UNIVERSITY OF Southampton

July 2021

ADVANCING LIFE SCIENCES

Institute for Life Sciences

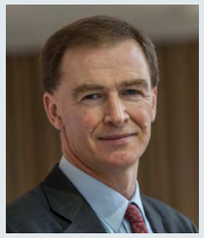
Spotlight on:
Working in partnership

News and features:
Understanding the long-term effect of COVID-19 on the lungs

Publications:
A sample of research outputs from our PhD students

FOUNDING MEMBER OF THE RUSSELL GROUP

WELCOME



The Institute for Life Sciences (IfLS) is marking 10 years since its launch in 2011. Throughout, the Institute and its members have demonstrated the power of interdisciplinarity and working in partnership with real-world impact.

The IfLS' mission is to facilitate a convergence of expertise, broadening opportunities to transform key challenges in health, society and enterprise. Our aim is to draw together communities in areas of strength and support interdisciplinary research initiatives.

During the pandemic, this came into sharper focus where IfLS members pivoted research activity towards COVID-19 and there are some exciting examples of this in the current annual report.

Engagement with regional partners, such as the University Hospital Southampton NHS Foundation Trust, was paramount throughout and we continue to develop such partnerships to improve our region's health and economy.

This year's Annual Report captures the spirit and impact of working in partnership.

Professor Peter JS Smith
Director of the Institute for Life Sciences
University of Southampton

The importance of Life Sciences research at Southampton and the strength of our community came to the fore during the Covid-19 pandemic. Our investment in an interdisciplinary culture and research excellence yielded exciting contributions and mitigations for the global pandemic. We witnessed teams forming to conduct the necessary research and deliver effective solutions at extreme pace, with colleagues from across clinical and biomedical sciences, engineering, psychology, health sciences, data and physical sciences coming together, developing new ideas and innovation .

Engagement with key partners, including the University Hospital Southampton NHS Foundation Trust and local businesses, was a key element in our response and exemplified our role as a civic University contributing to the health and economy of the Wessex region. Partnership was essential and this Annual Report highlights just how much can be done when we are agile, collaborative and focused.

Professor Mark Spearing
Vice President, Research and Enterprise
University of Southampton

Front cover image credit: Professor Max Crispin. Digitally rendered image of SARS-CoV-2 viral spikes induced by the Oxford/Astra Zeneca vaccine.

Find out more:
www.southampton.ac.uk/life-sciences

CONTENTS

ENERGISING OUR PARTNERSHIPS IN A CRITICAL YEAR

Image credit: Professor Max Crispin.
Digitally rendered image of SARS-CoV-2 viral spikes induced by the Oxford/Astra Zeneca vaccine.

Find out more:
www.southampton.ac.uk/life-sciences

As the global pandemic struck, researchers and clinicians around the world concentrated on meeting the many challenges that arose every day.

In Southampton a unique collaboration between the University and University Hospital Southampton formed to deliver an extraordinary and productive effort – from developing vaccines; producing personal protective equipment; trialling saliva testing programmes; reducing the spread of the disease; and analysing and managing data to try and reduce the burden on hospitals.

The Institute for Life Sciences (IfLS) played a leading role in coordinating the response to drive forward research and find solutions to the ever-changing environment.

The IfLS' extensive experience in encouraging and supporting interdisciplinary research projects put its members in a prime position to activate existing networks and work with the global effort to better understand and address the COVID-19 pandemic.

Responding to the pandemic

"As a civic University, we had already developed close networks with regional institutions such as the councils and Local Enterprise Partnerships, fellow higher education institutes and hospital NHS Trusts, so the partnerships were already in place to be able to react immediately to the growing, changing situation," said Professor Peter JS Smith, Director of the IfLS.

"We had previous experience of working together in the regional arena with networks such as FortisNet, IDeAC and Health Data Sciences. All of these activities had built up networks of individuals both within the University, regionally and nationally, but most importantly with the University Hospital Southampton NHS Foundation Trust (UHS).

"When COVID-19 struck, we could immediately be proactive and pivot our activities and our resources into the pandemic-response. It was a time of great uncertainty, and no-one knew what was going to happen. IfLS played a key role in a rapidly formed response committee made up of research leaders from the University and UHS who came together to prioritise research. In some cases, IfLS invested funds to support COVID-19 research projects, such as PeRSo, which had an immediate impact on the emergency response.

"This quick turnaround demonstrated the existing network of trust that had developed over the years – our academics were already very conversant and comfortable with the idea of interdisciplinarity and, through the Institute, could be put in touch with the right people to work with. The speed at which we were able to adapt activities and respond is a reflection of the interdisciplinary culture that had already developed."

Christine McGrath, Director of Research and Development at UHS, said: "Our research partnership with the University has been over 15 years in the making.

"We usually deliver around 800 studies at any one time. When COVID-19 hit, we turned all of that on a pin head at phenomenal speed. Within days we'd paused all studies, except those patients' treatment depended on. Our entire infrastructure then redeployed to research tackling COVID-19.

"The partnership with the University was crucial to that response. We'd long established the relationships, trust, governance and quality assurance. That's what allowed us to pivot and go so quickly.

"Together we delivered on prevention, testing and treatment. That includes over 16 vaccine trials. Southampton's a big part of the AstraZeneca-Oxford jab story. It includes rapid point of care testing. That entered frontline service here within two months and went NHS-wide by the winter. It includes multiple treatments through the RECOVERY trial and others. The progress of University spin-out Synairgen's inhaled Interferon Beta is a major highlight.

"The relevance and value of our joint research has never been higher among our staff and the public. In the teeth of the pandemic we have delivered answers, with them and for them. I think that for everyone, the experience intensified and made real-time the direct benefits of our research."

Peter added: "During the first wave of the pandemic, a lot of our people put everything else to one side and focused their time and energy on the challenges that COVID-19 raised. The IfLS community responded spectacularly well and put their whole lives into it. Less critical activities went on the back burner as efforts were prioritised towards the crisis.

"Ten years ago, the University made a long-term investment into interdisciplinary working with the creation of the IfLS and this has been recognised with the important role that the IfLS played in the COVID-19 response. Now we are looking at how we can sustain and develop that spirit of regional collaboration, while also supporting our academic colleagues in finding solutions to pressing problems and challenges in the life sciences.

The future

Although interdisciplinary networks were in place prior to the pandemic, COVID-19 shone a spotlight on the great importance of long-term regional structures and engagement.

This was exemplified during the early days of the pandemic through a regional competition run by three Wessex universities - Southampton, Portsmouth and Bournemouth - who joined forces in a mission to address the wide-ranging challenges of COVID-19. The competition yielded a strong response and nine innovative projects at the three universities were awarded funds to progress their ideas.

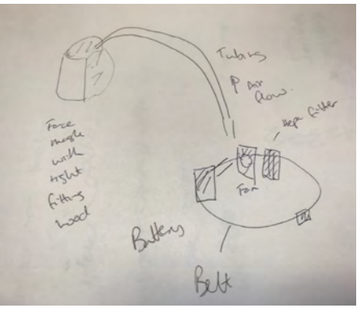
The IfLS is part of a group of institutions working to create a formal network – Wessex Health Partners – that will address and improve the health of people in the Wessex area. They will sculpt a national exemplar for working across disciplines to address health needs.

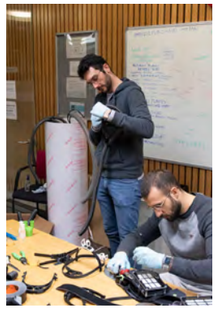
Incorporating the higher education institutions in Southampton, Portsmouth and Bournemouth with the regional local authorities and NHS trusts, the partnership aims to create mechanisms to identify health or operational needs and engage the academic community in driving technology and data capabilities to achieve improvements in health.

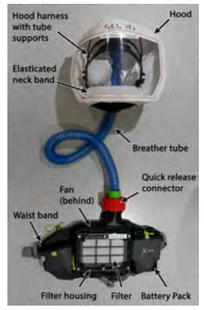
Peter said: "Our primary driver is the realisation that by acting together, we can significantly improve our region's economy and our health."

Find out more:
www.southampton.ac.uk/life-sciences

Research excellence in action: We look at some of the ways in which we rose to the challenge of COVID-19:







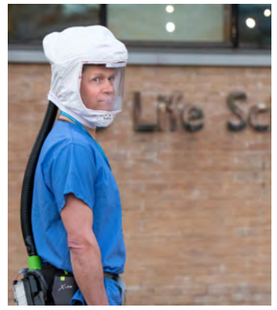


Image credit: Ric Gillams. The development of PeRSo: from concept sketch, design build by members of the PeRSo team to the prototype worn by Professor Paul Elkington.

Pioneering personal respirators

As the country went into the first lockdown, Professor Paul Elkington, an academic in Medicine and a University Hospital Southampton (UHS) clinician, initiated a project in partnership with IfLS Deputy Director Professor Hywel Morgan, from Electronics and Computer Science.

The IfLS helped assemble a team of University engineers, UHS clinicians and industry partners to develop a pioneering protective respirator – PeRSo.

In less than a week, the team created a prototype of the respirator which went on to be used by frontline healthcare staff treating COVID-19 patients around the country.

The project was an enormous and complex effort with lots of people collaborating at different stages. Partners such as McLaren Racing and Kemp Sails made a considerable contribution to the early stages, while the commercial manufacturer, INDO Lighting and UHS the first client, were critical to the success of the project throughout.

Protection from exposure to the SARS-CoV-2 virus and healthcare staff user needs were paramount to the prototype development. The respirator hood covers the wearer's head and has a plastic visor to protect their face. It delivers clean air through a High Efficiency Particulate Air (HEPA) filter with belt-mounted fan pack and can be worn throughout a long shift and reused after appropriate cleaning.

The device was well-received by UHS staff who were involved in the user testing. Dr Becky Egglestone, a doctor on the general intensive care unit at UHS, said: "We were extremely grateful for all the work that the team put into producing the PeRSo hoods. They are much more comfortable than alternative personal protective equipment (PPE), which makes a huge difference to us during our long shifts.

"Being able to see each other's faces makes it easier for our team to communicate, and knowing that patients take comfort from being able to see the faces of the people looking after them is a boost to morale."

Peter Baker, Programme Director at UHS, said: "Linking academic, clinical, and industrial expertise to respond to the pandemic by bringing a critical product to market at such speed was a great example of the strength of the relationship between the organisations."

The first PeRSo to enter production was the PeRSo 3.0 which achieved BSI and HSE approval for use in healthcare during the pandemic, via a streamlined regulatory process. HSE guidelines state that a powered air purifying respirator (such as PeRSo) is a better PPE option when the user has to wear a tight-fitting mask for more than an hour. In fact, no staff member who was issued with a PeRSo during the initial peak was infected with SARS-CoV-2. In the second wave, over 3,600 PeRSos were in use at UHS, requested by staff.

Professor Mark Spearing, the University's Vice-President (Research and Enterprise), said: "PeRSo is a triumph of ingenuity at a time of global adversity and national emergency thanks to the collaborative efforts of like-minded colleagues from across the University of Southampton and key partners from industry."

The concept was published open-source rapidly and made available to other manufacturers and organisations around the world. The team also worked with people in developing countries to create simpler prototypes making it clear, in each case, that the devices must pass local safety regulations.

PeRSo prototypes and examples of the commercial products have been donated by request to museums including the Southampton City Museum for historical reference and potential future COVID-19 exhibitions.

Paul and Hywel were recognised for their work with MBEs in the 2020 Queen's Birthday Honours. The team also received a Royal Academy of Engineering President's Special Award for Pandemic Service and the SETsquared 2021 Impact Award.

Read the paper A Personal Respirator to Improve Protection for Healthcare Workers Treating COVID-19 (PeRSo).

Image credit: Ric Gillams. Decontaminating a PeRSo prototype at UHS in March 2020.

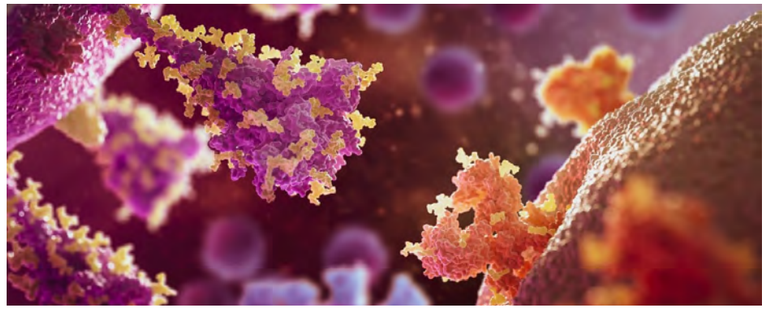


Image credit: NEXU Science Communication and Professor Max Crispin. Digitally rendered image of SARS-CoV-2 viral spike near the ACE2 receptor.

Supporting demand for PPE safety fitting

The MisSo team, involving staff from Medicine and Chemistry worked around the clock to produce supplies of vital solutions used to ensure facemasks for healthcare workers were fitted safely.

As COVID-19 spread, an unprecedented demand for facemasks was created as part of the personal protective equipment (PPE) for staff working on the frontline in hospitals and throughout the healthcare sector.

As each facemask was adjusted to the individual wearer's face, the increase in the number of masks led to a subsequent rise in demand for solutions to test the seal is fitted correctly. If the wearer can taste the flavour whilst performing certain exercises, then the mask is not fitted correctly as droplets must have penetrated the seal.

In order to ensure their hospital colleagues had enough testing solutions, University staff transformed labs into a full-scale production, testing and distribution facility, and in just over a week produced the first batches of solutions.

Professor Gill Reid, the University's former Head of Chemistry, said "Our colleagues on the frontline of the COVID-19 pandemic were doing amazing work and we were keen to do our bit to help them stay healthy and keep caring for the people who needed their support.

"Our team carried out every phase of the process from bringing in the raw materials and equipment we needed, making up batches of the solutions, sterilising, bottling, rigorous quality testing and labelling, then finally packing and distributing."

The team produced standard operating procedures for the production and testing of their solutions which were made open source so that institutions around the country had the information they needed to help make sure there were enough supplies produced nationally.

Revealing the coronavirus camouflage

A team led by IfLS Member Professor Max Crispin, from Biological Sciences, worked with colleagues at the University of Oxford to compare for the first-time images of the protein spikes that develop on the surface of cells exposed to the Oxford AstraZeneca vaccine, with the protein spike of the SARS-CoV-2 coronavirus.

The images showed that the spikes were highly similar to those of the virus and supported the modified adenovirus used in the vaccine as a leading platform to combat COVID-19.

The work builds on previous research, led by Max, that revealed the fundamental features of the SARS-CoV-2 coronavirus, which causes COVID-19. Max's team also included PhD students Yasunori Watanabe and Joel Allen.

The study showed that the virus has a large number of spikes sticking out of its surface that it uses to attach to, and enter, cells in the human body. These spikes are coated in sugars, known as glycans, which disguise their viral proteins and help them evade the body's immune system. These are the target of antibodies and vaccine research.

The vaccine developed by the University of Oxford and AstraZeneca is an adenovirus-vectored vaccine, which involves taking a safe version of a virus and adding in the information from part of a pathogen, in this case the SAR-CoV-2 spike, in order to generate neutralising antibodies against that target. Key vaccine trials took place at Southampton.

Max, a Professor of Glycobiology, said: "In this study we set out to see how closely the vaccine induced spikes resembled those of the infectious virus. We were really pleased to see a large amount of native-like spikes.

"This study will hopefully provide further understanding for the public, helping them see how the Oxford-AstraZeneca vaccine works. Many people may not realise how their cells become little factories manufacturing viral spikes that then trigger the immune response needed to fight off the disease. This may also provide reassurance that the vaccine is doing its job and generating the material that we need to present to our immune systems."

The study was published in ACS Central Science.

IMPROVING WEARABLE DEVICES

Image: Dr Kai Yang printing electronics on textile for wearable healthcare applications.

Technology, textiles and health sciences partnerships, led by Institute for Life Sciences (IfLS) members are enabling research into a range of devices that interact with the skin.

Smart textiles to ease the pain of osteoarthritis sufferers

The pain of osteoarthritis sufferers in the UK could be relieved, thanks to the interdisciplinary work of IfLS member Dr Kai Yang.

Kai, an Associate Professor in Textile Design, has been working for a number of years on research to develop an e-textile knee brace that helps ease the pain generated by the condition.

Osteoporosis is a leading cause of pain and disability that affects people's independence and quality of life, and represents a massive burden on NHS resources. The number of people with osteoarthritis-affected knees is estimated to increase from 4.7 million to 8.3 million by 2035, due to the UK's ageing population, obesity and physical inactivity.

Kai's research has explored the use of e-textile technology as a therapeutic application enabling self-management of healthcare conditions to help people feel better and live longer. She is nearing the end of a £600,000 EPSRC Fellowship which has seen her collaborate with colleagues in Health Sciences and industry to develop a functional working prototype.

She said: "People who are in severe pain are less mobile and this technology could enable them to become more independent, engage in more activities and experience better health for longer. Wearable e-textiles will provide a comfortable to wear, easy to use and cost-effective solution to end-users."

Kai, who was previously based in Electronics and Computer Science at the University, has recently moved to the University's Winchester School of Art (WSA) to further develop the material and appearance of the device.

She said: "My research so far has focused on developing the technology, but now I want to make the device as comfortable and aesthetically-pleasing as possible. By being integrated into WSA I can benefit from their innovative textile expertise. My undergraduate degree and PhD were in textiles so I feel like I am coming full circle. I am disseminating my research to students and colleagues throughout the WSA; and building collaborations with colleagues to deliver a fit for purpose solution that can benefit people with osteoarthritis joint pain."

The next stage of Kai's research is to apply for further funding to undertake product development and clinical trials. Throughout the project she has continually consulted the end-users and clinicians to incorporate their views on the design and functionality. She also works closely with industry to gain useful insight on market needs and scalable manufacturing.

She said: "The IfLS has been really supportive in enabling me to consult with a wide network of people, particularly through FortisNet - an interdisciplinary hub of expertise in regenerative medicine, orthopaedics, prosthetics and assistive technologies launched by the IfLS."

Find out more:
www.southampton.ac.uk/life-sciences

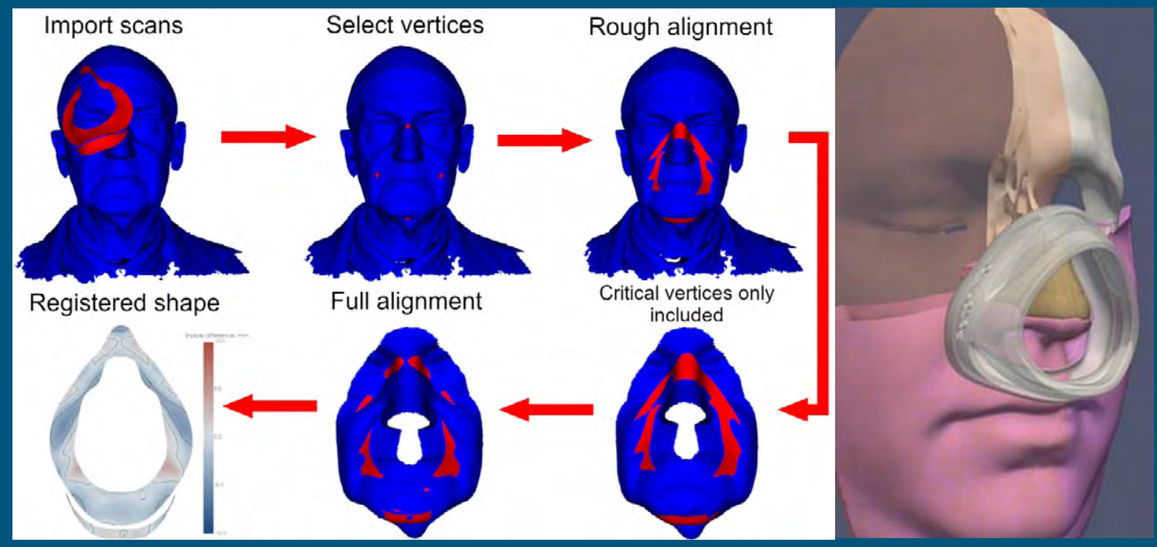


Image: A semi-automated algorithm to analyse respiratory mask fitting and assess their goodness of fit across population data.

Image: A computational modelling platform to support the pre-clinical design of respiratory masks using finite element modelling (University of Southampton, Radii and Philips collaboration).

Creating perfect fitting face masks

As the COVID-19 crisis hit last year, Southampton academics quickly adapted their IfLS-supported research into developing perfectly fitting face masks.

A team of interdisciplinary researchers from Health Sciences and Engineering, led by Professor Dan Bader, had been working together for the past five years exploring how non-invasive ventilation mask designs can be optimised to fit better and protect skin health for vulnerbale patient groups.

This formed a key theme of their EPSRC-NIHR Medical Devices and Vulnerable Skin Network and their work subsequently resulted in collaborative projects with industry leaders. One of these projects was led by Dr Peter Worsley, from Health Sciences, Dr Alex Dickinson, from Engineering, and a former IfLS-supported researcher, Dr Joshua Steer, who secured a combined research and enterprise project with Philips Respironics to create a novel testing platform for non-invasive ventilation mask designs. The project represents a collaboration between the University and their startup company Radii Devices – which was formed during Joshua's Royal Academy Enterprise Fellowship.

But as coronavirus spread and the requirement for FFP3 – the 99% filtration masks worn by clinicians – rose, the team were in a prime position to adapt their research to look at the fitting of these masks as well.

Peter said: "We were able to translate the work we had done with non-invasive ventilation masks and apply it to the respirator masks, as similar problems applied.

"The masks are based on generic designs, with standards based on an average white male face shape. As a result, many devices do not fit the diverse population of healthcare workers in the NHS. Where masks do not fit adequately, they are often strapped tightly to the face to achieve a good seal. However, this introduces things like skin reactions and pressure ulcers for the people who wear these masks regularly or for long periods of time."

The research has resulted in two complementary projects, funded by both the UKRI 'BE-SAFE RPE' and the IfLS 'COMFY'. The former project is in collaboration with Cardiff University, NHS England and NHS Improvement, industry partners Hybrisan and Additive Instruments Ltd, and the National Police Coordination Centre.

The latter project is led by Professor Ying Cheong, supported by Academic Clinical Fellow Dr Jagrati Chopra, from Medicine, and Dr Hansung Kim, from Electronics and Computer Science, working with Peter and Dr Cheryl Metcalf from Health Sciences.

The 'BE-SAFE RPE' project is using state-of-the-art computer software and MRI facial scans to precisely determine how face masks interact with different face shapes and sizes.

The project team is creating a series of designs and material interfaces that can accommodate a range of face shapes. The 'BE-SAFE RPE' and 'COMFY' projects are also working in collaboration to create technologies for contactless mask fitting using camera sensors to 'choose' the best mask for individual users.

UNDERSTANDING ADOLESCENTS' MENTAL AND PHYSICAL HEALTH

The COVID-19 pandemic and subsequent lockdowns, social distancing and ensuing restrictions have affected people's mental and physical health, not only in the UK but around the world.

The Institute for Life Sciences (IfLS) has supported a number of collaborative projects exploring the impact, particularly on young people, and how improvements could be made to the messaging and support available to them.

Better informing 'lost and anxious' young people during the pandemic

Understanding the impact of COVID-19 restrictions on young people and how they could be better supported during the pandemic, was the basis of a study funded by the IfLS at Southampton.

The Teenagers' Experience of COVID-19 (TeC-19) project involved ten groups of young people being consulted at various stages throughout lockdown to understand what they thought about government messaging, how they dealt with the restrictions on their freedom of movement, what support they felt would have helped them to stay at home and their views on potential approaches to safely coming out of a national lockdown.

The study was carried out by IfLS members from Medicine's MRC Lifecourse Epidemiology Centre and the Southampton Education School who sought the views of young people at regular intervals during the first year of the pandemic.

TeC-19 Programme Manager Dr Sofia Strommer said: "Generally, they felt decisions were being made without anybody consulting them, nobody was able to tell them how it was going to impact their future, and the messaging wasn't really directed at them. They wanted to feel more included and to be heard better in government decision-making."

Initial findings also revealed that young people in Years 11 and 13 said they felt particularly lost and anxious because their education had been suspended abruptly with their national exams cancelled.

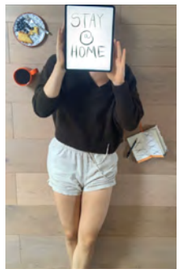


Image: TeC-19 'What does lockdown mean to young people?' photo competition winner.

TeC-19 lead Professor Mary Barker, Professor of Psychology and Behavioural Science, said: "Lockdown for young people was clearly a very difficult experience. In our conversations with them, we found them to be well-informed, articulate and very clear about the support they needed. It was beholden to us to listen to their voices and work with them to find ways of minimising the long-term negative impact on them of this extraordinary, unprecedented experience."

The TeC-19 team worked with Southampton City and Hampshire County councils sharing the outcomes of the adolescent focus groups and advising them on how they could better address and engage young people during the pandemic by using social media channels to ask questions of the young people on behalf on the councils, such as their views on the introduction of weekly testing.

More recently, the team has been collaborating with colleagues at the University of Edinburgh and University College London, who have also carried out projects exploring young people's feelings during the pandemic.

Their work is now spreading further afield with sustainable development-funded surveys in Ethiopia, Ghana and India; and self-funded mirror studies in Canada and South Africa.

Find out more:
www.southampton.ac.uk/life-sciences

Supporting families with vulnerable children

Southampton researchers joined with colleagues from the University of York to better understand how best to address the concerns of families with children and young people with serious conditions who may be feeling particularly vulnerable during the COVID-19 outbreak.

The SHARE study was designed to urgently understand the specific needs of these families as they faced these extraordinarily stressful circumstances and received funding support from the Southampton Coronavirus Response Fund: an emergency fund set up by the University that helped protect lives by accelerating response to the pandemic, globally and in the community , and a children's cancer charity.

Image: Twitter recruitment image – Children's Cancer and Leukaemia Group.

The SHARE study surveyed the families of children with cancer, cystic fibrosis, life-limiting conditions, hydrocephalus, congenital heart disease, and a kidney condition, in conjunction with national charities, the University Hospital Southampton NHS Foundation Trust and The Leeds Teaching Hospitals NHS Trust.

Professor Anne-Sophie Darlington, Professor of Child and Family Psychological Health and Principal Investigator, said: "During the COVID-19 outbreak, children and young people with cancer and other serious conditions felt more vulnerable, for example because of their weaker immune system during treatment, and their families constantly needed to assess the information they received.

"The information provided through established media outlets and social media was constant and ever-changing, and not always stable or reliable. Whilst we recognised that many people and organisations were doing what they could to provide support interventions and materials aimed at helping children and young people, it was only through investigating the first-hand experiences of the children, their parents and carers that we were able to advise on how to tailor and provide the right support they needed to reduce distress and anxiety."

"For example, our study revealed that people were scared of taking their child into hospital for appointments and/or treatment as they had a vision of hospitals being unsafe environments, but in fact the reality was very different, so we published a video on TikTok of a doctor reassuring children and families about hospitals."

The survey also showed that it was important to parents to receive reliable information targeted to their child's condition on which they could base their decisions. Most of the initial information that was provided was aimed at adults who were shielding, not young people in the same situation.

The SHARE team worked in partnership with the national charities to address these issues and put out timely, consistent and reassuring information.

Find out more about the project here.

Exploring the impact of the pandemic on global communities

IfLS member Professor Samuele Cortese took the UK lead in the largest worldwide study into the mental and physical impact of the COVID-19 pandemic.

The Collaborative Outcomes study on Health and Functioning during Infection Times (COH-FIT) surveyed people from more than 100 countries around the world about their mental and physical wellbeing, access to care and coping strategies.

The aim was to establish the short- and long-term impact of the pandemic and whether lockdown restrictions placed different sections of the population at different risk of developing physical and mental health problems. It also explored what protective measures people were putting in place to mitigate against these problems.

Samuele, Professor of Child and Adolescent Psychiatry at Southampton, said: "We collected anonymous information on adults and - with parental consent - adolescents and children aged six and older. It is planned in three stages – before, during and after the pandemic - looking at the different pressures experienced during the first lockdown, coming out of lockdown, going back into lockdown, and adapting to the 'new normal'.

"Due to the large number of countries involved in our study, we are in a unique position of being able to compare data across different countries and across different sub-sections of society."

First findings revealed that while for some people lockdown raised their anxiety, others appreciated the opportunity of a slower pace of life and more time to spend with families or doing hobbies.

The COH-FIT study was supported by the Association for Child and Adolescent Mental Health, and the UK team included academics from Kings College London, the University of Bristol, the University of Greenwich and Manchester University.

"We are planning to disseminate the results of the project nationally and internationally to the scientific community with the aim of helping to develop targeted interventions for persons at particularly high risk. We hope that our findings will help inform health policies in the UK and internationally" said Samuele.

COUNTERACTING THE SPREAD OF INFECTION

Image: Professor Bill Keevil

Find out more:
www.southampton.ac.uk/life-sciences

The COVID-19 outbreak highlighted the need to be extra vigilant about sanitisation to prevent the spread of the virus. A wide variety of research was being carried out to discover the best way to minimise the risk of infection, from washing hands, sterilising medical equipment, cleaning surfaces to protecting food products.

Researchers at Southampton have a long history of research in this field - investigating the length of time viruses and bacteria can remain on surfaces, exploring the effectiveness of various decontamination methods, as well as a particular focus on the antimicrobial benefits of copper.

IfLS members from Biological Sciences, Health Sciences and Engineering have played a key role leading much of this research. Their expertise, experience and established network of contacts meant they were ready to hit the ground running when the pandemic struck.

Over the past year, they have been working with a wide variety of UK and international companies. Here we look at how their work is making an impact:

Image: Dr Sandra Wilks

Image: HYGI-Group install the first anti-microbial metal to replicate stainless steel.

The antimicrobial uses of copper

Professor Bill Keevil with Dr Catherine Bryant, from Biological Sciences, and Dr Sandra Wilks, from Health Sciences, have been working on research into the antimicrobial use of copper and its protection properties against fungi, bacteria and viruses.

Bill published a paper in 2015 investigating how human coronavirus 229E, which is closely related to SARS-CoV-2, remains infectious on common touch surface materials such as stainless steel and how it can be rapidly inactivated on a range of copper alloys.

Bill said: "At the time very few people were publishing papers about coronavirus, so when COVID-19 began this was one of the key papers in this field of research. It meant we already had the foundation knowledge, had proved the antimicrobial properties of copper alloys and demonstrated their ability to kill a range of harmful bacterial and viral pathogens including MRSA and SARS-CoV-2.

"We were in an ideal position to respond to the global need to drive this research forward."

Their findings had already led to the installation of antimicrobial touch surfaces globally in hospitals, in supermarkets, on public transport and in a busy airport, and this has been further expanded during the pandemic.

The interdisciplinary team has been working with companies to test the effectiveness of solid copper and copper alloy materials and coatings in combatting the spread of COVID-19.

There was a major breakthrough when the production of the first copper alloy that looks like stainless steel was developed by the HYGI-Group in Devon. The HYGI-Metal alloy was tested by Bill and his team and was shown to inactivate the COVID-19 virus which previous work with the human coronavirus 229E revealed was due to disruption of the viral coat and destruction of the RNA genome.

Push plates, made from the product, have already been installed at the 2020-21 European and England rugby champions Exeter Chiefs changing rooms to enhance player safety.

Mark Isaacs, Exeter Chiefs' Stadium Manager, said: "They make a real difference in our changing areas for our players and create a safer environment for all the players and staff here."

Bill concluded: "HYGI should be very pleased by what they have done. This new alloy should have widespread use as a replacement for stainless steel."

The team has also been working with Copper Cover Ltd to show that their copper powder spray inactivates SARS-CoV-2 in as little as one minute. The powder is cold sprayed at high velocity, forming a bond with the base metal, stronger than a weld and producing a permanent, antimicrobial coating. They have `copperised' door, trolley and fridge handles at Morrisons, in Totton, and several door handles in Building 85 at the University.

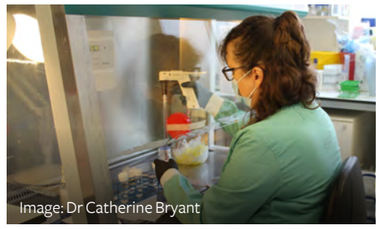


Image: Dr Catherine Bryant

Food products and packaging

The Southampton team has recently been commissioned by the Food Standards Agency (FSA) to carry out research exploring the survival of SARS-CoV-2 on the surfaces of various foods and food packaging materials at a range of temperatures, humidity levels and time periods.

They are conducting laboratory-based studies to artificially inoculate infectious SARS-CoV-2 virus onto these surfaces and then measure how the amount of infectious virus present on those surfaces declines over time.

The FSA completed and published a risk assessment in 2020 concluding that it was very unlikely that you could catch coronavirus via food.

The findings from the Southampton research will be used to confirm this assessment.

Decontamination of face masks

An interdisciplinary team including Bill, Dr Minkwan Kim and Professor Bharathram Ganapathisubramani, from Aeronautical and Astronautical Engineering, alongside project partners from George Washington University, the RB Group, JSP Ltd, Voltera and Air filtration Solutions, has been combining state-of-art plasma technologies and printed electronics to enable the safe reuse of face masks and respirators.

The research is fabricating a dry decontamination method, known as a 'plasma brush', to treat masks that have made contact with coronaviruses.

The rapid decontamination system would allow people to safely re-wear previously single-use face masks, helping safeguard against a global PPE shortage, and minimise the thousands of tonnes of plastic waste pollution being generated by disposable masks.

The technique of decontaminating face masks was applied to the development of the PeRSo respirator hood to enable it to meet regulatory requirements.


Image: Professor Paul Skipp

GAINING INSIGHT INTO COVID-19 THROUGH DATA

As COVID-19 spread around the globe, the collection and use of data played a vital role in how the world reacted to the pandemic.

Large amounts of data were accessed and analysed in unprecedented ways, providing a multitude of insights as we battled to get the virus under control.

From analysing how the virus was being spread, to the number of deaths, to shortages in hospital resources, to reducing infection by test and trace, data was used to reveal the global picture as it changed day by day.

Here we look at how experts in data research and analysis at Southampton were involved.

DRAGON project joins fight against coronavirus

Southampton scientists are leading the molecular phenotyping in a €11m EU-funded international consortium for COVID-19 advanced diagnostics.

The three-year DRAGON project is designing and building a patient-centred system that will enable more rapid and precise diagnosis and prognosis. They are collecting and using imaging and molecular phenotyping data of COVID-19 patients from across Europe. By using artificial intelligence (AI) techniques, they are creating a system to inform medical decisions about patient care.

The University, in collaboration with its spin-out company TopMD Precision Medicine, is contributing its expertise in molecular phenotyping for AI-assisted biomarker discovery for diagnosis and prognosis. Molecular phenotyping uses the quantitative measurement of thousands of biomolecules such as genes and proteins to measure biological pathway activity in order to better understand diseases and lead to improved diagnostic and treatment approaches.

As well as TopMD, the project also involves academics from Medicine and Biological Sciences at the University. It aims to use federated machine learning to analyse the large datasets and develop a patient-centred diagnostic support tool.

IfLS member Paul Skipp, Professor in Proteomics and Co-Founder of TopMD, is one of the leaders of Southampton's contribution to DRAGON. He said: "We are using AI and federated machine learning approaches to improve healthcare decision-making by putting patients front and centre. We are creating a platform that can securely capture big data from multiple locations across Europe, to rapidly identify which patients are likely to go on to be affected more severely and which patients are likely to experience milder symptoms and can recover at home."

DRAGON is being led by OncoRadiomics, a Belgian company that uses AI to develop medical products and services, in partnership with 21 SMEs, academic research institutions, biotech and pharma partners, patient-centred organisations and professional societies from the UK, Belgium, China, Italy, the Netherlands and Switzerland. Citizens and patients are also key partners in the development of the system.

The Southampton team is also participating in a national multi-centre trial using targeted proteomics to deliver a rapid and sensitive diagnostic test for SARS-CoV-2 which has recently been validated for use in clinical laboratories. The next steps are to validate multiplexed assays for seasonal winter illnesses and SARS-CoV-2 variants of concern. The legacy of this collaborative network will be the development of a diagnostic infrastructure that will expand the capabilities of NHS routine diagnostic services to increase the efficient delivery of healthcare and precision medicine.

Exploring the ethics of health data

Over recent years there has been an exponential increase in the generation and collection of data relating to health. Our ability to analyse and interpret what this means for healthcare lags behind because of concerns about ethical issues such as privacy, consent and trust around the use of large clinical data sets.

How should and can we analyse and interpret data to improve healthcare?

The interdisciplinary research group – Clinical Ethics and Law at Southampton (CELS) - has been focusing on this challenge through the Enabling New Approaches for COVID-19 Treatment (ENACT) project. ENACT aims to analyse data from patients who have been in hospital with COVID-19 to gain important insights into how to treat the disease.

An arm of this project, ENACT–Information Governance (ENACT-IG) is looking at methods to learn more from COVID-19 data collection by:

- clarifying the ethical and legal framework that is required
- Seeking the views of the public about the appropriate use of data and what protections need to be in place
- Researching whether and how the current pandemic has affected views about data linkage and privacy

CELS lead Professor Anneke Lucassen, Professor of Clinical Genetics, said: "As we collect more data about health, we also need to look at issues such as how we balance confidentiality of clinical data with the need to learn from it to improve healthcare; how we seek consent for this learning and how we make sure data collections can be trusted. We had already started looking at these issues using the example of genetics and how data might be relevant to family members, then the COVID-19 pandemic saw a need to share data with others to track the infection and contact trace. We wanted to research how people balance the important right to have their data kept private with the need to share data widely to learn from it for healthcare, and how this balancing act was affected by the pandemic.

"By widening access to data in an ethical way, we have huge potential to improve the health of our society. It is exciting to be at the forefront of


Image: Professor Anneke Lucassen

that research, but we need to make sure that the ethical and social issues are given due consideration."

Anneke has recently been awarded a Wellcome Trust and UKRI-MRC grant to research the wider ethical issues relating to data storage in use in large biobank and cohort studies.

Colleague Dr Kate Lyle, Senior Research Fellow in Clinical Ethics and Law, played a key role in the ENACT-IG project, and led the preceding research that explored the ethical, social and legal issues of working with large volumes of personal data. As part of the project, funded by IfLS Higher Education Innovation Fund, CELS convened a symposium exploring The Secret Life of Immortal Data at the 12th ACM Web Science Conference, hosted by Southampton.

She said: "We are moving towards a world in which data has a life beyond the individual; where the value and potential of data is ever-changing as technological developments bring new possibilities. This immortality of data raises new ethical and societal issues that have not yet been fully articulated, and consequently we are unprepared to deal with.

"As these challenges are becoming increasingly apparent in many fields of practice, we wanted to bring together people across a range of disciplines and industries to discuss how we might prepare for the consequences of large data collections, and how it might be necessary to rethink our understanding of issues of consent, ownership, ethics and privacy."

Visual minutes and the production of an animation to explore the tension between privacy/ consent and healthcare benefits were produced as a result of both projects.

Find out more:
www.southampton.ac.uk/life-sciences

Find out more:
www.southampton.ac.uk/life-sciences

PRIZE-WINNING AI-DRIVEN MODELLING OF CORONAVIRUS SPIKE PROTEIN

IfLS member Professor Syma Khalid was part of an international team of researchers that was recognised for successfully simulating the behaviour and vulnerabilities of the SARS-CoV-2 virus in a first-of-its-kind feat in high performance computing.

Syma and a US team, led by Rommie Amaro, were awarded the Gordon Bell Special Prize for High Performance Computing-Based COVID-19 Research by the Association for Computing Machinery (ACM).

The study investigated the movement and rearrangements in the shape of the SARS-CoV-2 spike protein to help understand how it triggers the process of infecting human cells, information which can be used in the future to design therapeutics or vaccines to mitigate the virus.

Syma said: "I am delighted to have played a small part in a large team effort. It was gratifying to be able to contribute expertise I have gained from my work on simulating bacterial membranes at Southampton, to help the team on their work on viral and eukaryotic membranes."

Syma is now collaborating with fellow Southampton IfLS colleague Professor Max Crispin, from Biological Sciences, and Dr Peter Bond, a group leader at the Bioinformatics Institute, A*STAR, in Singapore, using computational methods to identify hidden pockets in the spike protein which can potentially be targeted with drugs.

She was also one of just 12 UK scientists in 2021 to be presented with an Engineering and Physical Sciences Suffrage Science award that celebrate and inspire women in science.

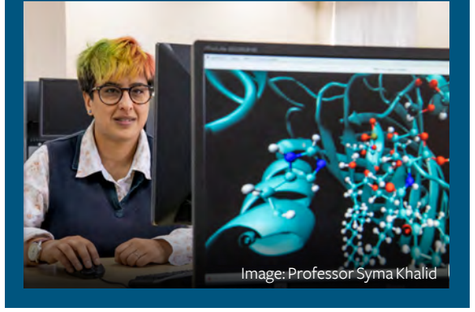


Image: Professor Syma Khalid

EFFECT OF CORONAVIRUS ON PHYSICAL ACTIVITY, MENTAL HEALTH AND WELLBEING

Image: Dr Danielle Lambrick

Health Sciences researcher Dr Danielle Lambrick was the Southampton lead on an IfLS-funded study exploring the effect of COVID-19 on people's physical activity, mental health and wellbeing.

Danielle, who is a member of the IfLS FortisNet network, partnered with colleagues from the Universities of Winchester, Portsmouth, Gloucestershire, Swansea, and Oxford Brookes to explore how the lockdown restrictions had an impact on people's physical activity.

Danielle said: "When the country went into lockdown, people were told they could only leave their homes to exercise once a day, and people who were shielding were advised by the government to stay at home entirely.

"People were restricted in the types of physical activities they could do, but no guidance was given on what people could do instead. We wanted to find out what people chose to do in the way of exercise and understand more about the subsequent effect on their mental health and wellbeing."

People were surveyed three times at different stages of lockdown and similar surveys were also carried out in New Zealand, Australia and Ireland, where they were experiencing comparable levels of restrictions at the same time.

Danielle added: "Results of the first survey showed that across all countries there was clear correlation between those people who had a negative change in their physical activity behaviour, having a corresponding negative change in their mental health and wellbeing. While those who made a positive change in their physical activity behaviour reported better mental health and wellbeing."

"The aim of the project is to influence policy to provide better support and guidance for people to become more physically active or maintain their physical activity levels when they are restricted in their movements due to a pandemic or similar circumstances" said Danielle.

"We have published a paper about our findings and are now engaging with policymakers and organisations so that they can be better prepared to support people if we encounter future lockdowns."

The project has led to an NIHR ARC Wessex-funded project focusing on understanding the impact of COVID-19 and government restrictions on the physical activity and mental health of people with long-term conditions."

Image: Yilu Zhou

INVESTIGATING THE LONG-TERM EFFECTS OF COVID-19

Institute for Life Sciences (IfLS) postgraduate student Yilu Zhou has been part of a research project that has shown most patients discharged from hospital after experiencing severe COVID-19 infection appear to return to full health, although up to a third do still have evidence of lung problems one year on.

Yilu is in the third year of his PhD, which is funded by the IfLS. He has been working on the research with Dr Yihua Wang, Lecturer in Biomedical Sciences and Dr Mark Jones, Associate Professor in Respiratory Medicine, both from the University of Southampton and NIHR Southampton Biomedical Research Centre.

They collaborated with colleagues in Wuhan, China, to investigate the natural history of recovery from severe COVID-19 pneumonia up to one year after hospitalisation and published a paper on their findings in The Lancet Respiratory Medicine.

COVID-19 has infected millions of people worldwide. People are most commonly hospitalised for COVID-19 infection when it affects the lungs – termed COVID-19 pneumonia. Whilst significant progress has been made in understanding and treating acute COVID-19 pneumonia, very little is understood about how long it takes for patients to fully recover and whether changes within the lungs persist.

Patients, who were discharged from hospital following severe COVID-19 pneumonia, were followed up after three, six, nine and twelve months to measure how well their lungs functioned. A computed tomography (CT) scan of their chest was taken and they undertook a walking test.

Over 12 months, most patients saw an improvement in their symptoms, exercise capacity, and COVID-19 related CT changes. After a year, the majority of patients appeared to have fully recovered although about five per cent of patients still reported breathlessness. A third of patients' measures of lung function were still reduced – in particular how efficiently oxygen is transferred in the lungs into the blood - and this was more frequently found in women than in men. In around a quarter of patients CT scans showed there were still small areas of change in the lungs, and this was more common in patients with more severe lung changes at time of hospitalisation.

Yilu said the interdisciplinary ethos at the heart of the IfLS had provided him with many opportunities to experience how people worked in different areas, and also to bring new techniques to his own research.

"I have attended seminars where I have learnt about techniques used by colleagues in different areas, such as machine learning, which could be applied to help me in my own research."

Professor Peter J Smith, Director of the IfLS, said: "It is wonderful that IfLS PhD students have the opportunity to work with collaborative teams on exciting research projects with important findings."

Image: The Life Sciences Building

Find out more:
www.southampton.ac.uk/life-sciences

A sample of publications from our interdisciplinary postgraduate students: 2019-2021

Institute for Life Science (IfLS) PhD students work on novel interdisciplinary research projects with support from a supervisory team across the project disciplines. This supportive interdisciplinary environment, shaped by the IfLS and host faculties, creates a unique training and development experience for the next generation of leaders.

Health and Medicine

Bramley JL, Worsley PR, Bostan LE, Bader DL, Dickinson AS (2020). Establishing a measurement array to assess tissue tolerance during loading representative of prosthetic use. *Med Eng Phys* 78:39. DOI: 10.1016/j.medengphy.2020.01.011

AlDossary NM, **Ostler C**, Donovan-Hall M, Metcalf CD (2021). Non-oncological outcomes following limb salvage surgery in patients with knee sarcoma: a scoping review. *Disabil Rehabil.* (In press). DOI: 10.1080/09638288.2021.1900409

Liu X, Zhou H, **Zhou Y**, Wu X, Zhao Y, Lu Y, Tan W, Yuan M, Ding X, Zou J, Li R, Liu H, Ewing RM, Hu Y, Nie H, Wang Y (2020). Risk factors associated with disease severity and length of hospital stay in COVID-19 patients. *J Infect* 81(1):e95. DOI: 10.1016/j.jinf.2020.04.008

Liu X, Zhou H, **Zhou Y**, Wu X, Zhao Y, Lu Y, Tan W, Yuan M, Ding X, Zou J, Li R, Liu H, Ewing RM, Hu Y, Nie H, Wang Y (2020). Temporal radiographic changes in COVID-19 patients: relationship to disease severity and viral clearance. *Sci Rep* 10(1):10263. DOI: 10.1038/s41598-020-66895-w

Warming H, **Pegasiou CM**, Pitera AP, Kariis H, **Houghton S**, Kurbatskaya K, Ahmed A, Grundy P, Vajramani G, Bulters D, Altafaj X, Deinhardt K, Vargas-Caballero M (2019). A primate-specific short GluN2A-NMDA receptor isoform is expressed in the human brain. *Mol Brain* 12:64. DOI: 10.1186/s13041-019-0485-9

Wu X, Liu X, **Zhou Y**, Yu H, Li R, Zhan Q, Ni F, Fang S, Lu Y, Ding X, Liu H, Ewing RM, Jones MG, Hu Y, Nie H, Wang Y (2021). 3-month, 6-month, 9-month, and 12-month respiratory outcomes in patients following COVID-19-related hospitalisation: a prospective study. *Lancet Respir Med*, 9(7):747. DOI: 10.1016/S2213-2600(21)00174-0

Yuan Y, **Zhou Y**, Li Y, Hill C, Ewing RM, Jones MG, Davies DE, Jiang Z, Wang Y (2020). Deconvolution of RNA-seq analysis of hyperbaric oxygen-treated mice lungs reveals mesenchymal cell subtype changes. *Int J Mol Sci* 21(4):1371. DOI: 10.3390/ijms21041371

Zhou Y, Hill C, Yao L, Li J, Hancock D, Downward J, Jones M, Davies D, Ewing R, Skipp P, Wang Y. (2021). Quantitative proteomic analysis in alveolar type II cells reveals the different capacities of RAS and TGF-β to induce epithelial-mesenchymal transition. *Front Mol Biosci* 8:595712. DOI:10.3389/fmolb.2021.595712

Living Systems

Barker CT, Naish D, Clarkin CE, Farrell P, Hullmann G, Lockyer J, Schneider P, Ward RKC, Gostling NJ (2020). A highly pneumatic middle Cretaceous theropod from the British Lower Greensand. *Pap Palaeontol* 6(4):661. DOI: 10.1002/spp2.1338

Shepherd S, **Hollands G**, Godley VC, Sharkh SM, Jackson CW, Newland PL (2019). Increased aggression and reduced aversive learning in honey bees exposed to extremely low frequency electromagnetic fields. *PLoS ONE* 14(10): e0223614. DOI: 10.1371/journal.pone.0223614

Life Technologies

Doigneaux C, Pedley AM, Mistry IN, Papayova M, Benkovic SJ, Tavassoli A (2020). Hypoxia drives the assembly of the multienzyme purinosome complex. *J Biol Chem* 295(28):9551. DOI: 10.1074/jbc.RA119.012175

Ferri S, Wu Q, De Grazia A, Polydorou A, May JP, Stride E, Evans ND, Carugo D (2021). Tailoring the size of ultrasound responsive lipid-shelled nanodroplets by varying production parameters and environmental conditions. *Ultrason Sonochem* 73:105482. DOI: 10.1016/j.ultsonch.2021.105482

Goggin P, Ho EML, Gnaegi H, Searle S, Oreffo ROC, Schneider P (2020). Development of protocols for the first serial block-face scanning electron microscopy (SBF SEM) studies of bone tissue. *Bone* 131:115107. DOI: 10.1016/j.bone.2019.115107

Herdzik KP, Bourdakos KN, Johnson PB, Lister AP, Pitera AP, Guo C, Horak P, Richardson DJ, Price JHV, Mahajan S (2020). Multimodal spectral focusing CARS and SFG microscopy with a tailored coherent continuum from a microstructured fiber. *Appl Phys B* 126:84. DOI: 10.1007/s00340-020-7406-6

Lennard KR, Gardner RM, **Doigneaux C**, Castillo F, Tavassoli A (2019). Development of a cyclic peptide inhibitor of the p6/UEV protein-protein interaction. *ACS Chem Biol* 14(9):1874. DOI: 10.1021/acschembio.9b00627

Pedebos C, Smith IPS, **Boags A**, Khalid S (2021). The hitchhiker's guide to the periplasm: unexpected molecular interactions of polymyxin B1 in E. coli. *Structure* 29(5):1. DOI: 10.1016/j.str.2021.01.009

Plata M, Hale WG, Sharma M, Werner J, Utz M (2021). Microfluidic platform for serial mixing experiments with *in operando* nuclear magnetic resonance spectroscopy. *Lab Chip* 21(8):1598. DOI: 10.1039/d0lc01100b

Pu T, Ou JY, Savinov V, Yuan G, Papasimakis N, Zheludev NI (2020). Unlabeled far-field deeply subwavelength topological microscopy (DSTM). *Adv Sci* 8(1):2002886. DOI: 10.1002/advs.202002886

Takahashi T, **Herdzik KP**, Bourdakos KN, Read JA, Mahajan S (2021). Selective imaging of microplastic and organic particles in flow by multimodal coherent anti-Stokes Raman scattering and two-photon excited autofluorescence analysis. *Anal Chem* 93(12):5234. DOI: 10.1021/acs.analchem.0c05474.

Find out more:
www.southampton.ac.uk/life-sciences

Wu Q, Mannaris C, May JP, Bau L, Polydorou A, **Ferri S**, Carugo D, Evans ND, Stride E (2021). Investigation of the acoustic vaporization threshold of lipid-coated perfluorobutane nanodroplets using both high-speed optical imaging and acoustic methods. *Ultrasound Med Biol* 47(7):1826. DOI: 10.1016/j.ultrasmedbio.2021.02.019

Insights through Data

Ashton JJ, Boukas K, Davies J, **Stafford IS**, Vallejo AF, Haggarty R, Coelho TAF, Batra A, Afzal NA, Vadgama B, Williams AP, Beattie RM, Polak ME, Ennis S (2020). Ileal transcriptomic analysis in paediatric Crohn's disease reveals IL-17- and NOD- signalling expression signatures in treatment-naïve patients and identifies epithelial cells driving differentially expressed genes. *J Crohns Colitis* 15(5):774. DOI: 10.1093/ecco-jcc/jjaa236

Ashton JJ, **Mossotto E**, **Stafford IS**, Haggarty R, Coelho TAF, Batra A, Afzal NA, Mort M, Bunyan D, Beattie RM, Ennis S (2020). Genetic sequencing of pediatric patients identifies mutations in monogenic inflammatory bowel disease genes that translate to distinct clinical phenotypes. *Clin Transl Gastroenterol.* 11(2):e00129. DOI: 10.14309/ctg.0000000000000129

Casey MJ, Sanchez-Garcia RJ, MacArthur BD (2020). Measuring the information obtained from a single-cell sequencing experiment. *bioRxiv* DOI: 10.1101/2020.10.01.322255 Preprint

Casey MJ, Stumpf PS, MacArthur BD (2020). Theory of cell fate. *WIREs Syst Biol Med* 12:e1471. DOI: 10.1002/wsbm.1471

Coelho T, **Mossotto E**, Gao Y, Haggarty R, Ashton JJ, Batra A, **Stafford IS**, Beattie RM, Williams AP, Ennis S (2020). Immunological profiling of paediatric inflammatory bowel disease using unsupervised machine learning. *J Pediatr Gastroenterol Nutr* 70(6):833. DOI: 10.1097/mpg.0000000000002719

Coelho T, Sonnenberg-Riethmacher E, Gao Y, **Mossotto E**, Khojanazarov A, Griffin A, Mukanova S, Ashimkhanova A, Haggarty R, Borissenko A, Ashton JJ, **Stafford IS**, Batra A, Afzal NA, Stanton MP, Vadgama B, Adrisova K, Beattie RM, Williams AP, Ennis S, Riethmacher D (2021). Expression profile of the matricellular protein periostin in paediatric inflammatory bowel disease. *Sci Rep* 11(1):6194. DOI: 10.1038/s41598-021-85096-7

Egan JR, Elliott T, MacArthur BD (2021). Fluctuations in TCR and pMHC interactions regulate T cell activation. *bioRxiv* DOI: 10.1101/2021.02.09.430441 Preprint

Greulich P, MacArthur BD, **Parigini C**, Sánchez-García RJ (2019). Stability and steady state of complex cooperative systems: a diakoptic approach. *R Soc Open Sci.* 6(12):191090. DOI: 10.1098/rsos.191090

Greulich P, MacArthur BD, **Parigini C**, Sánchez-García RJ (2021). Universal principles of lineage architecture and stem cell identity in renewing tissues. *Development* 148(11):dev194399. DOI: 10.1242/dev.194399.

Horscroft C, Pengelly R, Sluckin TJ, Collins A (2020). zalpha: an R package for the identification of regions of the genome under selection. *J Open Source Softw* 5(56):2638. DOI: 10.21105/joss.02638

Jabalameli MR, **Horscroft C**, Vergara-Lope A, Pengelly RJ, Collins A (2019). Gene-dense autosomal chromosomes show evidence for increased selection. *Heredity* 123(6):774. DOI:10.1038/s41437-019-0272-5

Parigini C, Greulich P (2020). Universality of clonal dynamics poses fundamental limits to identify stem cell self-renewal strategies. *eLife* 9:e56532. DOI: 10.7554/eLife.56532

Schofield JPR, Burg D, Nicholas B, **Strazzeri F**, Brandsma J, Staykova D, Folisi C, Bansal AT, Xian Y, Guo Y, Rowe A, Corfield J, Wilson S, Ward J, Lutter R, Shaw DE, Bakke PS, Caruso M, Dahlen SE, Fowler SJ, Horváth I, Howarth P, Krug N, Montuschi P, Sanak M, Sandström T, Sun K, Pandis I, Riley J, Auffray C, De Meulder B, Lefaudeux D, Sousa AR, Adcock IM, Chung KF, Sterk PJ, Skipp PJ, Djukanovic R, U-BIOPRED Study Group (2019). Stratification of asthma phenotypes by airway proteomic signatures. *J Allergy Clin Immunol* 144(1):70. DOI: 10.1016/j.jaci.2019.03.013

Stafford IS, Kellermann M, **Mossotto E**, Beattie RM, MacArthur BD, Ennis S (2020). A systematic review of the applications of artificial intelligence and machine learning in autoimmune diseases. *NPJ Digit Med.* 3:30. DOI: 10.1038/s41746-020-0229-3

Testori M, Kempf M, Hoyle R, Eisenbarth H (2019). When do psychopathic traits affect cooperative behavior? An iterated prisoner's dilemma experimental study. *J Individ Differ* 40(4):227. DOI:10.1027/1614-0001/a000295

Vergara-Lope A, Jabalameli MR, **Horscroft C**, Ennis S, Collins A, Pengelly RJ (2019). Linkage disequilibrium maps for European and African populations constructed from whole genome sequence data. *Sci Data* 6(1):208. DOI:10.1038/s41597-019-0227-y

High resolution micro-CT has revolutionised our understanding of bone microstructural changes during disease. Imaging technology optimised on small mammal bones are now being applied to human clinical studies to assess bone health following FortisNet collaborative partnerships.

Image: IfLS PhD student Alisha Sharma and supervisor Dr Claire Clarkin

Find out more:
www.southampton.ac.uk/life-sciences

IfLSAdmin@southampton.ac.uk