Imperial/54
THE MAGAZINE FOR THE IMPERIAL COMMUNITY
SUMMER 2023

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Imperial/54

Publisher
Imperial College London, South Kensington Campus, London SW7 2AZ
imperial.ac.uk

Editorial enquiries
imperialmagazine@imperial.ac.uk
+44 (0)20 7594 7443
imperial.ac.uk/imperialmagazine

Alumni enquiries
alumni@imperial.ac.uk
+44 (0)20 7594 6138
imperial.ac.uk/alumni

Imperial is published by YBM Ltd on behalf of Imperial College London Communications
imperial.ac.uk/communications

Editor: Mira Katbamna
Managing Editor: Steve McGrath
Art Director: Finnie Finn
For Imperial College London: Michael Booth, Susannah Evans and Lily Baker Haynes.

Cover credit: Kamioka Observatory, ICRR (Institute for Cosmic Ray Research), The University of Tokyo.

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YBM

DIGEST

NEW MEDICAL SCHOOL

Imperial and Cumbria join forces

The University of Cumbria and Imperial College London are working together to launch a new graduate entry medical school in Cumbria.

Imperial's medical school is one of the best in the world. This partnership is uniting that strength with the University of Cumbria's expertise in the education of nurses, midwives and allied health professionals to improve the region's access to world-class clinical care. The new medical school plans to enrol its first students in the autumn of 2025.

The partnership is the result of a shared vision to train more medical professionals to serve their local communities, in regions with the greatest need. The school will be situated in an area of England where recruitment and retention of medical staff is a significant challenge.

Martin Lupton, Vice Dean (Education) at Imperial's Faculty of Medicine, says: "Our two institutions are complementary – bringing their own unique set of attributes to the collaboration – and share a common mission to improve health and wellbeing through education and research."

Professor Brian Webster-Henderson, Deputy Vice Chancellor (Health, Environment & Innovation) and the University of Cumbria's lead on this strategic initiative, says that the new school's location will have a dual benefit: "It will open up more opportunities to study medicine in the North West and provide a steady stream of trained doctors for the region." ◆

ILLUSTRATION LEFT: FRAN PULIDO. ILLUSTRATION ABOVE RIGHT: MIKE LEMANSKI

WRITE TO US

Letters

Join the debate and tell us your news and views.

75 years at Silwood

I was at Imperial from 1984 to 1987 and spent quite a bit of time at Silwood over those years.

I stayed in touch with many at Silwood during my subsequent career, which has involved being a chief scientific adviser in the government and now the Deputy Exec Chair of the Biotechnology and Biological Sciences Research Council. This is alongside my personal research, which was started at Silwood, where I published my first paper from work done at Ashurst Lodge!

Guy Poppy
(Pure and Applied Biology 1987)

In the late 1970s, when we did our PhDs, the business park was not created and although Plant Ecology was based in a 'temporary' prefabricated Nissan hut, Silwood Park was like a beautiful stately home environment to work in.

The conservatory was where morning coffee and afternoon tea were served, and there was an on-site refectory for lunchtime and evening meals – Paddy was the chef.

Silwood Park was a great place socially with lots of parties – Guy Fawkes, British Student Party, International Student Party, Summer Ball and monthly Dinner-in-Hall in the main hall.

There were also monthly camping trips, softball, football and mixed hockey on the field below the house, croquet on the back lawn and other activities.

Dr Martin Alcock
(Botany and Plant Technology 1974, PhD 1977)

Met at Imperial

My husband Ben and I met while at Imperial in the School of Medicine. Ben did the BSc Surgery and Anaesthesia and I did the MBBS. We met through the Imperial College Boat Club (ICBC). While at the boat club, Ben won Henley Royal Regatta in 2013 and I represented Italy at the Under 23 World Championships in 2016, so we were a true rowing couple! We have both stopped rowing since; Ben joined the Army, I continued my training as a doctor, but we both still very proudly support and follow the achievements of the rowers currently at ICBC.

Maddalena Ardissino
(MBBS Medicine 2019)

Reel-life stories

It was good to read how far FilmSoc has developed (Imperial 53, Reel Life) since my time as a projectionist. In my day, we had two planks fixed across the back rows of the lecture theatre to support the pair of Bell & Howell projectors – one manual threader and one with an auto feed.

Most films were three-reelers, but once or twice we had a longer showing, such as *Tora! Tora! Tora!* about the Japanese raid on Pearl Harbor. On that occasion, I ran reel 1 into the manual threader, handed over to my more senior colleague as the sync marks came up, then sat watching the film thinking: "The continuity is a bit jumpy." He passed me reel 3 which I threaded up, then noticed that although the container had a clear '3' on it, the reel inside had a '2'. We stopped at the end of this reel and I drew the short straw of giving the audience the choice of continuing with reel 4, doing the missed 2 then jumping to 4, or watching 2 and 3 again and then 4. Much laughter – and 2, 3, 4 it was! Happy days.

Peter Best
(Chemistry 1976)

Dr Paul Atherton

Entrepreneur and mentor Dr Paul Atherton (PhD Physics 1978) has died following a short illness at the age of 69. Paul was the Non-Executive Director of Imperial Innovations from 2004 to 2014 and the Founding Director of Imperial Venture Mentoring Service. In 2021, he became joint winner of Imperial's inaugural Alumni Entrepreneur Award.

You can read more about Paul's achievements on our website: imperial.ac.uk/news/244557/in-memory-dr-paul-atherton/

CONTACT US

Keep up with the latest from the College and share your thoughts and news. Please mark your message 'For publication'. Messages may be edited for length.

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@imperialcollege, #OurImperial

For the latest news from the College as it happens, and to be a part of the Imperial community, visit our Imperial alumni Facebook page and LinkedIn group.

fb.com/alumni.imperialcollegelondon
www.linkedin.com/groups/87488

FROM THE PRESIDENT / PROFESSOR HUGH BRADY

Imperial: a productive environment for innovation, impact and entrepreneurship

Less than a year into my tenure as President, I continue to be amazed by the innovation, entrepreneurship and impact our community creates every day. Our staff, students and alumni are making the world healthier, smarter, safer, more prosperous and more sustainable.

This edition of *Imperial* Magazine is packed with examples of this in action. From answering fundamental questions about why matter exists to feeding the world's ever-growing population, these stories show how Imperial's community remains a world-changing global powerhouse that makes a real difference to society.

It is testament to our innovative environment that so many global success stories have started with study at Imperial. In these pages, you can read about Notpla's winning formula to drive down plastic pollution (page 10), as well as three inspiring stories of graduates who have turned their research into commercial success (page 22).

How we protect and enhance our work in the decades ahead is a key focus this year and we will be launching a new Imperial strategy in October. Thank you to everyone who shared their views during our initial phase of consultation. We will keep you updated as this develops and look forward to sharing more details with you in future editions.

As ever, our alumni are a core part of these discussions. I was honoured to be part of our biggest-ever graduation ceremony day in May. Over 4,700 graduands and 8,500 guests took part in our Postgraduate ceremonies, filling the Royal Albert Hall three times over. It was tremendous to see so many members of our community celebrate their achievements. It certainly made for quite a buzz on campus!

I have also enjoyed seeing our work making an impact on the global stage. My recent visit to the United States was a fantastic opportunity to meet our brilliant alumni and showcase a range of innovative Imperial startups. And over in French Guyana, Imperial-led technology was at the forefront of a huge milestone in space exploration at the launch of the Jupiter Icy Moons Explorer. The successful launch, watched by audiences around the world, carried Imperial kit on a mission to Jupiter's moons. Like me, I know all of you will be following its journey over the years ahead.

Another source of great pride – and global success – is our partnerships at home and abroad. The collaboration with Cornell University, that I announced during my visit to the United States, will use AI to accelerate scientific discovery and future technologies – a truly exciting opportunity to share our expertise. And in May, we launched a major partnership with Japanese counterparts

Our work continues to attract the world's biggest names to partner with us

in Tokyo. Both are great examples of Imperial working with others to have an impact on the big issues of today. It is this collaboration that continues to attract the world's most influential names to partner with us and learn about our work – names like Bill Gates, Rishi Sunak, Lewis Hamilton and the President of Estonia, who have all visited us in the past few months.

I hope you find this edition stimulating and thought-provoking, and I look forward to seeing or hearing from you in the months ahead. ◆

> ***Professor Hugh Brady** is President of Imperial College London.*

PHOTOGRAPHY: IMPERIAL COLLEGE LONDON/THOMAS ANGUS.

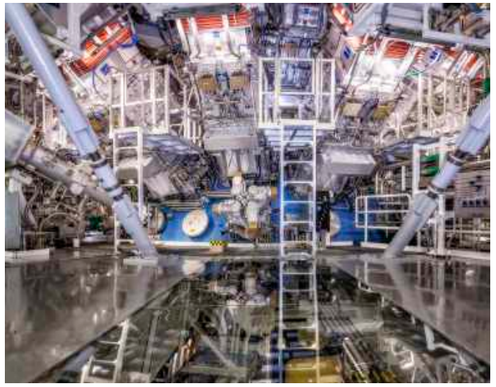
ENERGY

Nuclear fusion breakthrough

Imperial scientists are analysing the data from a breakthrough experiment in which a fusion reaction generated more energy than was used to create it. The successful experiment – which scientists have been trying to achieve for 70 years – was carried out at the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in the USA.

Imperial has strong links with the facility through the Centre for Inertial Fusion Studies (CIFS) and more than 30 Imperial PhD students have gone on to work at NIF.

The experiment could bring us closer to the goal of generating fusion power on a much larger scale, says Professor Jeremy Chittenden, Co-Director of the CIFS. "The key thing is that with today's results we know that fusion power is within reach."



Above: The National Ignition Facility at Lawrence Livermore National Laboratory.

RESEARCH

iKnife can diagnose womb cancer

An intelligent knife that 'smells' tumours can diagnose womb cancer in minutes, new Imperial-led research has found.

Researchers, led by the Department of Surgery and Cancer's Professor Sadaf Ghaem-Maghami and funded by The Eve Appeal, used the iKnife to analyse biopsies from the womb. The tool cuts through tissue, heating as it cuts, and analyses the vapour released for cancer flags.

This research could revolutionise the management of women with abnormal vaginal bleeding referred to rapid access clinics, says Ghaem-Maghami.

"With its high diagnostic accuracy and positive predictive value, we could immediately reassure women of the very low likelihood of having cancer if the iKnife result is negative, and expedite further tests, scans and treatment for women whose biopsies indicate the presence of cancer."

ILLUSTRATION: MIKE LEMANSKI. PHOTO: DAMIEN JEMISON/LLNL

42

The Hitchhiker's Guide to the Galaxy says 42 is the answer. But what is the question? For Professor Faith Osier it is: What are the parasite proteins that trigger immunity to malaria?

It's well known that malaria kills, on a massive scale. But surprising numbers of people actually survive infection – and go on to become resistant. Understanding why, says Professor Faith Osier, Co-Director of Imperial's Institute of Infection, could be the key to the eradication of the disease.

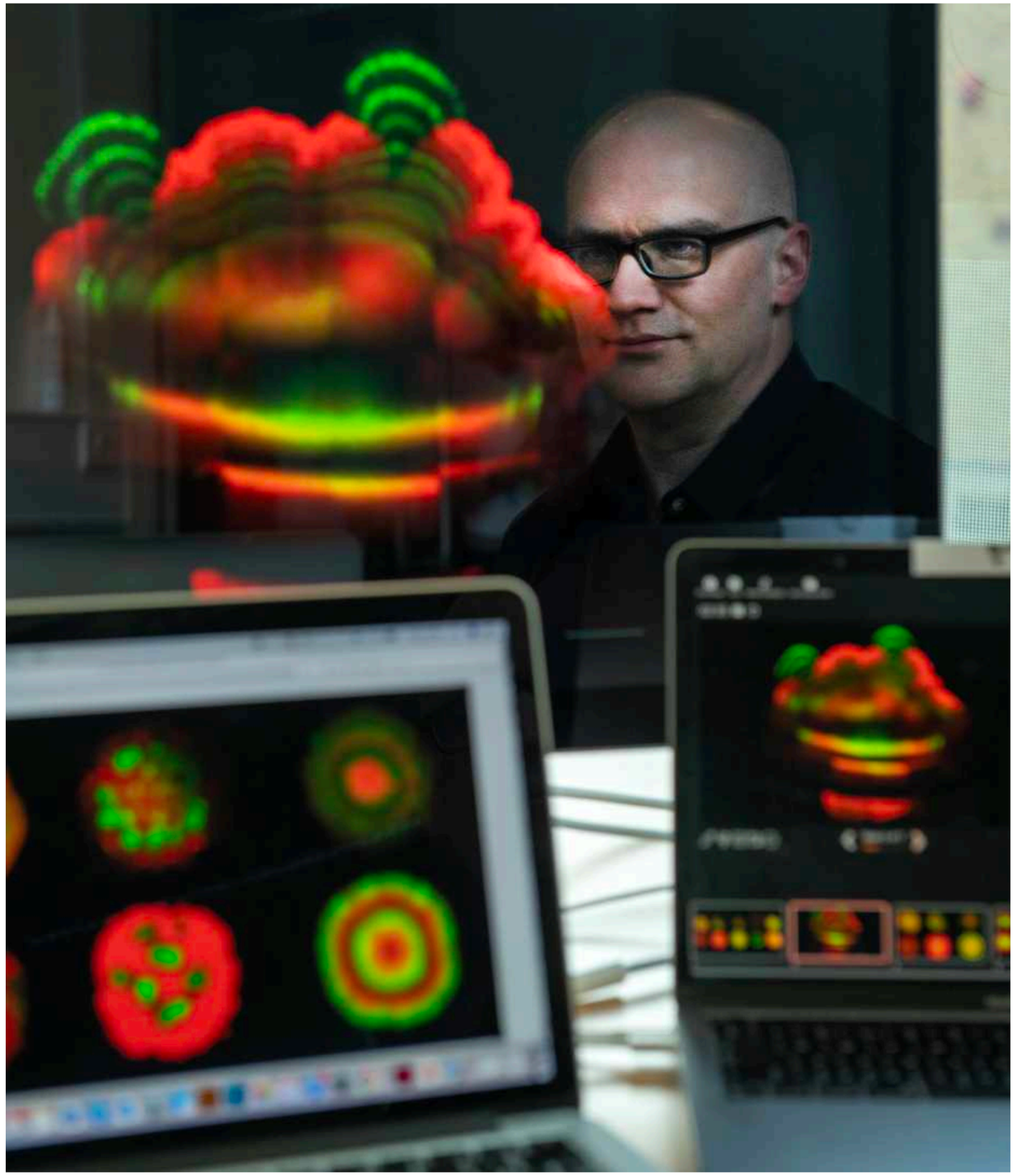
"How some people with malaria parasites present in their blood are able to live entirely unaffected by the disease, while others fall desperately ill or die, is a mystery yet to be solved," says Osier. "And the reason we still don't know the answer is that the malaria parasite has got thousands of proteins." To give a sense of the scale of the challenge, the virus that causes COVID-19 has fewer than 30.

Osier has been exploring this issue on a molecular level for the past 20 years, attempting to isolate which parasite protein, or proteins, trigger the immune response. "We know that people can become immune because we've been studying immune responses in the population for a long time. But whatever the magic bullet is, it's concealed in a sea of other bullets."

The last decade has seen a major advance: challenge trials, in which consenting participants are infected with a well-understood, easily treatable strain of malaria and watched to see how their immune systems respond. Compared to studying malaria in the community, explains Osier, challenge trials make it "much easier to say who became sick as a result of this infection and who didn't". By analysing blood samples from the participants, her team has been able to significantly narrow down which of the parasite proteins may be responsible for disease.

The next, and hopefully final, step will be a further challenge trial, one that involves vaccinating participants before infecting them. Such a study could be just three years away, with results available two weeks following infection. "That is where my work must go for me to close the loop and retire in peace," says Osier.

> ***Professor Faith Osier** is Co-Director of Imperial's Institute of Infection and President of the International Union of Immunological Societies*



Right: Professor Robert Endres searches for patterns to help understand what makes biology 'work'.

ADVENTURES IN... THE LAWS OF BIOLOGY

In search of patterns

How to solve the 'problem' of biology? Just use physics and maths, says Professor Robert Endres.

Words: **Megan Welford** / Photography **Hannah Maule-ffinch**

Professor Robert Endres is a man who searches for order in disorder. As a child, he liked all sciences, but says he was drawn to physics because of its clear-cut laws. "It's the most fundamental science," he says. "You can apply the laws to the universe and learn how the world works."

Biology, he says, is messier, but no less fascinating. "I made a pond in our garden when I was 12 or so," he says, "and I was amazed by the variety of organisms you could see in those one or two square metres, if you looked carefully." But for the young Endres, looking wasn't enough. He wanted to understand, and he's still trying now.

"Physical laws can't explain the emergence of biology," he says. "Biology is really complicated. There are patterns, but they are often not reproducible in an experiment. Take the pond – insects and amphibians are complicated here. The pond is not a controlled environment – you have seasons, weather, water flowing in and out, frog migrations – so you can't just study the frogs, you need to take into account the whole ecosystem."

It's that search for a pattern that has driven much of his work in biological physics. Despite initially enjoying the satisfying nature of the laws of physics, Endres couldn't help being attracted to biology, finding at school that the most interesting elements of either living or non-living matter happened far from equilibrium. Emergent phenomena, like frogs, were interesting because they were more than the sum of their parts.

For his PhD, he studied small biochemical networks, their signalling pathways and how they turned on genes in response to their environment. And he became aware of a paper written by a visionary mathematician from the 20th century.

"Alan Turing wrote one paper out of the blue where he said that biology, essentially, is a maths problem," says Endres. The paper sets out a theory of 'diffusion-driven instability' to try and draw the patterns of biology using maths.

"It starts with a fixed domain on which molecules diffuse and start interacting, producing patterns. Turing is saying you can study two elements separately, but what happens when they interact is most interesting. Emergent phenomena again. At first, I didn't think the paper was so interesting, although the maths was beautiful. But now that I see the relevance to biology, I think it's a wonderful paper."

At Imperial, he began working with a professor of synthetic biology, Mark Isalan, who also saw the potential of the Turing Patterns. "The thing is, Turing just used chemicals," says Endres. "You can make patterns with chemistry but it's a bit boring. It's very clean and easily controlled."

On the other hand, biological phenomena such as embryos are "confusing and horribly complicated". To try and avoid their myriad influencing factors, Isalan is instead building biology from scratch – engineering bacteria and observing how they grow and interact, trying to read the patterns. Endres brings the more detached eye of a physicist, looking at the bigger picture, trying to establish the parameters and the physical boundary conditions of the cells' behaviour.

We're trying to simplify biology and recreate its patterns in a robust way

The pair are trying to understand what makes biology work. "What we're trying to do is simplify biology to the point that we can understand and recreate its patterns in a robust way. If we understand what the patterns can do, then we can engineer cells to create tissue, and engineer tissue to create organs, for example. Until we can predict the patterns, it's all a bit hit and miss. Someone might succeed in making a tiny clump of cells differentiate and get organised, for example, but they don't know why it worked, and can't do it again."

Engineering organs is not Endres' primary motivation, however. "There are many downstream applications," he says, "but I would be happy just to understand the rules of biology in a physical world." ◆

> ***Robert Endres** is Professor of Systems Biology in the Department of Life Sciences.*

EDUCATION – ABDULLAH AL-BURIAHI, SANCTUARY SCHOLAR

From Yemen to Imperial: the journey that changed my life forever

I have a saying: 'A dream is not something you see in your sleep, it's something that doesn't let you sleep.' My dream was to pursue further education at one of the world's top universities, but my home country of Yemen was shattered by ongoing war, and remains that way today.

So, embarking on a journey to pursue my education abroad was the only way. That journey began when I was 19 and left Yemen – and my family – for Malaysia, to gain my Bachelor of Civil Engineering at the Universiti Tun Hussein Onn.

Living away from home was hard but my belief that nothing in life is permanent kept me going. The fuel for my determination came from my mother's tears when she was praying daily for me, and my father's sweat when he was trying to support me. I had to keep going, until I tasted the flavour of success.

Eight years after leaving Yemen, in December 2021, I arrived in the UK. My first challenge was to improve my English quickly to meet the minimum requirement for study. I applied to Imperial to undertake a Master's in my specialist field of transport and was accepted. But I had no financial support, I had no permission to work and I had to find funding. That's when I became aware of Imperial's Sanctuary Scholarship, which provides educational funding to refugees and asylum seekers. I applied and was fortunate enough to receive it.

Scholarships like these are greatly needed. Many refugees and asylum seekers have the potential and drive to excel academically but may face many discrimination challenges. The Sanctuary Scholarship provides a glimmer of hope to those of us with ambition, offering us the chance to complete our studies and become active contributors to society in our various fields.

It's hard to describe how much happiness the Sanctuary Scholarship has brought me. First, of course, it has enabled me to complete my education. I enjoy every moment at Imperial and I try to use every second. I feel that I am truly a member of the Imperial community. I love playing badminton, going swimming, attending career fairs, meeting my friends at the library – and, of course, I love my studies.

I haven't seen my family since that day I left Yemen but I check on them all the time. And every time, they tell me that I shouldn't worry about them, that I should focus on my studies. So that's what I do.

> My determination comes from my mother's tears and my father's sweat

My Master's finishes this year, and I am now closer to the ambitions I have strived for all my life. While I have many aspirations, both personal and societal, my short-term goal is to become a respected policymaker in the transport industry, helping to improve people's lives and bring joy to their faces. I feel that we haven't yet reached the stage where people enjoy their journeys or feel completely safe. We should design our cities to be liveable, and our streets to be sustainable. People should enjoy their lives without having to worry about traffic. In the long term, I want to reach the point when I can do the work I love, when I want and wherever I want. I don't want to have any regrets about the life I have lived when I die. ◆

> ***Abdullah Al-Buriahi** is a Sanctuary Scholar studying MSc Transport in Imperial's Department of Civil and Environmental Engineering. The Sanctuary Scholarship Fund is just one of the many donor-funded initiatives supporting students at Imperial. You can donate to these via www.imperial.ac.uk/giving/spring-magazine-23*

INTERVIEW: LUCY JOLIN

IMPERIAL INNOVATES

Anything but plastic

Pierre Paslier *(MSc Innovation Design Engineering 2014)* reveals how his company, Notpla, is using seaweed to create a revolution in packaging.

Interview: **Peter Taylor-Whiffen**

Clockwise from left: The Notpla range: sachets, cosmetic packaging, coating and takeaway packaging, and food film sachets and oil pipettes.

Far left: Notpla co-founders Pierre Paslier and Rodrigo Garcia Gonzalez.

Making biodegradable packaging out of seaweed began as our student project at Imperial – we never planned to create a business. But our videos went viral and we felt a responsibility to the planet to take it further.

Now our company, Notpla, has attracted £15 million in investment, we supply several major food manufacturers and restaurants, and we've just won Prince William's Earthshot Prize. All we wanted was to provide an alternative – now everyone wants to join our revolution.

The story began in 2014, when I came to Imperial for a Master's in Innovation Design Engineering and met my Notpla co-founder, Rodrigo Garcia Gonzalez. We set ourselves the challenge of making a 'man-made fruit', complete with packaging that would feel like it came from nature.

We were inspired by the way 'bubbles' of fake caviar were made by Unilever in the 1950s, and after experimenting with gum from the roots of plants, we turned to seaweed. Working out of our kitchen, we were able to create a viscous paste from the raw seaweed, which we then developed into bubbles to use for packaging. The initial results were not refined – smelling of seaweed and sometimes leaky – but when we posted videos of our work, they went viral.

The initial results were not refined – smelling of seaweed and sometimes leaky – but when we posted videos of our work, they went viral

At that point our Master's was coming to an end, but we applied to a few competitions and got our first funding from what is now Undaunted, a programme from Imperial's Grantham Institute. We got so much support from Imperial – incubating our business, training, mentoring, and then legal help when American companies tried to frighten us off by falsely claiming we'd stolen their idea.

Our product range grew. We started packaging water, then fruit liquids. As a result of our videos, Lucozade contacted us and we provided their packaging for energy gels at the 2019 London Marathon – runners could either consume the whole thing or discard the packaging to biodegrade in just six weeks. We've developed whisky cocktail pouches with Glenlivet and edible ketchup and mayo sachets with Kraft Heinz. Fast food boxes all have a thin plastic film on the inside so we developed an alternative seaweed coating and are now working with Just Eat on these.

And we keep developing – we've made a coffee stick with packaging that dissolves in boiling water, and a soluble box for Swiss watch firm, ID Genève (the box comes with 'destruction instructions' for the watch-owners to dissolve it in their watering can, so two hours later they can use it to water and fertilise their plants). We now have 70 staff in our premises in London but are looking to expand in mainland Europe and the US. Food packaging possibilities are exciting but there are many other opportunities in cosmetics, fashion, garments –the £1 million Earthshot Prize has opened up so many more opportunities.

It's truly exciting to be pioneers, but we welcome competition; we can't be the only supplier. To have real impact we need a whole ecosystem, and for the sake of the planet, we need everyone to make packaging like this. ◆

PHOTOS: SAM SCALES

IN BRIEF

Maths School to open in September
The Imperial College London Mathematics School is set to open in north London in September 2023. A specialist school for sixth-form students, it focuses on attracting students from groups currently underrepresented in STEM careers.
bit.ly/imperial-54-maths

Imperial at the movies
A film based on research by Imperial's Advanced Research Fellow Dr Lindsay Dewa has premiered at the British Film Institute. *Nexus* examines the impact of COVID-19 on young people's mental health, eating-related coping strategies, and the power of connection.
It was co-produced with those with experience of mental health difficulties.
bit.ly/imperial-54-film

Inspiring engineers
Imperial has published a new book to inspire engineers of the future. *Engineers Making a Difference* – by mechanical engineer, broadcaster and producer Dr Shini Somara – showcases 46 inspiring individuals from across the engineering world, and copies have been sent to every state secondary school in the UK.
bit.ly/imperial-54-book

OVERHEARD ON CAMPUS

***DreamLab:** an app which harnesses the computing power of smartphones while their users sleep. A new project with Imperial will use existing historical data to create cyclone simulations – and the millions of smartphones signed up to DreamLab will then crunch the data to build new cyclone prediction models.*

***VR training:** virtual reality headsets for trainee medics that simulate emergency situations. Each simulation takes the trainee through the event via a series of multiple-choice questions. It's hoped they will help new doctors feel more confident.*

***Behaviour fingerprints:** movement patterns which can predict future disease progression and increase the efficiency of clinical trials in two rare disorders, Duchenne muscular dystrophy and Friedreich's ataxia. New Imperial research has combined wearable tech with a powerful AI technology to discern these patterns.*

HOW DO WE FEED THE WORLD'S NINE BILLION POPULATION IN 2050?

Words: **Jo Caird** / Photography **David Vintiner**

Famine is already a reality, and climate change means the problem is only going to get worse. Could Imperial have uncovered the solution?

Previous pages:
Right: A vegetable plug plant: Dr Laura Barter works on the efficiency in food crops by probing translocation across plant membranes.

Left: A metal mug of beans: Dr Samrat Singh is leading technical assistance on the World Food Programme's Home Grown School Feeding initiative.

This page, right:
Dr Laura Barter, Director of Imperial's Agri-Futures Lab.

Following page:
Dr Samrat Singh, Head of Programmes, Partnership for Child Development.

The world's population is expected to grow by up to two billion in the next 30 years, pushing towards a level four times larger than it was in the mid-20th century. So, how will the world feed itself in 2050?

Famine is already a reality in eastern and central Africa, with more than 35 million people, including 6.7 million children, currently unable to meet their most basic food and nutrition needs, according to the Food and Agriculture Organization, UNICEF and the World Food Programme. And climate change means the problem of food insecurity is only going to get worse, as extreme climate events cause failed harvests and mass livestock deaths.

Where to start? Dr Laura Barter (Chemistry 1995, PhD Biochemistry 1999), a Reader in Plant Chemical Biology in the Chemistry Department at Imperial and Director of Imperial's Agri-Futures Lab, says a holistic approach is vital. "Connectivity between the whole food system is going to be crucial," she says. "When we talk about food, we have to think of it from field to fork."

Barter's research focuses on developing chemical biology tools to enhance photosynthetic efficiency in food crops. "The overall conversion of sunlight to stored biomass in the leaf is only of the order of one to two per cent efficient," she explains. "Make this process work better and you can improve crop yield, thereby feeding more people without needing to convert more land to agricultural use."

To make it happen, Barter's team, in collaboration with Professor Nick Long and Dr Rudiger Woscholski in the Department of Chemistry, are exploring chemical mimetics of an enzyme that increases concentrations of carbon dioxide at particular locations in the leaf. The results of this research are promising so far, says Barter, but developing the mimetic itself is only half the battle – which is why she is also collaborating with a group at Imperial, led by Professor Oscar Ces, to learn more about how to get the chemical to its target within the plant.

"That's going to be probably our next biggest challenge," she says, though a partnership with agrichemical company Syngenta could make the difference. "We're developing a platform that we can use to start to test the translocation properties of these molecules and help to tailor them, with the help from formulation chemists at Syngenta."

Collaborations across disciplines, and with stakeholders beyond academia, are key to Barter's work, not just on this particular research project but in her roles as Director of Imperial's Agri-Futures Lab and AGRI-net, an agri-science chemical biology network.

"Both of those are aimed at connecting people," she says. "Very often people don't realise that their tools and technologies can be translated to tackle challenges within agri-science." The membrane translocation technology Barter and Ces are using is a case in point – it was originally created to try to understand drug translocation in humans.

FOCUS ON FOOD SYSTEMS

But food security – all people being able to access enough safe and nutritious food to meet their requirements for a healthy life – is about far more than just food, says Dr Samrat Singh (PhD Environmental Policy 2022), Head of Programmes, Partnership for Child Development at the School of Public Health. "There's an emphasis now on looking at food systems, public health and ecology altogether," says Singh, whose work focuses on food systems and the interactions between nutrition, health and agriculture.

Partnering with governments in Asia and sub-Saharan Africa, Singh's team provides operational research and technical assistance on food system interventions, as well as conducting research in the field and generating evidence. "That evidence then feeds into government policy-making: whether something is working or not working, and if it's working, how's it working, as well as all the policy changes that need to be made," explains Singh.

For the past ten years, Singh has been working with the government of Nigeria on a "home-grown school feeding" programme. "We identify foods that are rich in micronutrients, climate-smart and compatible with local culture," Singh says, "and then the school ▶

“WE IDENTIFY FOODS THAT ARE RICH IN MICRONUTRIENTS, CLIMATE-SMART AND COMPATIBLE WITH LOCAL CULTURE”

Dr Samrat Singh, Research Associate in Food Policy in the School of Public Health

Imperial’s Global Development Hub
Launched in April 2021, Imperial’s Global Development Hub is a platform to promote and support the College’s sustainable development research, education and innovation. By building communities of practice across sectors and disciplines, the Hub advances Imperial’s contribution to the 17 Sustainable Development Goals (SDGs) laid out in the UN’s 2030 Agenda for Sustainable Development. From enabling multidisciplinary research to delivering education activities and programmes in lower-middle income countries, the Hub helps the College prioritise work that is relevant to the SDGs.
www.imperial.ac.uk/global-development-hub/

Above:
Dr Elisabetta Aurino, Visiting Researcher at Imperial Business School.

menus and the procurement are designed to benefit local agricultural economies.” Evidence gathered over the course of the project has been incorporated into the programme in Nigeria and also into the African Union’s agriculture, public health and nutrition policies.

Another route to improved food security is mitigating the impacts of agriculture on climate change. “Agriculture is one of the biggest contributors to greenhouse gas emissions,” says Singh. “How do we reduce the carbon footprint of agriculture through the projects we do?” One of his latest, a collaboration with the London School of Hygiene and Tropical Medicine, involves modelling the total carbon footprint of different diets in order to map the optimum diet in a given location. This research, when complete, will hopefully enable governments to “provide more sustainable and secure food programmes,” says Singh.

So-called ‘climate-smart’ foods – crops that are naturally drought-resistant – are becoming increasingly important as the impacts of the climate crisis are felt ever more forcefully in developing nations. With the homogenisation of agriculture globally, traditional crops such as local varieties of millet or ground nuts have been eschewed in favour of maize and rice. Part of Singh’s work involves promoting a return to these old-style crops that are better suited to a warming planet.

IMPROVING CHILD DEVELOPMENT

Creating a carbon-neutral, biodiverse food supply chain that benefits local economies and ecologies would be of enormous benefit to food security, but it’s only one piece of the puzzle. Ensuring that communities and individuals have equitable access to that food is another. Dr Elisabetta Aurino (Economics 2013) is a Visiting Researcher in the Imperial College Business School and Assistant Professor of Economics at the University of Barcelona, whose research in Ghana is looking at the outcomes of poor nutrition. In recent years, she has worked with the Ghanaian government on expanding its school meals programme. “We worked to identify districts that were more in need, looking at different food insecurity indicators and the effect of nutrition on learning,” she explains.

After two years, Aurino’s team observed improved height for age in early primary school children and girls, particularly those from more disadvantaged families. “This study was the first to show that in a low-income context, a programme that is run at scale, by a government, works for child development outcomes,” says Aurino. The government of Ghana has since rolled out the school meals programme across 216 districts.

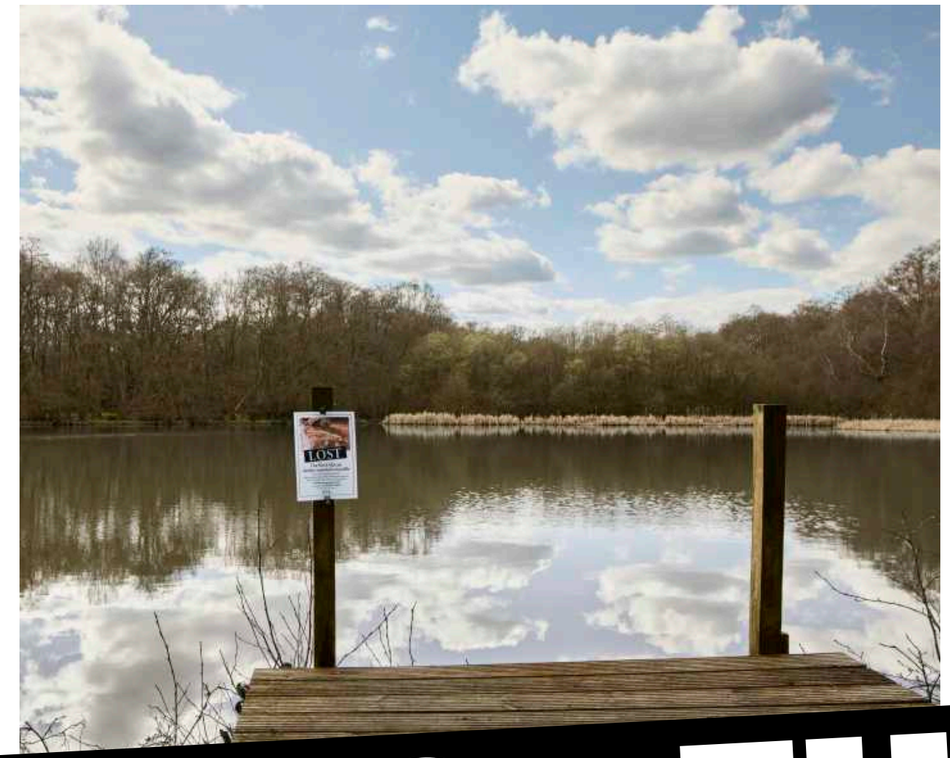
“This study was the first to show that in a low-income context, a programme that is run at scale, by a government, works for child development outcomes”
Dr Elisabetta Aurino, Visiting Researcher

For feeding programmes like this to be effective, however, there is also the crucial question of how people can transform the food that they access into good nutrition for themselves, says Aurino. “In the low-income countries where I work, children may have enough food, but they may be infested with parasites from the soil or water, and that hampers the absorption of nutrients. So they end up anaemic or they don’t grow as much as they should as a child, and this has long-term repercussions for their health, education and productivity.”

A food security policy that does not consider sanitation and public health measures, therefore, can only achieve so much. When you add in cultural factors such as gender bias – the fact that in some household settings women and girls do not receive their fair share of food – you have a very complex picture.

The good news, says Aurino, is that we know what works to address these challenges, whether through improved infrastructure, education, social protection or a whole range of other tried and tested interventions. “The problem is that there is often a lack of political will to do so.” But by working together across disciplines, academics like herself, Singh and Barter can help make the case to governments for policies with the potential to truly change people’s lives. ◆

All images:
Imperial's Silwood Park, which recently celebrated its 75th anniversary, is a leading international centre for research and teaching in ecology, evolution and conservation.



CLOSE TO THE EDGE

More than a million species on Earth are believed to be on the verge of extinction. But there is still hope – if we act now.

Words: **Lucy Jolin**
Photography: **Thom Atkinson**

A bird flies over a field in Ghana, devouring the insects, which, in turn, are looking to devour the crops. A microorganism munches away at the soil around a tree's roots on an old sheep pasture in Wales. A tapir wanders the Amazonian rainforest, picking at fruit and spreading seeds far and wide in its droppings. Every single one of these tiny processes matters: to grow crops, to keep the climate stable, to allow all life on the planet to flourish.

But that very biodiversity – which plays such a vital part in the complex ecosystems that keep us and our planet alive – is collapsing. The numbers are staggering: a million of the Earth's estimated eight to nine million species face extinction; in the sea, 90 per cent of global fish stocks are fully exploited, over-exploited or depleted; and 75 per cent of the Earth's land surface has been significantly altered by human actions – leaving many species with nowhere to go.

"The cumulative diversity we stand to lose is greater than the age of the universe," says Dr Rikki Gumbs (PhD Life Sciences 2020), Postdoctoral Research Scientist at ZSL's EDGE of Extinction programme – that's EDGE as in Evolutionarily Distinct and Globally Endangered. "The magnitude of the loss we face is terrifying."

Humans are causing this – we're currently using the equivalent of 1.6 Earths to maintain the way we live now. So, can humans repair the damage they've done? Yes, say biodiversity experts, all hope is not lost – but only if we act now, and act wisely. The great extinction has many causes, so it's going to have many solutions.

Finding out what birds in Ghana are eating, for example, could lead to practical, effective solutions to biodiversity loss. That's the aim of Dr Joseph Tobias's lab, which has pioneered the use of meta barcoding: catching birds and mammals, collecting faecal samples, and sequencing the DNA of all the things they have eaten. "Over time, we build a trophic web from this information: which animals are eating which pests?" says Tobias, Reader in Biodiversity and Ecosystems at Silwood Park, Imperial's international centre for research and teaching in ecology, evolution and conservation.

Working closely with local communities, they now have information about several hundred birds and bats living on the edge of agricultural landscapes in Ghana and Zambia, and are expanding that research to other tropical regions.

"And that means we can start asking questions about which parts of biodiversity are the most important for humans," says Tobias. "Which agricultural practices can help to promote nature-based solutions for controlling pest populations, pollinating crops or maintaining adjacent rainforest?"

A world away, in central Wales, Dr Bonnie Waring, Senior Lecturer in Ecology at the Grantham Institute, is working on just such a ▶

Below:
The Hamilton Building on campus which holds the Faculty of Life Sciences.

Right:
The wooded area at Silwood Park.

solution – attempting to turn sheep pasture that has been grazed for centuries into biodiversity-rich forest. Since 2000, around 437 million hectares of tree cover have been lost globally, mainly to agriculture, logging and wildfires. The changing use of sea or land was identified by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service as one of the five direct drivers of biodiversity loss. And, of course, forest photosynthesis and forest breathing are also vital for removing and returning vast amounts of carbon to the atmosphere. While Waring emphasises that forests should ideally be allowed to regenerate naturally, "sometimes nature needs a helping hand".

That helping hand could be as simple as a few handfuls of soil. At the sheep pasture where Waring is running her research project in collaboration with charity The Carbon Community, no natural regeneration has been observed. "So, we need to plant trees. But we must help the forest through that very vulnerable early stage of its development where the seedlings are defenceless and very prone to dying of drought or being eaten. And we need to do that by working with the natural ecology of the ecosystem, not against it."

Just like the gut microbiomes that help us to digest food, trees have evolved over hundreds of millions of years to partner with beneficial microbes that help them acquire nutrients. Waring's team planted trees and inoculated them with microbes from a very closely located healthy forest. Adding that little bit of soil from a healthy nearby forest made those seedlings grow more than 50 per cent faster.

Waring and her team don't yet know how this will translate to greater carbon capture and the ecosystem in the long term. But it has certainly speeded up the trajectory of healthy tree growth – and it can be easily replicated by anyone, anywhere, with a little guidance. "Reforestation as a climate solution will not work unless the people who live most closely and interact most frequently with the forests that are created have an incentive to keep those forests," says Waring. "We can't have a one-size-fits-all approach. We need adaptable solutions with a low barrier to entry and which can be used by local groups, not imposed across the world by big organisations. This is something else in the toolkit."

And these tools range from low-tech soil to high-tech data crunching. Dr Will Pearse (MSc Life Sciences 2009), Senior Lecturer in Applied Ecology at the Silwood Park campus, is using the evolutionary history of numerous species to better understand the challenges that face them today. Using fossil records along with DNA sequencing, they build models of how tiny changes in DNA have accumulated through time, and how those changes came together in the ancestors of each individual.

"This allows us to figure out the path that links every species," says Pearse. "What we lack is a map of how biodiversity change will affect ecosystem functions around the world. We're building a new generation of forecast models that are capable of forecasting how ecosystems will function after these profound biodiversity declines worldwide."

A recent project examined two traits of the rodent family tree – body mass and global location – and crunched vast amounts of data looking for patterns. "We found that in two groups of similar-sized rodents that don't live near each other, body mass evolved more slowly," explains Pearse. "If you're the same-size rodent, you eat the same kinds of things and you live in the same kinds of places. You don't want to live next to someone who is the same size as you, as you'll be competing for food."

"The cumulative diversity we stand to lose is greater than the age of the universe"
Dr Rikki Gumbs, EDGE Postdoctoral Research Scientist

This has important conservation implications, he says: it's now understood that trying to move or evolve to avoid competition is a key factor in how a species might behave under pressure, such as climate change. "And tracking how a species we know well is responding to land-use change or climate helps us predict what will happen to those rare and threatened species that are also responding to those drivers."

Identifying these rare species deemed as highest priority for conservation action is the role of ZSL's Gumbs. "Pangolins or elephants seem weird because they are alone and unique on the tree of life," he says. "We measure how evolutionarily isolated or unique a species is and combine that with its extinction risk." Once a species is identified, a local EDGE Fellow is assigned to it: they learn more about it, and work to help preserve it in partnership with local communities.

This approach often leads to the identification of specific and distinct species, but why is it so important to preserve, say, the Australian mountain pygmy possum or the Archey's frog? Because we know very little about them, says Gumbs. "We know what the impact would be if we lose bumblebees or worms. But there is a relationship between the distinctiveness of a species and the uniqueness of its features and traits. We are constantly discovering that unexpected species have unexpected benefits." Consider, for example, the Tasmanian Devil: proteins in its milk were found to kill antibiotic-resistant human pathogens. Or the tapir, which has been shown to be extraordinarily good at spreading seeds in its droppings – thus aiding reforestation.

It's easy to feel helpless in the face of this threat of mass extinction. But we can all play a part, however small it might seem. Write a letter to your MP, advises Pearse. Or consider going vegetarian, says Gumbs: the conversion of natural habitats to agriculture and pasture farming is one of the biggest contributors to biodiversity loss.

We can turn this around, says Tobias – if we act now. "That is the amazing thing about nature and biodiversity: it can regenerate. Do I see hope for the future? Yes." ◆

Enterprising minds

WHERE DO THE BEST IDEAS COME FROM? AT IMPERIAL, THEY OFTEN START WITH A PhD. WE MEET THE ALUMNI WHO HAVE TURNED THEIR DREAMS INTO COMMERCIAL REALITY.

Words: **Tom Knowles** / Illustration **Antonio Sortini**

The numbers speak for themselves: More than 200 startups have been set up by Imperial students in the past six years, making the College one of the best places in the country to become an entrepreneur. So, what's its secret? Three little letters: PhD.

"There is absolutely no way whatsoever I'd have started this kind of tech company without having a PhD at Imperial first," says Dr Robert Quinn (PhD Mechanical Engineering 2021). Quinn is the co-founder of MakeSense Technologies, which is developing a small handheld tool that helps blind or visually impaired people navigate themselves without the use of a cane or guide dog.

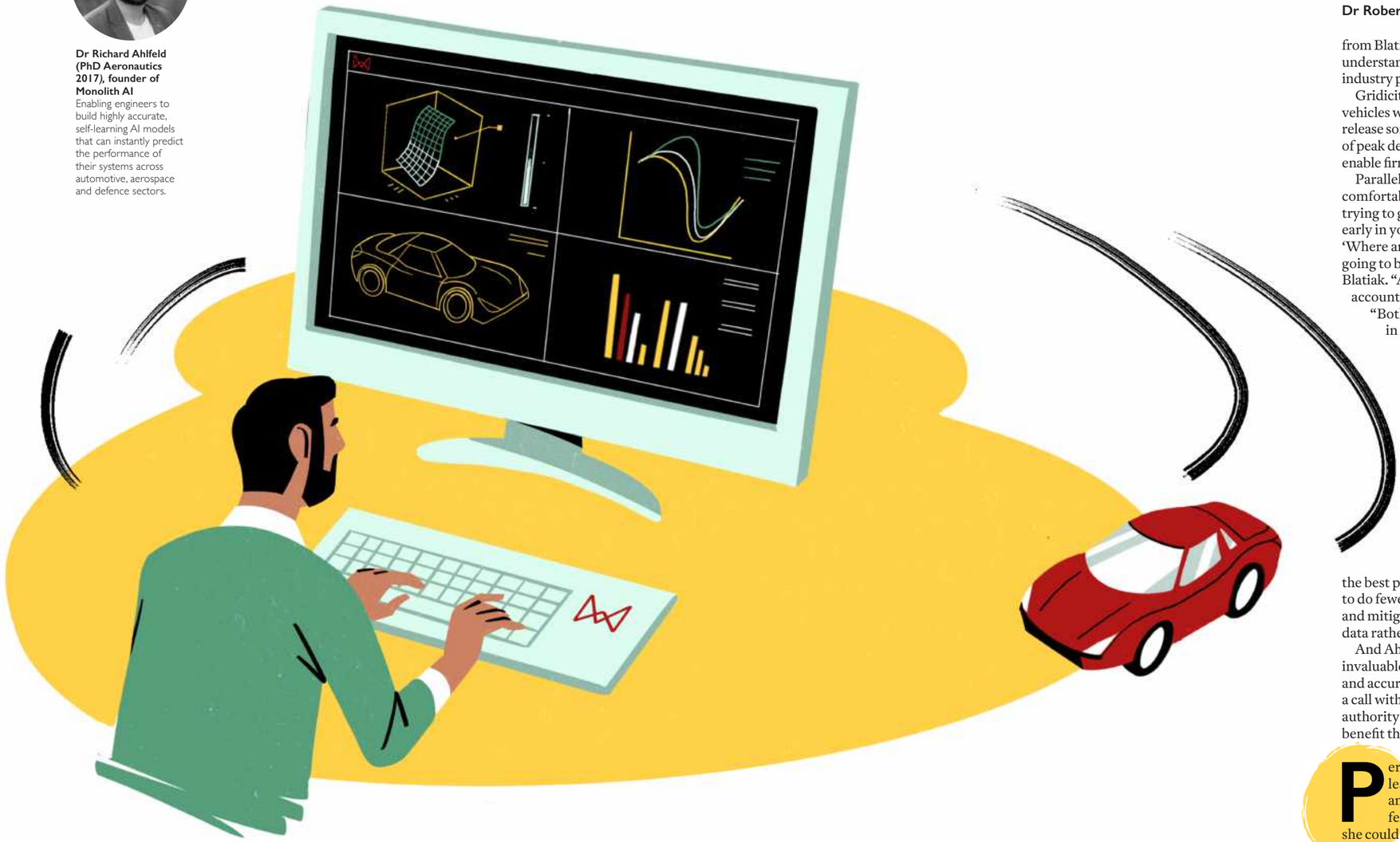
Through the Imperial Enterprise Lab, a training centre dedicated to entrepreneurship at the university, he was able to access the Discovery Fund, a programme that provides specialist training for students and recent alumni who want to explore and test an early-stage idea. "They teach you how to analyse your ideas, how to talk to customers and how to not bias your customers with your own point of view," says Quinn. "It also meant I was able to speak directly to visually impaired people and get a better understanding of how to improve the product."

It's just one example of the unique entrepreneurial ecosystems that enable Imperial PhD students to thrive. In Quinn's case, he discovered that Dr Ad Spiers, a lecturer in Robotics and Machine Learning at Imperial, was actively researching a related technology area, having pioneered the field of shape-changing devices that can provide navigation to the visually impaired. Spiers has since joined Quinn's company. "By taking the groundwork he's laid and building upon it, we've now developed a really effective sensory substitution machine for people who are visually impaired," Quinn says.

That Imperial ecosystem has also been of huge benefit to Alicia Blatiak (Materials 2009, completing PhD Electrical and Electronic Engineering in 2023), founder of software company Gridicity. The company stems ▶

Dr Robert Quinn (PhD Mechanical Engineering 2021), co-founder of MakeSense Technology
Computer vision, GPS and lidar technology combine to help blind people navigate.

Dr Richard Ahlfeld (PhD Aeronautics 2017), founder of Monolith AI
Enabling engineers to build highly accurate, self-learning AI models that can instantly predict the performance of their systems across automotive, aerospace and defence sectors.



There is absolutely no way whatsoever I'd have started this kind of tech company without having a PhD at Imperial first

Dr Robert Quinn, MakeSense Technologies

from Blatiak's PhD research on capturing value from electric vehicles and understanding their role in the future power system. "I was working on an industry project during my PhD and saw the opportunities first hand," she says.

Gridicity provides software that can tell businesses running a fleet of electric vehicles when is the best time to charge up, but also when to decharge and release some of a vehicle's battery power back into the energy grid at times of peak demand. This helps costs and cuts emissions but also will eventually enable firms to be paid by local networks to release this energy back.

Parallels with her PhD are everywhere, for example in learning how to be comfortable with high levels of unpredictability, which can be essential when trying to get a business off the ground. "The degree of uncertainty you face early in your PhD is very high due to the questions you're faced with, like: 'Where am I going to make my contribution' or 'What is my methodology going to be?' Not even your supervisor can tell you things like that," says Blatiak. "And you have to drive a product independently for years; there's no accountability, it's just you. So you've got to really want it." Quinn agrees: "Both tasks require a tremendous amount of belief in your conviction, in order to persevere when things aren't working," he says.

That self-belief in a business idea was also instilled in Dr Richard Ahlfeld (PhD Aeronautics 2017), Chief Executive of Monolith AI, a company that uses deep learning to help engineering teams develop new products and solve problems.

"I remember hearing Matt Clifford, co-founder of Entrepreneur First, talking about the three things that you need to have as a founder: you need to really understand the topic; you need to never take no as an answer; and you need optimism and to believe it's going to work," Ahlfeld says.

Ahlfeld has since worked with major corporations such as Siemens, Honeywell and Rolls-Royce after setting up his own company in 2018. Monolith uses deep learning software that can analyse huge amounts of historical sensor and system data that engineering teams feed it to come up with the best potential solutions to challenging problems, requiring the engineers to do fewer actual physical tests. It meant BMW, for example, could assess and mitigate against the potential outcomes of car crashes by analysing past data rather than having to carry out expensive and time-consuming tests.

And Ahlfield says the research skills he picked up during his PhD have been invaluable. "I know how to skim literature and digest information quickly and accurately," he says, "because I've done it for three years. So when I have a call with a head of global engineering at a robotics company, I can talk with authority about their products and be clear how machine learning could benefit them. I think in the area we're in that's critical for success."

Perhaps unsurprisingly in a place filled with some of the country's leading experts on engineering, science, technology, mathematics and medicine, the company founders have also gained inspiration from fellow students and alumni at Imperial. For Blatiak, the realisation she could set up a company herself came after attending a talk from a fellow PhD student, Dr Jochen Cremer (PhD Electrical and Electronic Engineering 2020). He had already set up the Climate Entrepreneur's Club at Imperial, encouraging students to take on entrepreneurial initiatives that help the planet.

Blatiak says: "I went to an event he hosted, and he said, 'I know we all feel that after our PhD, we can either go into a corporate industry job or we go into academia. But I'm here to tell you, there is another path.' It just completely inspired me." ▶

Your gifts helped me realise my dreams

When MSc student Zoya moved from Pakistan during the pandemic, generous donations from Imperial supporters took away her financial worries so she could focus on her studies.

Growing up in Pakistan, it was Zoya's dream to study at a top university in the UK. When her father passed away, her mum became a school teacher to make ends meet and support Zoya's education. Zoya and her two siblings helped out by taking up jobs alongside their studies. Inspired by her father, who had a degree in health sciences, her ambition was to be a scientist. Her dream came true when she was admitted to Imperial to study an MSc in Advanced Chemical Engineering.

Yet when the pandemic hit, Zoya had to put her dreams on hold. When the day came to start her course at Imperial, she had to find money for the mandatory 10-day hotel quarantine – even though she had "barely saved up enough to survive". It blew a hole in her savings before she had even started.

Your generosity changes lives

"I had days of extreme stress," she says. "I was new in London with no contacts or friends, and I had the money shortage looming over my head." She tried to figure out a way to get a part-time job, but it was really difficult. Zoya's dream hung in the balance. That's when generous donations from Imperial alumni and supporters like you made all the difference.

Thanks to your gifts, Zoya was able to access student hardship support to cover her rent and bills so she could settle into London and her new life at Imperial free from worry. "I was very relieved," she says. "It took a huge burden off me. I was able to give my course my full attention and explore all that Imperial has to offer."

Opening doors to the future

Now, Zoya can focus on developing her research skills and building her knowledge, so she can change the world for the better, "I want to assure donors to the College that the support was put to good use," she says. "To realise my dream is something that will always be my proudest accomplishment."

Will you help more students like Zoya?

No one knows the life-changing impact of an Imperial education better than the College community. Your support can remove financial barriers, so that students from all backgrounds can afford to come to Imperial and excel. If you would like to support more students like Zoya, please make a gift today using the form enclosed or online at **bit.ly/ICL-Magazine-23**

Cremer encouraged Blatiak to apply to WE Innovate, a six-month programme at the Enterprise Lab for female-led startups. "It's for early stage companies, with some really cool alumni presentations from female founders who would come in and share their experiences, and that was really inspirational," Blatiak says. Blatiak also made use of Techcelerate, a four-month programme run by Imperial that aims to help participants commercialise their research and make a 'real-world impact. Gridicity is now also part of an accelerator called Undaunted: The Greenhouse that supports startups looking to tackle climate change.

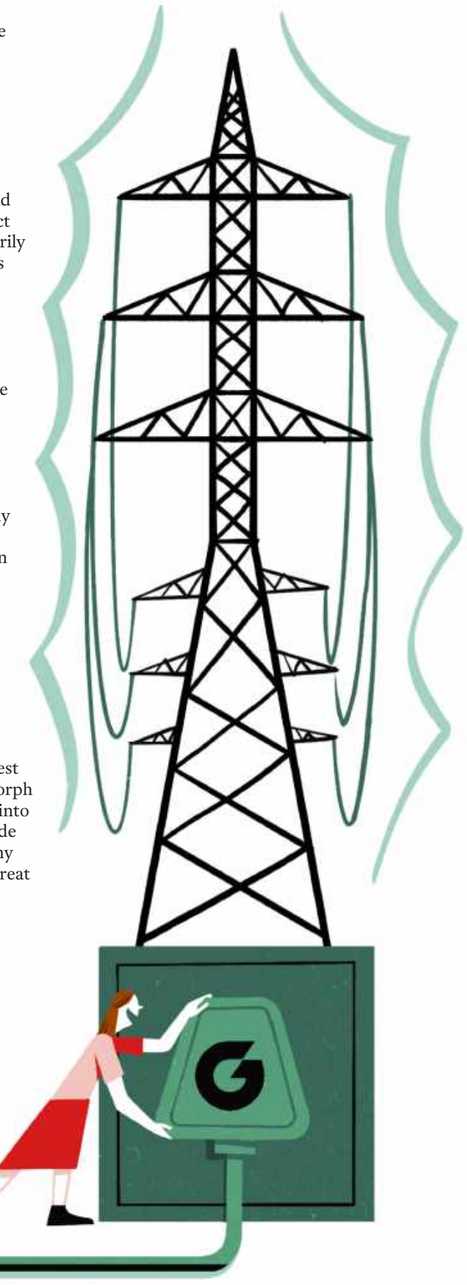
Of course, the transition from university to the commercial world is not always smooth – particularly getting to grips with the fact that the emphasis placed on novelty in academia is not necessarily replicated in the startup environment. "In academia, novelty is the holy grail as you have to make a novel contribution to get a PhD and further science," says Blatiak. "Whereas in the startup world, you can have a new idea, but it doesn't mean you are necessarily going to have a successful business. It's so much more about execution. You might have the most cutting-edge technology, but you've also got to answer questions like who are your customers, what's your product-market fit and what's the size of your market. It's a different language."

For Ahlfeld, one of the hardest transitions has been in learning how to manage other people. "If there's one thing you do not learn as an academic it's how to efficiently run a team and a company," he says. "In academia, you're sort of taught the professor knows everything and people need to ask their opinion and what to do next. But a good company doesn't do that – it encourages people to think and do stuff themselves."

At the same time, some parts of having a business are perhaps easier than outsiders would believe. Quinn invested £30,000 of his own savings into MakeSense Technologies, but found it less challenging than he thought to raise money from investors for seed funding. "Rather than spending those savings, I could have tried pitching to investors first. The tax breaks for early-stage investment are very generous, so it can be quite easy to raise money," he says. Quinn was also supported by being one of five startups to win £10,000 in the Venture Catalyst Challenge, which is Imperial's flagship entrepreneurial competition.

Quinn urges potential startup founders not to be concerned if the idea for their business changes as they develop. "Start with an idea and then test it out and ask people about it. In the process of doing so, it will evolve, morph and change," he says. "Eventually, with enough perseverance, it morphs into something where you've really tried to understand the customer and made something totally bespoke for them – that doesn't just appear without any effort. But anyone can do it, even if you don't have what you believe is a great idea. Just go with it, stick with it, and you might be surprised." ◆

Alicia Blatiak (Materials 2009, completing PhD Electrical and Electronic Engineering in 2023), founder, Gridicity
Providing smart charging solutions for electric vehicle fleet operators.



“Maybe I was lucky with the timing, or had a bit of a trailblazer in me, but the environment was changing”

The experience of female students at Imperial has changed radically over the past 50 years. Five former students share their stories.

Words: **Kat Brown**
Photography: **Dunja Opalko**

Below:
Hayley Wong, (Aeronautics with Spacecraft Engineering, 2022), Union President, sitting in the Student Union Dining Hall.

Carolyn Hansson (Metallurgy 1962, DIC 1965) has had a remarkable career in engineering. And it all began at the Royal College of Mines, where she was one of the first female students. And the first six months, she says, were hell.

“I didn’t know I was going to be the only woman there,” says Hansson. “People were pointing and saying: ‘That’s the Mines woman!’ I was a museum piece, and I think maybe people thought I was just there to get a husband. Nobody wanted to be my lab partner or anything like that.”

Eventually, she and two male colleagues formed a research group, and her fellows eased around her – “They understood that I wouldn’t date them, let alone marry them.” By her third year, Hansson had settled in, ▶

Right:
Dominique Kleyn (Microbiology 1983, MBA 2005), biotech entrepreneur, standing on the top floor of the Sir Alexander Fleming Building.

Far right:
Dr Jess Wade (MSci Physics 2012, PhD 2016), Research Fellow in the Department of Materials, seated in the stairwell of the School of Mines.

forming a strong network of friends among the cricket team, for whom she acted as team scorer. Not that it was all plain sailing. "The head of the department called me into his office one day and said: 'If you fail, there isn't going to be another woman admitted to a metallurgy department for many years.'" No pressure, then.

Now Professor Emerita at Canada's University of Waterloo, this has been the story of her life, she says, including her transatlantic move to America shortly after her PhD. "When I got the job at Martin Marietta [now part of Lockheed Martin], they said to me: 'Well, if you work out, maybe we'll consider hiring other women,'" she remembers. "My attitude has always been: I'd better not screw up. Because if I screw up, it's going to affect so many other people."

Since those early days, Imperial has come a long way, but the perfection trap is one that can still affect minority groups. It's why Dr Jess Wade (MSci Physics 2012, PhD 2016), Research Fellow in the Department of Materials, makes such a big effort in outreach activities. "Instead of platitudes or awareness campaigns, we really need to focus on some actions that make a difference." Among numerous other awards, she was presented with the British Empire Medal in 2019 for her service to gender diversity in science.

Wade says that the institutionalised mindsets of the past can be difficult to change – in men and women – and she has experienced "the ladder being drawn up" by female mentors. But she says this has just made her more determined than ever not to be that kind of person, and that there are plenty of positives out there.

"I love teaching, and Imperial is a wonderful place to work because the students are absolutely incredible," she says. "They want a more diverse culture than ever before, so inclusivity is both a student and a moral thing. I find it really unfair to think that you could be a teenage girl and never know about subjects like material science or physics because society gender-stereotypes you out of them."

Such stereotypes were the key reason for Imperial Union's first female Student Union President, Judith Walker (Electrical Engineering 1971), to choose to study science. "I always felt it was my duty as a woman," she says. "People at school always said that 'girls didn't do science' – imagine being told that as a teenager!"

Walker came to Imperial for a one-year Master's. "The first thing I did was join the Socialist Society," she remembers. ▶

I find it really unfair that you could be a teenage girl and never know about subjects like material science or physics because society gender-stereotypes you out of them

Dr Jess Wade

Above:
Carolyn Hansson (Metallurgy 1962, DIC 1965).

Below:
Judith Walker (MSc Electrical Engineering 1971), Imperial Student Union's first female President, in the stairwell of the Electrical and Electronic Engineering Building.

HAIR AND MAKE-UP: NADIRA PERSAUD

"They thought it might be in line with the disruptive intentions they had for society to put forward a woman for the Presidency – that, along with the fact that there were not many people or willing volunteers. I was very much a continuity candidate; some of the same themes carried on because of the wider politics of the Sixties." Walker's presidency was a last hurrah for the Socialist Society's political run, which died down after she left.

Walker is very much still in touch with her Imperial 'gang'. "It was through the societies and the Union where I came across other women. There just weren't many of us." And her experience helped broaden her circle of alumni after graduating. "I was much involved with the British Society for Social Responsibility and Science, which is a dreadful name, but was a radical science movement with many people from Imperial."

As more and more women follow in these pioneering footsteps, so the number of female role models continues to increase. And that's crucial, says Hayley Wong (Aeronautics with Spacecraft Engineering, 2022), current Union President. "In the Department of Aeronautics, Professor Zahra Sharif Khodaei acted as the Tutor for Women," says Wong. "It was great because I knew there was someone in the Department that I could go to that would have an understanding of the issues I face as a woman in a male-dominated environment. My personal tutor, Dr Thulasi Mylvaganam (MEng Electrical and Electronic Engineering 2010, PhD 2014), was another great female role model for me and supported me through my degree. The Department also ran town halls for women, providing a safe space for us to share and discuss any issues we may be facing."

Wong was a member of two of the societies focused on those who identified as women – Women in SET (Science, Engineering and Technology) and Women in Business. "As student-led societies, they ran regular social and professional events and provided us with a platform to network with inspiring women across industry. It's amazing to be part of a community with so many people from so many different backgrounds."

Dominique Kleyn (Microbiology 1983, MBA 2005) agrees, saying her time at Imperial has given her friendship groups around the world. "What's really wonderful is being connected by not just the same interests, but also a shared desire to move those interests on with new developments," she says. Those connections have also led to career moves, including her current role as co-founder and CEO of Orthonika, which develops orthopaedic implants using novel textile technology. "Imperial connections have given me the opportunity to start my own business – that's a real privilege."

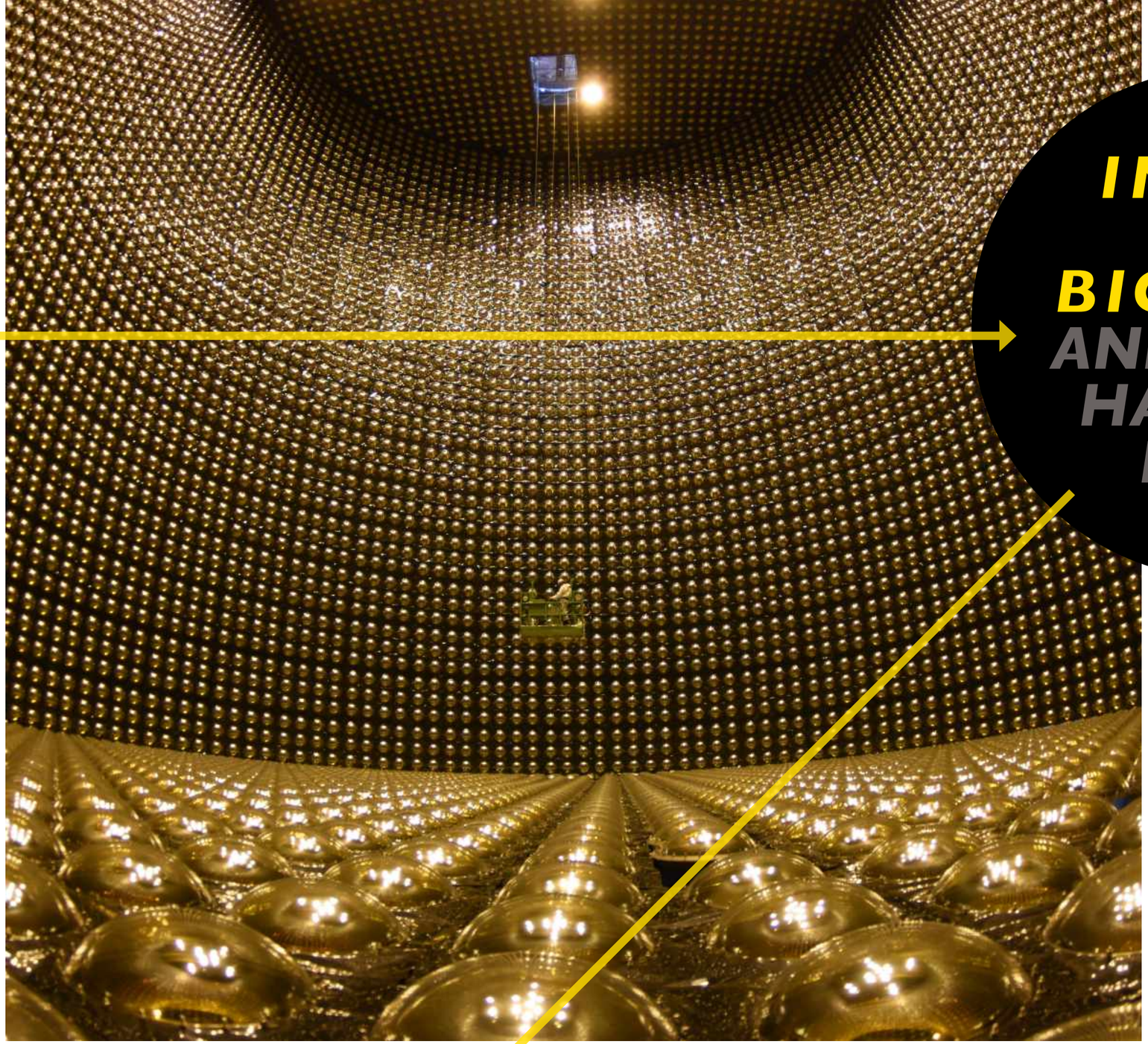
Kleyn had returned to Imperial for an MBA nine years after graduating, using her industry experience for new venture support as part of Imperial Innovations. "I did look at other universities, but technology entrepreneurship is a niche that Imperial does really well and the others don't seem to have quite the same focus on that side," she says.

Kleyn continues to work with new ventures through the Imperial Venture Mentoring Service, in which prestigious business leaders help companies started by students and staff. She has built that entrepreneurial side since graduation when she went straight into the milk round.

"That was a fabulous time really," she says. "It was part of Unilever's corporate venture to commercialise research that had come out of its labs in Coworth. They had developed some monoclonal antibody production technology, and we were looking at how you could use those monoclonal antibodies in diagnostic tests." The result was the Clearblue pregnancy testing kit.

"Maybe I was just lucky with the timing," she says. "Or maybe there was a bit of a trailblazer in me, but the environment was changing. I could work with people who could enable me to achieve my potential. Imperial does empower you: it's an empowering place." ◆

People at school always said that 'girls didn't do science' – imagine being told that as a teenager!
Judith Walker



INSIDE THE BIG BANG AND WHAT HAPPENS NEXT

Words: **Mark Frary**

Right:
Upgrade work to the Japanese neutrino observatory, Super-Kamiokande, in 2018.

There's a new player in our drive to understand the very deepest secrets of the universe – although 'new' may be a bit of a stretch for something that's been around for more than 13 billion years. But the humble neutrino, everywhere around us but fiendishly difficult to locate, could unlock a new world of understanding, if recent breakthroughs are anything to go by.

The story begins with the Big Bang. This seismic event should, the scientists tell us, have created matter and antimatter in equal proportion. But that's not the case. "Virtually everything we can see – you, the magazine or screen in front of you, the stars – is made of matter," says Dr Patrick Dunne (PhD Physics 2016), who is a leading member of the Imperial neutrino team of 20 people, including two postdoctoral research associates and three PhD students. That leaves only the smallest fraction of one per cent as antimatter, and no one knows why.

That could all be about to change, however. Recent developments in our understanding of antimatter – what it is, where it is and, more importantly perhaps, where it isn't – have fundamentally changed the face of physics. And ongoing research could provide answers to some of the world's biggest questions.

"Every time we have a fundamental paradigm shift in the way we understand our universe, we can use that to innovate," says Dunne. "Quantum mechanics gave us the computer, CERN gave us the World Wide Web, this field has also given us proton therapy for cancer, magnets for MRI scanning and the touchscreen. Now there is the tantalising possibility that we may finally understand some of the universe's biggest conundrums, such as how black holes form and whether the four forces of nature are actually just facets of a single, unified force."

Until this point, the problem has been that physicists' best explanation of how the universe works – a toolbox of elementary particles and fundamental forces called the Standard Model, from which everything can be constructed – failed to explain the prevalence of matter over antimatter. But Dunne and his colleagues at Imperial now think that the explanation for the lack of antimatter in the universe could actually be down to one of the oddest particles in the Standard Model toolkit: the neutrino.

Neutrinos were a latecomer to the particle physics party because they are so hard to detect. When they were first proposed, in 1930, it was believed that because of their composition (no mass, zero electric charge and untroubled by the strong nuclear force), neutrinos would only interact via one of the four forces in the Standard Model – the weak nuclear force. That meant it stayed largely out of the limelight, even though the sun – the biggest nuclear reactor in our solar system – produces vast quantities of them as a result of the fusion reactions happening in its core. ▶

However, despite the huge number of neutrinos coming from the Sun every second, experiments in the 1960s seemed to show far fewer of them were arriving on Earth than could be explained by physics. It was only in 2002 that an explanation was found.

In the Standard Model, the electron has two heavier but similar family members known as the muon and the tau particle. Similarly, there are three flavours of neutrino to complement these: an electron neutrino, a muon neutrino and a tau neutrino. The sun's nuclear reactions only produce the electron neutrino but not enough were seemingly arriving on Earth. What scientists realised was that neutrinos could oscillate between the three different flavours. "It's like me saying I am going to throw you a football and then finding it had turned into a basketball when it got to the other end. This was really unexpected," says Dunne. This, in turn, meant that they had to have mass because, as Einstein pointed out, massless things have to travel at the speed of light, and time stands still – there can be no evolution when time is not passing.

And the result of these revelations? It means the trusty Standard Model needs to be revisited – and we may finally be able to explain the absence of antimatter. "We have found indications that neutrinos are different in their behaviour for matter and antimatter," says Dunne. "In the past five years, we have started to measure something called delta CP, which is an indication of how matter and antimatter neutrinos oscillate differently."

Imperial is part of a team from 12 countries that is working on an experiment called T2K. In this, a highly intense beam of muon neutrinos is generated at J-PARC, a research complex in Tokai on the east coast of Japan, and directed to a neutrino detector 300km away at Super-Kamiokande in the west of the country.

"We start off with protons, accelerate them until they get to near the speed of light and then fire them into a target made of carbon or beryllium," says Edward Atkin (PhD Physics 2022), a Postdoctoral Researcher in the Imperial neutrino group. "This produces lots of charged particles called pions and kaons, and we can focus them into a beam using magnets. These charged particles then decay into a mixture of neutrinos and other particles."

Because neutrinos are so hard to spot, the detector needs to be rather special. Sitting beneath a mountain range and deep inside a mine, Super-Kamiokande is made up of 50,000 tonnes of ultrapure water surrounded by 13,000 light sensors. When a neutrino hits a water molecule, it creates something called Cherenkov radiation as it slows down. This is rather like a sonic boom and creates a distinctive cone of light that can be detected by the sensors. Different types of cones indicate different flavours of neutrino, so by seeing how the beam changes over the 300km journey, scientists are able to better understand oscillation and the strange world of neutrinos.

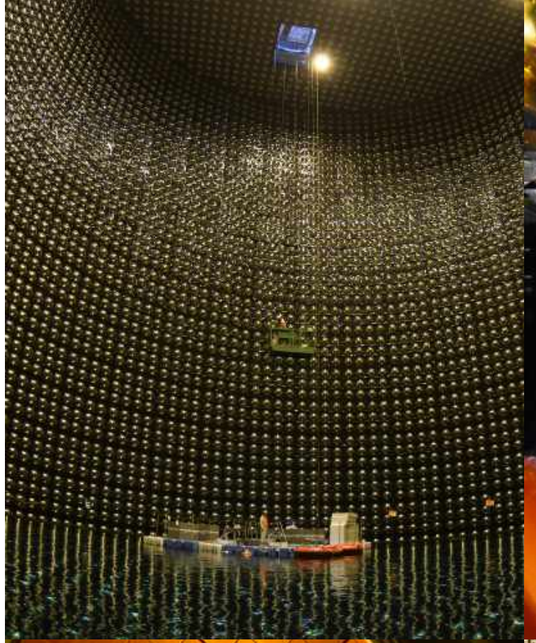
The Imperial team are already working on two next-generation neutrino experiments, the upgrade of T2K, called Hyper-Kamiokande, and one called the Deep Underground Neutrino Experiment, or DUNE for short. Based in the US, DUNE will use a much more powerful beam than the T2K experiment to fire neutrinos on a 1,300km journey from the Fermi National Accelerator Laboratory in Chicago to the Sanford Underground Research Facility in South Dakota.

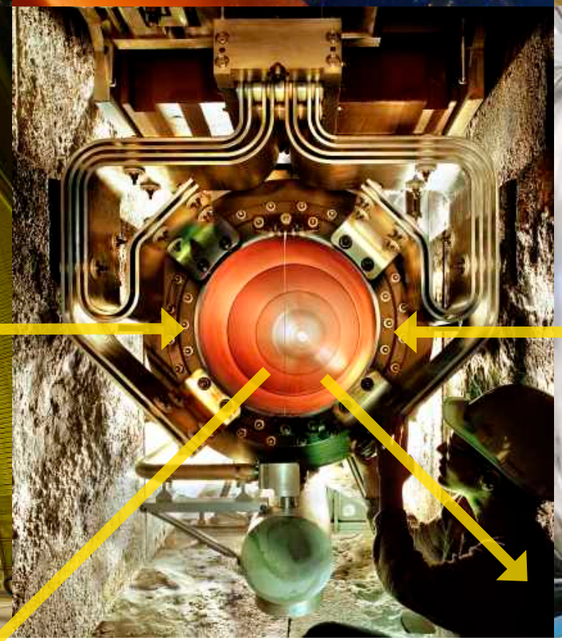
Rather than using water to detect these neutrinos, DUNE will use liquid argon – 70,000 tonnes of it. But it will bring a step-change in precision and the amount of data. "These new experiments are going to change physics," says Atkin. "The amount of data we will collect at DUNE is hundreds of times greater than T2K."

Ioannis Xiotidis, a postdoc working on the detector side of the neutrino team, says that the Imperial team do everything from designing the hardware and testing the circuit boards to installing the equipment at T2K and DUNE. "You need to design something with a lifetime of 30 years or more. You need a processing unit that can handle the huge amount of data produced by the experiment. Even though it doesn't exist now, it might in ten years' time. Not many people have those sorts of technical challenges in their work," he says.

Whatever new technologies the study of neutrinos yields, it seems as though the world as we know it is about to undergo a shift, and we may have taken one small step towards understanding why the world is made up of something, not nothing. And that could change everything. ◆

PREVIOUS PAGE AND THIS PAGE, (TOP LINE): KAMIOKA OBSERVATORY, ICRR (INSTITUTE FOR COSMIC RAY RESEARCH), THE UNIVERSITY OF TOKYO. PHOTOS THIS PAGE (BOTTOM LINE): CERN, FERMILAB





All pictures were taken during the upgrade work on Super-Kamiokande in 2018.

Top row:
Left: With the water level reduced to 3m (from 40m), a gondola descends to a floating platform.

Middle: Measurement of the magnetic field in the inner detector.

Right: Replacement work on the inner detector's photo sensors.

Bottom row:
Left: A prototype detector for the vertical drift DUNE far detector, protoDUNE-VD, that is being tested at the Neutrino Platform at CERN.

Middle: Construction of the NuMI horn which is part of the NuMI neutrino beamline.

Right: A cryostat for the PIP II accelerator which will power the beam to DUNE.

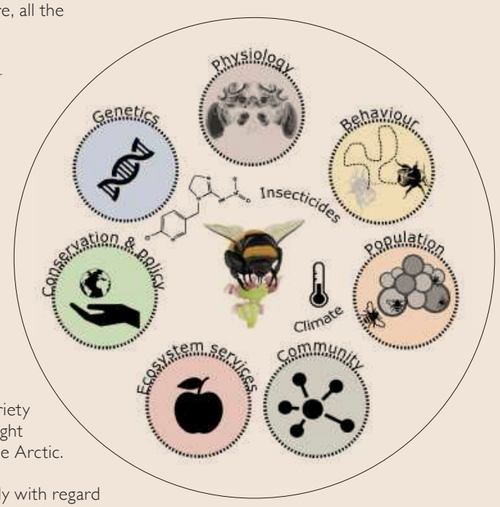
Ongoing research could provide the answers to some of the world's biggest questions

DATASET – DR RICHARD GILL,
SENIOR LECTURER IN THE DEPARTMENT OF LIFE SCIENCES AT IMPERIAL'S SILWOOD PARK CAMPUS

Pollinator crisis: making a beeline to save the planet

Context The world's pollinators are in crisis. The likelihood of a bumblebee population surviving in any given place has declined 30 per cent in a single human generation – and that is disastrous for all of us. A decline in pollinators affects the health and diversity of plants, with further implications for the animals that eat them, resulting in millions of direct and indirect adverse consequences on the balance of nature, all the way up the food chain to the food on our table.

Background "We know there are a number of factors for this decline – mostly caused by humans," says Dr Richard Gill, a Senior Lecturer in the Department of Life Sciences at Imperial's Silwood Park Campus. "These are mainly to do with land use changes resulting in loss of habitat, the use of chemicals on that land and climate change. We know these factors have the potential to threaten pollinators, but we don't know to what degree, and how they interact. If we can quantify the impact of all these factors, we can develop more accurate models to predict future insect responses to varied environmental scenarios and inform evidence-based decision making."



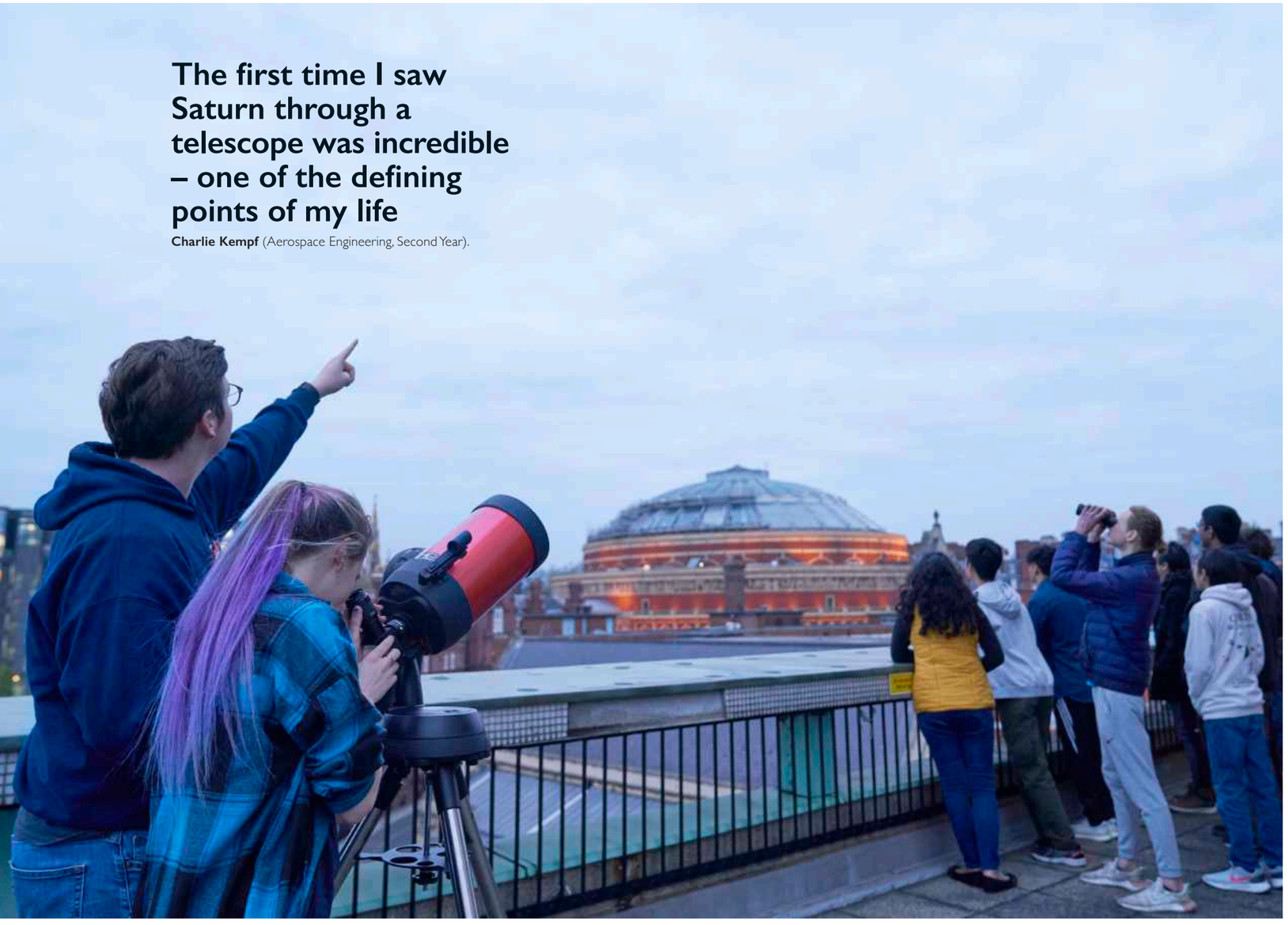
Above:
Gill and his research group investigate the effects of environmental pollution (primarily insecticides) and climate change on bees across different biological levels.

Methodology So, Gill and his team are attempting to understand and mitigate how environmental stressors place insect pollinators at risk. There are several strands of ongoing research, including studying bees' genetic, behavioural and population responses to the impacts of environmental warming, pesticide levels and nutritional deficits. They have also been measuring wing size and body symmetry using data from multiple museum collections, to establish short- and long-term trends. The team have used a variety of approaches, including genome sequencing, microchipping, developing bee flight mills, shape analysis using machine learning, and even studying bees found in the Arctic.

Findings "The results have been both fascinating and worrying, particularly with regard to pesticides and climate," says Gill. For instance, a previously held assumption was that bees would naturally avoid crops sprayed with insecticides. Not only is this not necessarily accurate, but in the case of neonicotinoids (chemically similar to nicotine) the reverse is true. "Further, we applied the advancing technology of micro-CT scanning on the heads of adult bees that had been exposed to pesticides as larvae. We found the neonicotinoids impeded growth of the brain, but primarily in the regions known to be involved in learning. So, while these pesticides do not kill the bees, they do severely impact their behaviour and productivity." Gill has also been tracking the numbers, size and shape of pollinators over the past century, with support from colleagues at the Natural History Museum among others. With researcher Aoife Cantwell-Jones (as part of an MRes Life Sciences thesis in 2020), they have used collections to track what has been placing bees under stress over the 20th century. "A normal, healthy bee will develop symmetrically, but by studying their morphology, we have found that where bees have developed asymmetrically, it has correlated with warmer, wetter years and other specific meteorological events," says Cantwell-Jones, who is now a PhD student in the Gill group studying Arctic bee responses to climate change.

Outcomes In his latest paper, Gill examines how pesticide and climate change can interact to affect bee behaviours. "We are finding that the risk of pesticides is completely temperature dependent, so climate change and the weather extremes it brings will increase the pesticide risk to bees. This is something that has not been appropriately quantified and has limited our ability to predict risks across the world's climate regions and under future warming scenarios. Hopefully, with this information and further research, we can lobby decision makers in industry and government to understand these links, and realise what they need to do to save our bee populations, secure our food production, and safeguard our planet." ◆

WORDS: PETER TAYLOR-WHIFFEN. IMAGE: AOIFE CANTWELL-JONES & RICHARD GILL



The first time I saw Saturn through a telescope was incredible – one of the defining points of my life

Charlie Kempf (Aerospace Engineering, Second Year).

Above:
Charlie Kempf and Dana Weetman, along with other members of the Astronomy Society, at a Star Observation meeting on the 8th floor balcony of the Blackett Building at the South Kensington campus.

IMPERIAL ASTRONOMY SOCIETY

The sky at night

The truth is out there – and the members of the Astronomy Society are determined to find it.

—

Words: **Lucy Jolin** / Photography: **Joe McGorty**

357 BC: Aristotle, a student of Plato, observes for the first time an epic heavenly event – the lunar occultation of Mars. More than two millennia later, members of AstroSoc observe the same event, which happens once every 15 years, as Mars partially blocks the moon. Their venue, however, is not quite as impressive: the parking lot of a pizza restaurant somewhere in London. "It was a bit of a challenge to find somewhere in London where the skyline was low enough to see properly – at three in the morning," says equipment officer Charlie Kempf (Aerospace Engineering, Second Year). "But it was worth it – the view was spectacular."

The society is dedicated to spreading a love of astronomy across Imperial's student population. And its stargazing events, such as the Mars occultation and the flagship South Downs trip, are a great place to start. The South Downs is relatively untouched by light pollution, and the recent trip, held in conjunction with the Hiking Society, saw 37 members observing at night and walking by day. "The best part for me was seeing a massive orange shooting star – the first one I'd ever seen," says President, Timothy Newman (Electrical Engineering, Third Year).

Of course, Imperial is a centre of space expertise, and the society makes the most of that. Dr Tim Horbury (Physics 1992, PhD 1995) at the Department of Physics recently gave a talk on the Interstellar Mapping and Acceleration Probe, which will carry a magnetometer built by Imperial scientists. But you don't need to be an expert – or even know how to use a telescope – to join.

"I developed a love of astronomy with my dad, looking at planets and meteor showers in our back garden," says publicity officer Dana Weetman (Maths, Fourth Year). "I don't really know my stuff – but space is cool to anyone. Plus, one of my favourite modules was general relativity, which is integrated with the study of black holes. There is still so much we don't know – so it could even end up being a career path for me."

For the partial eclipse of the sun, visible from London last October, the society organised an event on the Queen's Lawn, giving out eclipse glasses so that everyone could watch it safely. "It was so cool to see people who were just walking past realise what was happening, and become a part of it," says Weetman.

Around 100 people turned up for their first event of the year: looking at Jupiter's Great Red Spot. "I don't think any of them knew how to work a telescope but it's totally fine," says Kempf. "The point is just to share the experience with people. The first time I saw Saturn through a telescope was incredible: one of the defining points of my life. And I want to gift those moments to people who may not necessarily be able to set up a telescope by themselves." (London's light pollution doesn't affect views of the moon and planets, incidentally, as they're so bright: it only becomes an issue when you're trying to see galaxies or nebulae.)

More events are always being planned, and the society is hoping to develop a partnership with the Silwood Park Campus to hold regular stargazing events outside London. "There's so much in astronomy – from the equations that govern the movement of the planets to the question of the origin of the universe," says Newman. "I find it so fascinating. It's not just a science – it's a part of life." ◆

PUZZLES

Test your brain power

Ready to test your little grey cells? Imperial's top quizzers set the ultimate puzzle challenge to find out just how much you know.

1. What connects a manor house in the Cotswolds, a village in South Somerset, a rock formation off the coast of Cape Ann, Massachusetts, and a small village in Huntingdonshire?

2. What six-letter location is one of the longest words that can be formed by tracing a path across a keyboard? Letter repeats are allowed, although using the same letter twice in a row isn't.

3. What nine-letter country name is the longest country name that can be formed using only element symbols from the periodic table?

Set by Adam from the Imperial Quiz Society.

Find the answers on our website at:
www.imperial.ac.uk/be-inspired/magazine/issue-54/brain-power

FOR ISSUE 53 SOLUTIONS:
www.imperial.ac.uk/be-inspired/magazine/issue-53/brain-power

INTERVIEW: KAT BROWN. PHOTO: JAMES TYE. ILLUSTRATION: MIKE LEMANSKI

A WORKING LIFE

"I've got the skills, so I can make a difference"

How Dr Reeba Oliver's clinic for FGM victims is genuinely changing lives.

Left: Dr Reeba Oliver at her clinic in Whipps Cross.

When we started our clinic in Whipps Cross Hospital in London in 2019 – the UK's first walk-in clinic for victims of female genital mutilation (FGM) who are not pregnant – none of us thought it would grow into a service used by hundreds of women. We just felt very bad for our patients who were unable to find the help they needed. I would look at people who had been struggling for 40 years and think: 'This would take me five minutes to fix under local anaesthetic.' That's all it takes. I've got the skill so I can make a difference.

My basic job is being a doctor in the NHS, where I'm a consultant gynaecologist. When I sub-specialised in urogynecology – urinary incontinence, prolapse, female genital mutilation – which is another three to four years' training, there were fewer than 20 training posts in the country. That's very few considering we are looking at 50 per cent of the population. And with an ageing population, huge numbers of women will need the service in the future.

Women have always had issues down below, but because these are linked to childbirth and childbirth is 'normal' or a job that women 'have to do', the response is often: "Well, what do you expect?" It has never been addressed. This attitude is like a single thread that goes through every culture and every country: women were always seen as vessels to bear children.

When I was appointed a permanent consultant in 2015, there was nothing specially set up for FGM patients outside of pregnancy – often, victims were only looked after by the NHS if they were pregnant. So, I looked to set up a service using my skills and accreditation to cater for all FGM patients, catering not only for their physical wellbeing but also their psychological health. I'm a surgeon and I never learned to think psychologically, so that's when I established a team. Surgeons never think they need a team – when you hold the knife, you get used to thinking it's you who's going to save the life!

You have to approach this as though it's not a crime; you must never come across as judgmental

Since ancient times, it's the matriarchs who have driven FGM in the communities, and it's been interesting getting into the mindset of a matriarch because, while FGM is an assault and a crime, the difference is that it is usually done with love. The family truly believe this is good for their daughters and will help them find good husbands. You have to approach this as though it's not a crime; you must never come across as judgmental.

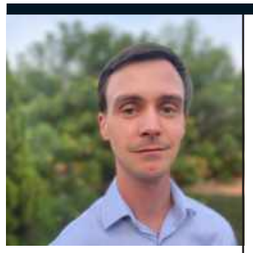
Finally, the most important ingredient is to have passion for the work you are doing, because it's a hard road. If you actually do it for the right reasons – because you've got the skill, know you can make a difference and you really want to see a person get better – then everything else, such as funding and recognition, will follow, often just by word of mouth. Even in our austere NHS, I've never had an issue with doing what I wanted to do for FGM work. ◆

> ***Dr Reeba Oliver** (PhD Clinical Medicine Research 2009) is Consultant Obstetrician and Gynaecologist at Barts Health NHS Trust and winner of Imperial's Emerging Alumni Leader Award 2022.*

OUR IMPERIAL

Fighting for energy justice

Meet the Imperial alumni working across the globe to make reliable and sustainable energy available to all.



DR PHILIP SANDWELL

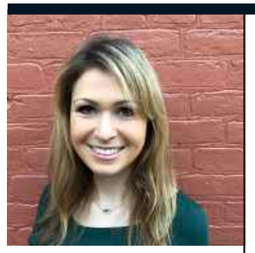
(MSci Physics 2013, PhD 2017), Humanitarian Energy Research Associate, United Nations Institute for Training and Research

Your Master's was in Theoretical Physics, studying complexity and dynamics in ant colonies. How did you move from that to your current work on sustainable energy access?
I had to twist the arm of my supervisor to let me study ant colonies in the first place – and there were questions from the examiners like: "How is this physics?" But physics gives us the methods, and you can apply physics to an ant colony just as much as a neutron star. My PhD was on the greenhouse gas mitigation potential of photovoltaic technologies, focusing on applications in developing countries. Luckily another PhD student at the Grantham Institute, Oorja's Clementine Chambon, was starting up her electrification work in rural India. I ended up going out to Bahraich District in Uttar Pradesh to collect data on energy consumption to inform my computer model. It was an amazing experience to hear the thoughts of local people and then translate them into computer code.

Had you expected to move from theoretical physics into more practical applications?
If you had asked me on day one as a physics undergraduate where my research would take me, I would have said CERN was a thousand times more likely than a village in rural India. But my pathway was made possible by my time at Imperial, where I received game-changing support from my supervisor, Professor Jenny Nelson. She always supported my harebrained ideas, including going out to India to collect data, and encouraged me to think about the impact of my research.

You remain closely linked with Imperial for your research, but you are also working in the field for the UN. Have you achieved a balance?
I am very lucky that I lead a double life these days: part researcher, part practitioner. My work has recently taken me to Rwanda, Kenya and Uganda. I meet fascinating people and I get to see the value that sustainable energy research can have. I find it very fulfilling to see what our research can mean to people.

> *Alongside his work at the UN,* ***Philip Sandwell*** *is continuing his research at Imperial as a Visiting Researcher, focusing on sustainable energy access in developing countries and displacement settings.*



DR MIRIAM ACZEL

(MSc Environmental Technology 2015, President's Scholar PhD 2020), McQuown Postdoctoral Fellow at the California Institute for Energy and Environment, UC Berkeley

When did you become interested in fracking?
I had never even heard of fracking until I saw the movie, *Gasland,* in 2014, which made me want to understand the science around it. I took a Master's in Environmental Technology at Imperial, focusing on the environmental health around fracking and its effect on communities. I was one of only a few Americans on the course and the range of life experiences and backgrounds of the other students in my cohort was incredible. Karen Makuch was the lecturer who gave me my first exposure to environmental law and very early on in the course I realised that this was what I wanted to keep doing.

How was your research outside of London?
My work focusing on community protection involved ethnographic research, for which I had to gain the trust of the local community in Blackpool. I found unique local aspects in Lancashire that linked to the global anti-fracking movement. I also spent some time at Beijing's Tsinghua University, and the following year I received funding from the São Paulo Research Foundation, Brazil to attend the São Paolo Advanced School on Water-Energy-Food Nexus at the University of Campinas.

You are now working on the Oakland EcoBlock project at Berkeley. Is that a natural progression from your research work at Imperial?
I am still affiliated to research at Imperial, which means a lot to me. The EcoBlock project is a radical retrofit of existing residential homes to improve resilience, sustainability and quality of life. Our aim is to create a model for a block-scale community solar microgrid with in-home energy and water-efficient retrofits, and we're currently trialling it in Oakland, CA. The eventual aim is to share lessons learned so that the model can be rolled out, not just across America but to disadvantaged communities everywhere that lack reliable energy access and live in ageing, inefficient housing stock. That fits neatly with my interest in how to leverage the power of the neighbourhood effect.

> ***Miriam Aczel*** *is Director of Scientific Communications at Leaders in Energy and Co-Founder and Co-Director of the non-profit Amir D. Aczel Foundation for Research and Education in Science and Mathematics.*

DR CLEMENTINE CHAMBON

(PhD Chemical Engineering 2017) CTO and co-founder of Oorja Development Solutions Limited

When did you first become interested in climate tech and energy access?
Soon after starting my PhD, I accepted an invitation through the Grantham Institute to participate in Climate-KIC, a five-week European Climate Innovation summer school. The aim was to create business ideas related to climate change mitigation and adaptation. Social entrepreneur Amit Saraogi and I joined the same group based on mutual interests. He explained energy access requirements in the Indian context. We soon saw that there was an opportunity to combine my knowledge of biomass energy production with his local experience. We became business partners and Oorja, meaning energy in Hindi, was the result.

You started the company while you were still studying for your PhD. How did that work?
I did successfully manage both – but it was very stressful! It helped that my supervisors were incredibly supportive. Climate-KIC gave me a great foundation, so I already knew what a financial model was and could build a business plan. Imperial is special because all the departments are so accessible; through the Grantham Institute I was able to link up with Philip Sandwell for help on my fieldwork. And it's a great place to be an entrepreneur – there are always events happening and early-stage funding is relatively easy to access if you have a good idea.

How has Oorja evolved?
We started out intending to power households via solar mini-grids, but soon discovered it was not commercially viable. In our pilot project, the people whose houses we were powering were farmers. They could farm more cheaply and sustainably if we helped them replace their diesel irrigation pumps with solar power. Today, Oorja is providing pay-per-use agricultural services powered by solar energy, and our model has received widespread recognition. We operate in Eastern Uttar Pradesh and Bihar. We are a team of 50 people working with 15,000 farmers and are closing our pre-series A funding round to expand into other parts of India.

> ***Clementine Chambon*** *received Imperial's Emerging Alumni Leader Award 2023. Her PhD was partly funded by the President's PhD Scholarship – supported by alumni and friends.*

INTERVIEWS: SARAH WOODWARD. IMAGE: ALAMY

POLICY AGENDA – PROFESSOR WASHINGTON YOTTO OCHIENG

Sleepwalking to disaster: why we need to act now on navigation systems

THE LANDSCAPE

The principles of PNT – positioning, navigation and timing – have been with us for ever. They are essential to everything we do. But as science, technology and innovation have developed, we increasingly need ever more sophisticated PNT systems to deliver data. Space science and technology, in the form of Global Navigation Satellite Systems such as the United States' GPS, now plays a fundamental role in this, underpinning the UK's 13 sectors of Critical National Infrastructure (CNI), including food, water, health, transport and emergency services.

Professor Washington Yotto Ochieng, Head of Imperial's Department of Civil and Environmental Engineering, Chair in Positioning and Navigational Systems, and Senior Security Science Fellow at the Institute for Security Science and Technology, was a key designer of the EU's satellite-based navigation programmes EGNOS and Galileo – but warns that since Brexit, we no longer have guaranteed access to these and are potentially "sleepwalking to disaster".

THE CHALLENGE

"As systems have got more complex, we now need to think about designing PNT systems within systems (system-of-systems)," says Ochieng. "These days we have to look at the entire value chain. Think about, say, food sector logistics – someone needs to find land, till it, fertilise, grow whatever they grow, harvest it and transport it to a supermarket: each stage needs PNT and all stages need to fit with each other. As the applications of PNT have grown in terms of stringency of the performance needed, so too has the science, technology and innovation to deliver performance in terms of the four required navigation performance (RNP) parameters – accuracy, integrity, reliability and continuity."

This need for higher performance, he says, means we can no longer rely on one type of technology, and need to combine terrestrial with space-based technologies to build resilience into the system. "But no automatic access to EGNOS and Galileo, which we rely on for our space-based PNT, leaves us vulnerable. It's essential for our national security but also our CNI – and many other applications.

> I've made it clear to government that we are currently very vulnerable

"There are other systems owned by Russia, China and the US and, as with the EU satellite programme, we are currently allowed access to them. But it's not guaranteed – they are provided at our own risk with the real potential for denial of service. There's always the potential that, say, for political reasons we wake up one day and the US has switched off GPS. Essentially our CNI is close to entire dependency on technology owned by other people."

THE RESPONSE

Ochieng is lobbying and advising politicians – he gave evidence at a recent UK Parliament Science and Technology Committee meeting focused on UK space strategy and satellite infrastructure, and has recently been invited to contribute to policy talks with Department for Business, Energy and Industrial Strategy Chief Scientific Adviser, Professor Paul Monks, who is co-ordinating the government's PNT strategy.

"My job is to tell government how urgent this issue is," he says. "I am providing evidence in terms of impact and pressing them to understand that time is of the essence. The UK cannot sit in a silo on this, it needs to reach out. Hopefully they will understand it from the CNI perspective, but the effect on their constituents may also play a part – what would their constituents' response be if they thought their MP was responsible for a lack of phone signal, or if their satnavs no longer work?"

THE FUTURE

Ochieng adds: "CNI requires a resilient layer, and we don't have access to that. The UK has to decide one way or the other whether it is going to own its own PNT capability or to work with others to ensure that mission-critical applications are covered. Economically, the UK is quite capable. A study by London Economics said that if we lost GPS, we'd lose £1 billion a day, so investing in our own sovereign systems would be cost-effective. But we need it soon. I've made it very clear to government that we are currently extremely vulnerable." ◆

> ***Professor Ochieng** is Head of the Department of Civil and Environmental Engineering.*

WORDS: PETER TAYLOR-WHIFFEN

WORDS: LUCY JOLIN

ALUMNI LIFE

Festival season

Experience the extraordinary on Great Exhibition Road.

Extract DNA from a strawberry. Taste extraordinary future foods. Play with Lego robots (and consider letting your kids have a go, too). And, of course, meet up with old friends in beloved old haunts. Yes, it's the Great Exhibition Road Festival 2023, which takes place on 17 and 18 June.

This year, we're celebrating the inspirational power of awe and wonder in science and the arts with an incredible array of free activities. And while everyone's welcome, it's great to see Imperial alumni bringing their families and friends.

Plus, as an Imperial graduate, you're invited to register for access to the exclusive Alumni Lounge. It's the perfect place to escape the crowds, meet up with friends, and relax and refuel with complimentary refreshments. And by purchasing an Alumni Lounge pass in advance, you also get early bird access to the most sought-after events of the weekend, including tours and talks to inspire, motivate and spark innovation.

For example, you might find yourself awed by the biggest dinosaurs that ever lived, rediscovering Black portraiture or learning about the incredible nature and heritage of the Royal Parks – from their smallest invertebrate to their grandest historic landscapes. The Human Genome

Celebrating the inspirational power of awe and wonder in science and the arts

Printshop invites you to contribute to a handprint mural celebrating DNA's story of individuality and shared history. Or why not take a tour of the wonders inside our bodies, or learn about new building materials in the Building the Future Zone? You'll find something new and fascinating for all ages around every corner.

But don't just take our word for it – listen to previous attendees. "Love the alumni hub and the enthusiasm of the staff teaching the kids," wrote one. "The tours are fantastic and something special!" wrote another. Yet more praise: "It's brilliant. Pat yourself on the back. It's really good to encourage children into STEM." And one attendee said their highlight was "being able to take my family (including, for the first time, grandchildren) to see Imperial and the Festival". ◆

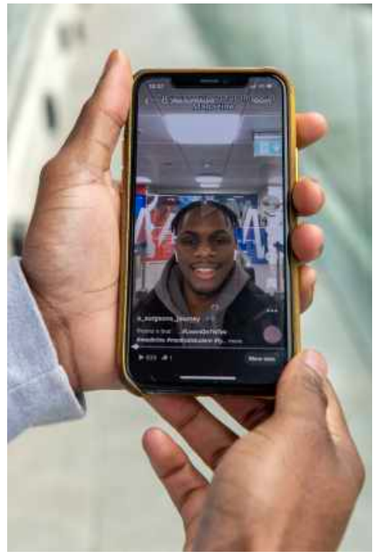
> ***To purchase an Alumni Lounge pass** in advance and find out more about the range of events taking place over Alumni Weekend, visit: www.imperial.ac.uk/alumni/events/alumni-weekend*

MY IMPERIAL

The power to influence

Dalitso Mwale *(intercalated BSc Medical Sciences with Humanities, Philosophy and Law, Fourth Year)*, TikTok creator, Imperial Communications Division.

Words: **Jo Caird** / Photography: **Hannah Maule-ffinch**



Above: TikTok creator Dalitso Mwale outside Ethos.

I go to the gym at Ethos, Imperial's sports facility, five or six times a week. Before I came to Imperial, I'd go to the gym maybe twice a week – I was taking rest days all the time and I'd be so tired. Now I go even if I don't feel like going because I know I'll bump into someone – it's mostly students in there and everyone's so friendly. So, I get all my work done and go before the gym closes in the evening.

I'm all about the free weights. The gym is never too busy, because you have to book in for your session, but even if it is crowded, people are always sharing equipment. If you don't know what you're doing, you just ask someone.

People ask you what you're lifting, if you need a spot, or can they join in with you. And when you start seeing someone over and over again it can develop into a nice friendship and it makes you want to go even more. I've made countless friends, and the friendships are social but also help you in your gym experience. It can be competitive, but always in a good way. After the gym we might grab a drink and some food to refuel. I've been training consistently since coming to Imperial last September, so people tell me they've noticed how my body has changed!

At university, everyone is in their groups. I'm always around medicine students, but then when I go to the gym, I'll be with engineering students, maths students, computer scientists, plus people in different years. It's quite cool.

You'll see the gym on my TikTok, both my personal account and on the Imperial TikTok account, where I work as a TikTok creator. I heard recently that someone had gone to study at the University of Leeds (where I completed the first part of my degree) because they'd watched my videos and wanted to see the place for themselves. It would be amazing if someone wanted to come to Imperial because of seeing my stuff on TikTok. ◆

Check out Imperial on TikTok: @imperialcollege