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The next generation of scientists

UNIVERSITY OF CAMBRIDGE | Yusuf Hamied Department of Chemistry

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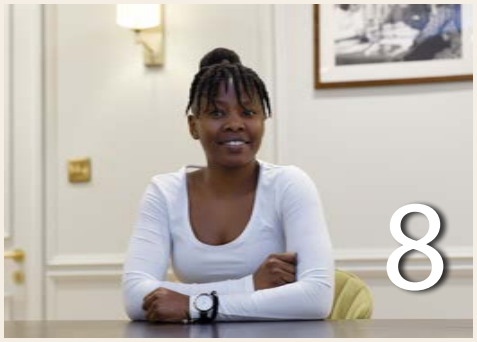

THE MOLECULE MAKER

UNSEEN DISABILITIES

Scientists of the future

The energy and enthusiasm of our students and early career researchers is a continuous source of pride and inspiration, so we decided to use this issue of Chem@Cam to tell you about some of their stories, and also about how they are supported by the department.

At the core of this support is our newly reconstituted Postgraduate Education Team, who explain how they are working to encourage postgrads back to live workshops, social gatherings and networking events after the enforced solitude of Covid.

We also feature a range of postgrad research and life, from Print Sakulsupich's research on sulphur dioxide emissions to molecule-maker Rosa Mueller, and Libby Brown's experience as an industry-sponsored PhD. Libby also interviewed two established academics to find out the advice they would have given to their younger selves.

We also report on our student-led Gender Equality, Black Women in Science, and Queer in Chemistry networks – it is so heartening to see how engaged the current generation is with important social issues. This includes the determination and bravery to reclaim the word "queer" to represent celebration and unity, which has not always been the case. You can also read about how one early career researcher is using the latest technology to overcome his unseen disability.

In 'What I did on my summer holiday' you can read about how we are using gifts from alumni to fund summer projects: four of our undergraduates describe what it was like to get into the lab and do real research for the first time. Such experiences are crucial in encouraging the next generation of researchers.

Finally, we have included a roundup of research bites and recent awards, and we welcome the return of the much-loved puzzle page with a chemistry-themed cryptic crossword written by postdoc Mary Wood. There will be a prize drawing from all correct entries received by 1st July (the solution will be revealed in our summer e-Chem@Cam, due in July).

James Keeler
Head of Department

Cover photo depicts sharing the joy of science at our Open Day.

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A note to my younger self

Dr Chiara Giorio and Dr Jenny Zhang share their top tips for PhD students and early career researchers.

PhD student Libby Brown writes: A PhD is a steep learning curve. You arrive on day one, fresh-faced and bright-eyed, ready to take on the world of research. You soon learn, however, that science is hard. For every breakthrough, there are months if not years of failure and disappointment. Although I am only three years into research life, there are already things I wish I'd known at the beginning of my PhD. I spoke to Dr Chiara Giorio and Dr Jenny Zhang about the advice they wish they had received when they started their research careers.

Gabriella Bocchetti, ©University of Cambridge

Dr Jenny Zhang

Jenny completed her PhD at the University of Sydney in 2012, before joining the Department as a Marie Curie International Incoming Fellow. She is now a David Phillips Research Fellow with her own research group, which is investigating biohybrid approaches for energy conversion.

Be brave and kind – to be a more robust and fulfilled scientist

Brave: It is okay to not always be confident, and having imposter syndrome can help you to develop competence before confidence. Be brave and do something that scares you. It is a good idea to put yourself out of your comfort zone and grasp opportunities that are presented to you.

Kind: Be kind to others. But more importantly, be kind to yourself. You will fail, fail and fail again but this is to be expected. It can take years to reach the polished form of who you want to be.

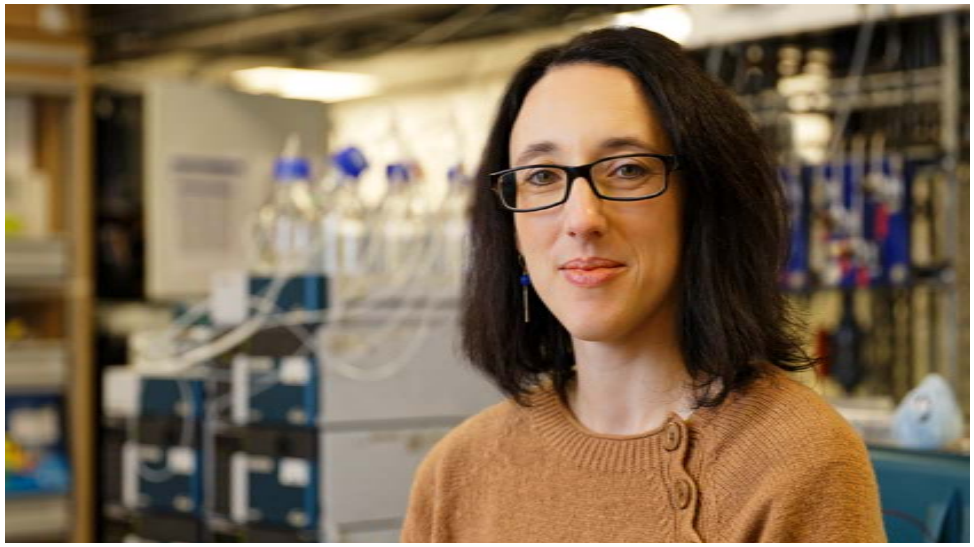
Work hard and develop a superpower

Find something (a skill, a topic) you love doing, and work hard to master it. This is something you will own and you can take it with you to bring value to other projects or paths.

Be cautious about all the advice you receive...

including this, recognising that everyone is speaking to you from some combination of luck and privilege.

Jenny wanted to leave us with this quote from science journalist Ed Yong: *Not all advice is useful – trust yourself, form your own opinions and develop confidence in your decisions.*



Nathan Pitt, ©University of Cambridge.

Dr Chiara Giorio

Chiara completed her PhD at the University of Padua (Italy) in 2012. She conducted research in the UK, France and Italy before joining the Department in 2020 as an Atmospheric Chemistry Lecturer. Research in the Giorio group is focused on exploring the present and past of the Earth's atmosphere.

Make use of the Cambridge University Mentoring Scheme

The University of Cambridge has a wide range of academic, peer-to-peer and PhD/postdoc mentorship programmes. Talking to people with more experience than yourself can open your eyes to new opportunities and career possibilities, not just academic, that you may not even know exist.

Make a plan but leave room for manoeuvre

To succeed as a researcher, you must be organised. But you also must be able to adapt and explore options when things go wrong.

You don't have to be full of ideas from the start

Many believe that to succeed as an academic you must be full of ideas throughout your PhD. However, ideas come with time and can develop later towards the end of your postgraduate research and throughout your postdoc. Accept that you will have lots of bad ideas along the way and read literature reviews to find knowledge gaps.

Failure and rejection are part of the game

Every good researcher has experienced failure. Don't take it personally, pick yourself up and learn from your mistakes.

1/3 lab work, 1/3 reading, 1/3 writing

This advice is pretty self-explanatory. Research should not just consist of experiments. Make time for reading and writing too.

Read more about Libby and her experience completing an industry-funded PhD with AstraZeneca and the Bernardes group on page 16.

We want to help students thrive

Our new postgraduate education team are working together to support our postgrads from initial application to viva and beyond.

"After a lot of staff turnover in the last two years, we're very much in the process of rebuilding," says Dr Rosanna Hunt (known as Rosie), who joined the team in December as Postgraduate and Admissions administrator. "That means in practice I'm the one who organises the training courses, and the pizza and beer," she laughs.

Postgraduate Student Coordinator Tessa Blackman, who started in August, is responsible for admissions and student records. Among many other responsibilities, she manages the often complex postgrad application process. Tessa says: "I see my role as supporting the chemistry postgraduate students and ensuring they have a happy, productive degree and reach their potential."

The team's third member, Dr Aruna Reddy, has recently returned to the department and will be gradually increasing her hours as Postgraduate Admissions and Education Manager. Aruna is the first contact for all information regarding departmental policy, postgraduate education and training. "But we all work very closely together," she explains, "and any one of us can be approached with questions or issues." The team also provides pastoral support and can help students understand and access the resources offered by the department, the university and its colleges.

Community building

The team have a number of goals for the coming year. "We want to ensure that our regular peer-to-peer programmes and courses run without delay or crisis. But we also want to rebuild the social activities that were lost over the pandemic," explains Rosie. "Community building is so important because that's how students develop lifelong friendships, boost their confidence and create meaningful business connections," she says.

The team have also revived the popular Outstanding Supervisor Competition, in which students review and nominate their supervisors. "It's about recognising excellence in supervisors and encouraging it throughout the department," explains Rosie.

Seeing the Outstanding Supervisor reviews also helps the team gain insight into students' needs. Rosie says: "What is most striking is the way students often value how supportive a supervisor is more than that person's academic expertise. They are also very grateful for staff who positively respond to and support difference. Basically the people who are nominated are making the department a better place to learn."

Representing postgrads' views

The team members report to the Postgraduate Education Committee (PEC), which is chaired by Director of Postgraduate Education Professor David Spring. They are also advised and supported by Head of Postgraduate Education Dr Deborah Longbottom. The PEC acts as a forum for discussion and decision-making about the welfare and support of postgrads in the department, in addition to the development and implementation of postgrad courses. It normally has two postgrad student reps who bring along the concerns, issues and suggestions of other postgrad students, and there will be opportunities to volunteer later in the year.

Rosie says: "To make improvements and meaningful change we need to know what students actually want. We want to create a positive and inclusive environment, but if we don't know where we're going wrong, we can't fix it."

Getting to know each other

The team feel the decrease in participation could be due to the lack of social interactions since Covid, which is something they are working hard to ameliorate. "We want to rebuild that feeling of being a cohort," explains Aruna. "Tessa and Rosie have a lot of new ideas, and we are looking forward to having a new team dynamic to build on these."

"We are trying to get the Postgrad Social and Network committee up and running again, and to get postgrads talking to each other and getting to know each other socially – not just in their own groups, but across the department," says Rosie. Previous postgrad committees have organised picnics, sports days and formal halls in college. "We are always happy to provide food and venues for events, which is where the pizza and beer comes in," says Rosie.

Michael Webb, ©University of Cambridge.

From left: Rosie Hunt, Tessa Blackman, Aruna Reddy.

The team hope that increased social interactions will help expand postgraduate involvement throughout the department. "I want all the students to be involved, to give more feedback, to participate – I don't want this to be a top-down role," says Rosie. "We'd also like Queer in Chemistry to be involved. We want to make sure that issues are getting discussed and that there is an examination of the cultures that have risen in some groups and not others, and how they can benefit each other."

Rosie came to her role with a keen EDI and accessibility focus, and she particularly would like to be confident that students with Student Support Documents (SSDs) are being properly supported by the department and the disability resource centre. "I'd like to make sure that students who may have felt challenged or disenfranchised because they had different needs are being properly supported and getting the same out of their education for the same amount of effort as everyone else – in other words, parity," she says.

Watch this space

Where would the team like to be in a year? "We would love to have had some successful peer-to-peer and showcase meetings, where students made friends across research groupss, learned about each other's research and gained confidence in their own work, getting to know staff they may not have met," says Rosie.

"We want to really build a community. We want students to not only feel that their voices are being heard, but to make sure they thrive."

Rosie Hunt

Our scholars

Meet some of the postgraduate students supported by philanthropic studentships and discover the range of research, from antibody design to sustainable catalysts, that is happening across the department.

Nathan Pitt, ©University of Cambridge

Hannah Lockett

Energy transfer catalysis in the Scherman group.

Hannah is in the second year of her PhD in the Scherman lab. She is interested in finding a more sustainable framework for catalysts.

Energy transfer catalysis stabilises energetic electrons which, in this context, is important to make their lifetimes longer. Easy access to high-energy electrons is desirable in the laboratory, but a lot of energy transfer catalysis is currently performed using unsustainable solvents and catalysts.

Hannah is investigating water-soluble hybrid catalysts spanning both the nano and molecular scale, which she achieves through initiating the self-assembly nanoparticles.

This technology has potential use in energy storage, photovoltaics and drug synthesis.

"My goal," says Hannah, "is to take chemistry that is already understood to some extent, then reimagine the unsustainable parts to enable more sustainable processes in the long term."

After her undergraduate degree at the University of Liverpool, Hannah took a break from science before applying to do an MPhil in Cambridge in April 2020. This was a nerve-wracking decision since it also coincided with the first big COVID-19 lockdown, but this pause turned out to be serendipitous since the Scherman group were searching for a suitable candidate for a multi-disciplinary project with a focus on catalysis.

Hannah is delighted with her project and says that it feels tailor-made for her, since she previously explored catalysis for her Bachelor's degree. Hannah also wants to participate in outreach to bring the experiences of university to people who don't come from academic families.

Hannah is funded alongside Chloe Balhatchet through the Walters-Kundert studentship programme, which supports up to two PhD students at Selwyn College to undertake doctoral work in this department. We are grateful to the Walters-Kundert Charitable Trust, which has long supported this department, and has endowed a Next Generation Fellowship and funds for the Chemistry Open Day in perpetuity.

Michael Webb, ©University of Cambridge

Choonzo Chiyumba

Designing enzymes in the Barker/Boss group.

Choonzo is in the first year of her PhD and is supervised jointly by Dr Paul Barker and Dr Sally Boss. She is designing artificial metalloenzymes that can act as catalysts.

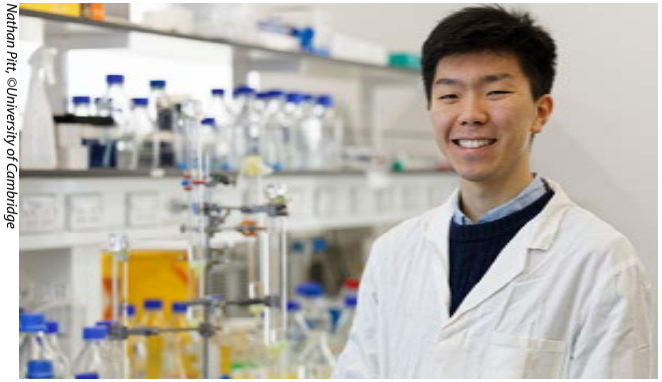
Proteins naturally have a section called a cofactor that acts as a catalyst to help kickstart reactions. Choonzo encourages proteins to catalyse new reactions that are currently unknown to nature by removing this natural cofactor and replacing it with one that she has designed.

"Think of it like this: we are helping nature pick up new skills," explains Choonzo, "I aim to speed up reactions, like the production of medicines or breaking down plastic waste."

Choonzo is combining these new catalysts with biosynthesis to use nature to synthesise products that would normally be unnatural. She is now gathering data about what sorts of reactions her new cofactor can catalyse by studying its interactions with different proteins and comparing the results to natural cofactors.

Choonzo had always aspired to study at Cambridge, and as a student in Africa labelled this as her unspoken dream because she felt this vision was so farfetched. As an undergraduate, Choonzo was inspired by Kelly Chibale, who was a PhD student in Stuart Warren's group in the 80s and is now Professor of Organic Chemistry at the University of Cape Town. Like Kelly, Choonzo studied at the University of Zambia, and later Rhodes University, before starting her research here.

Choonzo is the first student to be funded by the Stuart Warren PhD Studentship held jointly with Churchill College, which was founded in memory of Stuart's inspirational teaching, and supports students from the Southern African Development Community



Nathan Pitt, ©University of Cambridge

Elijah Suh

Investigating Parkinson's disease in the Vendruscolo group.

Elijah is an MPhil in the Centre for Misfolding Diseases focusing on the development of diagnostic methods for Alzheimer's and Parkinson's diseases. As the first drugs for these conditions are becoming available in the clinic, there is still a major unmet need to correctly diagnose patients using quantitative methods based on biomarkers. Elijah is developing a new type of antibody to recognise misfolded protein oligomers, which are characteristic of these diseases.

Elijah was an undergraduate at Harvard University and was intrigued by the collaborative research conditions fostered at the Centre for Misfolding Diseases (CMD). "The centre is unique," says Elijah, "it's not just chemists and biologists, it's also physicists and computer scientists, engineers and everyone is working at the same time in the same building. It is really distinctive and is part of what drew me to the research centre."

He is the first Una Finlay Scholar supported by the Finlay Scholars programme set up by Derek Finlay and hosted by Emmanuel and St John's Colleges. Derek's association with the CMD began in 2015, with a major donation which led to the foundation of the Una Finlay laboratory in memory of his wife, who died of Alzheimer's disease in 2016. His most recent gift, in 2022, was for bringing to the centre and the College a cohort of researchers like Elijah to develop new treatments for misfolding diseases.

Michael Webb, ©University of Cambridge

Queer in Chemistry

Last year was the first time that an event celebrating the LGTBQ+ members of the department had ever been hosted here.

The Queer in Chemistry Network (QiCN) was founded in 2022 after students identified the need for an LGBTQ+ friendly community in chemistry, and we spoke to six of their founding members. From the first slice of pizza at the opening pizza social, the group has been unstoppable with meetings, a logo, socials and a poster campaign for LGBTQ+ history month adorning the walls of the Cybercafé which showcased inspirational scientists from the LGBTQ+ community.

"We felt like there wasn't enough visibility of LGBTQ+ people, so this group is about making everyone feel welcome within the department," said Sam Daly, a PhD student in the Lee lab. Sam works on super-resolution microscopy, looking at biological samples below the diffraction limit of light and then translating this data into three-dimensional images to understand these structures in more detail.

Visibility

Whilst the group might be new, this is not the first time that Dr Joe Beckwith, a postdoc in the Lee lab, has helped run programmes for an LGBTQ+ network. Joe was a founding member of the Queer in Chemistry group at Princeton University, which set up a mentoring scheme that partnered a mentor with a mentee to share support, guidance and advice. He is piloting this scheme here, and the first round of mentor-mentees met for a pizza icebreaker in March.

Joe says: "We set up our mentoring scheme to help students see themselves at the next stage of academia." Joe's research in the Lee lab involves imaging brain tissue to find correlations between different cells and the onset of Parkinson's disease.

The mentorship scheme is exactly the sort of programme that students like co-founder Robin Horton, a PhD student in the Zhang group, wishes they'd had as an undergraduate.

"I feel like I can be the person that I needed to be two years ago when I was applying for PhDs and trawling through websites to find anyone who looks like me in academia," comments Robin. "Just to have seen somebody who was non-binary and in academia would have been such a relief." Robin works with cyanobacteria, a type of photosynthesising bacteria that lives in the ocean, and rewires them to harvest electrons.

Queer in Cambridge

The city of Cambridge has queer prestige that spans decades, from writer EM Forster to comedian Stephen Fry, and history lines its streets, such as the Anchor pub which was once a gay club. The group's members say this society is the next step for celebrating queerness in the city and it is in higher demand than even they anticipated. For a pub meet-up, they needed to drag over chairs and tables as more and more chemists arrived to network.

Finding and celebrating LGBTQ+ members of the city and the sciences is an important part of feeling like a community for the network. To aid this, the group organised an LGBTQ+ tour of the Sedgwick Museum of Earth Sciences, which is well-known for its exceptional dinosaur fossils, and the tour unearthed the treasure trove of queer history buried amongst the bones.

Evan Wroe, who helped found the group and also attended the museum tour, is a final year PhD student in the Zhang group. Like Robin, he is working on altering bacteria to create an electron flow from a sustainable source.

Evan says: "I loved the story of Baron Franz Nopcsa, the Hungarian palaeologist who had a life-long male love. They travelled across Europe together on motorcycles looking for fossils and made loads of discoveries. It completely explodes the archetypes of what an archaeologist or scientist should look or be like."

Chemistry in Cambridge

The final founder, Alex Rafaniello, is in the Gaunt group. He curated our Twitter account page for a day in March on behalf of QiCN. The event shared a day in the life of a third-year PhD student in synthetic chemistry, showcasing how Alex uses photochemistry to make amines that glow yellow to indicate the presence of electron donor acceptors, and also some behind-the-scenes images of QiCN.

"Every month we organise a coffee morning open to all staff and students, LGBTQ+ and allies," he says. "It's a great way to catch up with friends from across the department and, of course, spill some tea."

"We have plans to do something during Pride Month, which is in June, so watch out for us there!"

Anyone looking for more information on QiCN can email QiCN@ch.cam.ac.uk.

The Gender Equality Group

Georgia Harris, who is one of the founders of QiCN, has launched the Gender Equality Group this year. Networking events such as the Global Women's Breakfast in February were essential to the group's formation, which highlights the importance of creating these opportunities for scientists to connect. The group, which aims to promote inclusion of all genders in chemistry, has already hosted a movie night.

"The success of the Queer in Chemistry Network showed me that there is an appetite amongst the students and staff to be involved in communities in the department," notes Georgia.

Georgia is a final year PhD student in the Gaunt group, working in synthetic organic chemistry using visible light to make amines. These molecules are used a lot in the pharmaceutical industry and Georgia says her work is a bit like creating a toolbox for more sustainable amine synthesis. In addition to her research, Georgia's goals for the second half of the year are to organise more events for the group. To stay up to date, email gen-eq-net@ch.cam.ac.uk.

Robin Horton.

Evan Wroe.

Georgia Harris and Alex Rafaniello.

Sam Daly.

Up in the air

Atmospheric pollutants are often associated with warming the environment, but Vichawan 'Print' Sakulsupich investigates aerosols that cool down the atmosphere.

Print is a third-year PhD student in atmospheric sciences studying the effects of toxic sulphur dioxide emissions over two highly affected areas: Europe and Eastern Asia.

Aerosols formed from sulphur dioxide are responsible for cooling the planet; however, the precise amount has a large margin of uncertainty. Print is working in the Archibald group to reduce these error bars so that the effects of releasing sulphur dioxide gas can be accurately understood.

"It's very important to have accurate models to make better climate predictions," explains Print.

Sulphate aerosol

Sulphur dioxide is a corrosive gas that is harmful to humans and makes rain more acidic. It is released naturally into the atmosphere via volcanic activity but the majority of emissions are caused by industry, mostly through the burning of fossil fuels.

When sulphur dioxide is airborne it reacts with other molecules in the atmosphere to form aerosols. These aerosols act as a nucleus that water vapour clings to, which modifies cloud properties. Thanks to the aerosol, these clouds are brighter and whiter than naturally-forming clouds and reflect more sunlight away from the Earth's surface, which cools the atmosphere.

Most people are now aware that carbon dioxide has a long lifetime in the atmosphere, which is one of the reasons that global warming is a critical and enduring problem. Aerosols, on the other hand, have a short lifetime and leave the atmosphere as rain within about a week. This means that the effects of sulphur dioxide are local because the gas does not have time to mix evenly in the Earth's atmosphere.

The sulphur rain is acidic and enters soils, lakes and oceans changing the pH of the environment. Some species are susceptible to more acidic environments: fish eggs, for example, may not hatch if the water is too acidic, and damaged vegetation is a common sight in areas affected by acid rain.

UKESM

The United Kingdom Earth System Model is a model that simulates interactions between different components within the Earth, such as between ecosystems, ice sheets, oceans and the atmosphere, and which Print uses to investigate the Earth's atmospheric chemistry. It demonstrates how connected the planet is and how even localised changes in an environment can have effects that circulate around the globe.

This tool is especially important when looking for solutions to global warming. Whilst sulphur dioxide aerosols are harmful, they demonstrate that certain aerosols can help cool down the planet. Print muses that there may be a solution hidden in the model in the form of an aerosol that scientists could release into the atmosphere to cool the planet safely.

Nathan Pitt, eUniversity of Cambridge

"I'm grateful to be part of a group where more than half of the members are women from different countries and backgrounds."

Print Sakulsupich

"There are ideas about geo-engineering projects to release aerosols into the upper atmosphere to cool down areas locally, but the long-term effects of different aerosols on ecosystems and oceans are currently unknown," comments Print. "We would want to remove a lot of uncertainties first but it's an exciting idea."

Across the skies

Although her background is in physics, Print moved into meteorology and worked at the National Astronomical Research Institute of her native Thailand. When she first moved to Cambridge for her PhD, Print threw herself into college activities. She became combination room secretary at St Edmund's College where her first job was to help students get home or find accommodation during the COVID-19 lockdown.

"It was the first time I have ever moved abroad so there were a lot of new things to adjust to. For example, I moved in the middle of winter and Thailand doesn't even have a cold winter!"

"I've come this far because my supervisors, Professor Alex Archibald and Dr Paul Griffiths, and my group are really supportive and I'm grateful to be part of a group where more than half of the members are women from different countries and backgrounds."

Chemistry Open Day: Sharing the joy of science

Chemistry Open Day is a chance for postdocs, postgrads and undergrads to share their enthusiasm for chemistry with members of the public. Their engaging, hands-on activities convey real scientific principles at an understandable level. Meet some of the researchers who were getting messy, and find out about some of the science behind the fun.

Michael Webb ©University of Cambridge

Learning about non-Newtonian fluids the messy way!

"I think that outreach is one of the most important things we can do in science."

Marina Portoghese

Cornflour slime

Run across it and it holds you up, but stay still and you sink!

Explanation: Most fluids have a constant viscosity, but this suspension of very small cornflour particles is an example of a non-Newtonian fluid, which has variable viscosity dependent on stress.

Toys in water

Miniature toys appear suspended in a jar of water.

Explanation: When light travels at different speeds through different media it is subject to refraction which can cause phenomena like reflections or distortions. The jar is filled with agar beads (special hydrogels) which are swollen with water, so the light inside them is travelling at the same speed as water so it is not diffracted and the toys appear to be floating.

Hydrogen fuel

Create enough hydrogen to power a toy car.

Explanation: The hydrogen fuel from water electrolysis is captured and passed through a fuel cell, generating an electric current to power toy cars.

Find the shiny beetle

Use standard cinema 3D spectacles to spot a Jewel beetle.

Explanation: Jewel beetles have a shiny metallic appearance because the tiny structures on their bodies only reflect left-circulating polarised light. The Jewel beetle is brighter seen through the lens that permits left-circulating polarised light, which makes it easy to spot.

Liquid nitrogen ice cream

Instant ice cream using liquid nitrogen.

Explanation: Nitrogen becomes liquid at very low temperatures. It is so much colder than ice that it can almost instantly freeze a mixture of cream and sugar.

Pencil batteries

Pencils connected to a battery split water into hydrogen and oxygen.

Explanation: In this simple electrolyser setup, the pencil electrodes transfer electric current from the battery. The negative pencil tip (cathode) draws positively charged hydrogen ions and reduces them to hydrogen gas, which bubbles to the surface of the water. The positive pencil tip (anode) draws negative hydroxide ions and oxidises them to form oxygen gas.

Dylan Cleveland (opposite page)
Third year undergrad

I volunteered today because it's really nice sharing science knowledge, especially with the younger generation. When I was their age I came to a lot of things like this, and it really contributed to me wanting to do science. It's sort of nice to be on the other end of that. And the kids enjoy getting messy!

Linjia Jin (this page, bottom, leftmost in photo)
First year undergrad

I'm pretty interested in chemistry and I love interacting with children.

Tom Wharton
Third year Phd student, Spring group

I really enjoyed helping last year so I was very happy to be involved this year. Last year we did pH, which was fun, but you couldn't eat it!

Marina Portoghese
First year PhD student, Vignolini group

I think that outreach is one of the most important things we can do in science. If we don't share our knowledge and explain what we actually do in the lab, how will people be interested in joining us and continuing the development of science?

Najib Sharifi (this page, top)
Final year PhD student, Clarke group

I am very excited to interact with the young people. I think it might be very nice for us as well – we can learn from the young ones.

We gratefully acknowledge the Walters-Kundert Charitable Trust, whose support makes it possible for us to put on this annual event, and Outreach Coordinator Emma Powney, who always ensures the day runs smoothly.

This is just a selection of the many activities that were on offer at Open Day, and we'd like to thank all the students, researchers and volunteers who helped make the day a success!

As I see it

Libby Brown joined the department in 2019 to complete an industry-linked PhD. She describes her experience below.

The Industrial Cooperative Awards in Science and Technology programme funds students to undertake research in research collaborations between academic and partner organisations. In my case, I was given the opportunity to split my lab work between the Department of Chemistry and AstraZeneca.

So in October 2019, I started my BBSRC iCASE PhD studentship jointly supervised by Professor Gonçalo Bernardes in the Department of Chemistry and Dr Peter Ravn (followed by Dr Monika Papworth) at AstraZeneca.

Here, I describe my own experience of completing an industry-linked PhD.

Life in the lab

My research focuses on the construction of phage display libraries, to help identify new proteins or peptides that bind with high affinity to a therapeutic target of interest. Treatments for rheumatoid arthritis, lung cancer, psoriasis and inflammatory bowel disease have been discovered using this high throughput screening technique.

To further increase binding affinity, phage-displayed peptides can be cyclised, to reduce the entropic penalty of target binding. Over the past four years, I have been developing new chemical methods for cyclising peptides that are compatible with the phage display screening process.

Whilst I have enjoyed working on a project with clear practical applications such as drug discovery, others may prefer a more academic style of research, ie, research for the sake of learning. And as is often the case with industry-linked PhDs, approval is required to present at conferences or publish interesting findings, which some may find restrictive.

My usual day includes a lot of lab work but also a little bit of computational data analysis on the side. I am mainly based at AstraZeneca's Granta Park labs, located just south of Cambridge. The facilities are great, and I have access to all the high-tech equipment needed to perform phage display experiments.

Although I don't spend much time completing lab work in the Department of Chemistry, I still pop over for interesting talks and to teach undergraduate supervisions.

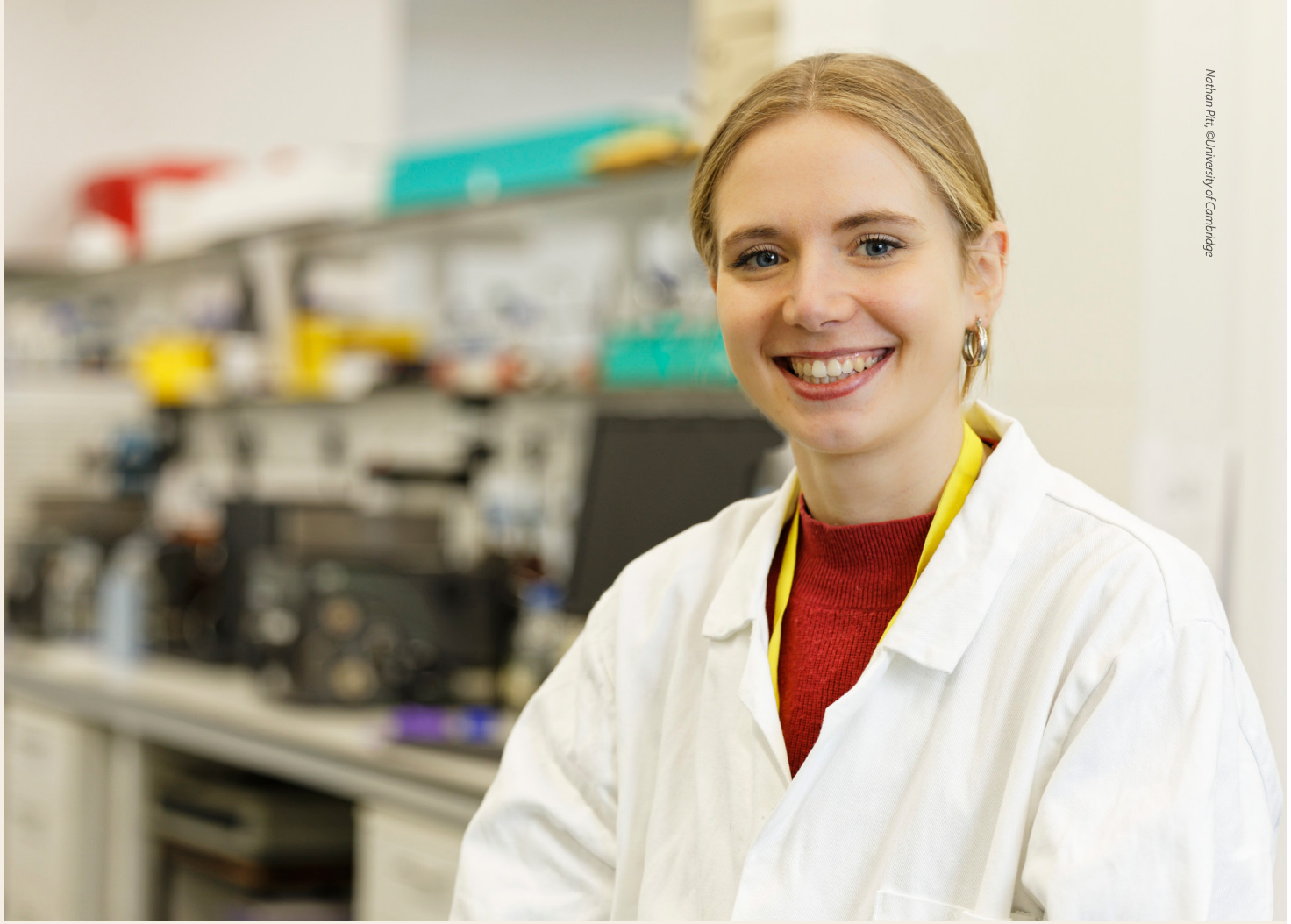
Time management

A joint university-industry PhD requires excellent time management. I have had to complete university and industry training courses, attend multiple group meetings (sometimes on the same day) and meet regularly with both my academic and industrial supervisor.

I discovered it can be difficult to arrange meetings when people from different industries and professions have different time commitments! But this experience has helped me develop my communication and organisational skills to bridge the gap between my academic supervisor, industrial supervisor and other collaborators.

Working hours

Unlike the Department of Chemistry, AstraZeneca is not open late at night or at the weekend, so my working hours tend to be 9 to 5, Monday to Friday. This means I have less flexibility in when I work than a standard PhD student, so I have had to learn to plan my experiments carefully and work efficiently.



Nathan Pitt, ©University of Cambridge

"I have had the opportunity to meet and work with some incredible scientists."

Libby Brown

On the plus side, this leaves lots of time to participate in extra-curricular activities (I run for the university) and attend events at my college (Jesus).

What's next?

I will be submitting my PhD in September this year. While there is no guarantee of a job at the end of an industry-based PhD, AstraZeneca has invested time and money in teaching me the experimental and transferable skills that they deem important.

By interacting with employees across the business, I have established a good professional network for career advice and interview practice. Together, these factors give me confidence as I apply to jobs at biotech and pharmaceutical companies (hopefully doing more phage display!).

To summarise...

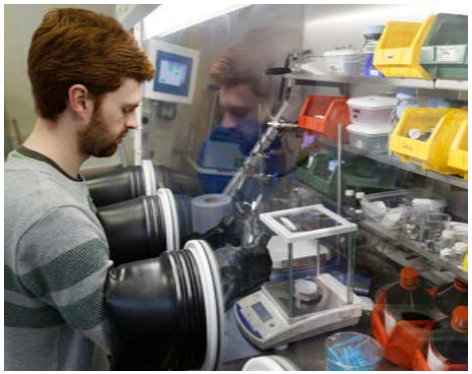
I have thoroughly enjoyed my joint Cambridge University-AstraZeneca PhD. I have worked on a project that has clear practical applications, had access to state-of-the-art technology and developed a good understanding of the entire drug development process from start to finish.

Through both the university and AstraZeneca, I have had the opportunity to meet and work with some incredible scientists who have provided me with support and guidance throughout my PhD.

Libby Brown

What I did on my summer holiday

Summer internships are a great way for undergrads to meet researchers, gain new skills and find out if working in a lab is for them. Here, four students describe their 2022 summer internships, all of which were funded by alumni gifts.



James Hill

James' internship was funded by the Chemistry@Cambridge Opportunity Fund, whose main contributors to date are Eddie Powell (Churchill 1967) and Jonathan Goldhill (Darwin 1976).

After finishing my Part II in Chemistry, I joined Professor Hugo Bronstein's group for an eight-week summer project synthesising new chiral small molecules and polymers, which involved both organic synthesis and characterisation.

I learned that research, in particular the synthesis component, is very different from what is experienced in teaching labs – in a good way! It is much easier to motivate yourself about the molecules and compounds you are making when there is a larger goal that you are working towards. It also gave me an idea of what it would be like to pursue academia further, and confirmed my intention to do a PhD.

I would like to do research in an area that involves inorganic synthesis and characterisation of new materials that help towards important societal goals, such as improved energy storage, energy generation or utilisation of captured CO_2. I'm now doing my Part III in Dr Alex Forse's research group, working on improving MOF-based supercapacitors.

I would like to say thank you to the donors who made this possible. It was an invaluable experience that confirmed my desire to continue chemistry into the future. These internships are a great idea as the experience they provide is very useful for students in deciding whether research is part of their future career path.

Cheng Qian

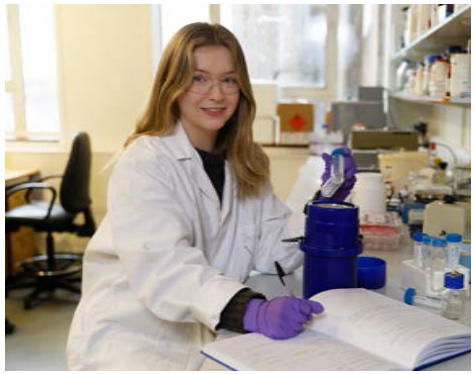
Cheng's internship was also funded by the Opportunity Fund.

Because I matriculated just as the Covid epidemic was starting, I spent much of my undergraduate degree taking Natural Sciences courses online from my home in China. I felt this internship was designed to help students like me who wanted to gain practical experience, but had missed out due to Covid, and I eagerly jumped at the opportunity to get hands-on experience in a real lab.

My project was to study self-assembled cages in Professor Jonathan Nitschke's organic synthesis group. After testing different molecule combinations I was able to get quite a few cages. I learned the steps of a scientific project, new experimental techniques and how to write a formal research proposal. I also learned so much from other group members, which inspired me for my own academic pathway.

This experience opened my mind and helped me to have confidence in my research skills. I have decided to apply to Research Master's programmes which I would never have done without this internship. I am not sure if I will do a PhD, but for sure I will do something related to inorganic and material chemistry, which I found fascinating.

I would really like to express my deepest appreciation to the donors who helped fund this project. I would not have found my academic interest in supramolecular chemistry and nanoscience without this precious opportunity. I'd also like to express my appreciation to Jonathan and my fantastic supervisor Jieyu, who taught me a lot of techniques starting from zero. Thank you all so much for bringing me the best summer in my undergraduate study.



Ceinwen Baker

Ceinwen completed her internship in Professor David Klenerman's group in the Dementia Research Institute at the Cambridge Biomedical Campus. The internship was funded by Wyn Lewis-Bevan (Churchill 1979).

While completing my Part II in Chemistry I was very keen to get some lab experience via a summer project, and found this one which had a biochemical focus. The aim of my project was to establish a cellular model for fluorescently tagged FUS expression and to develop a new assay for detecting the FUS protein. FUS is the Fused in Sarcoma protein, which is known to aggregate and be dysfunctional in many cases of Motor Neurone Disease.

In addition to learning a great number of scientific techniques during the eight weeks of my internship, I also learned a lot about how to conduct research. While it wasn't my primary personal aim for the internship, I also became competent using Python coding for data analysis, which was very rewarding.

I would like to say how grateful I am to Wyn Lewis-Bevan, because without his generosity I couldn't have afforded to stay in Cambridge while completing a summer project. Because of this I have experience that is helping my current studies, as well as helping to decide my future career plans.

I am now completing my Part III looking into knotted proteins in Professor Sophie Jackson's lab. My aim is to apply for either a PhD position in pharmaceutical/medicinal chemistry or an industry job in the same realm.

Becky Larner

Becky's internship in Professor Stuart Clarke's surface science group was also funded by Wyn Lewis-Bevan.

I joined Professor Clarke's group because I'm most interested in physical chemistry. My project was to determine whether the mineral calcite could be flattened sufficiently to be examined using neutron reflectivity, which is a technique where you fire beamed neutrons at your surface to work out thickness of material, density and if a layer is attached. But you must have a really flat sample, with only about five angstroms variation, and calcite can vary by hundreds of angstroms. I spent a lot of time working on the methodology for figuring out how to flatten the surface using atomic force microscopy.

I enjoyed doing proper research in the lab and I would really like to stay in research chemistry. I'm currently doing my Part III in Professor Clare Grey's group, looking at battery technology and the degradation in sodium cells. It is interesting and I'm learning lots of new techniques.

I'd like to thank Wyn Lewis-Bevan for the funding and the opportunity; I've had a great summer and it's really helped me to focus on what I'd like to do next.

I think these internships are really valuable to the students, you learn so much about the wider world of science. And hopefully I helped the group a little bit!

Nathan Pitt, ©University of Cambridge

The molecule maker

Rosa Mueller started her PhD in October 2022 and is already building new molecules which could help improve plant growth and solar panel efficiency.

As a student in Professor of Inorganic Chemistry Dominic Wright's research group, Rosa is playing a key role in the development of new nanomaterials which can be used to enhance solar absorption in plants and solar cells.

The problem

Plants grow in sunlight, but crop plants are much more productive if exposed to higher amounts of the lower-energy wavelengths of the solar spectrum, such as red.

The Wright group is creating molecules which are able to 'down convert' the high-energy photons in sunlight to more plant-friendly wavelengths. The group is working in collaboration with an R & D start-up called Lambda Energy.

"Too much UV light is damaging for plants, so high-energy or blue-end light is not used efficiently for plant growth," explains Dr Boris Breiner, Lambda's Chief Scientist. "But if you can down convert the light to the optimum wavelength for plant growth, for example inside a greenhouse, you can increase crop yields without spending more on artificial lighting."

The science

Simply put, Rosa's job is to make new molecules. The more effective the molecules are at converting the high wavelengths to the visible spectrum, the greater the quantum yield.

Rosa describes the molecules she synthesises as 'chunky'. They are structured as molecular cages that include the lanthanide Europium, which is known to absorb UV light and emit red light. Rosa says: "We started with a very easy form of these compounds, and then you test them and learn which aspects you can improve."

The researchers use X-ray crystallography to confirm the characteristics of the new molecules, which are then tested for quantum yield. The most promising are scaled up by Dr Petra Cameron's group at the University of Bath and incorporated into polymer films by Lambda Energy before being tested once again.

"We based our initial studies on molecules which were reported to have quantum yields varying from 40 to 50 percent, but thanks to Rosa's molecules, we've now got a material with almost 100 percent quantum yield," explains Boris.

The new materials can also be used to improve the efficiency of the photovoltaic cells used in solar panels. These cells work best at converting red and near infrared light into electricity and are much less effective at converting UV and violet light. Lambda's new coatings could down convert these higher-energy wavelengths to red light, thereby increasing electrical output. Lambda has recently filed a patent to protect this new technology.

Next steps

The next challenge will be to increase the range of high energy photons that can be absorbed before being down converted. Rosa says: "If you look at the solar spectrum, there is not that much UV light, because it's absorbed by the atmosphere. So we are also trying to capture the photons in the blue and the green range. It is currently very tricky."

Boris agrees: "UV light is only three to five percent of the solar spectrum, but we want to capture 20 percent, so we need to shift absorption into the blue end of light. That is what we are working on now."

The team members are upbeat about the future, and are looking forward to testing their new nanomaterials in a series of greenhouse experiments at Cranfield University this summer.

"She's not just good. She's good good."

Boris Breiner

"We are developing new materials that are cheap, robust and with a very high quantum yield," says Boris. "They will not only improve crop yields in greenhouses, but they also have great potential for improving solar cell efficiency. They also have other uses in medical sensors, display technology, and anti-counterfeiting technology in money."

The scientist

Dom says: "This is a story of how a PhD student has basically built the molecular side of the project. Rosa's been the primary one delivering on the new materials and making the molecular chemistry actually work."

Boris agrees. "We give her minimal input. For example we come to her and say 'can you try this?' and it turns out she's already thought of that!"

In the little free time that she has, Rosa, who is a member of St John's College, loves to row. "I love Cambridge," she says. "Partially because I do so much rowing, but also it's been really easy to find a social environment that I like. And all the members of our group are really great."

But Rosa also enjoys making molecules, and Dom and Boris both agree that she is especially skilled in her role. "She's not just good," says Boris. "She's good good."

The joy of discovery

This year's Alex Hopkins memorial lecture was given by Nobel Laureate Professor Ben Feringa.

From left: Ben Faringa, Sally Boss, John Hopkins, Jeremy Sanders.

Alex Hopkins was an undergraduate in Natural Sciences, who went on to complete a PhD with Professor Dominic Wright. After finishing his studies, he became a Teaching Fellow in Inorganic Chemistry at Churchill College.

Infectious personality

Alex's humour and warmth, such important parts of who he was both as a scientist and as a person, proved to be infectious with students. He was a hugely popular lecturer, supervisor and mentor. He inspired students to learn about the Lanthanoids and Actinoids via a mnemonic competition to find the catchiest rhyme to plot the order of the elements.

He also gave students the chance to boost their vitamin intake if they correctly answered a trivia question in order to win a fruit- or vegetable-related scientist lecture prize. Famous scientists who featured included Pear and Marrow Curie and Louis Pasteur-nip!

Memorial lecture

Alex died of cancer in 2006 aged just 30. This lecture series was set up with generous support from his father John Hopkins to celebrate Alex's life and to remember his contribution to this Department and to Churchill College.

A personal journey

At his lecture, Professor Feringa explored the complexity of modern machines in terms of the periodic table: which elements are represented in the human body versus a smart phone, and why we need to think carefully about the abundance of elemental raw materials on the Earth as we develop the technologies of the future.

Ben's personal journey of discovery from his family farm in the Netherlands (where there is now a street named in his honour), to the Nobel Prize ceremony in Stockholm, was interwoven with his extraordinary scientific achievements, which involve dynamic molecular systems including the control of rotary motion, the synthesis of nano-cars, and light-activated antibiotic switches to give just a few examples.

Advice to younger scientists

Ben also shared his passion for teaching with the audience and offered advice to younger scientists to accept that experimental work can be difficult and is reliably unpredictable!

He presented his own work as a mixture of exceptional insight and careful planning interspersed with serendipity. Sometimes the unexpected can be more interesting than the expected!

Ben was awarded the 2016 Nobel Prize in Chemistry along with Professors Sir Fraser Stoddart and Jean-Pierre Sauvage, for the design and synthesis of molecular machines.

It was truly an honour to have Ben lecture in Alex's memory. He presented inspirational science with modesty, humour and great warmth, mirroring Alex's personality and passion for chemistry. A fitting tribute.

Noticeboard

Photosynthesis 'hack'

Dr Jenny Zhang and her team used ultrafast spectroscopy to study the earliest stages of photosynthesis in live cells at a timescale of a millionth of a millionth of a second, discovering previously unknown processes which could lead to new ways of using photosynthesis to generate renewable energy.

Outstanding educator

Dr Stephanie Smith has received a Pilkington Prize for her contributions to teaching undergrads. Prior to this prize, Stephanie received two student-led awards that also praised her teaching. Stephanie teaches students in the department and is also the Director of Studies in Chemistry at Pembroke College.

Global Women's Breakfast

Coffee, croissants and chemistry posters were served up at our breakfast celebrating diversity and encouraging scientific networking. The International Union of Pure and Applied Chemistry (IUPAC) promotes the event every year in conjunction with the UN International Day of Women and Girls in Science.

ERC grant for organic chemistry

Professor Robert Phipps was awarded a European Research Council consolidator grant for research into enantioselective radical chemistry. Robert's ambitious programme will apply unexplored ion-pairing strategies to control enantioselectivity in a range of radical chemistries where it currently cannot be controlled effectively.

Battery research funding

Professor Dame Clare Grey will play a key role in the Faraday Institution's £29 million funding commitment to battery research. Grey leads the Faraday's battery degradation project, whose crucial aim is to extend battery life. Professor Dominic Wright will also contribute to the project by synthesising new electrolyte formulations.

Diversity and inclusion award

PhD student Oluwatomi Akingbade was a joint winner of the British Society for Immunology Diversity and Inclusion Award, for her work in setting up the Black Women in Science Network (see page 25). The award recognises outstanding contributions to promoting the principles of equality, diversity and inclusion within immunology.

A representative role

A postdoc and postgrad representative discuss their roles and how to fit responsibilities around research.

As postdoc rep on the Committee for the Library and Scholarly Communication, Dr Shekhar Kedia plays the important role of communicating postdocs' views on the resources they need.

Shekhar joined the Klenerman Lab about a year ago to study neurodegenerative disorders such as Alzheimer's disease. He is a neuroscientist by training, but is now looking at neurological issues from a chemical perspective.

Shekhar is developing a method to isolate synaptosomes from brain tissue, so they can be investigated with the powerful super resolution microscopes developed in the Klenerman Lab. Synapses are junctions that control the flow of information between neurons in the brain, tuning learning and memory. Alzheimer's disease is considered to begin as an illness of the synapses, and the ability to isolate and visualise protein aggregates associated with neurodegenerative diseases at synapses is vital to understand the disease. The synaptosomes are extracted synaptic terminals used to further this research.

"The way our brain cells communicate is by synapses, and we think changes in the molecular makeup of the synapses may predispose people to neurodegenerative disorders," says Shekhar.

On being a postdoc rep...

It is enjoyable and friendly. We try to proactively seek ways of helping researchers maximise their research impact, so before every meeting I email my postdoc colleagues to find out what they want so I can share their views. On the committee we also discuss the different needs of postgrads and undergrads, and reach a consensus."

Shekhar Kedia

Srijit Seal, a final-year PhD student researching drug toxicity predictions in the Bender group, was elected as one of the department's postgrad representatives in 2022. Since then, he has been working hard to organise events to help promote connections between research groups. This isn't his first time in a group support role; Srijit had similar roles when he was doing his undergraduate degree at the University of Delhi, and he was the postgraduate president at Clare Hall.

The pandemic introduced new challenges to the role and altered a lot of established means of communication. This meant that Srijit needed to respond to it in new ways and he decided to go above and beyond to host events. Inclusivity is at the heart of lots of Srijit's decisions as he wants as many people as possible to feel welcome. This can sometimes mean simple solutions such as offering a larger variety of food and drink options, and hosting different types of events such as pub nights to board game evenings.

The next event on Srijit's radar is a conference called "Understanding Biology in the Age of Artificial Intelligence", which he is helping to organise in Cambridge this June. Its aim is to build a community of scholars from artificial intelligence, biology, chemistry and philosophy. Srijit strongly encourages students interested in this area to attend.

The importance of inclusivity...

It's so important to be connected. The department is really supportive of students but this role can be tough because the postgrads are spread over five different buildings. I'm trying to increase visibility, support and events so that I can best represent the department.

Srijit Seal

From left: Oluwatomi Akingbade, Dr Bernadine Idowu and Juliana Eniraiyetan.

Black Women in Science Network brunch

PhD student Tomi Akingbade alongside Juliana Eniraiyetan organised a networking brunch for black women in science from all across the UK. It was a huge success.

Hosted in the department by the Black Women in Science (BWiS) Network, the brunch brought together black women scientists for socialising and networking. The day kicked off with brunch followed by a talk from Dr Bernadine Idowu, associate professor at the School of Biomedical Sciences at the University of West London. She spoke about successes and challenges as a black woman in science during her career and founding the charity Youth Against Crime not Crime Against You.

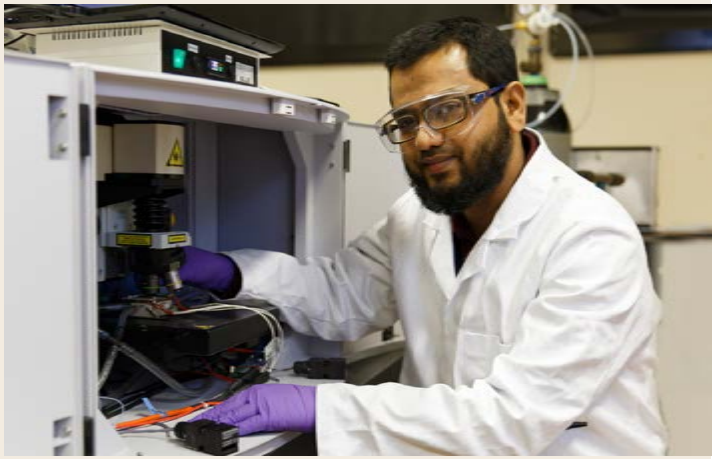
The BWiS Network is a community for women of African and Caribbean heritage at various stages of their scientific careers. The network was started by Tomi when she felt that she wanted to connect with other black women in science and it is now five years old. Tomi wants to host more brunches in different areas of the UK to reach and connect more scientists. Tomi, who researches aggregates in Alzheimer's disease in the Klenerman lab, said: "The energy at this event was indescribable, it meant so much to have so many impressive women in the room. I feel recharged and inspired. Massive thanks to the department for making this space available and being so accommodating."

Juliana Eniraiyetan, a data consultant at Rockborne who co-organised the event as the events officer at BWiS Network, said: "I am pleased the first Brunch Talks Live was a resounding success; the necessity of such a space for black women in the sciences was apparent and attendees really enjoyed the event. This could not have been the case without the support and contribution of the Yusuf Hamied Department of Chemistry. We are grateful for their partnership."

Dr Nick Bampos, Deputy Head of Department who was at the event, noted "the considerable impact that bringing together a group of remarkable women can have on their careers and their support of each other."

Solutions for scientists who stammer

Dr Mobbassar Hassan Sk has had a stammer his entire life. But this hasn't stopped him from achieving success as a researcher and lecturer.



Nathan Pal, University of Cambridge

Mobbassar is a postdoctoral researcher in Professor Stuart Clarke's surface sciences group. His research focuses on corrosion, where a material deteriorates in response to its surroundings. To investigate corrosion, Mobbassar designs and develops custom sample-cells and *in-situ* setups that can be used in various microscopic and spectroscopic instrument systems to watch chemical reactions happening in real time at the molecular level. Using this and a suite of state-of-the-art techniques, he can observe chemical processes happening on surfaces in extreme environments, such as under intense heat or pressure.

Observing reactions happening in real time is inherently powerful and leads to better understanding of many phenomena. "This is exciting and challenging work that I have really enjoyed," he says. These techniques could also be employed to characterise and understand surfaces in different supercapacitor materials, which are essential for advances in storing electricity sustainably.

Text to voice technology

Mobbassar has what could be defined as an unseen disability – he has a stammer and struggles to project his voice. "When I raise my voice it's like a pressure building inside me," he says. Mobbassar was worried how this would affect his career, especially when lecturing students and giving presentations. "My impediment isn't visible until I speak — you can't see my stammer."

Over 70 million people around the world are affected by stammering. Mobbassar's solution has been to enlist technology. He uses a speech synthesiser programme for teaching and when he is giving presentations. Mobbassar says the software is a simple way to help scientists who stammer to confidently focus on what they are saying — not how they are saying it. Another advantage he points out is that it makes sure he sticks to a conference time limit! When answering questions, Mobbassar speaks in keywords and phrases whilst simultaneously typing on a blank PowerPoint slide that the audience can see.

In the past, job interviews have been daunting, even exclusionary, for Mobbassar, and he is passionate that institutions have inclusive practices in place for people who stammer. Mobbassar feels he has been treated fairly here in the department. For example, when interviewed for his current role, he was provided with more time, and it is in Cambridge where he first started using a speech synthesiser to deliver talks. He says this has been greatly encouraged, and he still uses this technique for lectures and to collaborate in team meetings.

Scientists who stammer

In addition to his research, Mobbassar has published in the journal *Nature* a correspondence called *Communication tools for scientists who stammer*[1]. It covers some of the tools he uses to enhance his science communication and it is a useful read for anyone who wants to increase their awareness of how to create a more welcoming environment for people who stammer.

Mobbassar concludes: "There are fewer obstacles to doing great science when working with supportive colleagues."

[1]Hassan SK, *Communication tools for scientists who stammer*, *Nature* (2022) 607 197-199.

Conversations on Chemistry

Dr Peter Wothers gave a fascinating talk on pioneering science writer Jane Marcet at our annual alumni lecture on 11 February.

Marcet's most well-known work is *Conversations on Chemistry Intended More Especially for the Female Sex*, which was first published anonymously in 1805. Peter led viewers through some highlights of this early science textbook, including Marcet's correspondence with Michael Faraday, who thought very highly of her scientific abilities. Peter showed how the book needed to be updated in a series of later editions, as more elements were discovered or renamed.

Peter also referred to his interest in collecting rare and historic science texts, many of which were on display in the McGrath Centre at St Catherine's College, where the lecture was held. After the lecture, guests were able to view the collection, which included a copy of Marie Curie's signed thesis, a rare letter written by Humphry Davy, alchemical books, and an artwork representing the periodic table of electron orbitals which Peter designed with colleague George Trenins, a former student in theoretical chemistry at St Catharine's.

Former Head of Department and Fellow of St Catharine's College, Professor John Pyle, introduced Peter, who completed both his degrees at St Catharine's. The event also celebrated the UN International Day for Women and Girls in Science, which promotes equal access and participation in science for women and girls. Jane Marcet was one of the early women scientists who helped make this possible.

You can watch the lecture, along with many other great videos, on the Yusuf Hamied Department of Chemistry YouTube channel.

Dr Peter Wothers presentation 11 Feb 2023 taken by Michael Webb ©University of Cambridge

Nathan Pitt ©University of Cambridge

Turning a molehill into a mountain

When a potentially useful molecule is first synthesised, it is often produced in quantities no larger than a pinch of salt. Oliver Griffiths, a final year PhD student in the Ley lab, has been scaling up promising reactions so that they are more useful for industrial applications.

"New reactions which create potential drug candidates that only work in small quantities are often held back from stage two of development because their utility is limited due to their scale. Sometimes scaling up takes years," says Oliver.

When Oliver joined the Ley lab in 2020, he began exploring reactions to produce spirocycles, which are increasingly used in medicinal chemistry. Oliver describes spirocycles as being like "three-dimensional paper chains which contain big pockets to fill with chemicals." This chemical space gives synthetic chemists a whole new library of possibilities for drug design.

Oliver's innovation was to synthesise spirocycles all in one 'pot'. His reaction requires fewer steps, and uses simpler and cheaper starting materials. "Some syntheses require chemical reactions to take place in different beakers and flasks in multiple stages. This reaction can be done easily in the lab because the quantities we use are light enough to pick up, but in industry it is more complicated because the products weigh more. What is much easier and safer on a tonne scale is to add everything into one vessel from the start."

A lightbulb moment

Oliver uses photosynthesis for the reactions, which involves the use of light generated by LEDs to kickstart the photochemistry. One of the obstacles Oliver encountered to scaling up was how to deliver light effectively to larger quantities of liquid. He compares the problem to how the ocean becomes darker the deeper you go, because the sun cannot penetrate the liquid. "The process becomes more challenging as the beaker becomes larger," he says. Shining light through an industrial tank is not practical so Oliver's solution was to adopt a continuous flow platform, in which the liquid runs through a narrow tube that flows past the light. His current setup uses a tube no wider than a phone charging cable, but he says this sort of setup can be scaled up in industry with larger tubes and more powerful lights. Using this proof of concept, he created ten grams of product in three hours.

"This is the result that I am the most proud of. Those ten grams might not seem like much, it's how much coffee you might use for one cup, but the proof of concept started at 50 milligrams. That's orders of magnitude smaller than a pinch of salt. Even better is that the reaction is robust, reliable and automated so while it was brewing I could actually go and get a cup of coffee if I wanted."

[1] O. M. Griffiths and S. V. Ley, *Multicomponent Direct Assembly of N-Heterospirocycles Facilitated by Visible-Light-Driven Photocatalysis, J. Org. Chem* (2022) **87**, 19 13204-13223

Combining drugs to combat drug resistance

Linking drugs together can be more effective at inhibiting protein function than a single drug. For his PhD in Professor David Spring's organic synthesis group, Radu Costin Bizga Nicolescu investigated how drugs can combine to be more effective against diseases such as cancer.

This idea began when contemplating how to combat drug resistance, especially in prostate cancer, which often develops mutations in response to chemotherapy which are resistant to further treatment.

Whilst some research focuses on developing new drugs, there are already available therapies for prostate cancer, so Radu considered new ways to administer existing drugs more effectively.

"We looked at prostate cancer medications and how tumour cells can develop resistance to them. We wondered if covalently linking two drugs together could make them more effective at preventing the inevitable resistance."

Radu decided to make a combination drug that takes two treatments and joins them together with a linker to create a molecule with better cancer cell killing potency than each drug molecule has individually.

Click chemistry

Radu decided to connect the prostate cancer drugs EPI-001 and enzalutamide. On its own, EPI-001 requires a large number of pills every day to be effective, and enzalutamide slows down cancer growth but has notable limitations, such as potential tumour resistance.

To connect the two drugs Radu used click chemistry, the Nobel prize winning technique in which molecules form bonds between one another as easily as the 'click' of a seatbelt buckle. Click reactions connect two molecules rapidly and without any by-products, and the first click chemistry-based therapies have only entered clinical trials in the last few years. The technique's use in medicinal chemistry is rapidly growing and there is lots yet to explore.

Using click chemistry, Radu was able to link the drugs together and show that they had a more powerful effect *in vitro* than on their own.

Illuminating results

Radu tested the new linked drug using a substance that glows when certain genes are active, and stops producing light when these genes are blocked. The combination drug reduced the luminescence of this test by a quarter. This indicated that the combination drug is effective at preventing the genes associated with prostate cancer from activating.

Gabriella Bocchetti, ©University of Cambridge

The hypothesis of linking two drugs in one turned out to be promising, however Radu emphasises that the results need to be further tested. But this is a promising first step before the group considers *in vivo* studies.

Radu successfully submitted his PhD this year and now works at AstraZeneca where he continues to research and develop cancer therapies.

New 1920 Professor of Physical Chemistry

Professor Tuomas Knowles has been elected as the department's new Professor of Physical Chemistry (1920). He was selected from a strong field on the basis of his outstanding reputation and achievements, and for the ambition of his future research programme.

Much of Tuomas' research is focused on what happens when proteins misfold and how this relates to health and human disease, in particular Alzheimer's disease. However, his investigations into protein self-assembly have also led to the creation of sustainable materials that could replace single-use plastics.

The 1920 Professorship has been held by a succession of distinguished physical chemists since its establishment including: 1937-1965, Nobel Laureate Ronald Norrish FRS; 1978-1987, Sir John Meurig Thomas FRS, subsequently Director of the Royal Institution; 1988-2006, Sir David King FRS, subsequently Chief Scientific Adviser to the UK Government; and most recently John Pyle CBE FRS, who held the post from 2007 until his retirement in 2018.

Tuomas will officially take over the role on 1 October 2023.

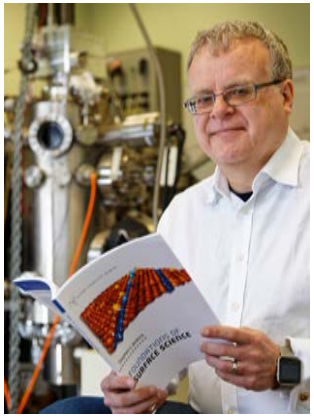
New surface science textbook

Professor Stephen Jenkins' new textbook, *Foundations of Surface Science*, was published in January. It is part of the acclaimed Oxford University Press Chemistry Primers series.

The new book is arranged thematically, with chapters covering thermodynamics, symmetry and structure, electronic structure, and the kinetics and dynamics of surfaces.

It includes an extended discussion of experimental methods and the growing role played by first-principles density functional theory in contemporary surface science research.

Stephen, who is Professor of Physical and Computational Surface Chemistry here, says: "I was approached to write this book as part of an ongoing revamp of the Oxford Chemistry Primers series. Their previous book on surfaces was published 25 years ago, and although excellent was starting to show its age. I think this new book fills a gap in the market for a systematic treatment of surface science, first emphasising the underlying principles of the field before illustrating them with a survey of key techniques."



Cryptic chemistry crossword

Challenge yourself with a cryptic crossword designed by Dr Mary Wood, a postdoc in the Zhang group, working with electron transport.

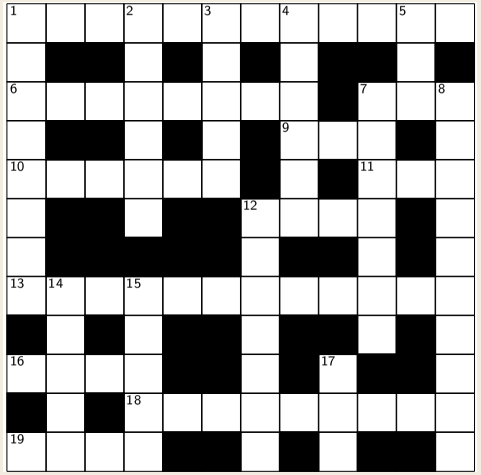
Mary is investigating how bacteria can interplay with electrodes to create a flow of electrons, and how scientists can harness this flow to create energy. Mary is a self-professed eco-warrior and her research is helping to solve the long-term challenges around sustainable energy.

If it wasn't already obvious that Mary enjoys solving problems, she created this crossword after trying a chemistry quiz and thinking to herself "but what if this were harder?" Good luck solving the crossword.

Win a prize

Send a photo of your answers by 31 May to Crossword@ch.ac.uk for a chance to win a sustainable Yusuf Hamied Department of Chemistry travel mug. The first correct answer to be drawn after 31 May will win. Answers will be sent out in our summer e-Chem@Cam.

If you don't receive e-Chem@Cam, please make sure you update your alumni preferences to include email communications, or contact us at news@ch.cam.ac.uk.



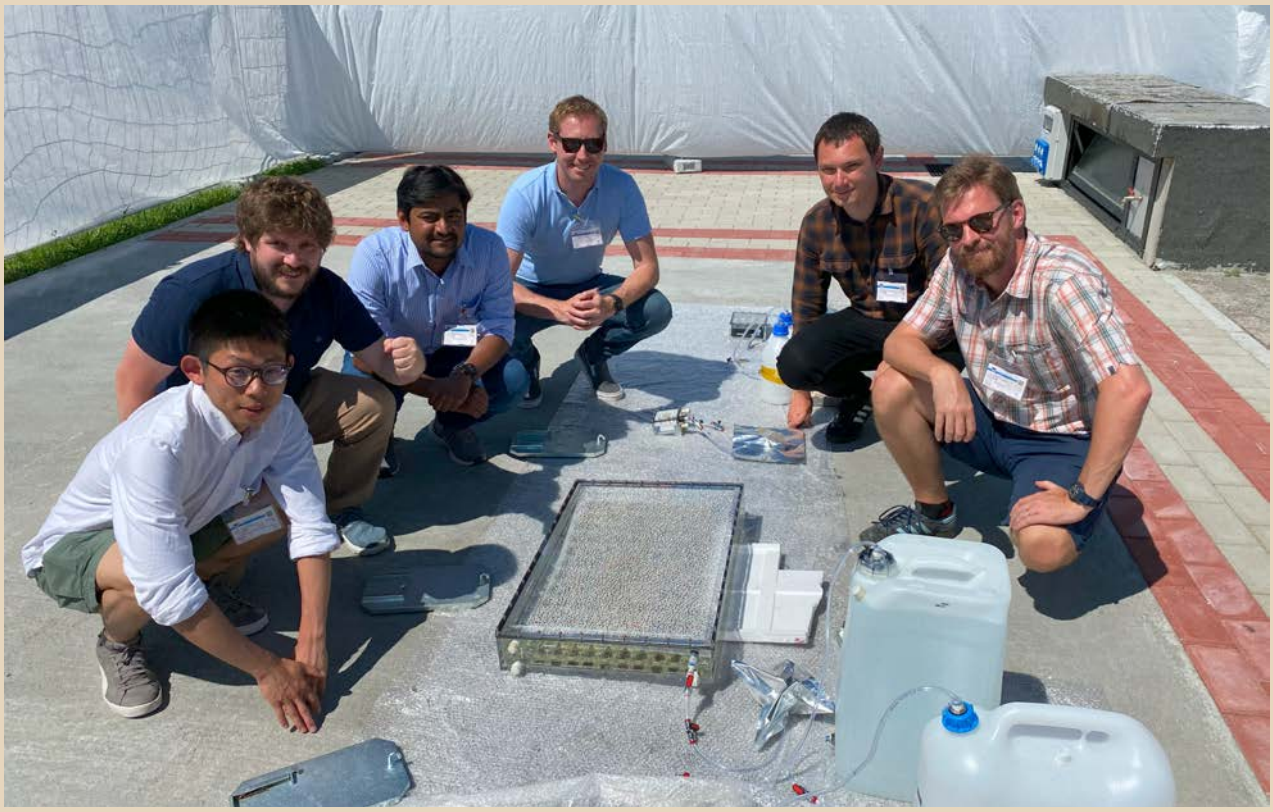
Across

1. Leave the undertaker's wagon in the centre of Cambridge for a bit of quiet. (7,5)
6. An odd data point leaves a fat trace. (8)
7. Black spurt? (3)
9. Lengthy period in some of her analysis. (3)
10. He sings the sly ode. (6)
11. A few seem to add together. (3)
12. How singular, Mr Cruise — indivisibly so! (4)
13. Watching all sine curve confused. (12)
16. The smallest is somewhere in Bodmin, I've been told. (4)
18. Time for a coffee break in the baccy reef? (9)
19. Give way to start the crystal nucleation, or so it sounds. (4)

Down

1. The venomous mammal mixes a sty with pulp. (9)
2. Our esteemed head, but also the underside, um? (6)
3. Streets, or sad? (5)
4. Please do not pet — it's very strong. (6)
5. Sounds like a lineup. (3)
7. Muddle the trigonometric function up with some jam — resulting in some fragrant tea. (7)
8. Mute, bleed the tungsten to create the desert plant. (10)
12. Aye doll, it's all mixed up. (7)
14. This evening, it's all about female sheep, or so it sounds to come together. (5)
15. I've initially Oscar coming to speak. (5)
17. It's nice, but cold when November is missing. (3)

Alumni festival



Last year researchers spoke about their summer project using artificial leaves to convert sunlight into solar fuel.

Save the date: Friday 22 September at 6pm

The University of Cambridge alumni festival is a weekend of discovery, intellectual adventure and reconnection which takes place every year in September. As part of the event, we will be hosting an educational and fun presentation about some of our latest research, suitable for ages 12 and above.

You will be able to enjoy a glass of something sparkling and some nibbles in our Cybercafé while learning about the exciting research going on here in the department. Watch for more details in the July e-Chem@Cam.