BETTER LIVING THROUGH CHEMISTRY

Professor Terence Cosgrove and Professor Julian Eastoe, members of the Colloid Research Group in the School of Chemistry, have known each other for over 15 years. Nick Riddle sits in on their wide-ranging discussion which begins with memories of their first close chemistry encounters.

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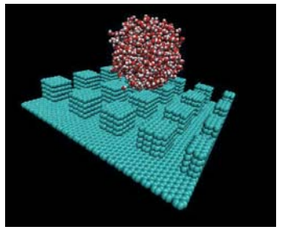

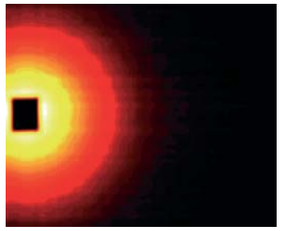

Above: Professor Julian Eastoe (left) and Professor Terence Cosgrove in Bristol ChemLabS, a new HEFCE-funded Centre for Excellence in Teaching and Learning
Left: Professors Eastoe and Cosgrove share a passion for research in colloid and interface science, from nanodrops on surfaces (far left) and the physics of neutron scattering (centre) to surfactants and all things 'soapy' (right)

Chemical beginnings

TC: In second-year Chemistry, at school, we were making some different materials, and they were all brightly coloured. I loved the colours, and I wanted to know how they were made. And then I realised I could make them myself.

JE: I got turned on by the coolest experiment in chemistry: making nylon. You take two totally different liquids and you make a solid. If you put these two liquids together, they tend to separate, but where they meet – at the interface – they react and form a disc of polymer. That's the nylon. If you poke down with some tweezers through the top liquid, and you start to pull that disc upwards, you start to expose new molecules, so you get more reaction. The more you pull it away, the more new molecules meet and react. It's called the Indian Rope Trick. I'll never forget seeing that; it'll probably flash before my eyes when I come to the end of this mortal coil.

TC: I used to do that as a demonstration in my lectures – it's quite impressive. But the ammonia it gives off… They had to evacuate the lecture theatre.

JE: I did a Physical Chemistry course in my final undergraduate year at the University of East Anglia, and there was this one experiment that amazed me. You take some simple gases, which existed at the dawn of the earth's history, and you seal them in a jar. When you pass a very high voltage through the gases, some solid material forms at the bottom. If you scrape that stuff out, you find that it's got the very building blocks of life in it: amino acids, these complex molecules that eventually generate living beings. And that's when I went, 'Oh – *that's* what it's all about'.

Collaborating

JE: We collaborate on research, but also we work together on the day-to-day running of the Colloid Science Groups, and on the teaching of the undergraduate programme, which is the root of it all – you need to inspire the students. So having someone like Terry is a great asset because he walks into a room and talks about chemistry, and science, and you can't help but leave that room saying, 'I've been in the presence of someone who's essentially crazy'. About science, I mean. If you don't get turned on to chemistry by a man like Terry Cosgrove, then there's no hope for you – you should try some other subject.

TC: But Julian's exactly the same. We're very similar.

JE: We travel a lot in our business, which is one of the perks of being a university academic. And about once a year I bump into Terence somewhere; I'm in Ohio or something, in an airport, and there he is, and we both ask, 'What are you doing here??' You turned up in San Diego once. I'm walking down the street, and there you are.

What *is* chemistry, anyway?

TC: It's very difficult to capture chemistry in a soundbite. For me, it's making molecules. I collect my atoms and my toolkit and put them together to make a new molecule. That's what we're good at – joining atoms together in ways that can be useful. And those uses cover everything from smoke detectors, shampoo and lubricants to drug delivery and new kinds of fabric.

JE: It's the same for me. We take the earth's resources and fashion them into new, exciting and potentially useful material.

TC: But the beauty of the subject is that everyone has their own definition. There are university chemists who probably haven't made anything since they were undergraduates. Not every chemist sits in a white coat with safety glasses and making smells. But if you want to make a new semiconductor, for instance, you need a chemist, because it involves putting atoms together in a complicated way.

JE: If you want to understand about global warming, you need a chemist.

TC: And if anyone's going to solve the global warming problem, it's going to be chemists.

JE: Although chemists get blamed for causing the problem…

TC: But what you're really blaming is society's need for more energy, regardless of the cost. All the chemist is doing is answering a need.

JE: The main questions are: Can you make something, and how quickly can you do it? It's no good if you discover a cure for cancer but it would take you a billion years to make it. A chemist might find a route that could generate this cancer-curing material, but then you'd need another bit of chemical insight to work out how to generate this wonderdrug quickly.

Why do it?

JE: I was walking the dog in the rain last night, and I was thinking about why you would want to become a research scientist in a university environment. And it's because the possibilities are totally endless. You're creating new forms that could have potential use – in other words, you're contributing to the growth of civilisation, in material terms.

TC: This morning I was doing a computer simulation with molecules. Tomorrow I might be in the lab mixing up something. You can be a cook one day, and you can be doing electronics the next day.

Saying something wrong

TC: With your students, you're looking forward to the day that they challenge you. Then you feel you've overcome something, an intellectual barrier, for them to realise that you're not always right.

JE: I'm a visiting professor in China, and that's a great challenge. In a deferential society, it's extremely difficult to get an open and honest discussion going. People don't want to say something wrong, so they'd rather say nothing. I've always tried to make it clear that I'm not frightened of being exposed for misunderstanding or ignorance. In fact I'd rather that happened, because that way I'm going to learn something. I've been going there for about five years, and this year I felt I'd cracked it. But that's only in one group. The minute I stepped outside of that group, into the wider culture, my heart sank and I realised how much more work there was to be done.

Getting it across

TC: I've got a thing about entropy. It's a very complicated thing, entropy. If you put a rubber band between your teeth and pull it quickly it heats up – and if you let it go quickly it cools. And that's to do with entropy and the second law of thermodynamics, one of the universal laws that help you an awful lot in chemistry. The word 'entropy' is everywhere these days – there's a stage play about it, and there's a pop group called Entropy. But it's a really dense concept and it's incredibly difficult to explain without getting a piece of paper out and covering it in scribbles.

JE: It's hard enough to explain what a molecule is. You mention the word 'molecule' and all of a sudden you've lost a lot of people.

In my experience, anyway. Maybe I've got the wrong way of saying molecule. I should try saying merrrla-cule. *(Laughter)*

You know how a sandy beach is made up of individual grains? Well, all materials are made up of individual molecules. It's just that a molecule is about a million times smaller than a sand grain.

I see public engagement as a challenge – I think we've got to get better at it. And we're definitely better than we used to be. About 12 years ago, we started giving public lectures on chemistry. The first year was hopeless; we tried to explain about molecules and so on – and we got nowhere. The next year we changed our approach; we got undergraduates to come up with a liquid formulation for making bubbles, using washing-up liquid, distilled water and glycerine. You could take away a recipe card and make this stuff at home. That worked a lot better. If anybody asked 'Why does that work?', that was our cue to say 'How much do you want to know?' Everyone's seen bubbles, so we take it from there. In some of these conversations we got down to the molecular level. But if you come in at any other level than the everyday, you have a difficult job getting anything across.

TC: You can start with simple questions: How do you get drunk on beer, which is 95 per cent water? Or why can a few picograms of polonium kill you? There are so many interesting questions in chemistry.

JE: It took us years to get to a point where we realised what was needed. That was in the early days of public engagement at Bristol. And now it's so much better – we've got a Professor of Public Engagement in Science, Kathy Sykes, for example.

TC: You also need to get things across when you're trying to explain a project to a grant-making body or a sponsor. And they say, 'Okay, say you've got a million dollars; how are you going to spend it?' And you've got to be able to distil all this stuff. This guy's got a million-dollar cheque book there and his pen is poised, and he says, 'Just explain to me how this thing of yours works…'

The chemical life

JE: As a scientist, you're never really off duty. It doesn't mean to say you can't have normal human relationships. My wife has no scientific background whatsoever.

TC: Chemistry is your life – it becomes your way of looking at the world. Like looking at nanoparticles in dispersion: if two or three particles come together, they might love each other and combine to form a bigger object, or hate each other and fly apart. So it's these molecular forces that govern matter. But if you look at the universe, it's basically the same thing – a dispersion of planets in the cosmos…

JE: Be careful – the physicists might take issue!

TC: I like the fact that there are *lots* of aspects of chemical reaction that we still don't understand. It seems unscientific, but if you try the same reaction over and over, you'll always have some attempts that just don't work... nobody knows why.

JE: For example, I make bread by hand every Sunday. It's really therapeutic to work on the dough with your hands. I've done it for about 20 years, and even now maybe once a year it'll go wrong and you can't work out what happened. You keep the recipe the same, and sometimes it rises too fast and the whole thing becomes top-heavy and it kind of splurges out. It's impossible to cut as well.

TC: But you get that lovely smell. Most chemical smells – around here anyway – are not very pleasant. But if you're cooking food, it's completely different.

JE: I get quite attached to some of these chemical smells, though. I quite like diethyl ether, for some reason.

TC: I like toluene.

JE: Toluene's horrible! It's like rank petrol.

TC: Well, I did my PhD in toluene, so…

JE: So it has an association for you.

TC: Yes. Anxiety and pain. *(Laughter)*

CHEMISTRY – THE MUSICAL

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Left: Professor Eastoe emphasises the importance of algebra using a song by Johnny Cash (1932-2003) who, although not a chemist, was no stranger to barbiturates

Right: Alexander Borodin (1833-1887), a member of the group of Russian composers known as the Mighty Handful, was also a respected chemist noted for his work on aldehydes

Left: Sir Edward Elgar (1857-1934) invented a device for making hydrogen sulphide gas. He called his laboratory 'The Ark'
(Photograph by permission of the Royal Society of Chemistry)

Music and chemistry might seem to make for an unstable compound, but as Professors Cosgrove and Eastoe point out, the two elements have been known to combine rather well.

TC: Did you know that several composers were also chemists? Borodin is the famous one. And Elgar had a chemistry lab in a shed behind his house.

JE: I sometimes use a Johnny Cash song to try to teach students the importance of mathematics. It's called 'Straight A's In Love', and he's singing about how his teacher says, 'Learn your algebra', but he only gets C's and D's. So even Johnny Cash knew the importance of algebra.

TC: There's a Flanders and Swann song about the second law of thermodynamics.

JE: Which you absolutely love, don't you? You played it during some lectures.

TC: They didn't really take it in. Then there's Tom Lehrer's 'The Elements', about the periodic table. Actually, that song put my career back years, because he sings them in the wrong order!