a patent application. The inventor(s) own their invention and other parties must derive ownership from the inventor(s). In extreme cases, wrongly identifying inventors can result in the patent being invalidated and a loss of patent rights or someone else being able to use your invention without your consent. Patent attorneys are skilled at reviewing work and assisting in identification of the correct inventors. If you have any concerns regarding inventorship please contact a patent attorney.

For more information, email cporter@fbrice.com.au.

The energy saga

At the time of writing (May 2017), the eastern seaboard of Australia is suffering from an energy crisis of our own making. There are serious issues with the reliability and price of electricity. This became apparent to the public when a storm last year precipitated the shut-down of the electricity grid in South Australia. Also, there is increasing uncertainty about the availability and price of gas. Both of these are interlinked in that gas is required in large volumes and on an intermittent basis to run open-cycle gas turbines as back-up generation when renewable power fails to generate sufficient electricity for the demand.

This is clearly demonstrated in the graphs on page 37, which show a significant rise for the cost of electricity for the NSW and Victorian wholesale electricity markets and for the gas market in Victoria. For the current level of electricity and gas prices, as I have discussed in previous articles, no producer of aluminium, fertiliser, methanol or similar product would be profitable. Continuation of energy prices at this level will ultimately result in the closure of most energy-intensive manufacturing on the eastern seaboard.

For years, many in the processing industries have been predicting a serious problem with energy supply (see, for example, Andrew Liveris of Dow Chemicals in an op-ed in *The Australian*, 25 April 2012). In a previous article (see October 2015, p. 36), I asked if the then-emerging LNG export industry was worth more to the country than the chemical process industry. As witnessed by the political inaction to solve the current crisis, it seems that the country's leaders, without exception, believe that LNG exports are not only worth more than the chemicals industry but are worth more than the entire manufacturing sector.

What action there has been to date appears piecemeal and inadequate. The three main LNG export companies and their gas suppliers have been exhorted to make more gas available to the domestic market. Not all have agreed to this. But more importantly, no mention is made of the price of gas; if it is not reduced dramatically (to below $5/GJ), large numbers of energy-intensive manufacturing facilities will be forced to close.

However, state governments continue to block the development of new gas supplies by bans on advanced production and well stimulation techniques, commonly called fracking, used across the world in the oil and gas industry, including off-shore Australia. This encompasses most of the major prospective gas resources that could relatively quickly supply gas to the eastern seaboard. Victoria has gone further by effectively closing development of its smaller gas fields in the west of the state, which have been producing gas since the late 1960s.

Furthermore, the progressive closure of older coal-fired generating stations is putting increasing pressure on the supply of electricity and increasing reliance on additional renewable sources, which require additional back-up gas-generating capacity somewhere in the system. And since renewable sources are inherently high-cost generators (due to the capital return demanded by private corporations on the high capital costs, which include the cost of effective and secure connection to

the grid), this high cost will be further exacerbated if expensive, and as yet unproven, battery technology is adopted as a partial back-up to renewable generators.

What are the alternatives for gas supply? I have summarised these as follows with my estimates for the likely costs and timing.

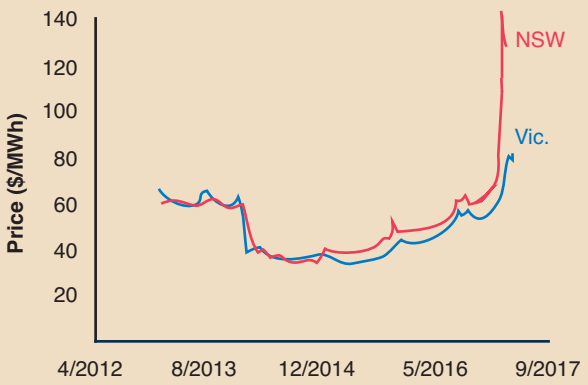
LNG import into southern states: Spot LNG is readily available and could be imported at one or several locations. The concept would require the construction of LNG re-gasification plant, which could be ship based. The cost of gas would be made up of the LNG price (say $6/GJ), shipping from the North West Shelf (shipping from Gladstone would be perverse), which would cost another $1/GJ, and re-gasification (another $1/GJ). The total gas cost would be at least $8/GJ. Taking into account permitting requirements and construction of a re-gasification facility, this could see gas delivered in three or four years.

Gas by pipeline from north-west Australia: The pipeline would deliver gas from the large resources off-shore north-west Australia to Moomba, which would deliver gas through existing pipelines to Brisbane, Sydney, Adelaide and then Melbourne. Pipelines of large transcontinental size as the ones proposed would cost $5 billion. This would include the provision of re-compressor stations every 100–200 kilometres. This solution is very sensitive to the amount of gas moved. Supplying all of the east coast non-LNG demand would cost about $3/GJ for carriage costs to be added to the pre-LNG cost of about $3/GJ. However, if the pipeline was only used for part of the demand (say 100 PJ/year), then the cost of carriage alone would be $8/GJ. Permitting has traditionally been easy in Australia but native title issues across inland Australia may now be a problem. This solution may take 8–10 years.

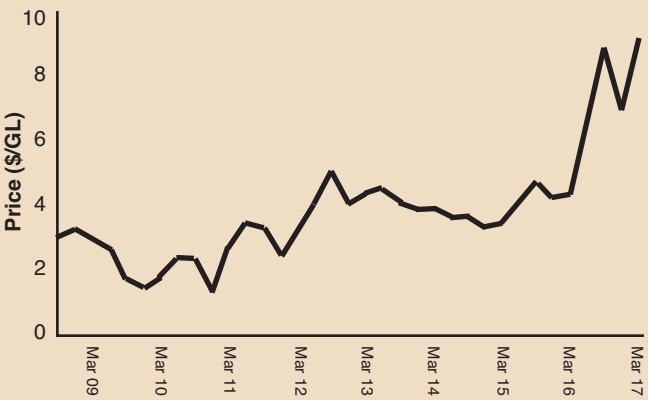
Gas by pipeline from northern Australia (Timor Sea): This is the proposed northern pipeline that would link gas fields off-shore the Northern Territory to the eastern grid at Mount Isa or Moomba. Should the NT government lift its ban on on-shore gas developments, these gas sources could be added. The cost is less than the transcontinental option at $1.5 billion but gas carried would be lower, increasing transmission costs ($4/GJ), so final cost would be similar to a transcontinental pipeline ($7/GJ). This is unlikely to be a solution within five years.

Synthetic natural gas (SNG) made from coal: SNG facilities could be located on a suitable coalfield and be coal of any type, including low-grade non-exportable coal. SNG would also have the advantage of producing significant co-generated electricity, which would reduce the SNG production cost. The cost of SNG would be in the region of $8–12/GJ depending on the scale and coal costs. Permitting and construction could take four or five years.

Complete lifting bans on exploration and production of gas in eastern Australia: This is the obvious solution but since bans have been in place, several other hurdles have arisen. To be effective, this would require reform of the fiscal regime of which a major one would require the states to give up part and preferably all of their royalty to landowners – farmers and native title custodians. This would encourage the exploration and development of new reserves. However, it is unlikely that a very large new on-shore development will occur, rather a series of small operations is most likely. Many of these discoveries require the development of coal seam gas or shale, which are inherently high cost ($5/GJ or more). Large-scale discoveries would, on past history, be more likely to come from off shore in deeper water off Bass Strait, the Otway Basin and the Australian Bight. These are costly, high-stakes operations requiring Commonwealth incentives not helped by current ideas to increase tax on off-shore oil and gas production. This solution would deliver large volumes of gas at low price (<$3/GJ) but starting from scratch would take at least five years.



Victorian and New South Wales wholesale power prices (AEMO data).



Victorian gas prices – average daily weighted imbalance price (Australian Energy Regulator website).

None of these proposals would deliver gas in the short term but, more importantly, all, except large-scale off-shore, are high-cost options. The prognosis for manufacturing and the chemical industry in eastern Australia is grim. This is not to say that all is lost. Gas costs in the west are competitive with international practice and there is plenty of gas to be developed to support local industries, so that energy-intensive and strategic manufacturing may survive. But then again, it would only take a few turns of the election cycle to destroy this as well.

Duncan Seddon FRACI CChem is a consultant to coal, oil, gas and chemicals industries specialising in adding value to natural resources.

Peter Doherty: why Australia needs to march for science

The mission posted on the March for Science international website states:

> The March for Science champions robustly funded and publicly communicated science as a pillar of human freedom and prosperity. We unite as a diverse, nonpartisan group to call for science that upholds the common good and for political leaders and policy makers to enact evidence based policies in the public interest. The March for Science is a celebration of science.

To me, it seems the reason concerned people across the planet are marching today is that, at least for the major players in the English-speaking world, there are major threats to the global culture of science.

Why? A clear understanding of what is happening with, for example, the atmosphere, oceans and climate creates irreconcilable problems for powerful vested interests, particularly in the fossil fuel and coastal real estate sectors.

Contrary to the data-free 'neocon/trickle down' belief system, the observed dissonance implies that we need robust, enforceable national and international tax and regulatory structures to drive the necessary innovation and renewal that will ensure global sustainability and a decent future for humanity and other, complex life forms.

Here in Australia, the March for Science joins a global movement initiated by a perceived anti-science stance in Donald Trump's administration.

Trump's 2018 budget proposal

In the USA, President Trump's proposed budget for 2018 incorporates massive cuts to the National Science Foundation (NSF), National Oceanographic and Atmospheric Administration (NOAA), the United States Environmental Protection Agency (EPA) and the National Institutes of Health (NIH).

And, though it in no sense reflects political hostility and deliberate ignorance, British scientists are fearful that Brexit will have a terrible impact on their funding and collaborative arrangements.

How does this affect us in Australia? Why should we care? The science culture is international and everyone benefits from progress made anywhere. NOAA records, analyses and curates much of the world's climate science data. A degraded EPA provides a disastrous model for all corrupt and regressive regimes.

Science depends on a 'churn', both of information and people. After completing their PhD 'ticket', many of our best young researchers will spend 3–5 years employed as postdoctoral fellows in the USA, Europe and (increasingly) the Asian countries to our north, while young American, Asian and European/British scientists come to work for a time with our leading scientists.

The proposed 2018 US President's budget would, for example, abolish the NIH Fogarty International Centre that has enabled many young scientists from across the planet to work in North America. In turn, we recruited 'keepers' like Harvard-educated Brian Schmidt, our first, resident Nobel Prize winner for physics and current Vice Chancellor of the Australian National University (ANU).

We might also recall that – supported strongly by Prime Ministers J.J. Curtin and R.G. Menzies – the ANU (with three Nobel Prizes to its credit) was founded as a research university to position us in science and international affairs.

Not a done deal, yet

What looks to be happening in the US is not a done deal.

The US political system is very different from our own. The Division of Powers in the US Constitution means that the President is in many respects less powerful than our PM.

Unable to introduce legislation, a President can only pass (or veto) bills that come from the Congress. Through to September, we will be watching a vigorous negotiation process where separate budgets from the House and the Senate (which may well ignore most, if not all, of the President's ambit claims) will develop a 'reconciled' budget that will be presented for President Trump's signature.

How March for Science might help

The hope is that this international celebration of science will cause US legislators, particularly the more thoughtful on the right of politics, to reflect a little and understand what they risk if they choose to erode their global scientific leadership.

There are massive problems to be solved, along with great economic opportunities stemming from the development of novel therapies and new, smart 'clean and green' technologies in, particularly, the energy generation and conservation sector.

Ignoring, or denying, problems does not make them go away. Whether or not the message is welcome, the enormous power of science and technology means we can only go forward if future generations are to experience the levels of human well-being and benign environmental conditions we enjoy today.

There is no going back. The past is a largely imagined, and irretrievable country.

Peter C. Doherty, Laureate Professor, The Peter Doherty Institute for Infection and Immunity. Adapted from a speech delivered at the Melbourne March for Science on Saturday 22 April, 2017. First published at www.theconversation.com.

Wine sensory profiling with music

In the December 1996 issue, I wrote an article entitled 'Wine, electrochemistry and song!'. The article outlined the advantages of using electrochemistry for a wide range of oenological analyses. The 'song' part came about as we had access to an instrument that would play *I'm forever blowing bubbles* during the degassing step in stripping analysis. Some recent research in psychology seems to suggest that there may be a little more to wine and song.

A friend in Paris recently sent me a link to an article on the Guardian website that was addressed 'Can music really change the taste of wine' (bit.ly/2mnUPxZ). Jo Burzynska, a presenter at the World Science Forum in Brisbane in March this year, explained to Clarissa Sebag-Montefiore the concept of stimulating our response to wine sensory characters by tasting the wine while playing music. The conference workshop was presented in a 'sterile, sound-controlled room', with different music playing while tasting and then writing impressions of the wine. This is a long way from my experience in sensory analysis of sitting in a cubicle with a computer screen with a set of glasses and some aroma and taste standards nearby to check my impressions against the standards. But maybe my experience is classical sensory science while the music/wine association allows people 'to reconnect with their senses', to use Burzynska's term.

In trying to find the science underpinning the impact of music on wine sensory profiling, Professor Adrian North published a detailed study entitled 'The effect of background music on the taste of wine' in the *British Journal of Psychology* (2012, vol. 103, pp. 293–301). At Heriot Watt University at the time (Professor North is now at Curtin University), the study involved 250 students tasting one red and one white wine in groups of 25 (alternating 12/13 female/male) in a room with the music playing at 70 dB. Each group of 25 tasted the wine with different music playing in separate rooms and also in one room without music. Four descriptors were provided in advance and, after tasting, the students scored the descriptors on a scale of 0 (not at all) to 10 (very much).

The selected descriptors used in the North study (with the selected music in parentheses) were *powerful and heavy* (*Carmina Burana* by Carl Orff), *subtle and refined* (*Waltz of the Flowers* by Tchaikovsky), *zingy and refreshing* (*Just can't get enough of you* by Nouvelle Vague) and *mellow and soft* (*Slow breakdown* by Michael Brook). The results showed that the music/descriptor matching always had the highest rating. That is, when the wine was tasted with *Carmina Burana* in the background, the highest rating was obtained for *powerful/heavy* while tasting the same wine with *Slow breakdown* in the background, the *mellow/soft* rating came out in front. There was little variation in the descriptor ratings when no music was played in the tasting room.

There are numerous studies in the literature suggesting a link between auditory stimuli and flavour or taste perception, and the results of the North study are in general agreement

Stockphoto/narongcp

with these other studies. Subsequent to the North paper, Charles Spence and Qian Wang have written three reviews on the wine/music theme in the open-access journal *Flavour* (doi: 10.1186/s13411-015-0045-x; 10.1186/s13411-015-0043-z; 10.1186/s13411-015-0046-9). These reviews are descriptive, sometimes labelled as accretion rather than explanation (see reference in bit.ly/10Q03I9).

One of the questions associated with the type of study used by North is that the music may not communicate the message that is intended. While I love seeing *Carmina Burana* performed on stage, it is too distracting for me to contemplate playing it when tasting wine. Similarly, the *Waltz of the Flowers* brings to my mind the distracting image of silly things dancing, although Michael Brooks' *Slow breakdown* does have the *mellow/soft* character ascribed to it in the North study. North commented that his methodology checked that participants did understand the 'music message'. While the groups were matched for gender, it would be interesting to see if there is a gender response effect – we saw very clear evidence of this when we looked at ethanol metabolism in a study some years ago.

To me, present evidence for a wine/music effect has perhaps opened up more questions than it has answered. The concept does have significant implications for wine marketing strategy – what music should be played in cellar door sales that might stimulate the customer to purchase wine would be a fascinating research study.

Perhaps by way of self-contradiction, I should point out that I listen to music for relaxation, or 'de-stressing' to use the current euphemism. So I am writing this article while listening to Joseph Haydn's Emperor string quartet. Haydn's string quartets are my preferred music at home when we are dining. Unfortunately, I do not have the financial resources of the Esterházy princes who provided Haydn with a small orchestra to play for them in the palace dining room.

Geoffrey R. Scollary FRACI CChem (scollary@unimelb.edu.au) was the foundation professor of oenology at Charles Sturt University and foundation director of the National Wine and Grape Industry Centre. He continues his wine research at the University of Melbourne and Charles Sturt University.

Online learning

I just failed a course. It seemed a good idea to enrol in a Massive Open Online Course (MOOC) on healthy food and nutrition. The course started in the Easter week. I was busy at my paid employment, and preparing for the long weekend. After Easter, there were more work and social commitments. Suddenly, I had missed more than half the course and was several weeks behind schedule. It was all too hard to catch up; I failed. When I enrolled, my expectation was that it should be easy to find time to fit study around my other activities. My reality was that I lacked a commitment to studying this course and continually gave higher priorities to other things.

The above account is true, but it reads like fiction because it closely parallels the story of some of my university students. Fortunately for me, there was no financial cost, and the non-completion will have no detrimental effects on my career prospects. Not so for my students. When they fail to complete a course or unit of study, there are large financial costs and severe consequences. In a 2008 Australian Learning and Teaching Council (ALTC) project, Gosper and co-workers found that a significant number of students do not complete online learning tasks because they do not establish a study routine, which was my recent experience. Conversely, attending face-to-face classes in a regular schedule helps to establish a routine for study.

One Australian university has reported that completion rates for some MOOCs are typically about 2% of enrolments, and half of the enrolled students never even start the course. Much of the enrolment in MOOCs is driven by impulse. I failed the MOOC because the spur-of-the-moment decision to enrol was not associated with an evaluation of how the course would (or wouldn't) fit into my day-to-day routine. This experience is different from enrolment in university or TAFE courses, which usually requires a would-be student to go through a multi-step procedure, usually with some financial cost just for submitting the application. The proportion of university and TAFE students who enrol but never start a course is much less than in MOOCs.

An overestimation of the time available for study, coupled with an underestimation of the amount of time needed to fulfil non-study commitments is an important factor. Around 70% of Australian youth in tertiary study (aged between 20 and 24) have a part-time or full-time job. For those studying full-time, working has a negative impact on study. For example, working 16–24 hours a week reduces the completion rate by 8%, while more than 24 hours of employment reduces it by 14%. While this problem is not restricted to online learning, the lack of an externally imposed study routine makes this problem more significant in the online context.

Given a choice between online and face-to-face classes, the latter are preferable: students in face-to-face classes report higher student engagement, development of cognitive and social intelligence competencies in class, and cognitive engagement out of class, although these outcomes were not specifically targeted as learning outcomes.

Online learning has several positive aspects. Sometimes there is no other choice. Between 50% and 60% of on-campus university students do not attend at least some of the face-to-face lectures available, and of these students, 75% indicated this was because they 'couldn't attend' class. These statistics are about 10 years old; anecdotal evidence is that the number of on-campus students who do not attend some or all classes has increased over the last 10 years. The flexibility of time and place to study is in the tradition of the Royal Flying Doctor's *School of the Air* in which technology is seen as an opportunity of reaching out to students rather than replacing traditional modes of teaching and learning.

Online learning is also good for revision or for those who want to pause a lesson to clarify a point before continuing. Even for students enrolled in on-campus study, there is a positive relationship between the use of online resources and examination performance. Students who do not use optional online learning because they forgot or ran out of time achieve lower marks than those who do not use optional online learning for other reasons. The availability of online learning is not a remedy for poor study routines or having too many commitments.

Online learning is another mode for learning. Like other learning tools in a broader teaching and learning toolbox, it has advantages and disadvantages, but it is not intrinsically good or bad. Furthermore, teaching science online is more demanding than many other disciplines. Ultimately, the effectiveness of online learning depends on how it is used by both the educator and the learner.

Kieran F. Lim (林 百 君) FRACI CChem
(kieran.lim@deakin.edu.au) is an associate professor in the School of Life and Environmental Sciences at Deakin University. In the past, he has successfully completed online courses of study.

Dr Findlay Down Under

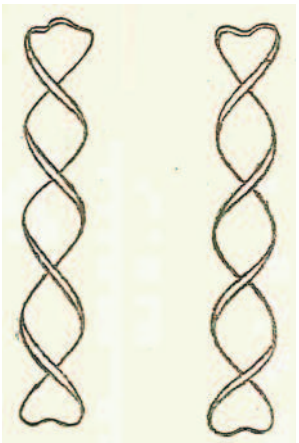
I wrote last month about Alexander Findlay (1874–1966), who was Professor of Physical Chemistry at the University of Aberdeen. Closer to home, he was the external examiner in chemistry for the University of New Zealand in the days when the various university colleges there were badged as sections of the national institution. In 1938, Findlay came south to perform face-to-face the duties that are normally exercised at a distance by external examiners. Accompanied by his wife, he spent five weeks holidaying in New Zealand, only occasionally calling in at a scientific institution. The newspapers reported his admiring comments on the state of science there. In addition to his examining duties, Findlay lectured several times on the subject of 'Science and the Community'. This wasn't quite what I (or perhaps the NZ community) was expecting, since in his lecture Findlay spoke strongly about the perceived iniquities of industry. 'While people were grateful for the many benefits which science had produced', he said, 'there were some who felt that the gospel of industrial efficiency, if carried into action without regard to higher considerations, might be productive of great evil', and that 'the gospel of efficiency must always be softened by the gospel of righteousness'.

Although Findlay did not write extensively on this theme, his social critique of science is included in the preface of his 1916 book where he seems to have a bet each way. 'Science stands for efficiency *in all the activities of life*', he wrote, 'and the neglect of science spells waste and industrial decay'. On the other hand, science has cultural value and he urges appreciation of 'science not entirely on account of its utilitarian value as a means of increasing wealth and material prosperity'.

On his way home, Findlay called at Sydney in September to deliver the 1938 Liversidge Lecture. It was entitled 'Chemistry in Space' and reading this I wondered if it was an early, unrecognised version of the 'molecules in space' (aka galactochemistry, a title that always reminded me of the Milky Way) research and speculation of the 1970s. It wasn't, of course: it was all about stereochemistry – van't Hoff and Le Bel, and of course Pasteur and his tartrates. Findlay included some of this in the chapter on molecular structure in his 1916 book, *Chemistry in the service of man,* later revised and retitled *The spirit of chemistry* in which he ascribed the 'Chemistry in Space' tag to Pasteur.

In his stereochemical chapter, Findlay described a lecture demonstration that was new to me and I wondered if he used it in his Sydney lecture. If a beam of polarised light is passed down a cylinder filled with turbid water, the path of the light beam can be seen clearly. If the water is replaced with a strong solution of cane sugar, then the beam appears as a spiral, as shown in the accompanying diagram. The demonstration is included in his *Introduction to physical chemistry*, and was said to be due to the British physicist George Stokes (1819–1903) and published in the *Zeitschrift für physikalische Chemie* in 1899 by Nicolai A. Umoff. I should be interested to know if any reader has seen this demonstration.

If the water is replaced with a strong solution of cane sugar, then the beam appears as a spiral ...



After the Sydney visit, the Findlays set off for home and their ship called at ports along the south coast of Australia.

Mrs F was not mentioned in the press reports, but I read that Findlay lunched with chemists in Melbourne, spoke to press about the need for four-year degrees when his ship berthed in Adelaide, and went ashore at Fremantle to lunch in Perth with the WA branch of the Chemical Institute. Sailing on, they disembarked in Bombay 'to go overland to Bahrain in the Persian Gulf, to see their son'.

It seems likely that Findlay Jr was working for the Bahrain Petroleum Company (BAPCO) and, if so, I wonder if he shared his father's reservations about the impacts of industry. BAPCO took over Gulf Oil's assets in Bahrain and, having obtained the only oil concession from the government in 1930, started searching. Their reward came with the discovery of the Awali field in 1932 – the first of many oil discoveries in the Arabian Gulf region. BAPCO shares changed hands a few times in the ensuing years but eventually came to be all owned by the Bahrain Government. The company still operates in that country.

I was told when I visited Saudi Arabia in 1991 that petroleum geologists in Bahrain in the early 1930s had recognised, just across the water on the mainland near Dhahran, a 'jebel' – the characteristic domed landform arising from an anticline that might have oil trapped far underground. They encouraged partner organisations to explore there, and success came in 1938, leading to the formation of the Saudi Aramco company.

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 provides advice on chemical hazards and pollution.

events

3rd International Conference on Organic and Inorganic Chemistry
17–19 July 2017, Chicago, Illinois, USA
http://organicchemistry.conferenceseries.com

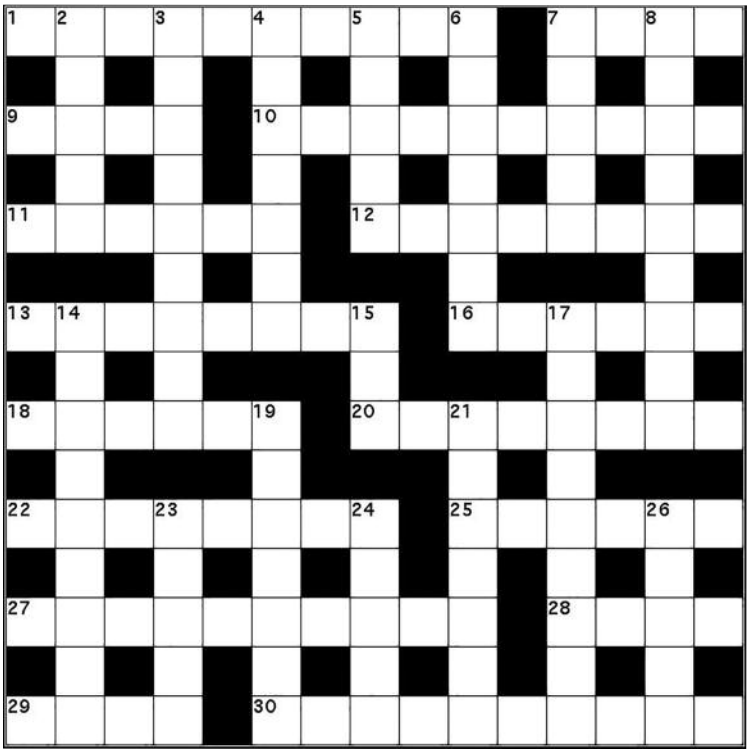
Vic Branch Centenary Gala Dinner and Ball
22 July 2017, Plaza Ballroom, Melbourne, Vic.
https://icmsaust.eventsair.com/raci2017/centenary-gala-dinner/Site/Register

6th Modern Solid Phase Peptide Synthesis and its Applications Symposium
12–14 October 2017, Fraser Island, Qld
www.solidphase.org

International Conference and Exhibition on Pharmaceutical Nanotechnology
27–29 October 2017, Rome, Italy
http://nanotechnology.pharmaceuticalconferences.com

RACI events are shown in blue.

cryptic chemistry



Across

1 Studied carbon true colour. (10)
7 Exclusively singular. (4)
9 Animal! Second overturns champion. (4)
10 Vatican gift, no fluorine compound, getting out of mothballs. (10)
11 Negative coward jibe. (6)
12 & 29 Across Your errand is confusing for someone with low level permissions. (8,4)
13 Radiation from 10 nm to 200 nm/void/radiation from 10 nm to 400 nm. (6,1.1.)
16 Failing sense of application of bromocresol green, perhaps. (6)
18 & 23 Down The French canvas blunder caused by dormant conditions. (6,5)
20 Penalty payments said to be negative. (8)
22 Does lion destroy coil? (8)
25 Tables sense changes. (6)
27 Match position. (10)
28 Plateau in constant-volume sampling. (4)
29 See 12 Across.
30 Neon term is in the soup. (10)

Down

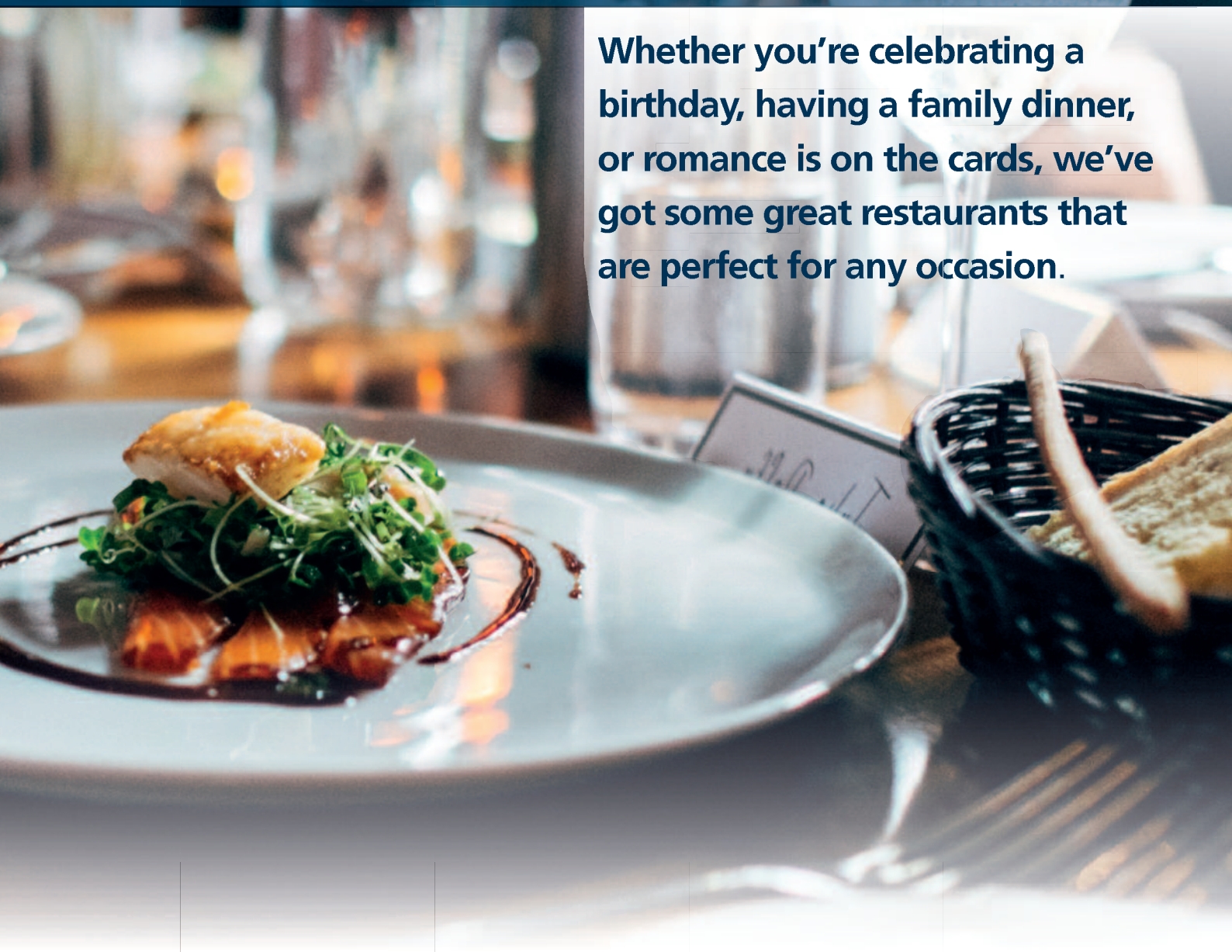
2 Adjacent to radical 19 Down in O_2. (5)
3 & 4 Down A picture that helps us make agar/turmeric dust! (9,7)
4 See 3 Down.
5 Dated in period style. (5)
6 Put into groups showing disunity. (7)
7 Time and again of neon. (5)
8 Way-out press gang enrol. (4-5)
14 Comparable USA lagoon swamped. (9)
15 Front vehicle. (3)
17 Can metal ores be a source of rubber?! (9)
19 Esmark's discovery made him tour. (7)
21 Excursions over into scholar's levarterenol studies. (7)
23 See 18 Across.
24 Chosen under stress. (5)
26 75th error typically converts into polymer. (5)

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

23-28 July 2017 | Melbourne

raci 100 Centenary Congress

Perfect Setting. Great Company. Generous Savings.



Whether you're celebrating a birthday, having a family dinner, or romance is on the cards, we've got some great restaurants that are perfect for any occasion.

Your RACI Member Benefits lets you access up to 400 participating restaurants offering great discounts and savings.

To discover venues where you can take advantage of your benefits;
Call 1300 853 352 or visit
www.memberadvantage.com.au/raci

Member ADVANTAGE®

23-28 July 2017 | Melbourne

www.racicongress.com

#RACI100

Centenary Congress

The Organising Committee would like to invite you to the 2017 RACI Centenary Congress.

The RACI is the oldest scientific or technical professional society in Australia. The Centenary Congress is an opportunity to celebrate the contributions that chemistry has made to Australia's (and the world's) social, economic and intellectual advancement over the past century.

17 ACC
17th Asian Chemical Congress and 19th General Assembly of FACS

ACCC6
6th Asian Conference on Coordination Chemistry

AIMECS 2017
11th AFMC International Medicinal Chemistry

For all enquiries, please email
info@racicongress.com

Carbon 2017
World Conference on Carbon

Chemeca 2017
Australian and New Zealand Federation of Chemical Engineers Annual Conference

GSC8
8th International Conference on Green and Sustainable Chemistry

Tetrahedron
18th Asian Edition Tetrahedron Symposium