University of Southampton

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ADVANCING LIFE SCIENCES

Institute for Life Sciences

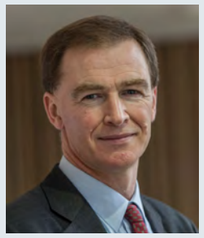
Spotlight on: Building on success

News and features: Understanding why proteins misbehave

Publications: A sample of research outputs from our PhD students

FOUNDING MEMBER OF THE RUSSELL GROUP

WELCOME



The Institute for Life Sciences' (IfLS) mission is to catalyse and enable ambitious interdisciplinary life sciences research and enterprise across the University. In recent years, the IfLS focus has broadened towards encouraging interdisciplinary links and research engagement between the university and regional partners.

This year's Annual Report highlights the breadth and expertise in interdisciplinary life sciences at Southampton and focuses on regional partnership engagement towards real-world impact. The national emphasis is shifting towards organisations working as regions, by pooling capabilities to improve critical mass, and working together to contribute niche areas of expertise.

Partner organisations include other universities, NHS organisations in the Wessex region and local government. We continue to build on our successful network strengths to engage more fully with policy development through collaborative engagement with the Southern Policy Centre.

The IfLS continues to grow and enthusiastically champion interdisciplinary life sciences research and its impact to society, economy and technology as highlighted by the case studies in this report.

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

Interdisciplinary research is a core objective for the University's research strategy and triple helix approach to research, education, knowledge exchange and enterprise. Working in partnership in an interdisciplinary way encourages creative and novel approaches to research that produce fascinating and fantastic research to address global challenges and really make a difference. In the Research and Excellence Framework 2021 assessment Southampton performed exceptionally well in impact and received a particular commendation for the strength of our interdisciplinary research.

The Institute for Life Sciences has an important role to play in terms of catalysing interdisciplinary life sciences research across the University and by regional engagement with stakeholders in the Wessex region. The Institute is effective in terms of mapping out and connecting life sciences research and enterprise strengths of the University and stimulating internal research networks in areas of potential growth and this Annual Report highlights case studies of these achievements.

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

Front cover image credit:
Nobeastsofierce/Science Photo Library.
Muscle cells, illustration.

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

CONTENTS

BUILDING ON SUCCESS - FROM SMALL ROOTS TO NATIONAL IMPACT

Image: Dr Nicole Prior and PhD student Grazia Battaglino

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

Southampton's Institute for Life Sciences (IfLS) was launched in 2011 and faced the challenging task of bringing together academics across the University to collaborate in interdisciplinary research.

Eleven years later and it is a thriving institution that has not only generated a strong network of interdisciplinarity at the University but is now playing a significant role in the life sciences landscape regionally and nationally, driving forward life sciences research and development.

At the beginning

The IfLS was created to encourage these interdisciplinary links and research not only across the University but subsequently out into the local region.

IfLS Director Professor Peter Smith said: "One of the first things we did was to investigate the life sciences portfolio in the region. We wanted to take advantage of government and regional funding and in order to do that, we had to be better informed about the business capabilities in the local area.

"We worked with the Local Enterprise Partnerships (LEPs) and discovered there was an abundance of life sciences-focused organisations in the region – not only in therapeutics development but in medical technology (MedTech) and medical data.

"As there was a particular emphasis on musculoskeletal health, we decided to create FortisNet – the first pan-Wessex organisation that brought together parties with a vested interest in musculoskeletal health to create a supportive network with a common aim and a commitment to working collaboratively. It included participants from enterprise, academia, government and stakeholders, such as the defence sector and the NHS.

He added: "FortisNet was a tremendous success. It created a community of individuals who communicated with each other, saw value in these conversations and who trusted each other – a vital element in interdisciplinary working."

Building on success

Building on the achievements of FortisNet, the IfLS has grown in strength and impact, developing networks and partnerships across the region and beyond.

It is now a key contributor in a regional life sciences sector identifying the healthcare challenges of the future, enabling life-changing research and influencing policy both nationally and internationally.

Peter said: "The strength of the IfLS lies in our membership. Over the years we have created a community across the University which has spread out into the region. Together we have grown stronger because we have acquired a huge amount of knowledge and expertise that means we are ahead of the game in terms of what needs to be done before a project is started.

"We bring together like-minded people in academia, industry, hospital trusts and clinical research to develop collegiate networks and discover solutions."

A wider perspective

Nationally, the government and research councils are placing a stronger emphasis on supporting interdisciplinary regional networks, with all parties working together as regional hubs.

Peter said: "In order to be effective, we need to have a wider regional perspective on society and patient health needs. Solutions in healthcare come through collaborative activities and in having a far-reaching perspective of what the problem is.

"The national emphasis has been shifting towards organisations working as regions, pooling their capabilities. We can all benefit by associating together – this improves our critical mass and we can all contribute our niche areas of expertise."

With its established network of regional partners and collaborators, the IfLS is at the heart of the Wessex region's drive to meet the health priorities of the future.

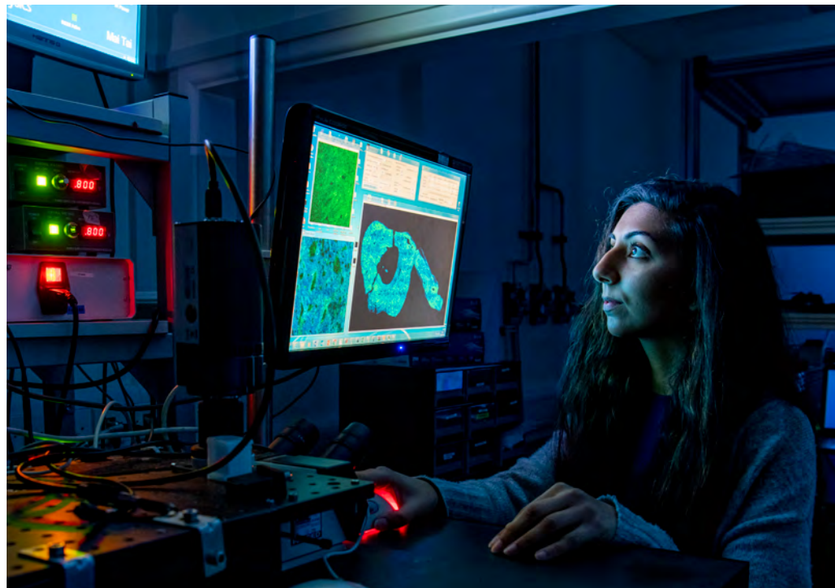


Image: Dr Aikta Sharma and Dr Claire Clarkin. Bone is a dynamic tissue that is constantly renewed throughout life. Changes in collagen structure are well-known indicators of bone disease, which can be measured using Second Harmonic Generation imaging.

Here are some of the ways that the IfLS is having a significant wider influence:

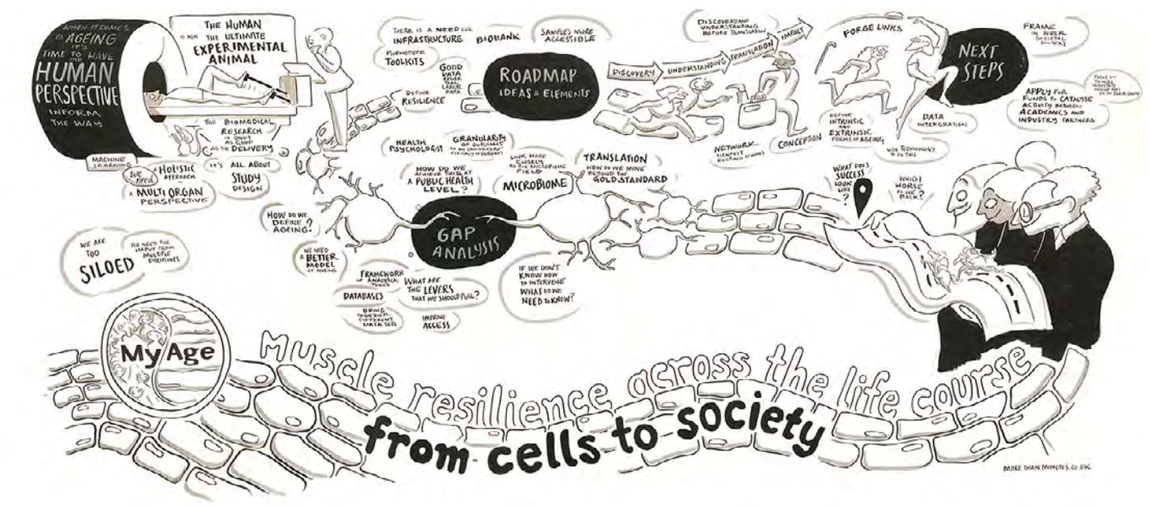


Image: Muscle resilience across the life course from cells to society - first steps towards a MyAge Roadmap. Art created by Jonny Glover from More Than Minutes at the MyAge Launch in May 2022.

MyAge

MyAge is a national research network that builds on the experience gained from FortisNet. It is one of 11 UK Ageing Networks funded by the Biotechnology and Biological Sciences Research Council (BBSRC) and Medical Research Council (MRC) to tackle challenges in ageing. Led by IfLS Director Professor Peter Smith, scientists from Southampton and beyond are exploring muscle resilience across the life course: from cells to society.

The two-year project brings together experts from different disciplines and sectors to understand the fundamental mechanisms behind muscle ageing. They are also helping funding councils to create a strategic roadmap to address this issue that has societal impact.

Peter said: "MyAge is expanding on what we learnt from FortisNet to create a nationally focused network. We are raising our visibility nationally and internationally as we explore muscle resilience in ageing at a whole system level from sub-cellular to society.

"Together with the other 10 networks, we will bring forward our insights at the end of the project to draw up an effective policy document."

Wessex Health Partners

The IfLS has played a central role in developing Wessex Health Partners (WHP) – a strategic collaboration between the expertise of the region's universities, health and care systems, patients and public, industry and government.

Through research, innovation and training, the WHP is accelerating improvement to health and social care for the benefit of patients and the wider society in Wessex. Their knowledge will be shared nationally and internationally.

Peter said: "For the first time ever, we have a single recognised umbrella organisation that includes all of the major players in the delivery of health to Wessex citizens. We will be delivering new solutions to problems by driving medicine in an interdisciplinary direction."

Southern Policy Centre

The IfLS is working with independent think tank and policy forum Southern Policy Centre (SPC) and other institutions across the central South to promote the region's strength in fostering and promoting the life sciences.

They have been a steering force in the recently published SPC report Life Sciences in the central South. The report highlights the unique regional initiatives that are making strides towards the Office for Life Sciences' (OfLS) vision in tackling dementia and ageing, in keeping the UK ahead in vaccine science, in managing and preventing long term conditions, developing immune therapies, understanding and improving mental health, and tackling entrenched health inequalities. It also outlines the significant assets, expanding facilities and clusters of expertise that the region has to offer the UK both in research and enterprise.

Image: IfLS academics and PhD student in a Teams meeting.

As part of the SPC initiative, the IfLS is contributing to the ideas and encouraging debate on how the central South's economy, environment and communities can be improved. It is also helping ensure that ground-breaking research can be translated into innovation and become part of clinical practice, benefiting as many people as possible.

Helping people living with multiple long-term health conditions

IfLS and Web Science Institute (WSI) member Professor Michael Boniface has been Co-Investigator with an interdisciplinary team from the University and University Hospital Southampton on two NIHR projects that are using artificial intelligence (AI) to explore the challenges related to the growing number of people living with multiple long-term health conditions like diabetes, heart disease or dementia.

Multidisciplinary Ecosystem to study Lifecourse Determinants and Prevention on Early-onset Burdensome Multimorbidity (MELD and MELD-B) are helping to understand more about how factors in people's lives can influence their chances of developing multiple burdensome conditions.

The projects are led by Professor Nisreen Alwan and Dr Simon Fraser, from Medicine, and aim to understand the order in which people develop conditions and how these conditions can group together to become more burdensome. The IfLS supported the team by identifying members who could contribute their expertise to the projects.

Michael said: "Living with multiple long-term conditions places considerable burden on patients and impacts their quality of life. The experience of burden can come from symptoms, treatment regimes, or a weak support network.

Understanding how burden changes in relation to development of conditions over the lifecourse is important to identify preventative interventions but also ensure people are cared for appropriately, considering a broad range of socio-economic concerns."

The team is analysing large datasets representing people from across the UK (England, Wales and Scotland), as well as longitudinal birth cohorts that allow AI techniques to connect information on broader, socio-economic issues with medical information on long-term conditions.

The goal is to apply this learning to identify the best way to accurately estimate the risk at different life stages and identify key time points for targeted public health interventions.

> "With a population of 2.4 million, the central South punches well above its weight in life sciences. This is a region rich in assets, with unique strengths and the intellectual firepower to tackle the concerns of the future and drive prosperity."

Professor John Denham
Director, Southern Policy Centre

EXPLOITING IMAGING TECHNOLOGIES

Innovative imaging technologies developed by Southampton Institute for Life Sciences (IfLS) members are being used to drive forward improvements in healthcare diagnosis and treatment.

AT THE HEART OF DRUG DEVELOPMENT

A new partnership between IfLS members, global pharmaceutical company AstraZeneca and biophotonics company M Squared Life aims to revolutionise imaging technologies to speed up and improve the efficiency of drug and medicine discovery.

> "There has been great progress in the development of 3D cellular and Organ-on-Chip models designed to recapitulate the human body. We believe the imaging tools developed in this project could truly transform our ability to interrogate these models in order to gain greater insight into disease and how disease can be modulated by the drugs we develop."
>
> **Sam Peel**
> Head of UK Assay Development
> AstraZeneca

The five-year Prosperity Partnership – Transformative Imaging for Quantitative Biology (TIQBio) – is developing large-scale, high-resolution live 3D imaging tools to determine the efficacy of new drug candidates in treating various conditions.

IfLS Associate Director Professor Sumeet Mahajan, from Chemistry, is leading the University team that includes colleagues from the Optoelectronics Research Centre, Biological Sciences, Medicine and the IfLS.

The programme aims to provide the capability for rapid label-free imaging of live physiological human tissue models using novel technology combinations, targeting the field of new drug discovery at high throughput.

Southampton researchers are developing these new imaging tools and applying them across a broad range of healthcare applications with the aim of addressing the current limitations in available technology for 3D imaging of human model systems that will unlock the full potential of targeted drug discovery.

Partnering with industry

Sumeet said: "Traditional confocal microscopes focus light to a point and build an image by recording thousands of points across the area of interest. This means generating a single image is very slow and for a volume the process needs to be repeated, again and again.

"Lightsheet microscopes work differently by focusing light into a sheet and capturing the image in a single shot, which makes 3D imaging more than a hundred times faster than traditional methods. However, these methods require dyes to label or tag sites of interest that perturb the sample or require expensive non-human samples that are genetically modified.

"Pharma companies want to use physiologically-relevant models such as organoids that resemble human tissues to carry out their pre-clinical drug testing but there are no imaging tools and technologies that can interrogate them, especially that are label-free."

Southampton's innovative technology

"At Southampton, we have already developed label-free techniques in Raman spectroscopy and non-linear spectroscopy imaging with M Squared Life to combine our techniques and new lasers to create novel lightsheet microscopy systems so that pharma companies such as AstraZeneca can carry out high throughput drug discovery on 3D physiological models.

"Currently we are targeting diseases such as lung fibrosis and lung cancer, but it could be used for a much wider range of applications.

"The IfLS has been a strong pillar of support and IfLS Director Professor Peter JS Smith is a key member of the TIQBio team. He has been instrumental in connecting people and has a global view of what's happening in academia, industry and the NHS, particularly within the Wessex region."

> "The combination of rapid label-free imaging and 3D live human model systems applied to targeted drug discovery provides an amazing opportunity to shorten the development time drug candidates take to reach the clinic, which is truly exciting."
>
> **Dr Neveen Hosny**
> Head of Operations and Product Development at M Squared Life

Image credit: Dr Simon Lane. Generation 1 of a label-free lightsheet microscope developed at the University of Southampton.

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

Image: The Immunometabolism Laboratory, in Human Development and Health, Medicine, is led by Professor Jaswinder Sethi. Together with Dr Loreana Silveira, Maria Kousetti and Josh Bilson, their research seeks to understand how immune-derived signals impact on tissue remodelling in obesity-related metabolic diseases.

SHEDDING LIGHT ON OBESITY-RELATED DIABETES

IfLS researchers are using soft-tissue imaging technologies developed at Southampton to improve our understanding of how obesity may reduce health.

The team from Medicine, Engineering and the μ-VIS X-ray Imaging Centre is exploring the impact of obesity on the body's organs, focusing on the pancreas, which is affected in people with type-2 diabetes.

Obesity

Obesity is a global issue and it is widely recognised that people with obesity can have a shortened lifespan and an increased risk of developing metabolic diseases such as type-2 diabetes, non-alcoholic fatty liver disease, cardiovascular disease and some cancers.

Existing preclinical tools and methodologies have helped to determine why and how our genes may promote obesity. However, preventing obesity through diet and physical exercise has had little impact at a population level, and obesity and type-2 diabetes rates continue to climb worldwide. There is an urgent need to better understand why being obese increases the risk of developing metabolic disease.

Research by Professor Jaswinder Sethi, from Medicine, has looked at how fat tissues grow and what the consequences may be when their storage capacity becomes limiting. Until now, it has not been possible to accurately and non-invasively monitor the changes in fat accumulation and tissue structure in metabolic tissues like the pancreas.

Applying Southampton's advanced technology

Previous pioneering research by IfLS members revolutionised imaging of soft tissues by developing a μCT scanner capable of producing non-invasive 3D scans of soft tissue at microscopic resolutions. This reveals features hundreds of times more detailed than conventional CT scans without destroying the tissue and has been proven in lung research that is more straight forward to image as it has variable densities.

A new IfLS-funded pilot project has taken this technology to the next level and applied it to a pre-clinical model of obesity-related diabetes. Jaswinder and colleagues Professor Philipp Schneider, from Engineering, and Early Career Researchers Dr Stephanie Robinson and Dr Elena Konstantinopoulou, from the μ-VIS X-ray Imaging Centre, have exploited 3D X-ray histology, to discover how fat accumulation changes in the pancreas with obesity and may link to structural changes in this major metabolic organ.

Thanks to the IfLS pilot grant, the team has been able to test the potential application of 3D X-ray histology, on imaging whole pancreata from healthy non-obese and diseased obese pre-clinical models.

A better understanding of disease development

Jaswinder said: "For the first time, we have been able to use new high-resolution correlative 3D X-ray histology to investigate tissue-remodelling, fat accumulation and lymphatic dysfunction in soft metabolic tissues.

"We wanted to find out what happens to surplus fat. Does it accumulate in other tissues where it can cause health conditions such as diabetes, fatty liver disease and atherosclerosis?

"Previously we have looked at changes in tissues like the pancreas using traditional histological techniques that only provide limited understanding but this new technology enables us to locate and quantify specific structural features that occur throughout the entire organ with minimal processing. Combined with traditional histology, we can map specific changes that occur in conditions such as obesity-related type-2 diabetes. We now have proof-of-concept evidence of obesity-linked pancreatic pathologies."

Impacting the future

This research enables the development of new, non-invasive diagnostic technology and improves understanding of tissue remodelling in chronic metabolic disease.

Jaswinder said: "It is an excellent example of technological advances being applied to biomedical research that is helping improve our understanding of disease development. By comparing multiple pancreatic scans from healthy and obese individuals, we can measure how much fat is accumulating and, importantly, where in the pancreas it is amassing. Ultimately, a better understanding could help improve risk prediction, earlier diagnosis and identify potential new therapeutic targets.

"The IfLS support has enabled us to use this imaging technology to scan soft organs and we hope it can be applied to other organs and translated to other clinically relevant disease settings."

IMPROVING MENTAL HEALTH AND INCREASING RESILIENCE

Maintaining mental health is a significant issue that has been exacerbated by the global pandemic. Institute for Life Sciences (IfLS) members are leading a number of different initiatives that are helping to address the challenge.

HOW CORAL REEFS ARE HELPING TEENAGERS TO STRENGTHEN THEIR RESILIENCE

Mental health researchers from the IfLS are using techniques developed by oceanographer colleagues at Southampton to help understand young people's abilities to develop resilience.

Professor Anne-Sophie Darlington, from Health Sciences, and Professor Graham Roberts, from Medicine, were awarded IfLS funding to collaborate with Professor Jasmin Godbold, a marine ecologist from Ocean and Earth Science who investigates the impacts of environmental change and human activities on marine ecosystems, and Professor Peter Smith, Professor in Social Statistics.

They used ecological theory and translated them into understanding how adolescents could improve their resilience to adversity.

Image: Professor Anne-Sophie Darlington

The research

Anne-Sophie said: "There is no time more important than now to support young people with their mental health. We looked at resilience in the context of mental health, and how some young people can develop or strengthen their resilience to protect themselves from mental health problems.

"We knew lots of things make up resilience – good friends, good relationships with parents, having confidence, good self-esteem - and we wanted to understand which ones are most important for young people.

"We had access to a huge dataset of information from young people, but we wanted to look at data analysis processes from other fields. Ecologists do a lot of work exploring the resilience of ecosystems and our colleague at the National Oceanography Centre Southampton has an interest in understanding what makes marine organisms and ecosystems resilient to changes such as water temperature.

"We used similar statistical approaches to analyse data from young people to understand their resilience better, exploring tipping points that may turn beneficial influences into negative influences."

The impact

Graham said: "Once we have identified what is important for young people and what can help them to be more resilient, we will be able to develop programmes and interventions to support them to build their resilience and reduce mental health problems."

The team is also working on a research project - funded by NIHR ARC Wessex – to develop an intervention to build resilience in young people with physical illnesses such as cancer and diabetes, which they hope will also be applicable for other young people.

> "This has been a fascinating and complex project. The health and resilience of natural ecosystems is affected by many internal and external factors as is the mental health of humans. It was interesting to see how we could use ecological theory to investigate the resilience in young adolescents."
>
> **Professor Jasmin Godbold**
> Professor in Marine Ecology, University of Southampton

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

Image: Dr Lucy Dorey, Professor Sam Chamberlain and Dr Ibrahim Aslan.

CREATING A NEW MENTAL HEALTH RESEARCH HUB FOR THE WESSEX REGION

IfLS members are playing a key role in the creation of a new Mental Health Research Hub to boost mental health research across the Wessex region.

The Hub is being created with the award of £875,000 from the NIHR and will be part of the NIHR Applied Research Collaboration (ARC) Wessex. It will increase research throughout the region to improve the quality of life for people with mental health problems.

The background

IfLS members Professor Sam Chamberlain and ARC Wessex Director Professor Alison Richardson, Clinical Professor of Cancer Nursing and End of Life Care, co-led the funding application to develop the Hub.

Sam said: "Throughout the Wessex region there are particular unmet needs in mental health care. Some really common mental health conditions are often overlooked which leads to a lot of suffering. The people with these conditions don't always get the treatment and support they need.

"By developing the Mental Health Research Hub, we aim to increase support and infrastructure to enable research networks to be created and expanded. By breaking down barriers, more research can also be carried out to improve recognition and treatment of these conditions."

IfLS members from Psychiatry, Medicine, Psychology, Rehabilitation Medicine and Health Sciences are involved in the Hub.

Hub activities

Sam said: "We are bringing together experts from different areas – universities, health and social care, voluntary and charitable organisations, NHS Trusts, as well as people who have lived experience of these conditions – to provide opportunities to expand research and collaboration and encourage talented people into research who haven't been involved before."

The Hub is:

- Employing four new postdoctoral researchers with an interest in mental health.
- Running a workshop for people working in health and social care who want to find out about the innovative research being done in the region and how to get involved.
- Developing research projects in the regions's key priority area – treatment-resistant anxiety and depression, alcohol and substance use disorders, gambling disorder, neurodevelopmental conditions such as ADHD, and the health and social care workforce.

Key areas of research

Anxiety and depression - the Hub will be conducting projects to address those treatment-resistant conditions assessing the scientific benefits of social prescribing.

Alcohol, substance and gambling disorders - the Hub will be helping create a new gambling clinic in Southampton that will give people with gambling disorders therapy over the Internet and will also develop a digital tool to collect information from people to help in the clinical decision-making process. Outcomes from both initiatives will be analysed for their effectiveness and efficiency.

Neurodevelopmental conditions - the Hub will be looking at care transitions from children to adult care and how evidence-based ADHD treatments can be improved. It will also be comparing different treatments using advanced statistical approaches, to inform clinical guidelines and practice.

The mental health and social care workforce – the Hub will be trying to understand how the pandemic exacerbated the mental health difficulties of frontline health workers who were already under a lot of strain. The Hub will explore what can be done to help and support this workforce.

Aims for the future

Sam said: "The most important focus of the Hub is to allow us to help identify up and coming people who have the potential to be the leaders of the future in applied healthcare research.

"It will also act as a catalyst for new high-quality research that can lead to improved identification and treatment of common, and often overlooked, mental health conditions across the region."

BRINGING ANTIBIOTICS BACK TO LIFE

Image: Dr Franklin Nobrega

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

Antibiotic resistant bacteria are spreading across the globe at an alarming pace, claiming a few hundred thousand lives a year. This number is estimated to rise drastically by 2050 and requires action from all government sectors and society. An interdisciplinary team from the Institute for Life Sciences (IfLS) has been awarded Higher Education Innovation Funds (HEIF) from the IfLS to develop new approaches to rejuvenate antibiotics against superbugs.

Led by Dr Franklin Nobrega, Principal Investigator in Microbiology, the research explored how phage-based strategy can give new life to old antibiotics. It has already led to an Innovation Award from Wessex Medical Research that will be used to gather further preliminary data to support a potential proposal for a Leverhulme Investigator Award in Science.

The background

Franklin said: "Human health can change dramatically due to the emergence of untreatable, antibiotic-resistant bacterial infections. If no solutions are found soon, even trivial bacterial infections and routine medical surgery may become life-threatening. We are using bacteriophages (viruses that attack bacteria) to reactivate antibiotics to clear bacterial infections.

"To kill bacteria, bacteriophages attach to specific structures on the surface of the bacterial cell. To try to prevent attachment of bacteriophages, bacteria often mutate these structures. Luckily for us, it is often the case that these surface structures are involved in antibiotic resistance, and therefore their mutation will make the bacteria lose their ability to resist antibiotics. If we combine bacteriophages and antibiotics we can create a synergetic approach that represents a broadly applicable, cost-effective, and safe treatment against many kinds of antibiotic-resistant bacterial infections, giving new life to old antibiotics."

An interdisciplinary endeavour

The research team includes five collaborators with complementary areas of knowledge – Franklin, from Biological Sciences who has expertise in phage biology; Professor Saul Faust, from Medicine, who has expertise in clinical trials; Dr Kordo Saeed, from University Hospital Southampton's Department of Infection, who has expertise in clinical microbiology, infection prevention and antimicrobial stewardship; and Professor Larry Lynch, Head of Winchester School of Art, who has expertise in public mediation and engagement, and Professor Sunil Manghani, Deputy Head of Winchester School of Art, who has expertise in critical theory and image studies.

Together they are developing the first Phage Therapy Experimental Medicine programme in the UK as part of the new NIHR Biomedical Research Centre (BRC) Infection Theme.

Saul said: "Our major goal is to bring phage therapy to the forefront of antibacterial treatments, which can only be achieved by acknowledging the limitations of current approaches and broadening the scope of phage therapy towards combination therapies. We have taken the first steps towards the establishment of more efficient and reliable phage-based treatments, exploring improved forms of phage therapy combining phages and antibiotics to restore antibiotic susceptibility. This will critically impact our ability to treat infections caused by antibiotic-resistant strains."

Kordo added: "Tackling antimicrobial resistance is one of the aims of this approach, which will potentially lead to reduction of traditional antibiotic use which will have positive impact not only on individual patients' microbiome, but also on the wider public health in reducing selection pressure."

Franklin said: "This study has benefited from the close collaboration of researchers from different disciplines, who were brought together via the IfLS to address some of the most challenging aspects of tackling antibiotic resistance using bacteriophages. By combining disciplines, we are helping scientists to acquire the ability to radically change the way we use bacteriophages today to fight antibiotic resistance."

Science communication and public engagement

As well as the academic/clinical research, the team also wanted to ensure that the public were involved in the research. Using the expertise from Larry and Sunil at Winchester School of Art and expertise from the Clinical Research Facility and the BRC in patient involvement and engagement, they created an informative leaflet explaining phage therapy to the layman which is being distributed at UHS. They have also developed an engagement project for secondary school students – Petri in the Box – where students get involved in the research by helping with isolating new bacteriophages.

Larry said: "Our overarching goal is to bridge the distance between research and the public. We are exploring further potential funding opportunities for outreach projects that can not only inform the public but also encourage their active participation in our research."

Image: Postgraduate student Daniela Rothschild Rodriguez, who is funded by the Institute for Life Sciences and the South Coast Biosciences Doctoral Training Partnership, with academic visitor Patrick Schimmel. CAT2 Microbiology Laboratory.

IMPROVING HEALTH THROUGH DATA INSIGHTS

Institute for Life Sciences (IfLS) members are exploiting data analysis to reveal previously unseen information and to enable faster and more efficient treatment and diagnosis.

PREVENTING RISK FRACTURE IN OSTEOPOROSIS

Interdisciplinary data analysis research is revealing insights into image screening that are invisible to the naked eye, which could help diagnose people with osteoporosis and reduce their risk of fracture.

IfLS researchers from Medicine and Electronics and Computer Science (ECS) are combining their expertise in machine learning and imaging techniques to develop computer technologies that could help people to be diagnosed earlier and faster, enabling them to be treated and substantially lowering their fracture risk.

The research has been supported by IfLS pump priming funding and is being led by Professor Mahesan Niranjan, from ECS, and Dr Nicholas Fuggle, from Medicine.

A silent disease

Osteoporosis affects 50 per cent of women and one in five men over the age of 50, leading to increased bone fragility, loss of independence and predisposition to fracture. It is also associated with huge morbidity and mortality rates and is a substantial burden on the health economy.

It is a disease with no signs or symptoms until the moment of fracture. Therefore, it can only be picked up by active screening or fragility fracture history. Once diagnosed, people can be treated and their fracture risk can be substantially reduced.

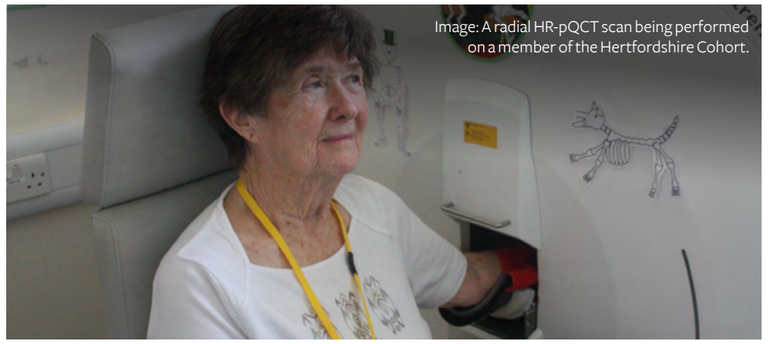


Image: A radial HR-pQCT scan being performed on a member of the Hertfordshire Cohort.

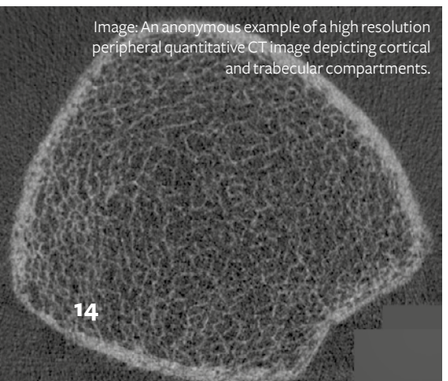


Image: An anonymous example of a high resolution peripheral quantitative CT image depicting cortical and trabecular compartments.

Current diagnosis

Currently there are a couple of ways to diagnose the disease:

- by assessing clinical risk factors such as age, alcohol intake and body mass index;
- by assessing bone mineral density using dual energy x-ray absorptiometry (DEXA).

DEXA is fairly easy and quick to do, however it only provides bone mineral density in 2D form not 3D. High resolution peripheral quantitative computed tomography (HR-pQCT) provides a great deal of bone-related information as it takes about 100 slice images that can be reconstructed into a 3D image but it is currently largely a research tool. The results provide intricate measures of the bone structure in both the inner and outer compartments.

Mathematical modelling with small amounts of data

A long history of analysing medical images using machine learning has had a huge boost with the tremendous advances in computer vision in the last decade.

Niranjan said: "We have enormous power to generate lots of images of these objects from which the computers can learn, but, when it comes to medicine the number of images and data is very small. It could be that a small number of people suffer from that condition, there could be issues of data privacy or data could be difficult to access if stored at more than one location. This makes it a challenge for mathematical modelling."

The solution

The two teams have been working together to develop a computer vision approach using the HR-pQCT 3D scans to improve fracture discrimination.

Nicholas said: "Using these scans via this computer vision method has the potential to provide enhanced and more accurate prediction of people who are at risk of fracture, so that they can be treated, and their fracture risk can be decreased, leading to reduced morbidity and mortality."

Niranjan added: "We can pull out information from the high-resolution 3D scans that's not visible to the naked eye. It identifies subtle changes and is far more accurate than what we can get from the 2D DEXA scans."

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

HELPING CHILDREN WITH SPEECH IMPAIRMENTS

IfLS members have been working with industry and the NHS to develop tools to help young children with potential speech impediments and impairments who face long waiting times.

Experts in machine learning and topology, from Southampton, Kids Speech Lab, in Ireland, and Salisbury NHS Foundation Trust Cleft Speech and Language Therapy service are creating tools to help children be assessed earlier, to identify how urgently they need help, and to give them exercises to do while they are waiting to see a speech therapist.

The challenge

Children develop speech and sounds at different stages in their lives, making it incredibly difficult to develop algorithmic diagnostic and therapeutic tools to assess whether their development falls within normal bounds or whether help from an expert is required.

In many parts of the country waiting lists for speech therapists are very long, and there are no tools to help parents or careers who might be worried about their child's speech development.

Industry need

Kids Speech Lab provides online screening of children's speech and language skills to enable parents to understand if their child's speech is on track. They contacted the IfLS seeking academic research input for algorithmic speech classification tools to enhance their work. The IfLS connected them with an interdisciplinary University team, led by Professor Jacek Brodzki, from Mathematical Sciences, and Professor Adriane Chapman, from ECS. The team included Dr Ingrid Membrillo Solis, who was partially supported by a grant from the IfLS.

The solution

Supported by Higher Education Innovation Funds (HEIF) from the IfLS, they used their expertise to develop tools to analyse and detect speech problems in order to shorten waiting times and ensure children with the most urgent need are prioritised. They also identified appropriate speech exercises based on specific problems.

Adriane said: "Children can be on long waiting lists to access speech therapy. We wanted to see if we could help create new technology to evaluate and triage children on these waiting lists.

"We faced a number of issues with developing algorithms that can accurately score a child's ability to master speech sounds, as children's speech develops at different ages, boys and girls speak differently, regional accents sound different, and some children have English as a second language.

"Initially we focused on a small number of sounds, and we were pleased to find out that we could distinguish them. The results provided a proof of concept."

Jacek said: "We were able to demonstrate that our topological methods are subtle and flexible enough to classify speech patterns and to identify potential problems. We are now working on a synthesis of the topology with machine learning to creating diagnostic tools to support both experts and parents."

IfLS support

Adriane added: "Without the IfLS getting us together to address the industry need, and the HEIF funding, we wouldn't have been able to provide this proof of concept. Together with the incredible support from IfLS Collaboration Manager Dr Alexandra Mant, we have been able to put together a competitive proposal to widen the vocabulary of words and different types of speech impairment."

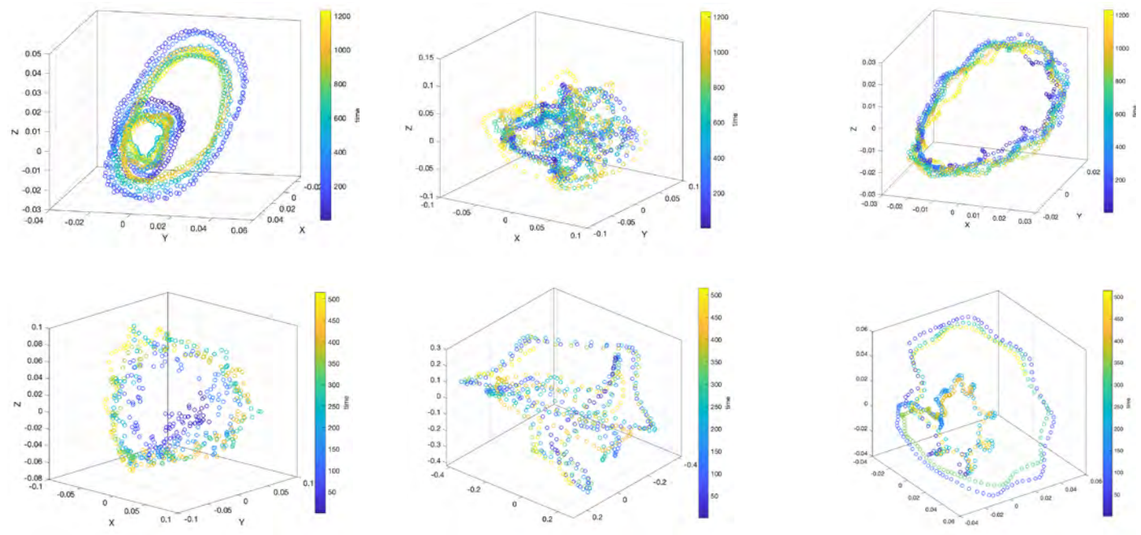


Image: The figure represents a topological description of speech patterns for two different sounds (rows) for three children (columns). The clearly visible differences are quantifiable, and form a basis for classification and diagnosis. Topological modelling and illustration by Ingrid Membrillo Solis

BOOSTING COMMERCIAL ACTIVITY IN LIFE SCIENCES ACROSS THE UNIVERSITY

Institute for Life Sciences (IfLS) Royal Society Entrepreneur in Residence Dr Kam Pooni is sharing his 27 years of expertise in the life science industry with researchers across the University of Southampton.

Kam is currently CEO of Glyconics Ltd and has previously held senior positions in Astellas Pharma Europe, Thomson Reuters and Eli Lilley. He started the role at the University earlier this year and has already run a series of workshops and weekly one-one sessions to help budding entrepreneurs understand the business environment.

He said: "I have extensive experience in starting up, managing and growing both Pharma and MedTech businesses. There were people that helped me in my career, and I wanted to give back to future entrepreneurs. This is my way of doing that.

"I am spending one day a week at Southampton for a year and am passionate about helping academics on the journey of taking their idea or product into the commercial market.

"My wealth of industry experience and networks can help and support academics who have an idea or product to learn more about how to translate it into the market place. I can make them aware of the commercial realities and regulatory environment and help them understand the language before they speak to potential investors. The more evidence they can gather as they go along the better."

Kam was particularly keen to share his experience at Southampton due to the ethos of interdisciplinarity that is already being fostered throughout the University and region by the IfLS.


Image: Dr Kam Pooni

He said: "What the IfLS is trying to do is very valuable. It enables experts and their skills to be brought together in the area of life sciences to develop products for people's lives. It is interconnecting disciplines, not just at the University, but across the wider region.

"The life sciences market is one of the biggest markets in the world and it is growing. The challenging thing is getting ideas and products to market. The IfLS and the Entrepreneurs in Residence have all the support in place to be a springboard and help potential entrepreneurs get ahead of the curve."

SPINOUT COMPANY STARTED BY IFLS MEMBER SECURES BILLION DOLLAR DEAL

Institute for Life Sciences (IfLS) member Professor Ali Tavassoli is celebrating his spinout company Curve Therapeutics signing a US$1.7billion deal with multinational pharmaceutical company MSD.

The two companies are collaborating on research using Curve Therapeutics' drug discovery platform that allows the direct discovery of functionally active molecules against difficult-to-drug targets – enabling new ways to treat complex diseases.

Ali, a Professor of Chemical Biology, credits the IfLS with supporting him since the early days of his independent career at Southampton research and emphasises the importance of this to current early career researchers.

He said: "The IfLS has always been very supportive of my research, which is at the interface of chemistry and biology. I have had several PhD studentships sponsored by them and their networking events were really useful for finding collaborators.

"I also took part in and was selected as a winner of an IfLS Dragons' Den-type event. This resulted in me collaborating with IfLS Entrepreneur in Residence James Otter who went through some very helpful business scenarios with me. It is support like this that gave me the energy and belief to keep going on the entrepreneurial path.

"The IfLS is a real champion for research at the interface of the physical and biological sciences. They provide support to help make ideas a reality and advance the interdisciplinary agenda at the University.

"Southampton has a long tradition of actively supporting interdisciplinary research and the University is reaping the rewards of that. Curve Therapeutics is just one of the examples where the support for multidisciplinary research has borne fruit, and it is important to ensure continuation of this support."


Image: Professor Ali Tavassoli

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


Image: IfLS PhD student Rosie Bannister and Dr Sam Thompson

IfLS PHD STUDENT EXPLORES WHY PROTEINS MISBEHAVE

Institute for Life Sciences (IfLS) PhD student Rosie Bannister is developing chemistry tools to help unlock the mystery of how proteins interact in conditions such as Alzheimer's and Parkinson's disease.

Based in Chemistry, Rosie is also working with colleagues in Biological Sciences to produce and test these tools.

She said: "Proteins control almost everything in biology and can sometimes misfold leading to a range of conditions including Alzheimer's, Parkinson's and Huntingdon's. We do not fully understand how and why they do this.

"My research brings together the interdisciplinary approach of the IfLS, with organic chemistry, and biological and biophysical techniques, to develop a powerful approach to understanding the fundamental science of why these proteins misbehave.

"I am making mimics of naturally-occurring proteins that can be used to interrogate biological systems giving us an insight into how they act."

Rose is supervised by Dr Sam Thompson, in Chemistry, and Professor Paul Skipp and Dr Rob Ewing in Biological Sciences. She has also been working with the National Crystallography Service, based at the University, to obtain atomic-level insights of the 3D shape of her mimics.

She said: "My PhD is sponsored by the IfLS and this provides me access to a wide range of equipment and excellent supervisors who are experts in their fields. The interdisciplinarity at the IfLS and the University of Southampton as a whole, allows me to have a large amount of analytics at my disposal. It is also giving me the opportunity to develop my interdisciplinary skills."

Sam said: "Rosie's research focuses on the basic science of understanding the structure and function of the interactions between these proteins. Learning more about them and understanding them better will provide novel starting points for therapies towards currently intractable diseases."

RECOGNITION FOR PERSO CREATORS

Institute for Life Sciences (IfLS) Deputy Director Professor Hywel Morgan and IfLS Member Professor Paul Elkington were awarded MBEs in the 2020 Queen's Birthday Honours in recognition of their work leading the development of the PeRSo respirator hood.

The pair brought together a team from across the University, University Hospital NHS Foundation Trust and industry to create the innovative respirator hood that was used by healthcare staff tackling COVID-19 on the frontline.

Hywel received the award in honour of his services to biomedical engineering and Paul received his award for his services to medicine.

Hywel said: "It was heartening to be part of a team of academics, clinicians and engineers that came together in a time of adversity, all motivated to protect NHS staff so they could keep caring for patients suffering with COVID-19. The team worked round the clock in the early days of the pandemic and the final product would not have materialised without their efforts. So this award is for them as well."

Paul added: "I was completely taken aback when I opened the letter and was delighted to accept the award on behalf of everyone who has made PeRSo a reality. The work on PeRSo hasn't stopped. We have been developing new versions that can be worn in a range of other work and care settings. The award has been further motivation to progress that as rapidly as possible."

Image credit: Jude Palmer and the Royal Academy of Engineering. Professor Paul Elkington and Professor Hywel Morgan

Image: The Life Sciences Building

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

A sample of publications from our interdisciplinary postgraduate students: 2021-2022

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.

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From Mars to Humans

From Mars to Humans is a laser-based spectroscopic technology that is being used by the 2021 Mars Rover mission to detect possible traces of life on the planet, is being used innovatively by Southampton scientists to develop a public engagement activity that demonstrates transformative tools for the diagnosis and treatment of disease. The hands-on activity is based on the research work in Professor Sumeet Mahajan's group.

The activity has been further developed with the EPSRC-funded Transformative Healthcare 2050 'InlightenUs' programme (Southampton, Edinburgh, and Nottingham) which is exploring how tools using Raman spectroscopy and similar label-free light-based techniques can be developed to enable better, earlier, and more accurate diagnoses of skin cancer and bone disease, without using X-ray radiation or chemical labels. It aims to do this from outside the body using harmless light.

The InLightenUs team has recently been selected to showcase the 'From Mars to Humans' exhibit at the Royal Society Summer Exhibition in London in July 2023.

The Mars to Humans rover was built by Southampton PhD students Jacob Kleboe and Hiroki Cook (pictured).

Find out more:
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