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Towards psychiatric disorder detection and diagnostics of the future

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From left to right: Adarsh Arun, Bowen Huang, Sina Schack, Madhuri Manohar, Elena Gonzalez, Sarah Barron, Yong Tan Re, Cristina Lopez, and Pier Cacciamani (not featured)

The Editorial Team wishes its global readership a fantastic 2020!

CEB Focus Newsletter is the product of a joint team effort led by Chief Editor Elena Gonzalez assisted by volunteer editors. Incidentally, the Editorial Team welcomed five new editorial members last term: Madhuri Manohar, Adarsh Arun, Sarah Barron, Pier Cacciamani and Cristina Lopez, all either Master's or research students. We'd also like to take this opportunity to thank former member Gemma Siddall, who is leaving the team to focus on writing her thesis after two years of service.

We are due to start working on a department rebranding exercise to coincide with a campaign to be launched later on this year focusing on the impact of our research work and highlighting our academic achievements and our commitment and efforts to educate the engineers and biotechnologists of the future. See more on future department plans on the "Message from HoD"

The "Main Article" focuses on the ground-breaking work from psychiatrist Professor Sabine Bahn, lead PI from Cambridge Centre for Neuropsychiatric Research at CEB, who is helping develop mental health technologies to help streamline diagnosis for psychiatric illnesses.

"Industry Business" gives an overview of the latest exciting industry collaborations and developments and features CEB spin-out Camnexus launched by alumna Jessica OCampos, as well as an acknowledgment of companies supporting our MPhil in Bioscience Enterprise course.

"Teaching Matters" focuses on news from our graduate and undergraduate student cohorts including insights from MPhil in Biotechnology on the course, transferable skills workshop run by Advanced Chemical Engineering course and the latest developments from our Master's in Bioscience Enterprise students, as well as some changes to the undergraduate Tripos course including plans for revamping the syllabus in the near future.

"Research Highlights" features an overview of the latest papers recently published by talented department researchers nominated as "paper of the month", including exciting research projects such as in the Process Integration group work on hydrogen energy production from urea present in wastewater.

In "CEB Women", Dr Chiara Gandini tells us about her work tackling the food crisis with indoor wheat farming and we get a taste of wellbeing in the workplace with yoga by PhD student Anthie Moysidou. Dr Fruk also discusses the biochemistry of custard in her regular column "Biotech Matters".

Among the "Achievements", one worth noting was last term's OpenSeneca collaborative air pollution project, which won the Vice Chancellor's Research Impact and Engagement Award.

"Alumni Corner" shares alumni recollections and well as highlights from alumni visits last summer.

In "Department and Outreach Events" an overview of last term events are listed as well as a note on upcoming events including: Building Bridges in Medical Sciences Conference on 13 March 2020, which CEB is sponsoring again, the vision-themed Science Festival at CEB on 21 March 2020, and the annual CEB Research Conference on 29 and 30 June 2020

As usual we'd like to thank department members, alumni, and partners in industry and academia, for their ongoing support. We welcome your news and contributions to the publication and we hope you continue sending suggestions for content and articles to ceb-focus@ceb.cam.ac.uk

Elena Gonzalez

Chief Editor

Message from HoD

Professor Lisa Hall.

A very happy 2020 to all our global readers! The back end of 2019 was certainly hectic at CEB and the department saw a considerable number of changes following restructuring of support and technical sections. 2020 will be a continuation of the driver for change seen last term and will work together towards a rebranding of the department highlighting our work to combat global challenges in the areas of energy and environment, sustainability, healthcare, food etc… and our ongoing dedication to developing innovative solutions in these areas. The department also plans to work more closely with industry and academia, not only developing existing collaborations but also building bridges and forging ties with new partners locally and globally via an exciting programme of outreach activities.

As part of your mission to be the very best we have to continue working hard to deliver a competitive offering to help us attract the very best students and staff and to secure support to be able to educate the leaders of tomorrow.

Lisa Hall

HoD

Psychiatrist Sabine Bahn, Director of theCambridge Centre for Neuropsychiatric Research (CCNR).

Towards psychiatric disorder detection and diagnostics of the future

Mental health concerns and diagnoses of neuropsychiatric conditions

Approximately one in four people in the UK experience mental health concerns at some time in their lives. While our understanding of mental ill-health is improving, significant barriers to effective detection, treatment and prevention remain.

Professor Sabine Bahn, Director of the Cambridge Centre for Neuropsychiatric Research (CCNR), has spent more than 20 years researching the molecular basis of neuropsychiatric disorders, with a focus on the major psychiatric disorders schizophrenia, bipolar disorder and depression. As a trained psychiatrist, Bahn is all too familiar with the challenges of accurately diagnosing mental health conditions and finding effective treatment.

“A GP has, on average, five to seven minutes to see a patient and provide a diagnosis,” says Bahn. “In that time, it is challenging to diagnose bipolar disorder, especially considering that a full psychiatric assessment by a psychiatrist would typically take between one and one and a half hours. Therefore, it is very hard for a GP to pick up these conditions and then refer them to psychiatric services.”

Adding to this challenge, many conditions present with overlapping symptoms. Thus, misdiagnosis and delayed diagnosis are extremely common. For example, in the UK, it takes an average of 12 years to clinically diagnose someone with bipolar disorder.

“Most bipolar patients initially present with symptoms of depression,” explains Bahn, “and it’s very difficult for a GP, who is usually the first person to see the patient, to assess if this is a so-called unipolar depressive disorder or a depressive episode in the context of bipolar disorder.”

A combined approach for mental ill-health diagnostics: the Censeo platform

While the clinical diagnostic process for many neuropsychiatric conditions is currently based around a patient interview, Bahn’s research is focused on identifying diagnostic biomarkers – specific molecules or compounds present in patients’ blood – of mental health disorders, to enable more objective tests, similar to those currently used in the field of oncology.

Her group at CCNR has previously identified biomarkers in the blood present in patients suffering with bipolar disorder, depression and schizophrenia. During recent studies testing for biomarkers in dried blood spots, her team has obtained encouraging results where blood biomarkers correlated with psychiatric diagnosis through traditional interview methods.

Seeking to transfer these advances from the lab to the real world, Bahn co-founded the company Psyomics Ltd in 2015. A spin-out from the University of Cambridge, Psyomics is a HealthTech company that has developed an innovative digital assessment platform designed to mirror the traditional method of assessment.

“This app-based diagnostic device digitalises a face-to-face psychiatric assessment, as undertaken by a

"As a psychiatrist, a full patient assessment will take between one and one and a half hours at least. It's very hard for a GP to pick up these conditions and then refer them to psychiatric services."

psychiatrist. With input from Professor Bahn using her experience as a practising psychiatrist, the system contains 1,700 nonlinear questions, so patients are only asked relevant questions based on earlier responses. So, for example, if you answer 'no' to the question: 'have you ever felt low in mood and hopeless?' it will not ask you all the further depression-related questions."

Censeo, the latest iteration of Psyomics's digital platform, will be trialled this year with GP practices. Censeo is a medical device in the form of an online mental health assessment and triaging platform. This device aims to establish an accurate, comprehensive and rules-based differential diagnosis of mental health disorders in primary care. Sabine's groundbreaking biomarker research is also being used by Psyomics as the basis for a complementary blood-based biomarker test.

"With the digital approach, we aim to diagnose seven conditions: bipolar disorder; depression; generalised anxiety disorder; social anxiety; panic disorder; insomnia; and obsessive compulsive disorder. We also screen for a number of other common psychiatric conditions."

The Censeo platform follows the International Statistical Classification of Diseases and Related Health Problems (ICD 10) and the Diagnostic and Statistical Manual of Mental Disorders (DSM–5) classification of mental and behavioural disorders diagnostic criteria and builds a diagnostic report based on the patient's answers to relevant questions. This diagnostic report will be shared with the patient's GP, maximising the efficacy of the time a GP spends per patient and helping them to reach an accurate diagnosis. The report will also help the GP to triage a patient to the

One of the Censeo mobile app slides

most appropriate intervention. A more accurate diagnosis could be obtained when the digital assessment results are combined with a home blood test screening for biomarkers, especially in more complex cases such as bipolar disorder and depression.

A blood test can help patients accept their diagnosis, as they are able to see its biological basis.

"We have also managed to diagnose subclinical conditions with the Censeo platform: people with serious concerns, who may not have a psychiatric disorder, but have problems with low mood, sub-threshold anxiety or stress-related symptoms and these individuals want and need help as well."

Further support tools are available to the patient via the Censeo platform, such as tailored resources and psychoeducation about the specific diagnosed condition, and signposting to relevant services.

"It's important that someone who has a mental health problem seeks and receives the right help early. We are there to provide this information at this crucial time," Professor Bahn adds.

Mental health technologies of the future

A prototype of the combined digital and biomarker test was tested in the "Delta Trial", a trial run by CCNR, where over 3,500 study participants completed the digital assessment and over 1,850 participants also provided dried blood spot samples. The next step is to test the Censeo platform with two GP practices in the UK. This clinical trial will start in February 2020.

"Our goal is not to deliver online therapy, but to diagnose mental health conditions and to signpost patients to the right mental health support for their specific condition in the local area," Bahn says.

"In the future, there will be a great need for mental health services to embrace technology because there are not enough psychiatrists and mental health professionals for all the people who have mental health concerns. Up to 50% of people who come to see a GP have mental health concerns, often alongside chronic pain or other physical symptoms. It is a growing challenge for GPs to address this clinical need.

"Our ultimate aim is to provide personalised recommendations, and put control into the hands of those seeking help and advice."

More information on Professor Bahn's research at CCNR and the work of Psyomics Ltd can be found at https://ccnr.ceb.cam.ac.uk and www.psyomics.com respectively.

"This app-based diagnostic device digitalises a face-to-face psychiatric assessment, as undertaken by a psychiatrist, which takes on average one to one and a half hours, and digitalises this assessment."

MPhil in Biotechnology one year on

The MPhil in Biotechnology programme was launched in 2018 with the intention of providing a way for students to gain the depth and breadth of knowledge and skills to become future leaders in the field of biotechnology. As the programme enters its second year, we caught up with last year's graduates to hear what they gained from the course.

Bergthor Traustason:

"I chose the MPhil in Biotechnology programme because I felt it was the perfect match to my research interests and allowed me to develop interdisciplinary skills in biotechnology as well as apply my background in physics and engineering.

I enjoyed the fact that you get a chance to not only work on in-depth research but also to explore current trends and the latest advances in biotechnology through various electives.

There was also the Transferable Skills module that provided an opportunity to learn about how to exploit entrepreneurial opportunities as well as transfer useful knowledge from academia to industry.

The course provided a unique opportunity to engage and connect with extraordinary individuals and leading experts in their fields. It also gave an opportunity for me to broaden my vision and challenge myself in new ways, such as by writing a literature review, which could later lead to a publication."

Maxime Crabé:

"I decided to apply for the MPhil in Biotechnology because of its broad range of electives, close connections with the industry, and to live the Cambridge experience!

The course made me discover how broad the field of biotechnology actually is, and how diverse your career possibilities are. Working in an academic lab or becoming an entrepreneur are two very different career plans that appeal to me, and this MPhil gave me an exposure to both of them.

The most enjoyable part of the MPhil was my individual research project. I was fully integrated within my team, the Bionano Engineering Group of Dr Ljiljana Fruk, and received all the support I needed to carry out my own research project.

Throughout the course I had the opportunity to meet a lot of enthusiastic and passionate researchers working in different academic or industrial labs. I might come back to Cambridge to work with some of them in the years to come!"

Wilson Wang:

"After specialising in chemistry during my last year at Williams College in the USA, I knew I wanted to see more of how science moves from theory to application. A rigorous education in the science and business of biotechnology in the innovation hub of Silicon Fen was the perfect way for me to do this.

One of the most striking aspects was how constantly changing the learning material we dived into was. I remember learning applications from the biotechnology core courses and electives, only to be told at the end that the applications were relatively outdated and there was a better way of sequencing genes or delivering siRNA. This acted as a catalyst for me to go out there myself and see the current status of biotechnology, offering a clearer picture of how far biotechnology has come and where it is tending towards.

The numerous speakers from the weekly Friday sessions informed us early on of the opportunities that Cambridge offers. I remember that Jane Dancer, Cambridge alumnus and CBO for F-Star, broached the idea of Enterprise Tuesdays that the Judge Business School offered. My subsequent attendance at Enterprise Tuesdays led me to other biotech events such as I-Teams and Biotech Health Venture Creation Weekend, which enriched my exposure to biotech by adding that business layer.

The MPhil in Biotechnology added a new layer to what I plan to do in the future. Although I aspire to pursue medicine in an MD degree in the USA, I am working towards adding an extra layer of biotechnology onto my responsibilities as a physician. I see biotechnology as a way to help future patients."

MPhil ACE preparing students for the future

Vilius Skrinska

The MPhil ACE course organised an assessment centre training day that involved fun games like 'saving Christmas' and solving "a murder mystery".

Nowadays, with the demanding expectations of companies, it is essential for universities to prepare students for the ever more challenging world of graduate recruitment. One of the new challenges that students face when trying to break into a career often includes group assessment centres. Here, fresh graduates are gathered in teams and have to achieve some common goal while being watched over by the assessors, with the clock ticking in the background. While team-based coursework provides students with team working skills, they don't quite simulate the fast-paced character of the dreaded assessment centres.

So, last year, students from the MPhil in Advanced Chemical Engineering (ACE) cohort organised something slightly different from traditional academic team-based activities for themselves by locking themselves in a room with the goal of completing a mission, such as "saving Christmas" or solving a "murder mystery", and escaping within a given timeframe. The team had to work together to race against the clock, solving various challenges that would unlock clues required to reach the final goal ultimately. Along the way, many important skills were used that are required in the real world such as teamworking, communication and prioritisation.

In the end, solving these challenges and "saving the world" has been a fun simulation of assessment centres and allowed the cohort to work together at the same time as putting to use and developing transferrable skills required to excel regardless of career aspirations.

Wearing different hats: Undergraduate student as Director of development initiative in Tanzania

Bahumi Motlhanka (left) speaking at Cambridge Development Initiative (CDI)

Bahumi Motlhanka, a recent graduate who completed her MEng in Chemical Engineering gives an overview of her year juggling her commitments to her degree (supervisions, lectures and research project), alongside her responsibilities as Director of the Cambridge Development Initiative (CDI).

CDI was started in 2014 by two undergraduate students from the University of Cambridge who believed that real, sustainable change occurs by empowering local change makers and that students could be the catalyst for this change. The charity is led by a committee of University of Cambridge students that collaborates closely with Kite Dar es Salaam, a charity run by students from Tanzanian Universities.

CDI runs four projects aimed at addressing the most pressing challenges for communities in Dar es Salaam, Tanzania. These four projects are: Water, Sanitation and Hygiene (WaSH); Health; Entrepreneurship; and Education.

Bahumi first became involved with CDI last summer as a volunteer on the WaSH project. CDI's values of collaboration really resonated with her because she is from Botswana and she felt that a lot of development projects based in Africa, and elsewhere, could more strongly incorporate the perspectives of the communities that they work with. Having worked on the monitoring and evaluation of the WaSH project, she was able to make suggestions to improve the project, which was an aspect of the role that she enjoyed.

She then applied for the Director position in order to have the opportunity to make an impact on the charity's strategy going forward. Her role as Director has been to provide feedback and advice on project design and implementation, work with the charity's board on the broader strategy and vision of the charity, and support her student committee whilst working to deliver projects which positively impact the beneficiaries. Bringing the Tanzanian perspective to the forefront was another important factor incentivising her to lead this organisation. It is through this belief that she has been able to start the charity's first Tanzania based research team to complement the secondary research done by students involved in Cambridge. This has allowed the projects to be better shaped and understood through the lenses of their potential beneficiaries.

Having the opportunity to work with the charity's board has been a great learning experience for Bahumi on a personal level, as she gets to hear from a wide range of voices. These voices have included individuals with decades of experience in international development, successful entrepreneurs and even the former Master of Trinity College Cambridge. Through these interactions, she was pushed and helped to think bigger in terms of what we could do in the communities that we work in.

Being involved with CDI has meant that she has spent many moments in the past year outside of her comfort zone. As a result, she was always learning. Constantly learning meant that she could surpass the limitations of what people thought she could do and most importantly what she thought she could do. This extends to the work of CDI and how they have been able to challenge the perceptions of student volunteering to deliver on impactful projects in Tanzania.

MBE course for future leaders in life sciences industry

The 2019-2020 MPhil in Bioscience Enterprise (MBE) cohort

The MPhil in Bioscience Enterprise (MBE) is designed for high-achieving professionals with a view towards enterprise and leadership roles in the life sciences. The programme provides a thorough understanding of business and the latest biotechnological advances, which participants apply to tangible business challenges in integrated placements.

Every year, MBE students come together from around the globe as strangers, meeting for the first time when they start their intense nine months at CEB. They will complete assessments, consult companies and draft business plans in teams. How do they do it? On their first day, the 2019-2020 cohort introduced themselves with flash presentations, professionally and personally, to find common ground. Within two weeks, Caroline Broad – an expert on effective teamwork with Board Associates – took MBE students through a team-building session, a structured and fun environment to get to know each other better, work out selected hypothetical and practical challenges, and become an effective team within the cohort. By week five, Peter Steinberg, President of Innovative Thought specialising in effective organisations, further enhanced students' team skills in a workshop on Leading Innovation, enabling them to employ creativity in the new environments and challenges that Lent Term brings.

A low-cost and open-source imaging technique for visualising organs

PhD student Pedro Vallejo Ramirez

The Laser Analytics group at CEB has developed a low-cost, open-source imaging system that can visualise groups of cells or organ tissues without cutting the tissues.

Optical projection tomography (OPT) is an imaging technique similar to that found in airport security scanners and used in medical Computed Tomography (CT) scans. However, OPT uses visible light instead of x-rays, and is typically used to examine samples which are millimeters in scale.

"The method can be thought of as an inverse problem in which you try to recover the shape of an object by taking pictures of its shadow," explains PhD student Pedro Vallejo Ramirez. "In OPT, we illuminate a translucent object with an LED and take pictures of the object as it rotates, and reconstruct a 3D rendering of the object using an algorithm called filtered back-projection. OPT has previously been used to examine the 3D morphology of zebrafish, mouse embryos, plants, and fruit flies, among others."

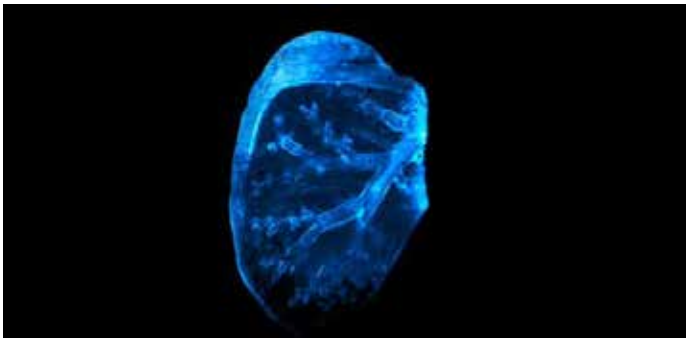
The technique is useful for imaging large organ samples (in this context, tens of millimeters) that are difficult or impossible to examine using traditional microscopy methods. However, OPT applications require advanced technical expertise, expensive equipment and bespoke software for reconstructions. The collaborative work of Vallejo Ramirez, supervisor Professor Clemens Kaminski, and scores of other researchers in CEB is looking to change that with their open-source solution: OptiJ.

OptiJ is a low-cost, open-source hardware and software system based on off-the-shelf, easy-to-assemble optical components and an ImageJ plugin library for OPT data reconstruction. Detailed instructions on how to build and operate the system are provided allowing for ready adoption by budget-conscious scientists who cannot afford commercial instruments.

"What the students have achieved here is tremendous taking an idea all the way from prototype to application," Professor Kaminski adds. "It enables high quality imaging in a cost effective and better way than existing technologies can achieve, opening up tomographic optical imaging to laboratories across the world."

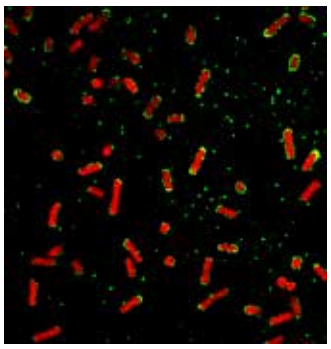
Reference:

Ramirez, P. P. V. et al. OptiJ : Open-source optical projection tomography of large organ samples. 1–9 (2019). doi:10.1038/s41598-019-52065-0



Reconstruction of a mouse lung using OptiJ – A low-cost and open-source Optical Projection Tomography (OPT) system

DNA origami as a tool in the fight against antibiotic resistance



E. coli (DNA nanostructures to specifically target bacteria)

The efficiency of available antibiotic treatments is in decline and the increasing rate of bacterial infections is a major health care burden worldwide. Postdoctoral researcher of CEB's Laser Analytics group Dr Ioanna Mela is tackling this challenge with her research on DNA origami nanostructures as a tool to deliver toxic molecules to bacterial cells. This allows for targeted destruction of bacteria and offers an alternative route to fight bacterial strains that have become resistant to antibiotic treatment.

"Antibiotic resistance is a growing worldwide health issue, rendering us vulnerable once again to infections that have been treatable for decades," says Mela. "Alternative approaches are urgently needed. I have used DNA nanostructures to specifically target bacteria and simultaneously deliver antimicrobial enzymes. It is a project that I am very proud of and excited about."

Reference:

www.ceb.cam.ac.uk/news/dna-origami-may-improve-performance-antibiotics

Open Enzymes: making biotechnology globally accessible

Open Bioeconomy Africa

Through a collaboration with Stanford University, Dr Jenny Molloy and Dr Chiara Gandini have developed a free, open-source and stable collection of enzymes for DNA design that enables scientists in low-resource settings to build biotechnology capability.

Biotechnology supplies require continues access to refrigeration – known as the cold chain. Molloy comments: "Enzymes for my teams in Ghana and Cameroon typically cost more than three times as much as in the U.S. and take weeks to months to arrive via an unreliable cold chain." To overcome the need for refrigeration, the Endy lab at Stanford University genetically modified bacteria – which don't need to be kept cold – to produce the enzymes. Dr Chiara Gandini, a postdoctoral researcher in the Open Bioeconomy Lab led by Molloy here at CEB, worked on compiling the list of genes in the open enzyme collection. Gandini also helped to set up molecular biology labs in both Cameroon (in Yaoundé, called Mboalab) and Ghana (in Kumasi, called Hive Bio Lab).

Reference:

www.ceb.cam.ac.uk/news/open-enzymes-making-biotechnology-globally-accessible

Finding the links between reactive molecules involved in soot formation

PhD student Jacob Martin

PhD student Jacob Martin and colleagues of Computational Modelling group at CEB discovered a new type of cross-linking between molecules involved in soot formation. Their findings could explain why soot forms and lead to new ways of breaking down carbon deposits. In their work, the group compares the reactivity between various molecules of soot by making use of electronic structure calculations to compute the energy needed to remove an electron from a particular spot on the "surface" of the molecular surface (average local ionisation energy). Using this method, they found the reactivity of pentagonal rings and a novel localised π-radical on pentagonal rings.

"Most of the ideas for how the molecules in flames come together to form soot particles have been either stacked physically interacting interactions or chemical bonds in a long polymer that did not stack. However, the localised π-radicals allow for stacked and bonded structures that are strongly bound. This could allow molecules to rapidly condense and then crosslink, which could explain the rapid growth of soot", Jacob explains.

He continues: "Our next steps are to determine the concentration of this reactive site in the flame. We also need to compare how all of the possible crosslinks contribute to soot formation. When we know this, we can consider how to stop particular reactive sites from forming with a view to eventually reducing soot emissions."

"Chemical mechanisms that lead to soot have been a mystery ever since we started exploring fire," says Professor Markus Kraft, head of the Computational Modelling group and principle investigator of Cambridge Centre for Carbon Reduction in Chemical Technology (C4T). "This paper provides an energy landscape mapping of dimers, which can be perceived to be the first building blocks for soot particles and have revealed new formation mechanisms that so far have yet to be considered."

References:

Jacob W. Martin, Dingyu Hou, Angiras Menon, Laura Pascazio, Jethro Akroyd, Xiaoqing You, and Markus Kraft. The Journal of Physical Chemistry C 2019 123 (43), 26673-26682. DOI: 10.1021/acs.jpcc.9b07558

nznano.blogspot.com/2019/11/new-reactive-aromatic-molecules-in-soot.html

www.ceb.cam.ac.uk/news/october-paper-month-finding-links-between-reactive-molecules-involved-soot-formation

New findings of a new type of cross-linking between molecules in soot formation could lead to alternative ways to clean up combustion.

Flexible production of micro and nanofluidic devices

PhD student Oliver Vanderpoorten

Researchers from the Laser Analytics group at CEB have developed a laser-based manufacturing process that can produce combined nanofluidic and microfluidic devices in a fast and scalable manner.

"Fluidic chip devices are similar to computer chips but instead of having metal wires connecting different areas you have tiny channels – microchannels – the width of a human hair, that are filled with liquid," says Oliver Vanderpoorten, a PhD student in the group who developed the method. "This allows us to study biological specimen in a very confined space. The liquid that goes through is always laminar and smooth and it makes everything very controllable."

Nanofluidic devices take this even further, featuring channels more than six hundred times smaller than the width of a human hair. Researchers can trap and image single molecules without modifying them through labelling or fixing them to a surface, saving valuable time and effort. Vanderpoorten further adds: "Proteins and aggregates like those that cause Alzheimer's disease are nanometer sized and we need new ways to filter these and study these on a single molecule level."

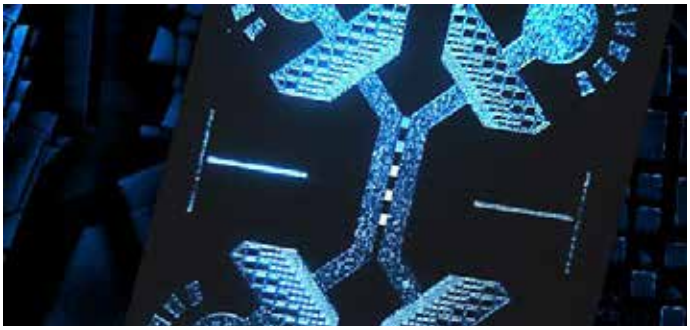
However, current methods to manufacture nanofluidic devices are slow and expensive. In their technique, Vanderpoorten and his colleagues Quentin Peter and Pavan Kumar Challa address these drawbacks by using conventional UV mask lithography to make their microfluidic features and then employing an innovative two-photon writing technique to add the nanoscale channels.

In this way, devices with both micro and nanofluidic properties can be prepared using quick, cheap and well established techniques.

"Our method is open source and can be adopted by a lot of people who can use their readily available systems to make these devices and do their own nanofluidic science," says Vanderpoorten. "I hope that with this method we can measure protein aggregates that are involved in Alzheimer's disease, on a chip; that would be my dream."

Reference:

Vanderpoorten, O. et al. Scalable integration of nano-, and microfluidics with hybrid two-photon lithography. Microsystems Nanoeng. 5, (2019).



A nanofluidic chip – a device which allows researchers to observe biological processes at the single-molecular level.

Energy recovery from wastewater - REWATERGY

Rubén Asiain, Marina Avena Maia and Dr Laura Torrente

The REWATERGY team consisting of various European Universities that will train eight Early Stage Researchers (ESRs) in the development of new technologies to reduce the energy demand in water treatments.

Access to energy and water underpin global economic and social development with an increasing demand of both of them. Simultaneously, we are currently facing the challenge of recycling materials and water of high quality to become carbon neutral by decreasing its energy consumption and CO^2 emissions. The current Water Framework Directive has strict regulations on a wide range of contaminants, and most waste water treatments continuously increase the energy demand of the water cycle. Yet, the EU, and UK in particular, is committed to ambitious targets to reduce greenhouse gas emissions, including the legally binding 2015 Paris agreement. These conflicting interests have motivated REWATERGY, an industrial – academic partnership within the water-energy nexus as part of the Marie Curie Industrial Doctorate training network funded by the European Commission within Horizon 2020. The Catalysis and Process Integration group (led by Dr Laura Torrente) will work together with Rey Juan Carlos University (Spain), Ulster University (UK) and three industrial partners, Delft IMP (Netherlands), ProPhotonix (Ireland) and FCC Aqualia (Spain). The consortium will train eight Early Stage Researchers (ESRs) in the development of new technologies to reduce the energy demand in water treatments while increasing the energy recovery from waste streams inspired by the circular economy concept. All of ESRs will equally spend their time in their associated university and company during their PhD project, getting a balanced training in research skills, technical knowledge and transferable skills with a focus on entrepreneurship, in order to enhance the competence of the European water industry.

Two of the ESRs based at CEB, Rubén Asiaín and Marina Avena are working on the development of technological processes for the energy recovery from wastewater streams. In particular they are investigating ways of recovering urea and ammonia from wastewater to avoid the current formation of waste water streams with high nitrogen content, which currently require large amounts of energy for their treatment. This approach opens the door to extract the high hydrogen content in these compounds for energy generation following the efforts in the group to deploy ammonia as a renewable energy vector.

Such innovative approach for sustainable waste water treatments have a wide range of impact. It can be deployed in the valorisation of high N-content streams in municipal wastewater treatment plants (i.e. centralised systems) but it can also be used in new decentralised systems in intelligent toilets for energy recovery in self-sustained cities. This development has also potential in rural areas (e.g. farms) and the improvement of sanitation in developing countries. REWATERGY will change the social perspective of wastewater from a residue into a sustainable energy source.

REWATERGY, an industrial – academic partnership within the water-energy nexus

Organic Light-Emitting Diodes – The future of medical implants?

Dr Bruno Matarèse, Research Associate at CEB

Organic light-emitting diode on glass substrate to test suitable materials for medical applications.

The research in its greater context

Great advances have been made in the development of implantable medical devices related to size shrinkage, material suitability, system delivery such as wireless communication, electrical power consumption and battery power. Society that is living ever longer demands solutions for a large number of clinical applications with the goal of developing miniature devices that can be fully implanted such as the pacemaker, cochlear implant or smart prosthetics.

What is the possible future of medical implants? The answer may be tunable chemically synthesised organic materials. Used in medical implants, these materials offer several advantages, e.g. being compatible with human tissue which means not causing any toxic or immunological responses. In our lab, we work on organic materials that can emit light which is crucial for a field called optogenetics. Based on our research to this date, we are confident that these new materials have a huge potential to innovate implantable medical devices and may play a crucial role in treating neurological diseases such as Alzheimer's and Parkinson's.

What is optogenetics?

Optogenetics is a combination of techniques from both the fields of optics and genetics which uses light to control the activity of individual cells such as brain cells . This is one of the major techniques that has changed –and will continue to transform - the practice of neuroscience. It represents a considerable advance on previous methods, such as electrical stimulation, that indiscriminately affects all cells. This means that individual organs, body parts, or even the behaviour of an entire organism can be more accurately targeted and controlled, making interventions more accurate, economic and effective. In this field, opsins – light-sensitive proteins extracted from organisms such as bacteria, algae and jellyfish – are key. For instance, it is possible for a cell to express a jellyfish opsin via protein engineering to enable the light control of electrically excitable cells in the brain, muscle or nerves. Using this technique, the gene encoding the special jellyfish photosensitive protein is carried into our cell by a virus. Targeted cells can then encode for the opsin's genes and start to produce photosensitive protein. The use of these proteins offers new opportunities for non-invasive, cell-specific neuronal stimulation in both culture and live animals. By these means, the new research field of optogenetics has been established.

Organic Light-Emitting Diodes (OLEDs)

As a result, neuroscientists have rapidly adopted these neural photosensitisation tools to investigate brain activity. Whilst important results have already been obtained in this relatively new field, a significant additional problem facing researchers is how to provide light to specific deep brain areas which are of interest to us to address major clinical issues. To date, this technique has been achieved using inorganic light-emitting diodes (LEDs) or lasers as hardware (e.g. integrated fiber-optic and solid-state light sources) that are able to deliver light with a precise wavelength to specific areas of the brain. These inorganic devices are obviously very brittle and this

Dr Bruno Matarèse in wet lab for the solution process steps of light-emitting polymers.

limits their effectiveness to operate as brain implants.

In contrast, Organic Light Emitting Diodes (OLEDs) are a light source that combines optical and electrical properties with the known advantages of customized materials to provide appropriate colour tunability, lightness, and low-cost solution processing. The intrinsic multi-functionality of organic materials, such as light emitting polymers, can be exploited to generate electroluminescence. An exploration of these issues formed part of this doctoral research in which we were supported by the EU Olimpia project funds, whose goal is the development of bio-sensors and bio-actuators and innovative technological solutions in the crossover between neurology and electronics. The study was recently published in the prestigious journal "Frontiers in Bioengineering and Biotechnology" in which the concepts and applications referred to above are set out in more detail (www.frontiersin.org/articles/10.3389/fbioe.2019.00278/full)[1]

Engineering optoelectronic devices for operation in liquid environments is, however, a challenge that requires a more comprehensive understanding of the consequences that may arise in designing OLEDs for incorporation into living tissue.[2-4] We believe that it will be soon possible to design highly biocompatible organic LEDs made entirely of polymers. Rapid advances in 3D printing technology will also allow the fabrication of organ prostheses made of hybrid hydrogels and OLEDs with sophisticated pores to let oxygen and water flow without impairment to tissues growing naturally within.

What are the future clinical applications?

The bio organic LED, (which is only a few microns in size), could be implanted in the brain with less risk of rejection and therefore use light to stimulate the electrical activity of the brain. Bio organic LEDs could also have an application in the field of rehabilitation, for example, in the case of retinal damage in which patients have impaired optic nerves. In this area it should be possible to insert chips under the optic nerve again with a lower probability of rejection. In the study of pathologies and syndromes such as epilepsy, Alzheimer's, Parkinson's and heart abnormalities we are relatively confident that OLED will help to restore some quality of life and help to understand neural circuit behaviour. This would undoubtedly help us find cures and treatments for other neurological and psychiatric disorders and mental health issues. The use of light could activate modified motor neurons and trigger muscle contractions and restore mobility in patients with paralysis. Moreover, light impulses from organic LEDs can regulate the rate of contractions for heart's natural pacemaker using the body's native mechanism.

We believe that it will be possible to produce low-cost interventions and electronic components and circuits to deliver significant clinical change. There is clearly a very large market for optogenetics across the globe. The major factors for the growth of the optogenetics market include advanced technology, increasing use of multimodal imaging and more sophisticated diagnostic tools. These areas are actively being developed. Other exciting non-medical applications include the use of OLEDs which are also expected to allow faster growth for smartphone's display and curved TV. Other potential applications are in the field of biochemical sensors and intelligent fabrics. The commercial market for developing this sort is huge and their use as medical implant for optogenetics have just begun to be investigated.

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There is more to custard than meets the eye (and the taste buds!) - Part 1

Dr Ljiljana Fruk, CEB lecturer and Bionano Engineering Group PI

You might think of custard as that deliciously creamy mix that brings the memories of cosy winter evenings or relaxing late summer afternoons. However, there is a chemical side to custard that is both complex and fascinating and absolutely fun to explore. Although made using three basic ingredients, and that said, we are not talking about the speedy "buy-the-powder-and-mix-it-wit-the-warm- milk" approach, a custard requires careful method optimisation. The beauty of it is that everyone can master the preparation, so there are no excuses for not doing some custard experiments in your kitchen after reading this.

First, you will need to get some fresh eggs, good full-fat milk, and sugar. Water could be used in an emergency, instead of milk, but do make sure it is enriched with some extra salt, some calcium ions, and good old fat in the shape of double cream.

Your ultimate magic ingredient is egg yolk, or chemically speaking, lipoproteins, which the egg yolk is made of. The yellow-orangey colour is a result of phospholipid lecithin and the number of carotenoids, but the high nutritional value of the yolk stems from lipoproteins. These are infamous LDL (low-density lipoprotein), sometimes (wrongly) referred to as bad cholesterol, and HDL (high-density lipoprotein). Low-density means there is less protein, more fat (Greek for fat is lipos therefore the lipoprotein name) within the structure, and high density describes more protein, fewer fats. Fats and proteins make a high-energy combo, very good for us when we need that extra energy after a workout or day of running around the lab.

Egg yolk contains lots of LDL in the plasma, clear yellowish liquid the yolks are made of, and lots of HDL in the granules within this plasma. Granules contain up to 70% of HDL, they can be from 300 nm to μm in size, and have very compact structures (granules are big, but HDL units are in fact smaller than that of LDL). Usually, HDL is bound into a complex with phosvitin proteins through calcium ion (Ca^{2+}) bridges. As it is packed very tightly, it is poorly accessible to the enzymes that would digest it, and it does not form gel structures readily. However, add a little salt, the humble sodium chloride, and the calcium bridges will be "disrupted", the solubility of granules will increase, and small particles will be formed, which can be nicely worked through into a smooth mix. Therefore, do not forget to put a pinch of salt into your custard mix.

LDL is a bit different. It has a low density of proteins and forms small spheric nanoparticles (60 nm). Unlike the HDL granules, it is very soluble under different conditions, apart from in very acidic solution. Add too much lemon to the egg yolk, and there will be clumps formed that will be hard to get rid of. The LDL is very important for the formation of the gel; the structure of the lipoproteins unwinds around 70°C, and the gels are usually formed around 75°C. Heat breaks up the bonds between different amino acids, particularly disulfide bridges between various cysteines, so that protein unwinds and cross-links into nice gel structures. HDL granules remain stable at this temperature, but act as structural reinforcers that make the gel even more stable. The process of gelation turns the emulsion of milk, sugar and egg yolk into harder, smooth and firm structure provided we stir the mix nicely.

And what is the role of milk and sugar? you might ask. They act as retardants, slowing down the unfolding and cross-linking of LDL. Without them, the egg yolk would turn into a hard structure we know of from a boiled or fried egg. However, add some milk, rich in fats and minerals such as calcium, which is an important cross-linker, and your gelation will have enough gluing species to be successful. The sugar, on the other hand, forms the coating around the proteins and prevents the formation of too many bonds between them as they unfold under heating. If too many bonds were formed too quickly, the gel would be too hard and the texture would just not be right. Incidentally, the more sugar you add, the longer it would take the custard to cook.

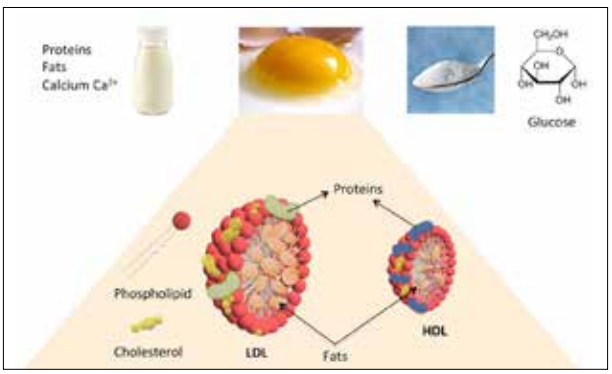
We are almost done and the only thing missing is that little something that makes custard special. If you are in Croatia, you might use a rose petal liqueur to enhance the taste (yummy!), somewhere else you might use fresh vanilla or orange peel. There are many variations, but just avoid anything acidic.

You do not need to be a chemist to do some delicious chemistry at home. If you want to avoid eggs, and you really doubt your mixing talents, you might buy the custard in the sachet. In this case, you would not work with LDL and HDL but with lots of starch, and that mix can be explosive… literally.

Check out next issue for part 2 on the role of starch in food technology.

For more information on Dr Fruk's activities see www.ceb.cam.ac.uk/research/research-groups/bionano-engineering and follow her on Twitter@FrukLab

Creamy custard. Credit taste.com.au



The Biochemistry of custard. Credit: Dr L. Fruk

Camnexus: Technology for innovation

Alumna Dr Jessica Ocampos, CEO & Co-founder of Camnexus IoT

A Process Engineer driven by innovation

I am Jessica Ocampos and I was born in Chile, South America, in a mining region in the north called Antofagasta. I did my undergraduate in Chile in Biotech Engineering at the University of Chile, and later decided to do my PhD in Chemical Engineering at the University of Cambridge (2011 – 2016). I discovered from a summer school in the University of Chile, which became my alma mater, where that biotechnology engineering was the right decision. I had this vision of this woman in a white lab coat making tremendous breakthroughs, which would transform the lives of many. As a graduate of a chemical engineering department, I realised that being a chemical engineer we are quite versatile in any industrial and engineering environment. I became a process engineer after I graduated. I have since always been involved in new product and technology development, then technology implementation, project management and capability building to support technology transfer and innovation process. This latter experience made me realise that innovation is not just about technology but about people.

Aiming for Sustainable Development Goals

After working for many years in Latin America, Europe, and the USA, one of the main challenges I experienced was the adoption capability of these technologies. In most cases, they were (and still are) not designed and developed for those regions or end users. This motivated me and a couple of PhD students from the University of Cambridge to create a nexus to support local innovation capability building: a bilateral platform. This platform expanded to become Camnexus. Camnexus works in collaboration with the International Outreach Programme of Cambridge Enterprise of the University of Cambridge and several international innovative agencies. By understanding the local context and needs, we provide solutions based on enabling technologies. However, such technologies would only make sense if transformed and adapted with local expertise to tackle the

Camnexus-IoT sensors network: Meteo-Plus© sensor for integrated weather station and water quality real-time monitoring. First network installed in hydroponic greenhouse farm in Brazil.

Brazilian and UK Camnexus Team installing the first IoT network for hydroponic farming in pilot greenhouse.

real global challenges.

With the Sustainable Development Goals (SDGs) from the UN in 2015 aiming for 2030 in mind, Camnexus has prioritised the promotion of enabling infrastructure and skills that can solve inequality in the digital divide and connectivity gap. This has given rise to Camnexus-IoT2 in 2018, a R&D and technology developer company with an international collaboration team. We are developing low-power digital infrastructure based on an 'end-to-end' Internet of Things network, which allows larger access and affordable scalability of connected devices and real-time data using low energy consumption sensors. By monitoring water quality and consumption, particularly in the food sector, with key international partners, we are tackling SDGs: 6, 7, 8, 9, 10, 11, 12 and 17.

Camnexus-IoT: an innovative solution

As part of Camnexus-IoT offer we are developing low-power sensor networks that can monitor, in real-time, environmental conditions and industrial assets in remote scenarios, where there is a lack of accessibility or critical operations. The system is based on the integration of low-power and long-range communication systems (in particular LoRa) which cover up to 5 km of distance with one concentrator, wireless low-power sensors with at least six months of battery life, and a management system where the data acquisition, processing, predictive analytics, display and real-time alerts are programmed.

Thanks to a seed fund, a couple of grants and a pilot paid by clients, we have been able to progress from prototype to pilot stage validating our technology and solution in agriculture and water utility in Chile and Brazil. We have successfully implemented the first underground wireless sensors network for real-time flooding alert in city sewers. In Brazil we have a sensors network to alert water quality and improve fertiliser management in hydroponic farming. This project involves an educational and local capability scope. We are working with two local universities of Santa Catarina region in Brazil (UNISUL and UFSC) and a local school of Tubarao. We are training engineering interns, who are learning about sensor development and the benefits of low-power communication systems for IoT. We want to understand, from the schools, how an earlier exposure to efficient and sustainable food production systems can impact the children's education, their school community, and their parents.

The company was founded by Pablo Salas and myself, both Chilean Cambridge graduates with industrial background prior to completing their PhDs. Pablo has been key in the creation of the academic collaborations in Brazil started in 2014. Thanks to the natural evolution of this relationship, we are currently working together in co-development and exploring commercial opportunities of technological solutions to support the water-food-energy Nexus in Brazil. With base in Cambridge, we have now builta very international team in two years working remotely in Chile, Brazil and soon Uganda, where we have recently been awarded some pilot funding to try our solution in the agriculture sector with support of the local Agricultural Extension Workers.

Becoming and entrepreneur and innovator

I recognise three Cambridge initiatives as key to my personal realisation as an entrepreneur/innovator: The first was "Enterprise Tuesdays", a series of talks organised then by the CfEL of the Judge Business School. Every Tuesday a renowned entrepreneur came to share their knowledge. Inspiration and networking were the highlights of the event. I learned about Cambridge University Entrepreneurs (CUE) business plan competition, the second initiative. I decided to submit my innovative ideas to CUE. After winning in the first stage I realised the potential of my ideas, and by being part of the programme, I could be mentored and trained and met more PhD students with similar interests. This was the beginning of my involvement in entrepreneurial programs. And finally, Enterprise WISE, a programme which was delivered at the Judge Business School, by Dr Shima Barakat and Shirley Jamieson. This programme was prepared and delivered by women to female PhDs and Postdocs in STEM at the University of Cambridge. I have been working on this initiative since 2014 which is now called Rising WISE, spanning Cambridge and Oxford, to include female PhDs, Postdocs, and engineers from Cambridge and Oxford Universities.

I have always been an advocate of inclusion, diversity and gender equality. Participating in these programmes hasmade me even more aware of my role and of the impact I could have on others. I have been actively involved either in mentoring, training, and raising awareness about the challenges, learning or achievements experienced as a female engineer, scientist, PhD, innovator or entrepreneur.

I am very grateful for having been invited as key speaker at the AIChE Annual Meeting in Orlando last year. I had the opportunity contribute to two panel sessions. The first was about "Overcoming Hurdles for Women in Innovation and Entrepreneurship", organised by WIC (Women in Chemical Engineering). The second panel was about "Challenges in Entrepreneurship: Ensuring Success for your Start-up" organised by the Topical Conference Entrepreneurship in Chemical Engineering. It was so reassuring to see such diverse and motivated people. We recognised that chemical engineering has this unique versatility allowing us to thrive in so many different sectors, from IoT to biotechnology. Moreover, this year I have been invited to give my first TEDx talk in Leicester, where I described the inclusive approach that motivated this project and the impact made.

To contact Jessica email jocampos@camnexus.co.uk and check out her LinkedIn profile on www.linkedin.com/in/jessicaocampos/

More info in www.camnexus.io

TEDx talk given by Jessica.

Dr Ocampos at the AIChE Annual Conference in Orlando in November 2019 with female entrepreneur Grecia Ro.

MBE builds on industry partnerships

MBE Class 2019-20 student cohort with course co-ordinators.

The MPhil in Bioscience Enterprise (MBE) is currently in its 18th year, as ever benefitting from its exceptional network of over 100 expert speakers. In 2018-2019, over 60 companies directly engaged with the programme and we are welcoming a number of new and expanded partnerships in 2019-2020.

The MPhil in Bioscience Enterprise (MBE) programme

The MPhil in Bioscience Enterprise (MBE) programme is an intensive nine-month biotechnology and business course for those who have an interest in entrepreneurship or who wish to take up leadership, executive, or consultancy roles in the life sciences sector. Participants normally join with an excellent first degree in the life sciences. Students with other backgrounds, e.g. physical sciences, law, or finance, may join with a demonstrable interest in the course's core disciplines. Prior professional experience in related industry, business, or academia is highly recommended.

Opportunities for companies to get involved include guest lectures and workshops with a group of high-achieving young professionals at the intersection of biotechnology and business. Sharing business challenges and opportunities with MBE participants, for a fresh perspective from their group consulting projects and individual research placements. Joining panels for business plans and assessments, sparking creative insight and novel ideas. Advising on the curriculum from an industry perspective, with a view towards outstanding graduates. Finally, customised sponsorship ensures that every talent gets to hone their skills.

A first shout-out goes to Deallus, a strategic intelligence consultancy operating across the global life sciences sector. Dr Julie Munch Kahn, Chief Commercial Officer, Dr Eugénie Joanny, Principal, and Emily Wyatt, Senior Associate delivered a tremendously well-received two-day workshop on Drug Discovery, Development, and Commercialisation. Our guest experts introduced MBE students to strategic considerations ranging from the development of a target product profile to forecasting. Participants experienced the process of brand planning in a fierce competition of case studies; congratulations to the winning team!

Practical experience is central to the MBE and students expand their professional skill set through each course component. M Ventures, Merck KGaA's strategic, corporate venture capital arm, will again deliver their workshop on "Due Diligence and Investment Deal Assessment", which ranks among the most popular course components. Building on fundamental concepts in corporate venture capital and strategic investing, students learn what drives an investor's decision in practice and critical points to look for in a business plan. Students then reflect this perspective in their own real-life business plans, frequently winning business plan competitions.

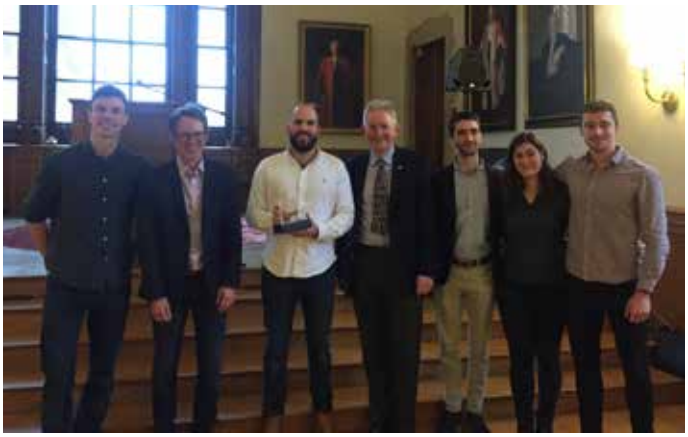
M Ventures re-join the MBE later in the year, hosting one of the six to eight-week individual research placements. We welcome diverse company contributions – both large and small – yet dual engagement in the taught and the research component of the course does feature among partners: it provides engagement with the entire cohort, followed by deep engagement with select individuals. Many of our specialised graduates have subsequently stayed with their host companies. This year, for example Partners4Access and Dolon – who both specialise in rare diseases and orphan drugs – have chosen to give a guest lecture and offer a research placement. Similarly, Cambridge Digital Health – who develop software solutions for healthcare – and Precision Xtract,who advise on global market access, are posing business questions to a small group of students in a consulting project and for an in-depth analysis in an individual research placement.

While the examples above centre around the biomedical sciences, the MBE overall covers a wide spectrum of biotechnology and we consistently update our portfolio. Our industry partners include a number of start-ups and innovative SMEs and we are acutely aware of their often limited capacity for external engagement. Our dedicated MBE Office, well-equipped facilities, and remote and/or no-cost placements make interaction with the MBE easy, cost-effective, and rewarding.

For more information on the MBE programme see www.ceb.cam.ac.uk/postgraduates-tab/mphil-mbe and to discuss opportunities or simply join the mailing list for MBE partners, contact Franziska Fischer, MBE Programme Manager at ceb-biosci@lists.cam.ac.uk

Open-Seneca wins the annual Vice-Chancellor's award for Impact and Engagement

Open-Seneca, a citizen science air pollution monitoring project led by a team of students from our Centre for Doctoral Training in 'Sensor Technologies for a Healthy and Sustainable future' are winners of the annual Vice-chancellor's Research Impact and Engagement award, in the collaboration category.



Members of the Open-Seneca team receiving Vice-Chancellor's award.

The Vice Chancellor's Public Engagement Awards recognise outstanding achievement, innovation, creativity, impact and public engagement through a research activity which has the potential to create significant economic, social, cultural impact and engage broad publics, new stakeholders and/or underserved audiences. This year Open-Seneca worked with policymakers in Buenos Aires and Nairobi and were awarded the Vice Chancellor's impact and engagement award, in the collaboration category. The award was presented on 14th October 2019 by Vice Chancellor Prof. Stephen Toope and includes a £1000 grant to be used for the development and delivery of engagement/impact activity or relevant training.

Lorena Gordillo-Dagallier, team member of Open-Seneca comments "It's not only a great honour to receive the award, but it also provides an excellent platform to raise awareness about the issues associated with air pollution. Our work has focused in developing regions around the world, where the effects of air pollution are often overlooked. We are proud that the Vice-Chancellor's Awards have recognised this effort, and we are excited to continue our work and collaborations around the world"

Source: www.ceb.cam.ac.uk/news/collaborative-air-pollution-project-wins-vice-chancellors-research-impact-and-engagement-award

Biotechnology MPhil wraps up a successful year

The first MPhil in Biotechnology 2018-19 came to an official close in September 2019 with the first student cohort presenting their work at the course symposium.

The Biotechnology MPhil programme offers an interdisciplinary curriculum to physical scientists and engineers who want to learn biotechnology and apply their problem solving skills in biological sciences.

At the symposium the students presented their individual research projects. In their individual research projects, which ran throughout the year from October to June, the students worked on a range of projects from computational biology and bioinformatics to the development of nanobeads for water remediation, polymeric prosthetic heart valves, supramolecular nano-vehicles for targeted drug delivery, and multivariate predictive models for process analytics. For their team project, the students spent the summer at AstraZeneca in Granta Park, working on predictive development of complex biopharmaceuticals.

First Biotechnology MPhil cohort celebrating at the course symposium

Dr Chris van der Walle, Director-Fellow at AstraZeneca said: "This was the first time that our laboratory scientists have supervised two teams of postgraduate MPhil students and the feedback has been positive. We will be using the data the students have generated to progress our efforts in bringing biologic medicines based on messenger RNA or bispecific antibodies to patients".

As part of the team project, the students also worked on an outreach challenge, developing didactic material explaining key concepts of the workings of a cell, including a booklet and a mix-and-match game for young kids and the students were greatly supported in this task by George Cronin from the Office of Scholarly Communication. The booklet and the game aim to demonstrate biotechnology concepts to the general public in a visual and engaging way, and they will be offered to the public at the next Cambridge Science festival at CEB in March 2020.

"A special thanks to the glorious seven, it has been an absolute pleasure to work with you, you've all been fantastic from the start," said Dr Gabi Kaminski, Course Director, addressing the MPhil students.

Many contributors from our department, other departments across the University and industry, including companies such as AstraZeneca and GSK, have provided invaluable support, without which the course would not have run successfully. Our MPhil in Biotechnology students are now taking their next career steps, with some moving on to further study in medicine or through research PhDs, and others entering consultancy and industry. We wish them every success in their future ventures.

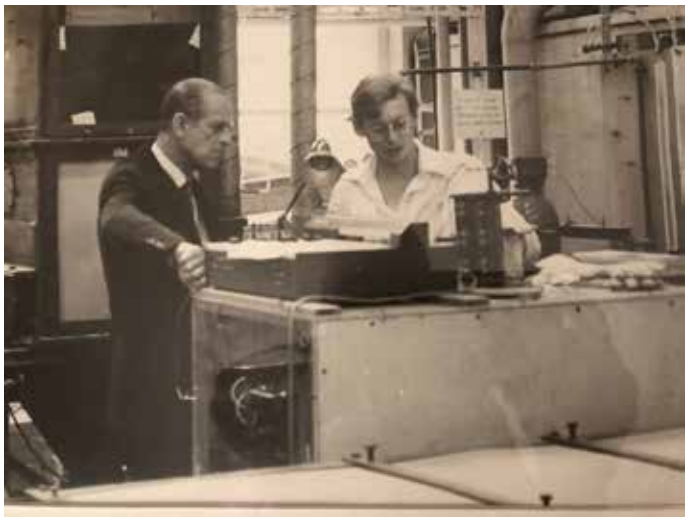
Sources:

www.ceb.cam.ac.uk/news/our-mphil-biotechnology-wraps-successful-first-year

www.ceb.cam.ac.uk/postgraduates-tab/mphil-biotechnology

Alumni visits in 2019

Laurie Scandret



Laurie as a young researcher talking to HRH the Duke of Edinburgh, when he visited the old Chemical Engineering Department on 23 June 1982. Credit: CEB

Laurie Scandrett standing by the 'walk of fame' wall at CEB featuring all annual Class Year photos.

Dr Laurie Scandrett is an Australian alumnus who did his PhD in the department between 1979 and 1982.

"I was working with Roland Clift and to a lesser extent with Allan Hayhurst. John Dennis was a close contemporary of mine and I remember Malcolm Mackley and Nigel Slater well, as well as John Davidson and Allan Hayhurst of course. I last visited CEB when I attended the Summer Symposium to celebrate John Davidson's 80th birthday in 2006," Laurie recollects

Laurie visited the new department last summer on 5 July, when he had the chance to talk to young researchers and academics, as well as to catch up with his contemporaries in the tearoom, including Allan Hay Hurst, who examined him on 1984. He also had a tour of the department and visited the library, where he managed to find a hard copy of his thesis 'The removal of alkali compounds from gases at high temperature."

Adam Shrier

A visiting scholar at the old Department of Chemical Engineering during 1965-66, Adam undertook his postdoctoral research studies under former HoD Professor Peter Danckwerts.

"I have not been back to Cambridge since my postdoctoral days, but I have followed with interest news about the department. My wife and I were attending a course at Madingley Hall last and we appreciated the opportunity to visit the expanded Department in its new quarters," commented Adam.

Adam and his wife on a walk along the lab corridors on their visit to the new building on 5 July 2019.

Elena Gonzalez took Adam and his wife around the department and showed them the room displaying all Class Year photographs where he was able to spot himself.

We love hearing about what our graduates are up to and always happy to receive visits. If you are in Cambridge and have the time to come and see us in West Cambridge please get in touch with Elena to arrange a visit (eg314@cam.ac.uk) as we would love to welcome you to our new home.

Alumni memories and recollections

Professor Ugur Tuzun

Professor Tuzun was a former PhD student in CEB supported by a Wolfson Foundation scholarship during his studies at Churchill College (1976-1979), which were followed by an EPSRC supported post-doctoral research appointment (1979-1982) in the old Department of Chemical Engineering in Cambridge.

"Thinking of the seven years I spent at Cambridge, first as a Postgrad and then as Postdoc between 1976 and 1983, I have no recollection of spending a Christmas at work. I guess I was lucky enough to always be on a plane to go home or to see friends. However, I remember coming back to some drastically cold and snow-bound Cambridge January following the Christmas and New Year celebrations. Looking back at those winters, it is impossible not to believe in global warming!

"I currently run a professional consultancy in chemical and

process engineering based in Weybridge, and have affiliations at Cambridge and Oxford and Surrey Universities. I am also involved with the European Federation of Chemical Engineering (EFCE) with involvements in France and Germany. My involvement with the universities is in a visiting academic capacity and is supported by individual contracts and research collaborations. I am also trying to keep contacts alive in the USA through my membership of the Particle Technology Forum and Sustainable Engineering Forum of the American Institute of Chemical Engineers (AIChE). I continue to act as panel referee for Research Councils in the UK and abroad as well as with international peer-reviewed journals such as the Chemical Engineering Science Journal. I am also following closely the zero carbon initiative of the University of Cambridge and the related future activities.

Ugur at the private gardens of the Windsor Castle in 1983 just before moving from Cambridge to take up a position as "New Blood Lecturer" in the Department of Chemical and Process Engineering at the University of Surrey.

"At some apparently coincidental but strangely holistic level, my established research activities in particle/nano technology and computer-aided tomography are finding new conduits in applications involving environmental systems engineering and neural network analysis. I can go on but I fear it will only get too technical beyond this point!

"I appreciate the department's alumni services provided and the ability to keep in contact like this. What a nice idea, to ask for recollections of Christmas. However, being from a neighbour country (The Netherlands), I always went home for Christmas," Ugur noted.

Professor Ugur Tuzun, PhD 1979

The Professor Tuzun also held the post of Head of Department of Chemical and Process Engineering at the University of Surrey between 1999 and 2008 as well as School of Engineering Director of Research (2003-2007).

"What I do remember from the days just before Christmas is the fact that it was pitch dark from about 4.30 pm! We have the benefit of the Berlin time, which means our time is 40 minutes off the solar time, so we get a little longer afternoon here in the Netherlands. Cambridge is almost exactly on solar time.

For me, a Cambridge Christmas was, therefore, going home with an ample supply of Christmas pudding and mince pies. The final year was extra special, because Christmas was my self-imposed deadline for submitting my PhD-dissertation, and I managed to finish it in time, with a few days to spare, which I spent in bed, ill. At Christmas itself, however, I was completely cured and without burden."

Dr Jaap Brinkert

Dr Jaap Brinkert

Chemical engineering alumnus (PhD 1993) and Senior Project Engineer at Reden Research & Development, The Netherlands.

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Graduate Dr Rachel Cooke on making wise career decisions

Alumna Dr Cooke sharing her career journey with undergrads.

Chemical Engineering graduate Dr Rachel Cooke, STEM ambassador and good friend of department, returned to CEB to share her professional experience with our undergraduates and tell them about her career choices, the experience gained and opportunities taken so far.

Dr Cooke completed her undergraduate studies in 2000 followed by a PhD on "The Rheology and Processing Behaviour of Complex Fluids used in Secondary Oil Field Recovery", which she gained in 2003 under the supervision of Professor Malcolm Mackey, now retired. With a special interest in the food and drink industries, she gained experience in the field as project manager in product development, manufacturing for international companies such as Cadbury Mondelez and SABMiller she developed a. She is now the Head of Central Programs and Capability - Engineering Services at Amazon, as well as an active advocate for women in engineering and supporter of diversity in the workplace.

During her talk, she highlighted the impact on one's career of making good choices earlier on and the importance of finding one's purpose, considering job location, preferred pay scale and organisational culture and values amongst other important factors.

"It's all about that decision to send an introduction email to the manager of a project you'd like to get involved in," said Rachel. "A career is a marathon not a sprint so have fun in the process. May be you volunteer for a role, which will help you get your next job, or take on an internship, which takes you down a specific career path. Make your career decisions wisely."

"The best piece of advice given to me was by my dad: ask to be on a committee, organise an event, etc., to get that volunteering experience on your CV," she added.

For job opportunities for undergraduates and graduates managing people see info on www.amazon.jobs

"It's all about that decision to send an introduction email to the manager of a project you'd like to get involved in"

Essential leadership skills in chemical engineering and industry

Alumnus Philip Mak shares tips on leadership skills required off chemical engineers.

Chemical Engineering graduate Philip Mak, STEM ambassador for IChemE and a good friend of the department, returned to CEB this year to give a talk on leadership and the skills required for working in Chemical Engineering and industry.

Philip has gained a great deal of industry experience having previously worked as Process Engineer for both British Sugar and BP, before moving onto Recticel to work as a Lead Process and Process Safety Engineer.

The lecture was aimed at all those with leadership responsibilities and at both undergrad and postgrad students interested in developing leadership awareness. Philip introduced key leadership themes and reflected on how these are applied in industry. His talk covered important skills like leading oneself and teams and also shared valuable reflections on technical leadership.

Leadership in industry is essential and chemical engineers are expected to work in multidisciplinary teams and expected to show and take responsibility.

"It is essential to know and understand yourself and others and take time to reflect on preferred working roles considering your own personality style, your preferences and those of others you are working with,' noted Philip. "In industry, leadership is an enabling skill that makes good engineering possible. Cambridge Chemical Engineering graduates have strong technical skills. Being able to influence, motivate and enable others is important. A safety calculation may mean nothing to a CEO, when you are trying to justify capital investment for risk reduction, for example: From a career perspective, many companies look to develop graduates into future leaders. Being open to leadership development is a path for engineers to reach senior roles. All good chemical engineers have the potential to become good leaders. Sadly, the opposite case is not always true - hence the need for strong technical leadership in industry."

If you are a STEM ambassador promoting science and engineering disciplines and careers, or a graduate in industry or academia interested helping us with outreach events please get in touch with Elena Gonzalez on eg314@cam.ac.uk, we'd be delighted to hear from you.

CEB sponsoring BBMS Conference, 13 March 2020

Building Bridges in Medical Sciences Conference 2020.

For the second year in a row CEB is proudly sponsoring Building Bridges in Medical Sciences (BBMS), a well-established biomedical health conference that has been running since 2010. The next edition will take place on Friday 13 March 2020 at Robinson College, University of Cambridge.

BBMS, a free event and open to University staff and student, aims to promote and discuss interdisciplinary medical science, encompassing basic research, public health, policy and industry. The conference has hosted some of the biggest names in the biomedical and health sciences and represents a fantastic opportunity for students and early-career researchers to discuss innovative interdisciplinary research and form valuable connections with colleagues working in different research areas."

Given CEB's strong focus on interdisciplinary research, the association with the BBMS Conference is a good fit. CEB sees this an opportunity to, not only support the conference and what it stands for, but also get our students involved with the local medical student community, expose them to the latest medical advances, and get them network with top researchers in medical fields.

For more info visit www.bbmscambridge.com

Science Festival 2020: "Vision" at CEB, 21 March 2020

The Cambridge Science Festival returns with the theme of "vision" this year and CEB will be opening its doors again on Saturday 21 March following the success from last year when

Science Festival 2020 Credit @camscience

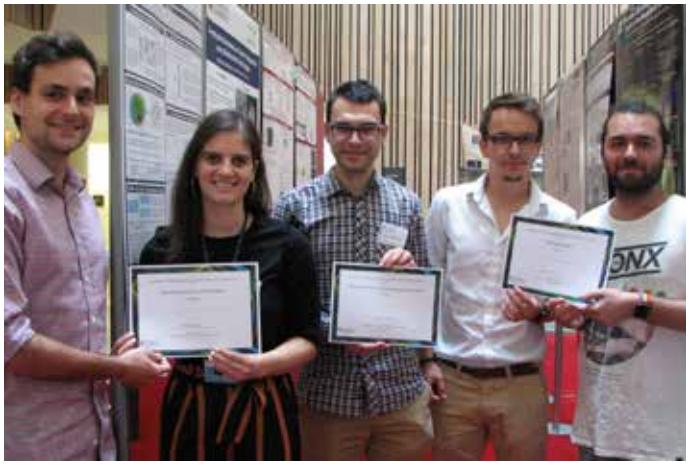
we welcomed a record of over 750 visitors in three hours. About 50 volunteer staff, students and researchers were involved either running science/engineering demos, giving talks or even leading speed-dating sessions with visitors eager to know more about science facts or our teaching programmes and research expertise.

Our enthusiastic volunteers, who wanted to get first-hand experience in public engagement and science communication activities, helped successfully deliver the biggest Science Festival at CEB to date, which was thoroughly enjoyed by all who attended, including many families with children.

This year we are looking to share our 'vision' with the outside world and show the general public how our researchers are working relentlessly to tackle global challenges and make positive impact in the areas of healthcare, sustainability, and energy and the environment.

For more updated info check on www.sciencefestival.cam.ac.uk or our dedicated webpage www.ceb.cam.ac.uk/events/science-festival-2020-vision-ceb, which will be populated with more updated information on activities at CEB on the day.

CEB Research Conference, 29 and 30 June 2020



Best Presentation and Best Poster winners from CEB Research Conference last year.

Our annual Research Conference returns this year to celebrate the multidisciplinary science and engineering discoveries and technology being developed across our department.

With research spanning from sustainable reaction engineering, chemical product and process design, to healthcare, measurement, and materials science, our department combines leading biotechnology research with chemical engineering skill, taking fundamental ideas from concept to application and innovating in the areas of healthcare, sustainability energy and environment to combat the toughest global challenges.

In this two-day conference, you will hear from our PhD students, post-doctoral researchers and academics, and plenary speakers, and get the chance to exchange ideas and build new collaborations. We will bring together researchers and academics from across the University of Cambridge and our extensive network of academic and industrial collaborators. A buffet dinner and drinks reception will beprovided on the first day during the evening poster session.

Industry and academic collaborators wishing to attend please contact our Communications Manager Ellie Hall on erh68@cam.ac.uk. Check updated information on www.ceb.cam.ac.uk/events/ceb-research-conference-2020

Time to rethink agriculture

CEB Focus Editorial Team caught up with Dr Chiara Gandini on intelligent and sustainable agriculture of the future and her research at the Open BioEconomy Laboratory at CEB.

Dr Chiara Gandini, Post-Doctoral Fellow at Dr Jenny Molloy's Laboratory.

Chiara at Slush 2019. Credits: Skolar photographer Vilja Pursiainen, Kaskas Media

Tell us a bit about yourself

I grew up in a small village on the Italian Alps with plenty of nature and silence around me. The professional choices I've made so far during my career were aimed at challenging my views of the world. For instance, I did a degree in Biotechnology because I had strong doubts in the usefulness of genetically modified organisms. It turned out I was wrong. Thereafter, I went on to do a PhD at Ludwig Maximilian University of Munich studying the molecular mechanism of plant photosynthesis. My first post-doctoral experience was at Rothamsted Research and now I'm here in CEB, working with Dr Jenny Molloy.

We recently read something fascinating about your research and your interest in speeding up the growth of wheat crops. Could you elaborate on this please?

The project called 'The Hectare' was born at Rothamsted Research, the oldest agricultural institute in the world, during the BASF's sustainability challenge. 'The Hectare' is a team of four scientists and we believe that if we want to make agriculture sustainable for the centuries to come, we must entirely rethink how agriculture is done today. If we draw back on history, compared to other research fields, agriculture is very similar today to how it was done when it was first invented! We believe it is time to push for a change.

What makes 'The Hectare' innovative?

We want to make indoor farming of staple crops like wheat, a viable reality. To do so, we propose to build a modular and open-source growth chamber. With that, we will be able to assess certain key points - what do we need to make this solution viable? Will a combination of the newest technologies with existing knowledge, be the solution to the challenge? Also, the project will be open, which means that the design, experiments and data will be available online and accessible to as many individuals as possible, to understand and replicate, as needed.

It's interesting to note that the outcome of your project will be open knowledge. What are your thoughts on 'open innovation' and how could we improve that?

We believe that there isn't a single solution found by few people to such a global issue. Different places have different assets for providing energy, technology and resources and we would like the technology to be as amenable to the needs of innovators around the world. Giants like Amazon and Google have already invested millions in indoor farming technologies. It is scary to think that in the future they might have the keys for the resilience of the food system.

We hear that you were nominated recently as a finalist of the Skolar Award 2019. Tell us a bit about the competition and your overall experience.

Participating in the Skolar Award and being a part of the eight finalists was exciting and an immense honour as well. All of us stayed together in a house facing the sea in the four days leading up to the finals. We were trained by an amazing team of Kaskas media on how to communicate science to the public, including journalists, and how we can tap into the potential benefits of social media. During that time, we also had to work on how each of us could best deliver a killing three-minute pitch in front of 2000 people at Slush, the biggest start-up event in the world. It is interesting to note that three out of eight ideas were focussed on food, underscoring its importance and need for further research.

Being a female researcher in a high-pressure and competitive environment, it would seem that one needs their 'survival-of-the-fittest' mode constantly on. What is your advice to young researchers, particularly women?

Keep doing what you like and work hard. Be strong and be nice. Unfortunately, some places aren't conducive for a collaborative effort and you'll need to survive them through resilience. Gender discrimination is one of the main reasons why I don't see myself moving back to Italy. I am particularly impressed and grateful for the efforts put in by Cambridge University and many UK institutions to fight all sorts of discrimination. This will certainly pay off for the economy as well as global research.

If you want to know more about the Hectare, or contact the team, visit www.hectare-indoor.org

Wellbeing at CEB: Yoga with Anthie

Anthie Moysidou, PhD student at Bioelectronics Systems Group

Yoga session with Anthie in one of the department balconies last summer.

It is 31 December 2019, early evening, just after my last yoga class of the year and the decade. Lying in "savasana" (corpse pose), stretched out comfortably on my mat, breathing deeply after a hard workout, reflecting on the past year, just before the new decade kicks. It was this moment when inspiration hit me to write about yoga, yoga and me, yoga and CEB.

Yoga for me started about five years ago, when my pilates instructor suggested that we introduce a couple of yoga sequences to spice up my workout a little bit. So, we started trying different yoga styles, comparing both yoga and pilates principles, the way of breathing to move from pose to pose and we came up with workouts that combined both. Soon after that I realised that yoga means more to me than just a workout, more than just a series of movements. I started catching myself missing the mat and 'craving' a sun salutation. I bought my own yoga mat and started practising at home with YouTube videos and enrolled myself into yoga classes around Thessaloniki (Greece) and around Cambridge for the last couple of years - to try different styles and improve my practice. Eventually, yoga became a way of life. Yoga is my way to step away from the hustle-and-bustle of everyday life in the laboratory, to shift my focus inwards and spend quality time with myself. Yoga gives me clarity and control when I feel I have none and perspective when I feel lost. Yoga allows me to stop and breathe in a place of stillness when I need to be calm or at a moment of energy when I need uplifting, to find contentment in the present moment and to realise that I am, and I do enough. Yoga is my way of self-exploration, of fighting my ego, of learning from my mistakes, of learning how to let things go and keep trying to be a better version of myself. Yoga is the teacher that points the way to humility, kindness, acceptance, forgiveness, compassion, courage, strength, growth, change, hope, freedom and love. Of course, this has not been easy but rather a big challenge that takes time and practice, patience and commitment to oneself, and that is the beauty of it.

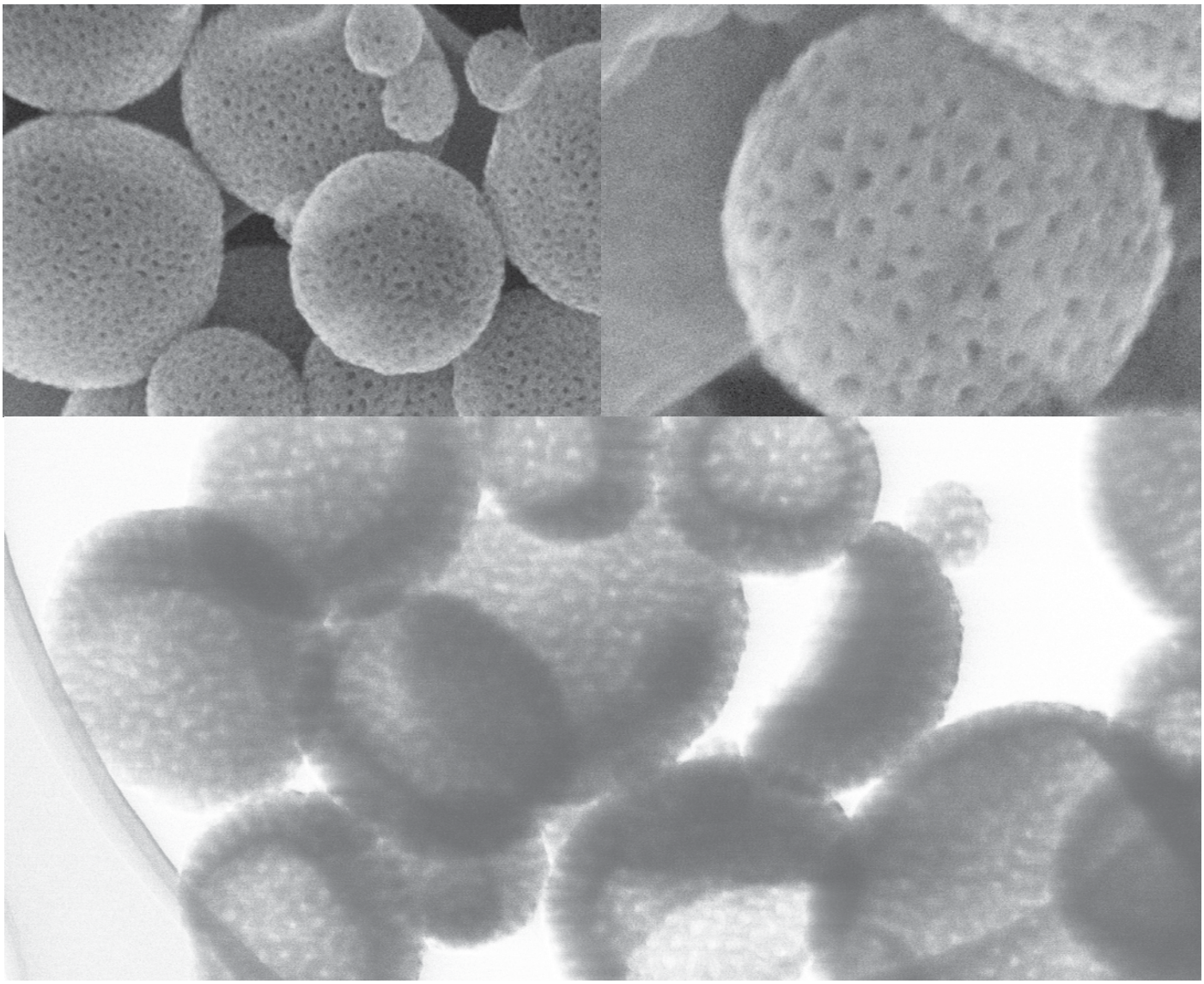
Yoga is the thing you want to share with everyone and the only way to give back to something that gives so much. The wonderful thing about sharing one's practice is that yoga might mean something totally different to everyone and by sharing our practice we find and establish a common ground between us all which is the aim of yoga sessions at CEB. I have been lucky enough to share my practice with CEB friends and colleagues the past couple of months. It all started when friends prompted me to take a break from laboratory work and practise with them, just for fun, just between us. We practised a couple of times last winter, but we couldn't find a quiet and cosy area in the department to inspire us, we didn't have enough mats, we were busy and so the whole yoga thing got side-lined in favour of our PhD life. Then, summer arrived and during lunch someone suggested we did a yoga flow under the sun in the department balcony. Since then, a fun activity between friends at work has become something more. We all know that the PhD and academic life is hard – we all share the same stress, fears and anxiousness, we all have moments when we feel overworked, lost, disappointed or that we are not trying hard enough. However, we hardly ever share these feelings with our colleagues and teammates, only to feel more stressed, alone and helpless.

I hope that our little yoga community at CEB has created a space for everyone to meet, share their time and energy, their thoughts and feelings in a safe and relaxed environment, to find support and help when they need it or to just take a break, to stretch and work out, to make friends and have fun. Graduate Researchers' Society (GRSoc) has been a great support for this initiative by advertising our activities and motivating me, just a passionate yogi, to keep sharing my practice. One of my hopes for 2020 is that the commitment and excitement of my fellow CEB yogis will break the stereotype that yoga is only for strong and flexible individuals or yoga is only for women with the 'Instagram yoga body type'. Yoga is for EVERYONE – just be open-minded and have willingness to grow. We, and your mat, got your back!

We usually practise every other Thursday at 6pm in the department atrium or balcony. The department has kindly provided a few yoga mats for us to practise.

Check out Anthie's work in Bioelectronic Systems Technology (BEST) group on www.ceb.cam.ac.uk/research/groups/best and Graduate Society activities Facebook www.facebook.com/groups/GRSoc

Did you know...?



Melanin-like nanoparticles imaged using STEM

Porous melanin-like nanoparticles

Melanin is a natural pigment and has diverse roles and functions in various organisms. As synthetic mimics of naturally occurring melanin, polydopamine nanoparticles have been investigated for tissue engineering, bioimaging, biosensing, catalysis and drug delivery. These different applications desire particles with different properties, size and shape. By using templating agents we can introduce pores to this material, which significantly increases its loading capacity. Electron microscopy has been used to investigate the detailed structure and surface topography of these porous nanoparticles.

Dr Andrea Bistrovic, Bionano Engineering Lab www.fruk-lab.com

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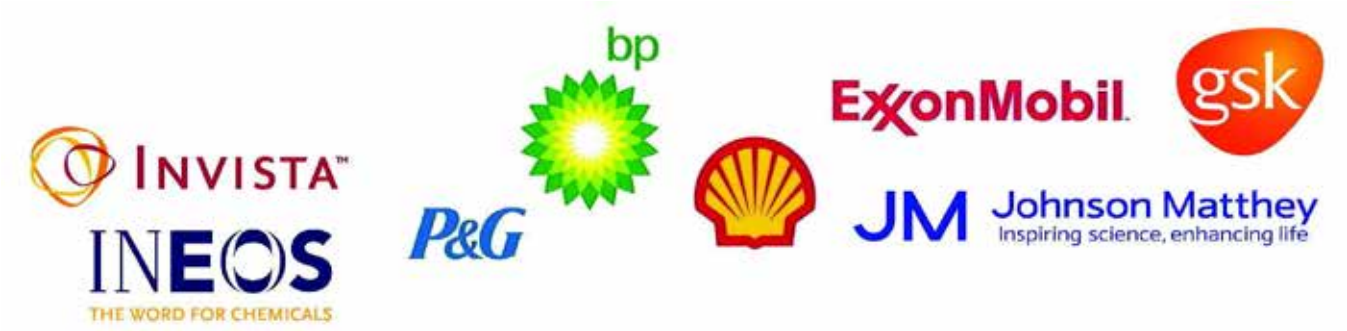

For more information on the CEB Teaching Consortium

visit www.ceb.cam.ac.uk/undergraduates/teaching-consortium

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